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Cost-Effective, Commercial Scale Production of Tanespimycin

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Cost-Effective, Commercial Scale Production of Tanespimycin

Abstract
Recent approaches to cancer therapy have centered on developing small molecule inhibitors for signaling pathways deranged in common cancers; these compounds are sometimes referred to as tumor antibiotics. One promising target for tumor antibiotics is Hsp90, a heat shock protein that plays a central role in promoting the functionality and stability of a group of proteins associated with cancer called client proteins. Hsp90 inhibitors have been receiving extensive research attention, with geldanamycin, tanespimycin, and their derivatives at the forefront. This report describes a novel, cost-effective, commercial scale process design for the production of tanespimycin. The proposed production facility is designed to deliver 1,084 kg/year through 55 batches, requiring operation of 293 days/year. Detailed economic analysis suggest the recuperation of funds after an initial investment into the biopharmaceutical plant and Phase III trials, which suggest that further investment in this process design would be highly profitable.

Keywords
tanespimycin, 17-AAG, geldanamycin, breast cancer, drug production

Disciplines
Biochemical and Biomolecular Engineering | Chemical Engineering | Engineering

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Rocky Diegmiller
Alexandra Dreyfuss
Shira Redlich
Melissa Schantz

April 7, 2015

Professor Leonard Fabiano
Dr. John Crocker
University of Pennsylvania, Dept. of Chemical & Biomolecular Engineering
Room 311A, Towne Bldg.
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University of Pennsylvania
Philadelphia, PA 19104-6393

Dear Advisors:

Enclosed is a detailed analysis of the economic and process design for the production of tanespimycin, a cancer therapeutic abandoned by Bristol-Myers Squibb after successful Phase II clinical trials. The current process as outlined in a 2003 patent was scaled up so as to meet the production goal of 1000 kg/year calculated from market analysis, which would allow for treatment of 112,000 patients per year. As such, it is recommended that two 50,000 L bioreactors staggered by 5 days operate for approximately 295 days/year in order to meet the production needs of geldanamycin, the precursor compound to our desired product.

This report details the equipment and units necessary for our proposed process, provides a thorough market analysis meant to simulate realistic capture of the breast cancer market, and describes a financial analysis that outlines a competitive pricing for tanespimycin which allows for greater capture of the prospective market and recoup of funds invested in phase III clinical trials and biopharamaceutical facility production. The plant will require an initial investment of the phase III clinical trial of an estimated $2 billion, as well as a total capital investment of $387 million. The internal rate of return (IRR) is 33% and the net present value of about $3.2 billion, assuming the plant operates for 14 years and the drug can be sold at a price of $2,136,752 per kg of tanespimycin, or $20,000 per treatment.

After careful consideration, we submit this report for review with strong recommendations to build the facility to produce tanespimycin, pending its success in Phase III trials to treat breast cancer under a method of treatment in conjunction with the current drug Herceptin.

Sincerely,

Department of Chemical & Biomolecular Engineering
Senior Design Report (CBE)

University of Pennsylvania, 2015

Cost-Effective, Commercial Scale Production of Tanespimycin

Rocky Diegmiller
University of Pennsylvania

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Advised by Dr. John Crocker

Table of Contents

1.0 Abstract

Recent approaches to cancer therapy have centered on developing small molecule inhibitors for signaling pathways deranged in common cancers; these compounds are sometimes referred to as tumor antibiotics. One promising target for tumor antibiotics is Hsp90, a heat shock protein that plays a central role in promoting the functionality and stability of a group of proteins associated with cancer called client proteins. Hsp90 inhibitors have been receiving extensive research attention, with geldanamycin, tanespimycin, and their derivatives at the forefront.

This report describes a novel, cost-effective, commercial scale process design for the production of tanespimycin. The proposed production facility is designed to deliver 1,084 kg/year through 55 batches, requiring operation of 293 days/year. Detailed economic analysis suggest the recuperation of funds after an initial investment into the biopharmaceutical plant and Phase III trials, which suggest that further investment in this process design would be highly profitable.

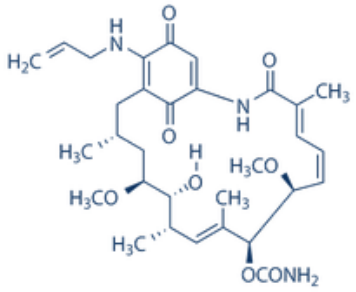
Keywords: tanespimycin, 17-AAG, geldanamycin, breast cancer, drug production

2.0 Introduction

2.1 Project Background

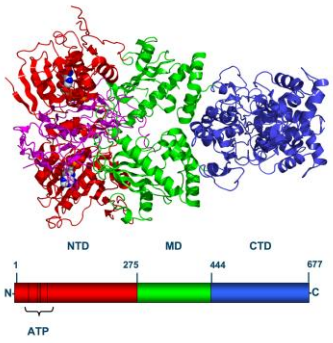
The pharmaceutical industry is driven financially by the number of lucrative drugs in each company's pipeline. As technologies grow and develop over time, advancements can be made that allow for new drugs to come to fruition. However, each of these new drugs must undergo a series of expensive and time consuming FDA regulated clinical trials before being sold as a good in the marketplace. The vast majority of drugs in the pipeline will fail in these trials; therefore, companies must be selective in choosing which drugs to pursue and which to abandon. Sometimes the expected return on investment projected by the company drives the discontinuation of a pipeline drug; other times it can be a change in a company's focus. Because the ebb and flow of drug markets is so transient, a useful thought experiment involves returning to ideas that were once halted and revisiting whether a once-abandoned drug has the potential to become profitable to a company.

Tanespimycin was a cancer therapeutic abandoned by Bristol-Myers Squibb (BMS) in 2010 for reasons that will not be disclosed but are not due to lack of efficacy or high levels of toxicity in patients. After successful Phase I and II trials, the company decided to halt its production before finishing Phase III trials. The drug, also known as 17-N-allylamino-17-demethoxygeldanamycin, or 17-AAG, had been particularly promising as a treatment for breast cancer, multiple myelomas, and childhood leukemias.



The precursor to tanespimycin is geldanamycin, which was first isolated as a fermentation product of the organism Streptomyces hygroscopicus, a general class of benzoquinone ansamycins. In the 1980s, research suggested that this molecule could act as a tyrosine kinase inhibitor through heat shock protein 90 (HSP90) chaperone function; however, clinical trials were never performed due to the toxicity of this molecule (NCI). More recently, several derivatives of geldanamycin have been investigated as alternatives to the parent compound with lower toxicity and greater chemical stability.

HSP90s are important for the folding, activation, and assembly of many proteins and specifically those involved in signal transduction, cell cycle control, and transcriptional regulation (from 2009 17-AAG patent), however, most heat shock proteins (HSPs) are molecular chaperones. Proper protein synthesis and folding is supported in vivo by molecular chaperones (Powers, 2007). These molecular chaperone facilitate the correct folding of nascent polypeptides, prevent non-specific interactions, and repair damage proteins (J.C. Young, 2004). Research suggests that HSPs have an important role in the pathology of cancer (Whitesell, 2005). This protein has been shown to aid other proteins found in tumor growth, which is why it has recently become to target of many cancer drugs, including tanespimycin. At the time of this publication, however, no HSP90 inhibitors have made it successfully through clinical trials and FDA recognition.



Although tanespimycin was not further pursued by Bristol-Myers Squibb at the beginning of the decade, the recent expiry of the original patent in 2014 has prompted a deeper investigation into the profitability of this drug, along with the potential for generic production in the future. As members of the company, we have been tasked with reevaluating the financials to decide if this drug is a potential moneymaker for BMS and if it could be competitive in today's market. BMS recently completed a new biologics production facility in Devens, Massachusetts, which offers over 60 acres of usable real estate for the large scale production of tanespimycin. As such, it will be assumed that as a group internal to Bristol-Myers Squibb, common-use equipment will be readily available to those on the production team. This equipment would include, but is not limited to, a waste neutralization system, industrial autoclaves, biosafety cabinets, a water purification system and WFI still, a steam generator, and any quality assurance equipment and testing necessary to ensure the purity of the product.

The installation of this facility is necessarily contingent upon the success of the Phase III trials for tanespimycin. A contract manufacturing organization will be used to produce the small amount of 17-AAG necessary for the trials. After FDA acceptance, the plant in Massachusetts will then be completed.

The financial analysis of this project assumes Phase III success for tanespimycin. However, many proposed drugs in pharmaceutical pipelines fail in Phase III. In fact, roughly 62% of drugs fail to yield results that are statistically significant. With this in mind, our analysis will shift to show the expected value of the return on investment is still lucrative enough to move forward with the production of the plant.

The plant itself and design process for tanespimycin was based off a 2009 patent from Conforma, but the parent geldanamycin will be produced using the language from a 2003 patent application from Upjohn Pharmaceuticals, which was acquired by Pfizer. In both cases, the process was scaled so as to meet the needs defined in the market analysis so as to minimize disposal costs and increase the efficiency of the process.

2.2 Project Charter

Project Name: Cost Effective, Commercial Scale Production of Tanespimycin

Project Leaders: Rocky Diegmiller, Alexanra Dreyfuss, Shira Redlich, Melissa Schantz

Specific Goal: To design a biologics plant and process to produce tanespimycin in bulk from its precursor geldanamycin, isolated from Streptomyces hygroscopicus cells.

Project Scope:

In Scope:

- Manufacturing process for tanespimycin from geldanamycin parent compound
- Post-manufacturing purification steps of geldanamycin from final fermentation to reactor for allylamine addition to become 17-AAG
- Meet current health and safety and health regulations for biologics
- Adherence to good manufacturing practices (GMP)

Out of Scope:

- Clinical Trials (assumed to have passed Phase I and II)
- Packaging and distribution of drug
- Cell line development

Deliverables: Business opportunity assessment

- What is the market for tanespimycin and breast cancer treatments in general?

Technical feasibility assessment

- Is it technically feasible to manufacture tanespimycin on a large scale using scale up from a baseline process following a patent?

Manufacturing capability assessment

- Can this facility be built and the process utilized without significant capital investment?
- Will this process satisfy FDA regulations?

Time Line: Facility and process design along with economic analysis within four months

3.0 Market and Competitive Analysis

The antitumor effect of tanespimycin has been demonstrated in a variety of Phase II clinical trials. Specifically, tanespimycin has been used to successfully treat patients suffering from renal tumors due to Von Hippel Lindau disease, pediatric acute lymphoblastic leukemia, and HER2-positive breast cancer. Focus should be placed on the largest target population due to the expense of a Phase III clinical trial that can conservatively be estimated to cost $2 billion dollars.

Dr. Diamond from the University of Pennsylvania, an expert in biotechnology, states that, if only considering the costs of treating the patients, a Phase III trial will cost $200 million to $500 million. The $2 billion dollar estimate includes the cost of failed trials suspecting that one drug may get approved for $500 million, but three others will fail at $500 million thus yielding the $2 billion dollar figure per drug. Also the $2 billion figure accounts for the opportunity cost of committing $1 billion dollars for 10 years, which could otherwise be invested for 5 percent for 10 years.

As seen in Figure 3.1, HER2-positive breast cancer patients represent the majority of potential beneficiaries of tanespimycin treatment; therefore, this will be the target patient population for this production.

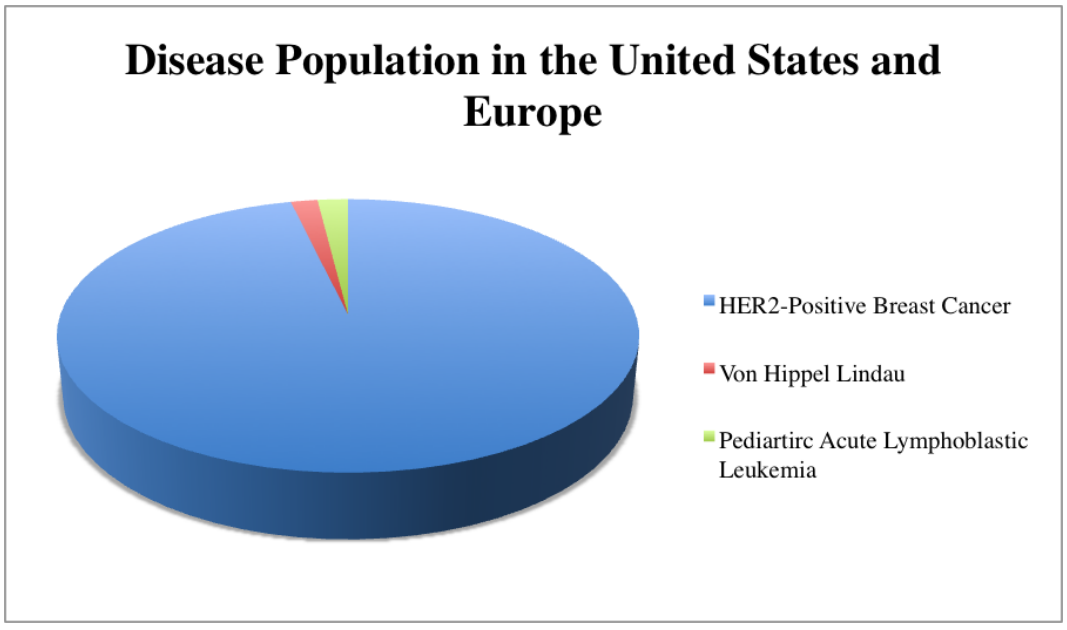


Figure 3.1 Representation of each patient population in the United States and in Europe.

The 2011 clinical trial detailing tanespimycin treatment for HER2-positive patients used a combination therapy with Herceptin, a humanized monoclonal antibody that blocks HER2 function. In order to define a production goal, limitations of the population of HER2-positive patients must be defined. The patient population is first narrowed to the percentage that already uses Herceptin in treatment. With further consideration that only a subset of these patients will respond positively and that not all Herceptin users will additionally choose to use tanespimycin, the target population is further limited to 6 percent of the total HER2-positive patients.

Following the dosing of the successful Phase II clinical trial, patients will receive weekly treatments of tanespimycin at 450 mg/m^2. The average treatment duration was three months thus yielding 13 weeks of therapy. With the average woman having a surface area of $1.6m^2$, 9.36 grams of tanespimycin are needed for one treatment. Using the narrowed target population, a production goal of approximately 1109 kg of tanespimycin per annum is achieved. Due to the limitations of the equipment yields, the process proposed maximally yields 1084 kg per year. To account for bad batches and potential equipment failure, only 95 percent of the maximal yield will be sold for treatment and accounted for in projected sales.

Medical News Today, estimated that in 2012 the average cost of a full course of Herceptin treatment costs about $70,000 according to various medical sources. Because tanespimycin will be used in conjunction to this drug the price will not be directly competitive, for combination treatment would then be twice as expensive as using Herceptin alone. Instead tanespimycin will be priced at XXX per treatment to account for the hesitancy to use a new method of treatment as well as the added expense of combination therapy. This price and level of production will yield annual sales totaling XXX.

4.0 Preliminary Process Synthesis

The overarching goal of this project is to design the most economically efficient process for the production of tanespimycin. To do so, it was first determined that the commercial price of geldanamycin (precursor to tanespimycin) of $383 million / 1.2 kg was indefensibly high (NCI, 2013). This motivated the undertaking of our own production of geldanamycin.

Figure 4.1 outlines a 'Decision Map' depicting the alternative flow sheets considered, and the process by which the final design for both geldanamycin and tanespimycin production was reached.

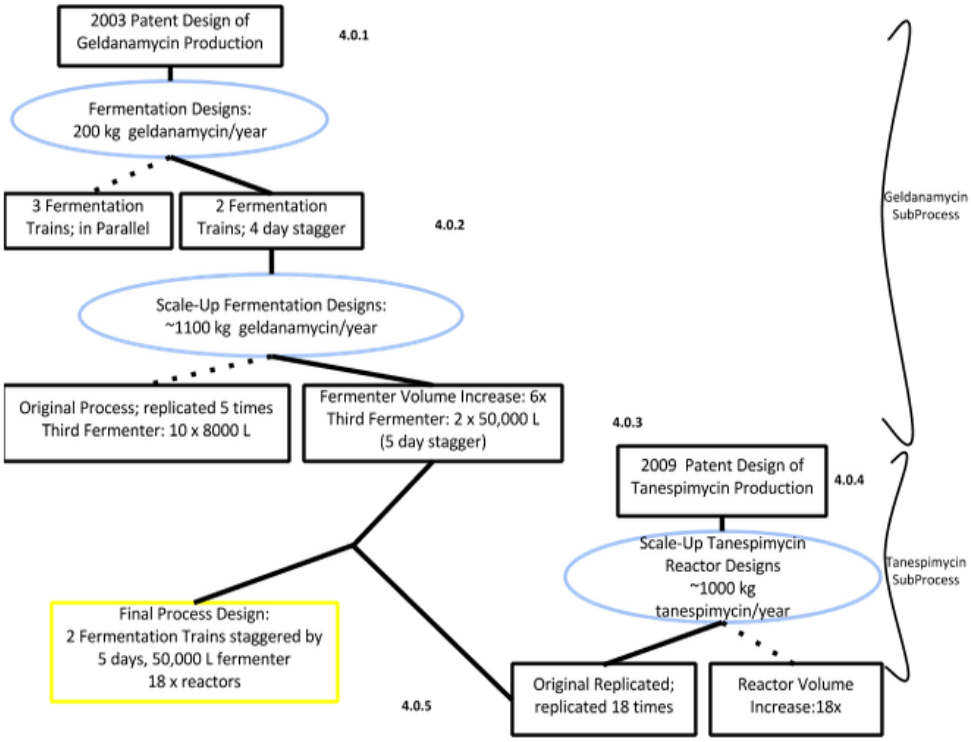
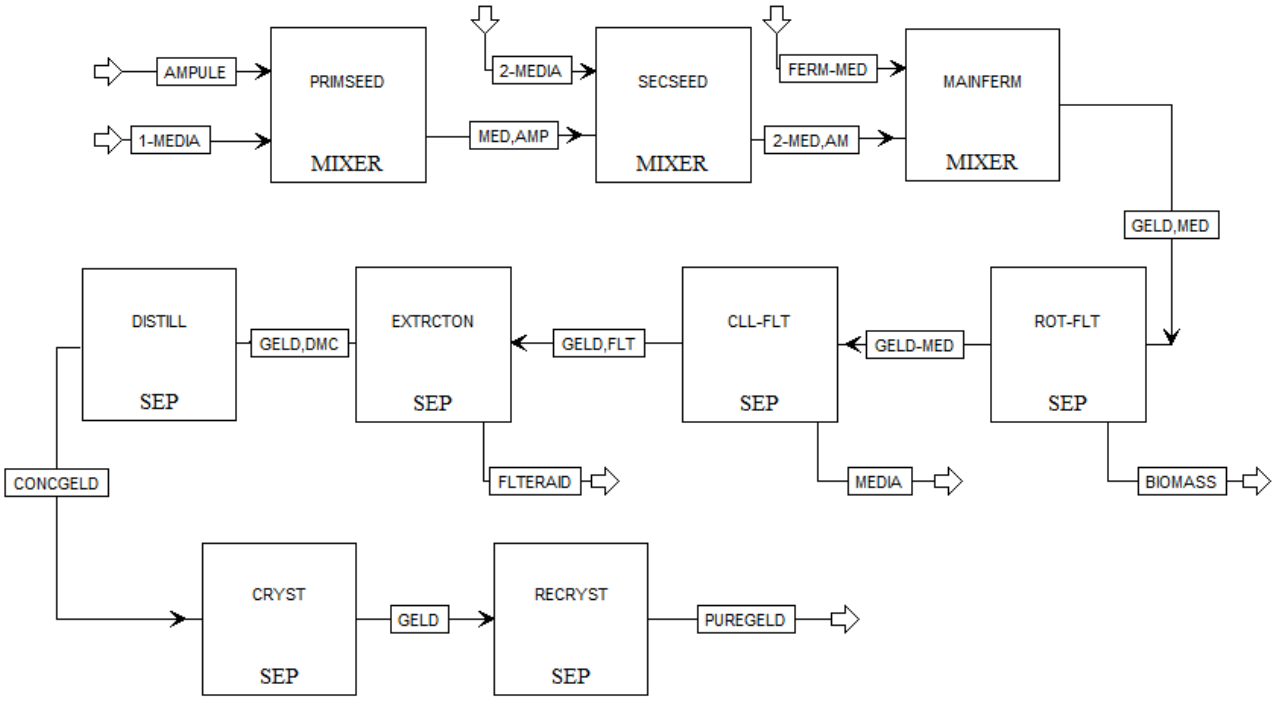


Figure 4.1 'Decision Map' documenting the alternative flow sheets considered in reaching the final design for geldanamycin and tanespimycin production.

4.0.1 Geldanamycin Patent Design

The design displayed in Figure 4.2 was used as a starting point for geldanamycin production design (Pharmacia & Upjohn Company, 2004). The process consists of three fermentation steps with ~25x scale-up between each, followed by several downstream isolation and purification steps: rotary

vacuum filtration to remove biomass, cellulose-based filtration to remove media, extraction to remove the cellulose-based filter media, distillation to concentrate the geldanamycin solution, crystallization, and recrystallization. The process produces 3.375 kg geldanamycin / batch with a 45% yield resulting from



loss of product in downstream processing.

Figure 4.2 Base design of geldanamycin production, modeled after Pharmacia & Upjohn Company's 2003 design.

4.0.2 Initial Production Goal

The initial process goal was to produce 100-200 kg tanespimycin / year. Since conversion of geldanamycin to tanespimycin is achieved with >85 % yield (Conforma Therapeutics Corporation, 2009), the original design was adjusted and tailored to produce ~200 kg geldanamycin / year. Two designs for the upstream process were considered, with downstream processing remaining the same albeit equipment sizing adjustments.

For the first design, it was determined that the cycle time of the described process was 15 days - 3 days for each of the first two fermentations, 8 days for the final fermentation, and 1 day for downstream

processing. Assuming operation of the plant for ~300 days / year, three fermentation trains running in parallel would yield (300/15)*3.375*3 = 202.5 kg geldanamycin / year.

Alternatively, by identifying the bottleneck of the process as the large fermenter with a total fermentation time of 8 days, we investigated the result of staggering two fermentation trains by 4 days. The total output from this design, again assuming 300 days of operation, was estimated as (1+ 285/4)*3.375 = 240 kg geldanamycin / year. Thus, this design was pursued.

4.0.3 Revised Production Goal & Scale-Up

Upon further analysis of the potential market, it became desirable to increase production to 1000 kg tanespimycin/ year, or ~1100 kg geldanamycin / year. (Refer to Chapter 3 for in-detail discussion of market analysis.) Two alternatives for scale up were proposed. The difference in each design was in the upstream geldanamycin production process, so only this portion of the process is shown in Figures 4.3 and 4.4.

Five-Fold Replication. The block block diagram for the five-fold replication of the base process design is displayed in Figure 4.3 Sizing of fermenters and storage tanks remain identical to that in the original process design, and each pair of fermenters remains staggered by 4 days. The total amount of geldanamycin produced / year is estimated as (240 kg geldanamycin / year * 5) = 1200 kg/year.

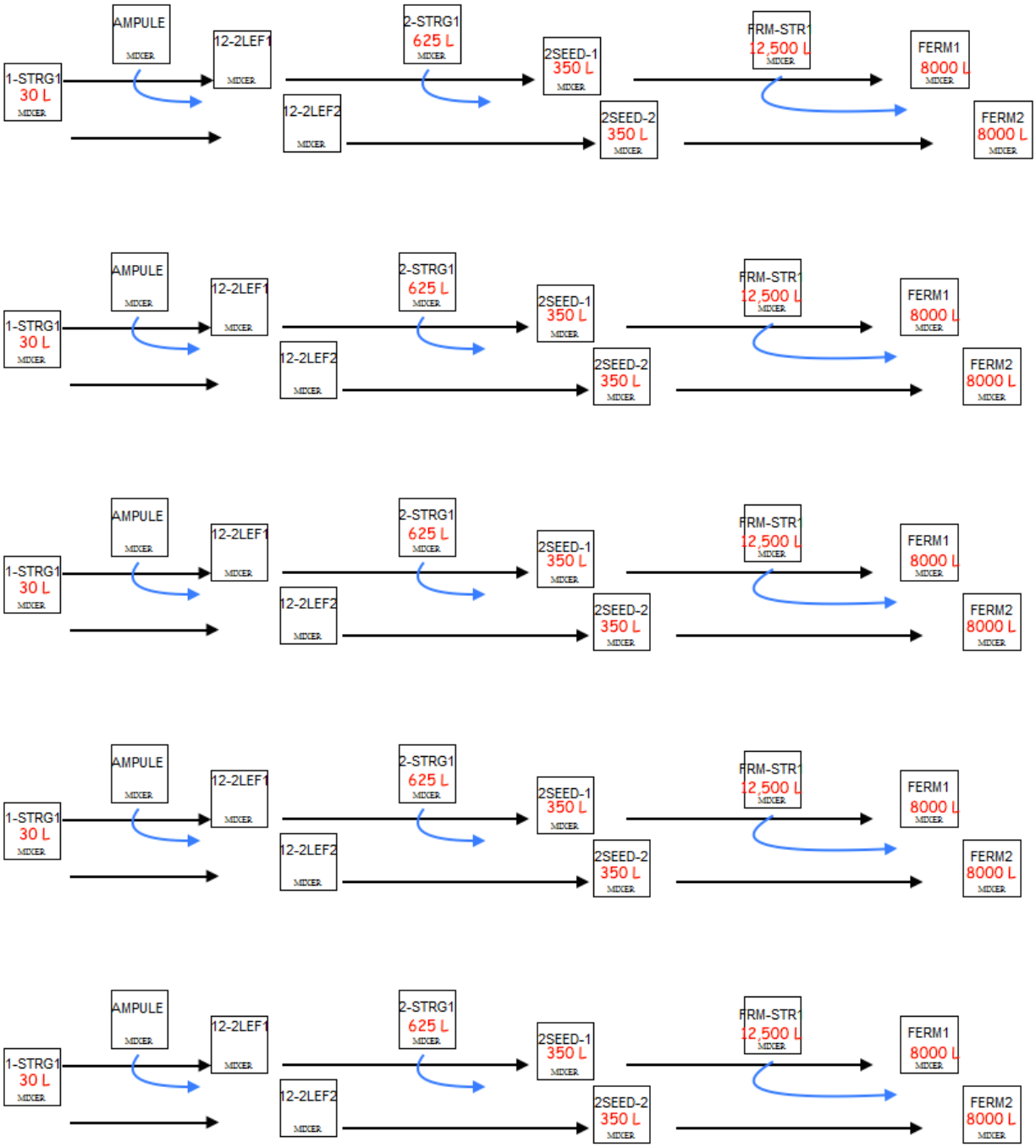


Figure 4.3 Upstream design replicated 5 times to achieve ~1000 kg geldanamycin / year. Vessel volumes shown in red. Pairs of fermentation trains staggered by 4 days. All FERM blocks feed into one storage tank for subsequent downstream processing.

Six-Fold Volume Scale-Up. The block diagram for the six-fold enlargement design is displayed in Figure 4.4. The most notable change in this design is the increased fermentation time of the 50,000 L fermenter from 8 days to 10 days. Thus, the two fermentation trains are staggered by five days, not four, with each fermenter giving 21.9 kg geldanamycin / batch. The total amount of geldanamycin produced / year is then (~55 batches*21.9) = 1205 kg/year..

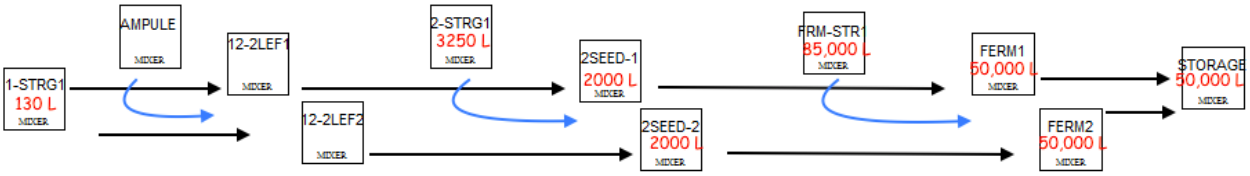


Figure 4.4 Block Diagram of six-fold volume scale up design for >1000 kg geldanamycin production/year.

The purchase cost of two 50,000 L fermenters (estimated by scaling up the price of two 8,000 L fermenters by 10^.6) as compared to the purchase cost of an additional eight 8,000 L fermenters would clearly require less investment. Additionally, when considering maintenance requirements, number of employees, and number of pumps for two larger or ten smaller fermenters, it is clear that a fewer number of large fermenters would have an overall lower cost. Thus, the six-fold volume scale up of the base design fermenters was pursued.

4.0.4 Tanespimycin Base Design & Scale-up.

Following the determination of a process design for geldanamycin, the design of a process on the appropriate scale for the conversion of geldanamycin to tanespimycin was needed. Conforma Therapeutics Corporation's bench-scale design was used as a basis, and two options for scale up were considered.

Reactor Volume Increase. This design, depicted in Figure 4.5, involves the scaling up of reactor volume to ~1000 L, accommodating the increased geldanamycin produced. However, this adjustment was not feasible because the reaction of geldanamycin with allylamine to produce tanespimycin would have

taken at least 90 days; allylamine must be added dropwise over an extended period of time (Conforma Therapeutics Corporation, 2009). In order to keep the reaction time under 5 days (duration of bottleneck step / 2 fermentation trains), another design was sought.

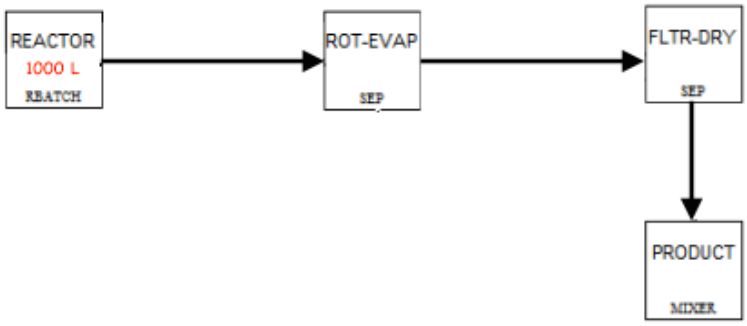


Figure 4.5 Reactor volume scale up to accommodate increase in geldanamycin being produced. Design not feasible due to the impractical duration of time needed to conduct the reaction on such a large scale.

Reactor Number Increase. To avoid the impractical reaction time resulting from reactor volume increase, reactor number increase was investigated. It was desirable to keep the reaction time under 5 days, as anything above 5 days would result in less batches/year and lower production rate. It was determined that 18 reactors were required to process the amount of geldanamycin produced/batch in the process designed above, with a reaction time of under 5 days. Calculations for this result are shown in Appendix A.

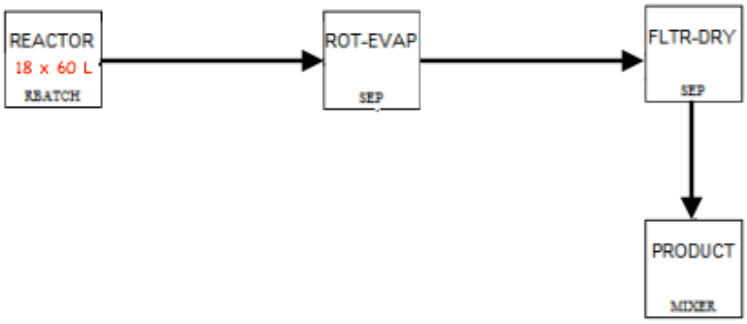


Figure 4.6 Reactor number increase to accommodate increase in geldanamycin production, while maintaining a reaction time of <5 days.

4.0.5 Final Design

The final process for the production of tanespimycin is a combination of the diagrams discussed above, and is shown in Figure 4.6. A detailed description can be found in Chapter 7. Additionally, deviations from patents and innovations are discussed in that chapter.

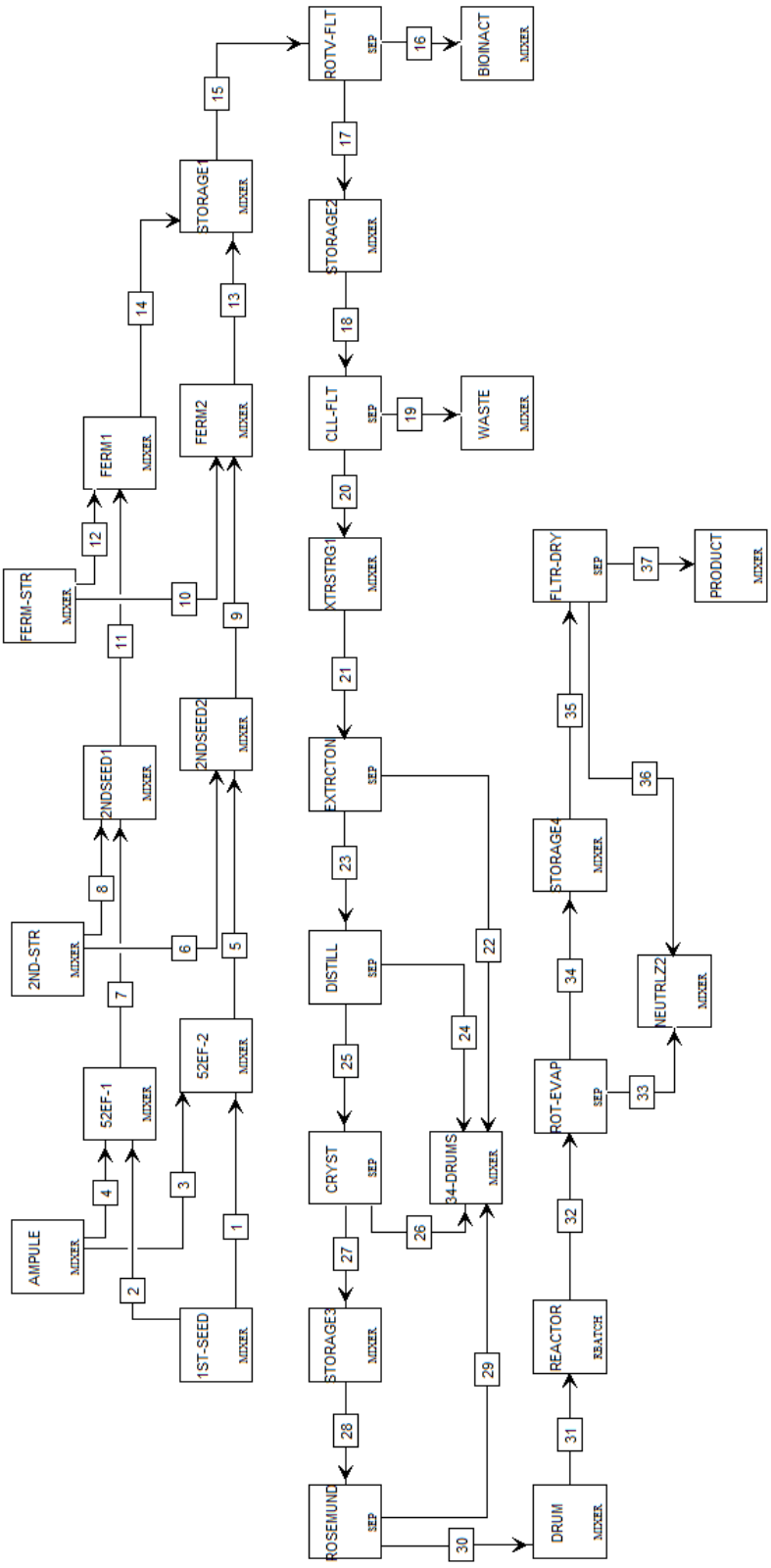


Figure 4.6 Block diagram of final process design for tanespimycin production

5.0 Assembly of Database

The database of chemical used throughout the process can be found in Appendix E as MSDS sheets. As such, it is worth noting that the only chemicals that have been deemed hazardous in this production process are that of methylene chloride and isooctane. Methylene chloride is a known carcinogen, which ensures that extra caution is taken when handling. Additionally, exposure to isooctane can cause damage to the central nervous system, as well as to the eye and stomach if contacted. Prices for all of the chemicals in the database are given in Table 5.1

Table 5.1 Principle Chemical Purchase Costs.

Component	Price($/Kg)	Source
Glucose Monohydrate	47.83	Millipore
Yeast Extract	192.02	Fisher BioReagents
Peptone Extract	194.99	Fisher BioReagents
Ampule (10 mg/mL)	354.24	ATCC
PEG (1.128 g/mL)	69.925	MP Biomedicals
Soyflour	9.48	MP Biomedicals
Corn Starch	22.35	Fisher Scientific
Ammonium Sulfate	33.14	Millipore
Calcium Carbonate	63.12	Fisher Chemical
Cobalt Chloride Dihydrate	650.63	MP Biomedicals
Ferrous Sulfate Heptahydrate	225.28	Millipore
Alpha Amylase	540.80	MP Biomedicals
Soybean Oil	165.57	MP Biomedicals
Polyalkylene Glycol	116.51	Sigma Aldrich
Filter Aid	16.98	Fisher Scientific

Cellulose-based Filter Media	16.98	Fisher Scientific
Methylene Chloride	37.25	Fisher Scientific
Isooctane	233.35	Fisher Scientific
THF	83.52	Fisher Scientific
Allylamine	251.64	Fisher Scientific

6.0 Process Flow Diagram & Material Balance

This chapter presents the proposed process flow diagram for tanespimycin production. The complete process flow diagram is shown in Figure 6.1. The overall component material balance is displayed in Table 1. Material flow rates, temperature, and pressure are also presented for each stream in Table 2. The ensuing sections of this chapter subdivide the process into three parts: upstream geldanamycin production, downstream geldanamycin production, and tanespimycin production, with respective flow diagrams and material balances on each piece of equipment presented. Material balances calculations were performed by scaling up patent specifications when applicable. All other calculations, including biomass production and flow rates for continuous processing steps are shown in Appendix A.

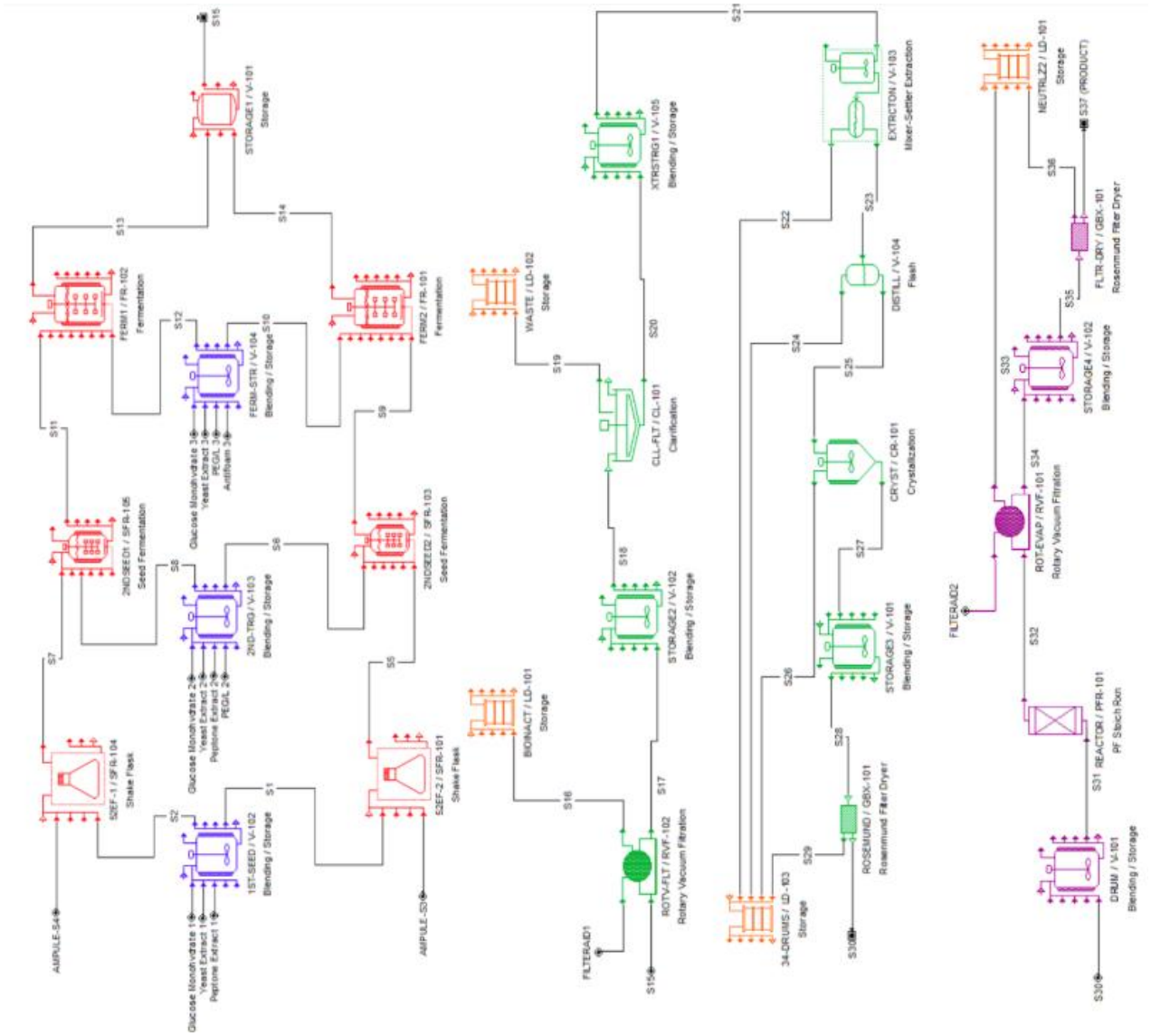


Figure 6.1 The complete process flow diagram of tanespimycin production.

Table 6.1 Overall Component Balances (kg/batch). Outlines inputs, outputs, and changes in mass.

Component	Input	Output	Produced	Consumed/Lost/Discarded	Out-In
Glucose Monohydrate	14.021	0.000	0.000	14.021	0.000
Yeast Extract	3.505	0.000	0.000	3.505	0.000
Peptone Extract	14.021	0.000	0.000	14.021	0.000
Cells	0.173	0.000	371.966	371.966	0.000
PEG	2.343	0.000	0.000	2.343	0.000
Geldanamycin	0.000	0.000	48.685	48.685	0.000
Soyflour	1217.137	0.000	0.000	1217.137	0.000
Corn Starch	2839.987	0.000	0.000	2839.987	0.000
Ammonium Sulfate	81.142	0.000	0.000	81.142	0.000
Calcium Carbonate	243.427	0.000	0.000	243.427	0.000
Cobalt Chloride Dihydrate	0.325	0.000	0.000	0.325	0.000
Ferrous Sulfate Heptahydrate	3.651	0.000	0.000	3.651	0.000
Alpha Amylase	1.623	0.000	0.000	1.623	0.000
Soybean Oil	0.001	0.000	0.000	0.001	0.000
Polyalkyleneglycol	5.193	0.000	0.000	5.193	0.000
Water Shots	5842.259	0.000	0.000	5842.259	0.000
Methylene Chloride	3464.650	0.000	0.000	3464.650	0.000
Isooctane	1725.000	0.000	0.000	1725.000	0.000
THF	627.232	0.000	0.000	627.232	0.000
Allyl Amine	34.685	0.000	0.000	34.685	0.000
H20	204.475	0.040	0.000	204.435	0.000
Tanespimycin	0.000	19.717	21.742	2.025	0.000
* Filter Aid	1352.912	0.000	0.000	1352.912	0.000
* Cellulose-based Filter Media	1352.912	0.000	0.000	1352.912	0.000

Table 6.2 Material Flow Rates, Temperatures, and Pressures of each stream.

Stream Summary	S1	S2	S3	S4	S5	S6	S7
Component (kg/batch)							
Media	1.17	1.17	0.00	0.00	0.58	31.54	0.58
Ampule (10 mg/mL)	0.00	0.00	0.17	0.17	0.00	0.00	0.00
Biomass	0.00	0.00	0.00	0.00	0.76	0.00	0.76
Geldanamycin	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Water Shots	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Mass (kg/batch)	1.17	1.17	0.17	0.17	1.34	31.54	1.34

Stream Summary	S8	S9	S10	S11	S12	S13	S14	S15
Component (kg/batch)								
Media	31.54	29.52	4392.49	29.52	4392.49	4242.165	4242.165	4242.165
Ampule (10 mg/mL)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Biomass	0.00	3.37	0.00	3.37	0.00	372.139	372.139	372.139
Geldanamycin	0.00	0.00	0.00	0.00	0.00	48.69	48.69	48.69
Water Shots	0.00	0.00	5842.26	0.00	5842.26	5604.65	5604.65	5604.65
Total Mass (kg/batch)	31.54	32.90	10234.75	32.90	10234.75	10267.64	10267.64	10267.64

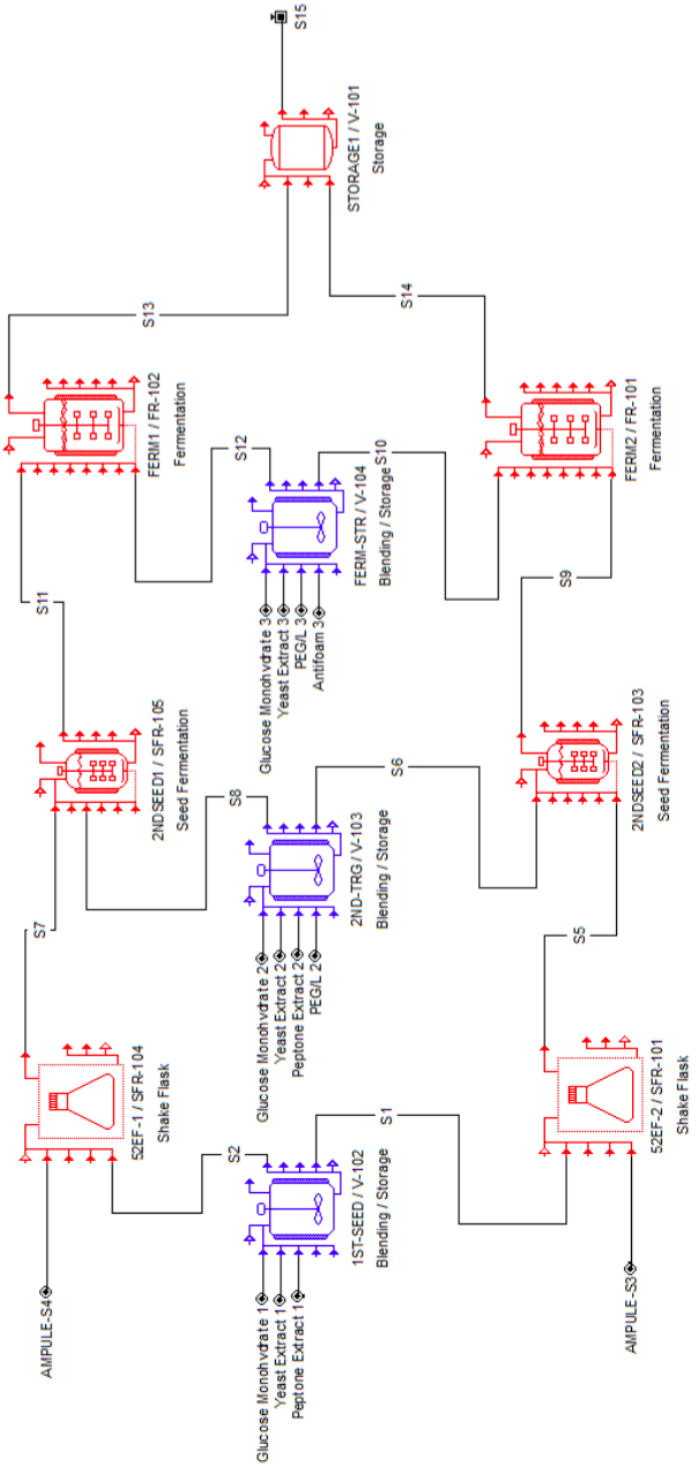
Stream Summary	S16	S17	S18	S19	S20	S21	S22
Component (kg/batch)							
Fermentation Media	0.00	9846.81	9846.81	7877.45	1969.36	1969.36	1969.36
Biomass	372.14	0.00	0.00	0.00	0.00	0.00	0.00
Geldanamycin	9.74	38.95	38.95	3.90	35.05	35.05	10.52
Filter Aid	1352.91	0.00	0.00	0.00	0.00	0.00	0.00
Cellulose-based Filter Media	0.00	0.00	0.00	0.00	1352.91	1352.91	1352.91
Methylene Chloride	0.00	0.00	0.00	0.00	0.00	0.00	6.65
Isooctane	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Mass (kg/batch)	1734.79	9885.77	9885.77	7881.35	3357.33	3357.33	3339.44

Stream Summary	S23	S24	S25	S26	S27	S28	S29	S30
Component (kg/batch)								
Fermentation Media	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Biomass	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Geldanamycin	24.54	0.00	24.54	2.45	22.08	22.08	0.18	21.91
Filter Aid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cellulose-based Filter Media	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Methylene Chloride	3458.00	133.00	3325.00	3291.75	33.25	33.25	33.25	0.00
Isooctane	0.00	0.00	0.00	1707.75	17.25	17.25	17.25	0.00
Total Mass (kg/batch)	3388.24	133.00	3349.54	5001.95	72.58	72.58	50.68	21.91

Stream Summary	S31	S32	S33	S34	S35	S36	S37
Component (kg/batch)							
Geldanamycin	21.91	1.10	0.00	1.10	1.10	1.10	0.00
THF	627.23	627.23	608.14	18.82	18.82	18.82	0.00
Allyl Amine in THF (1 mol/mL)	34.69	32.01	0.00	32.01	32.01	32.01	0.00
Tanespimycin	0.00	21.74	0.00	21.74	21.74	2.03	19.72
WFI	0.00	0.00	0.00	0.00	0.00	204.44	0.04
Total Mass (kg/batch)	683.83	682.07	608.14	73.66	73.66	258.38	19.76

6.1 Upstream Geldanamycin

6.1.1 Process Flow Diagram



6.1.2 Vessel Material Balances

Vessel names are obtained from the flowsheet in Figure 6.1 All mass values are presented in kg/batch and represent values for one fermentation train. Additionally, temperatures in vessels are included when notable deviations from room temperature are required. Temperature specifications are also addressed in Chapter 7.

1st-SEED.

Component	Input	Output /Ferm Train	Produced	Consumed/Lost	Out - In
Glucose Monohydrate	1.039	0.519	0.000	0.000	0.000
Yeast Extract	0.260	0.130	0.000	0.000	0.000
Peptone Extract	1.039	0.519	0.000	0.000	0.000

52EF-1 , 52EF-1.
Masses represent the input and output of all 52 erlenmeyer flasks combined.
Temperature = 28 °C

Component	Input	Output	Produced	Consumed/Lost	Out - In
1° Seed Medium	1.168	0.578	0.000	0.591	0.000
Ampule (10 mg/mL)	0.173	0.764	0.591	0.000	0.000

2NDSEED1 , 2NDSEED2.
Temperature = 28 °C

Component	Input	Output	Produced	Consumed/Lost	Out - In
1° Seed Medium	0.578	0.531	0.000	0.047	0.000
Cells	0.764	3.373	2.609	0.000	0.000
Glucose Monohydrate	12.983	11.929	0.000	1.054	0.000
Yeast Extract	3.246	2.982	0.000	0.264	0.000
Peptone Extract	12.983	11.929	0.000	1.054	0.000
PEG (1.128 g/mL)	2.343	2.153	0.000	0.190	0.000

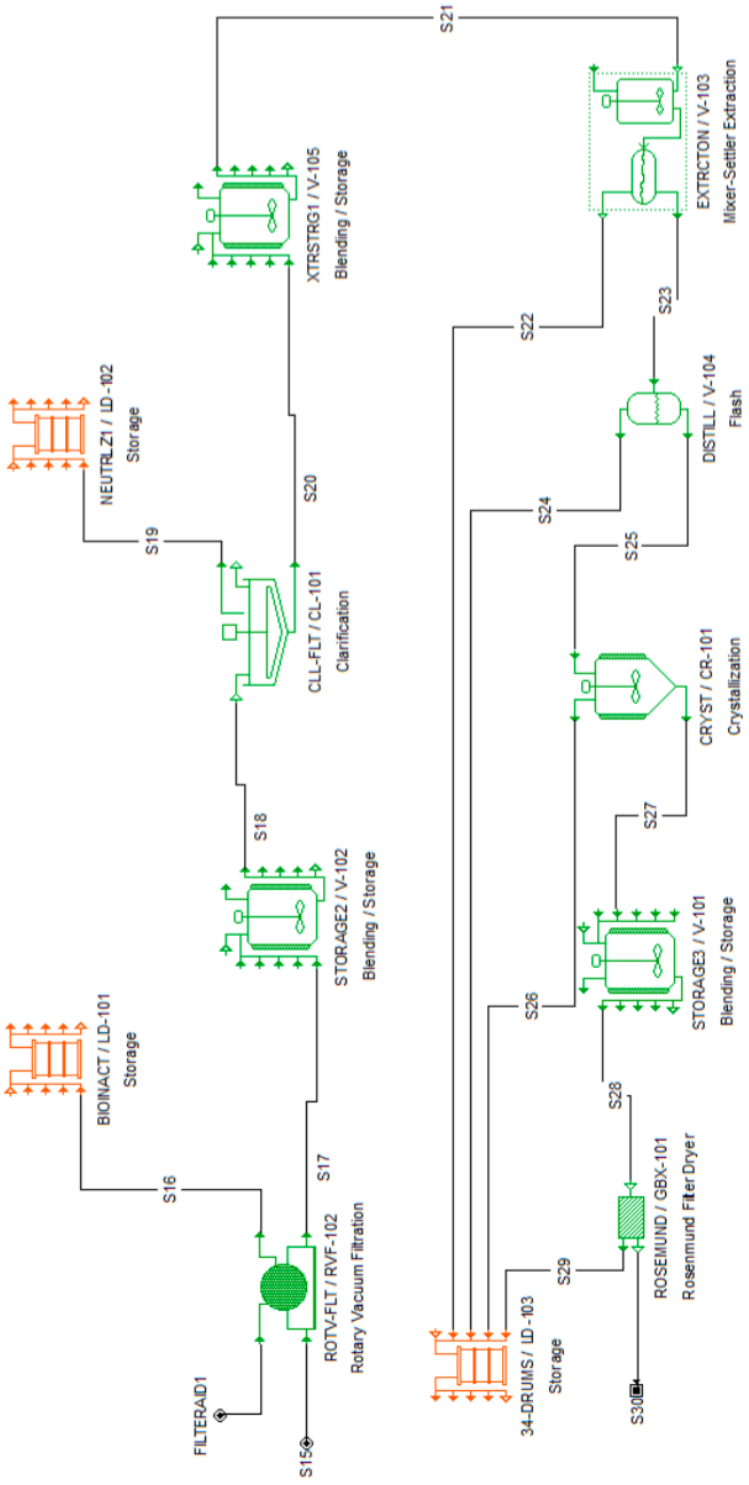
FERM1 , FERM2.

Temperature = 28 °C

Component	Input	Output	Produced	Consumed/Lost	Out - In
1° , 2° Seed Medium	29.523	28.322	0.000	1.201	0.000
Biomass	3.373	372.139	368.766	0.000	0.000
Geldanamycin	0.000	48.685	48.685	0.000	0.000
Soy flour	1217.137	1167.636	0.000	49.501	0.000
Corn Starch	2839.987	2791.994	0.000	47.993	0.000
Ammonium Sulfate	81.142	79.771	0.000	1.371	0.000
Calcium Carbonate	243.427	239.314	0.000	4.114	0.000
Cobalt Chloride Dihydrate	0.325	0.319	0.000	0.006	0.000
Ferrous Sulfate Heptahydrate	3.651	3.589	0.000	0.062	0.000
Alpha Amylase	1.623	1.595	0.000	0.028	0.000
Soybean Oil	0.00060	0.001	0.000	0.000	0.000
Polyalkylene glycol	5.193	5.105	0.000	0.088	0.000
Water Shots	5842.259	5742.902	0.000	99.357	0.000

6.2 Downstream Geldanamycin

6.2.1 Process Flow Diagram



6.2.2 Material Balances by Vessel

Downstream processing consists of both batch and continuous processes. Batch step material balances are presented in kg/batch, while continuous steps material balances are presented in kg/hr. Continuous steps are denoted with a '*'. Additionally, temperatures in vessels are included when notable deviations from room temperature are required.

ROTV-FLT.*

Component	Input	Discarded	Kept
Fermentation Media	2874.442	0.000	2874.442
Biomass	106.325	106.325	0.000
Geldanamycin	13.910	2.782	11.128
Filter Aid	386.546	386.546	0.000

CLL-FLT.

Component	Input	Discarded	Kept
Fermentation Media	10060.548	8048.439	2012.110
Geldanamycin	38.948	3.895	35.054
Cellulose-based Filter Media	1352.912	0.000	1352.912

EXTRCTION.*

Component	Input	Discarded	Kept
Fermentation Media	1006.055	1006.055	0.000
Geldanamycin	17.527	5.258	12.269
Methylene Chloride	1732.325	3.325	1729.000
Cellulose-based Filter Media	676.456	676.456	0.000

DISTILL.*

Component	Input	Discarded	Kept
Geldanamycin	3.505	0.000	3.505
Methylene Chloride	494.000	19.000	475.000

CRYST.*

Temperature = 35-40°C

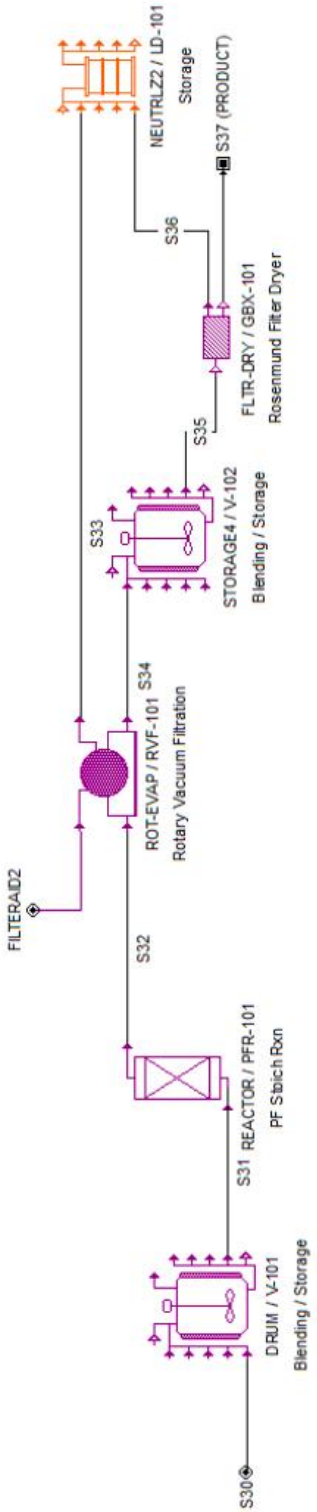
Component	Input	Discarded	Kept
Geldanamycin	3.505	0.350	3.155
Methylene Chloride	475.000	470.250	4.750
Isooctane	246.429	243.964	2.464

ROSENMUND.

Component	Input	Discarded	Kept
Geldanamycin	22.084	0.176	21.908
Methylene Chloride	33.250	33.250	0.000
Isooctane	17.250	17.250	0.000

6.3 Tanespimycin Production

6.3.1 Process Flow Diagram



6.3.2 Material Balances by Vessel

Conversion of geldanamycin to tanespimycin consists of both batch and continuous processing. Batch step material balances are presented in kg / batch, while continuous steps material balances are presented in kg/hr. Continuous steps are denoted with a '*.

REACTOR.

Masses are for all 18 reactors combined.

Temperature = ~45-50°C, slightly below THF boiling point of 66°C

Component	Input	Output	Produced	Consumed/Lost	Out - In
Geldanamycin	21.908	1.095	0.000	20.813	0.000
THF	627.232	627.232	0.000	0.000	0.000
Allyl Amine in THF	34.685	32.005	0.000	2.680	0.000
Tanespimycin	0.000	21.742	21.742	0.000	0.000

ROT-EVAP.*

Component	Input	Discarded	Kept
Geldanamycin	0.548	0.000	0.548
THF	313.616	304.208	9.408
Allyl Amine	16.002	0.000	16.002
Tanespimycin	10.871	0.000	10.871

FLTR-DRY.

Component	Input	Discarded	Kept
Geldanamycin	1.095	1.095	0.000
THF	18.817	18.817	0.000
Allyl Amine	32.005	32.005	0.000
Tanespimycin	21.742	2.025	19.717
WFI	204.475	204.435	0.040

7.0 Process Description

7.0.1 Process Overview

The tanespimycin production process is designed to run for 293 days/year. One batch will give 21.91 kg geldanamycin (45% yield), and then 19.7 kg tanespimycin (90% yield). The longest step in the process is the 10-day duration of the 50,000 L fermentor (cleaning time included). Thus, two identical fermentation processes will run staggered by 5 days. Every 5 days after the first 23 days (total process time = 15.75 day geldanamycin upstream + 2.25 days geldanamycin downstream + 5 days tanespimycin) 21.91 kg geldanamycin will be produced. The total mass of tanespimycin produced/year will then be 1084 kg. (55 batches/year) Accounting for bad batches, the total amount of usable tanespimycin produced/year, can be estimated according to Morphotek as approximately 95% of overall mass, or 1030 kg tanespimycin/year.

Important process parameters are: cycle time of 23 days, batch time of 5 days, and bottleneck of 50,000 L fermentation lasting 10 days. A Gantt Chart can be found in Chapter 7.

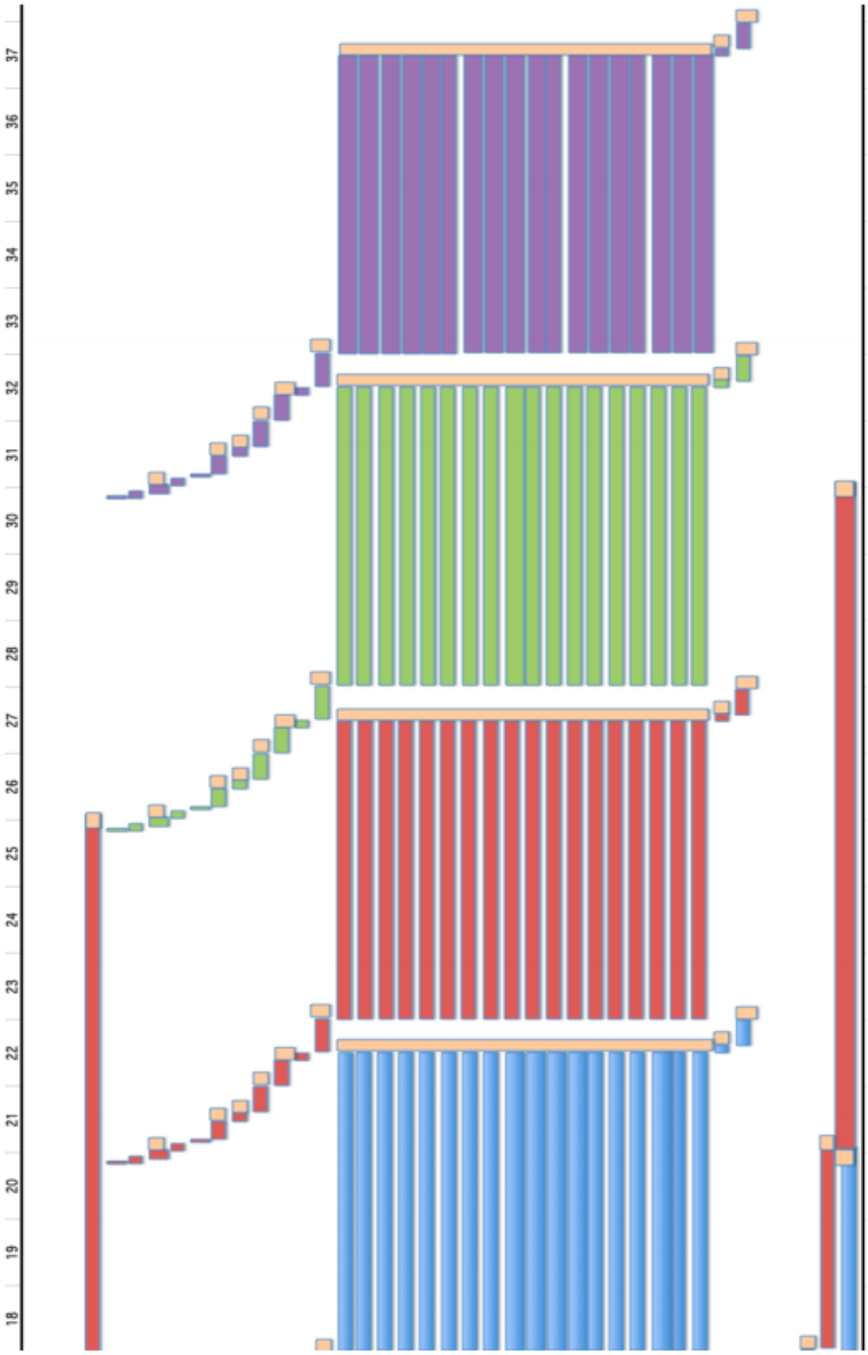
7.0.2 Employee Requirement

For the upstream and downstream geldanamycin process, a total of 13 employees per shift are required: 1 employee for fifty-two 2 L fermentors of both trains who will have a break every 5 days to monitor downstream, 1 employee for secondary fermentor of both trains who will have a break every 5 days to monitor downstream, 1 employee on each of the 50,000 L bioreactors at all times, and 1 employee at each of the downstream processes (ROTV-FLT, BIOINACT, CLL-FLT, NEUTRLZ1, EXTRCTON, DISTILL, CRYST, ROSEMUND, and 34-DRUMS) . For the tanespimycin production process, 11 employees per shift are required: 9 total employees for the 18 reactors, 1 employee for downstream, and 1 employee for maintenance. Assuming four 8-hour shifts/day, full time salary is required for 96 employees. Each employee will be paid $47,000/year (Bureau of Labor Statistics, 2014), for a total employee cost of $4,512,000/year.

7.0.3 Piping and Flow Rates

Flow rate of material between vessels throughout the entire tanespimycin production process occurs in pipes approximately 3” in diameter, corresponding to a flow rate of 400 LPM. Since many steps in the process involve solid-bearing liquids, all pipes will maintain at least a 5 ft/sec velocity to prevent the solids from settling out in the pipeline and provide sufficient turbulent conditions to keep the solids in suspension. At the end of every slurry transfer, the pipes will be flushed with clear liquid to sweep out all solids.

7.0.4 Gantt Chart Scheduling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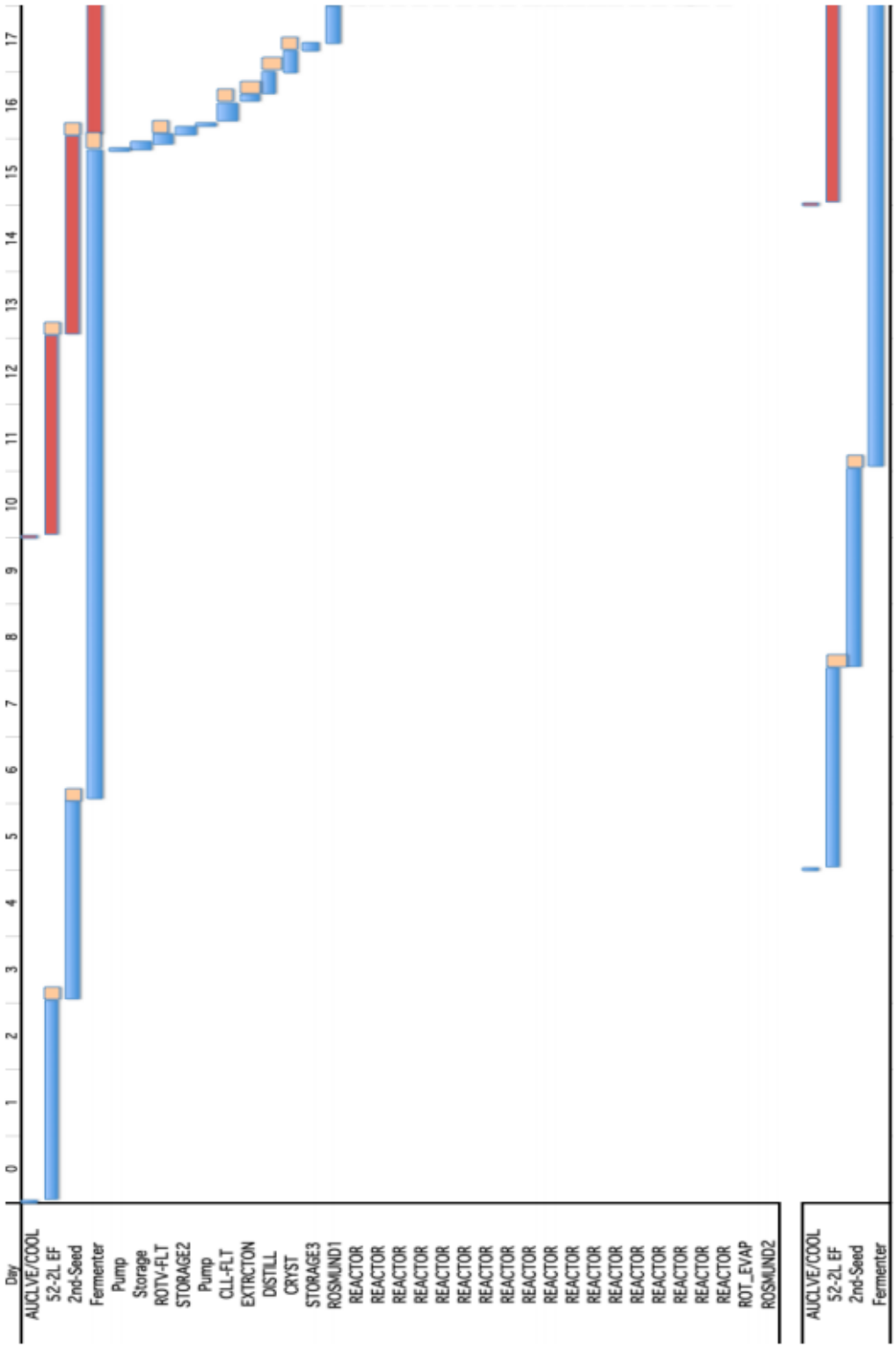
Day
AUCLVE/COOL
52-2L EF
2nd-Seed
Fermenter
Pump
Storage
ROTV-FLT
STORAGE2
Pump
CLL-FLT
EXTRCTON
DISTILL
CRYST
STORAGE3
ROSMUND1
REACTOR
REACTOR
REACTOR
REACTOR
REACTOR
REACTOR
REACTOR
REACTOR
REACTOR
REACTOR
REACTOR
REACTOR
REACTOR
REACTOR
REACTOR
REACTOR
ROT_EVAP
ROSMUND2
AUCLVE/COOL
52-2L EF
2nd-Seed
Fermenter
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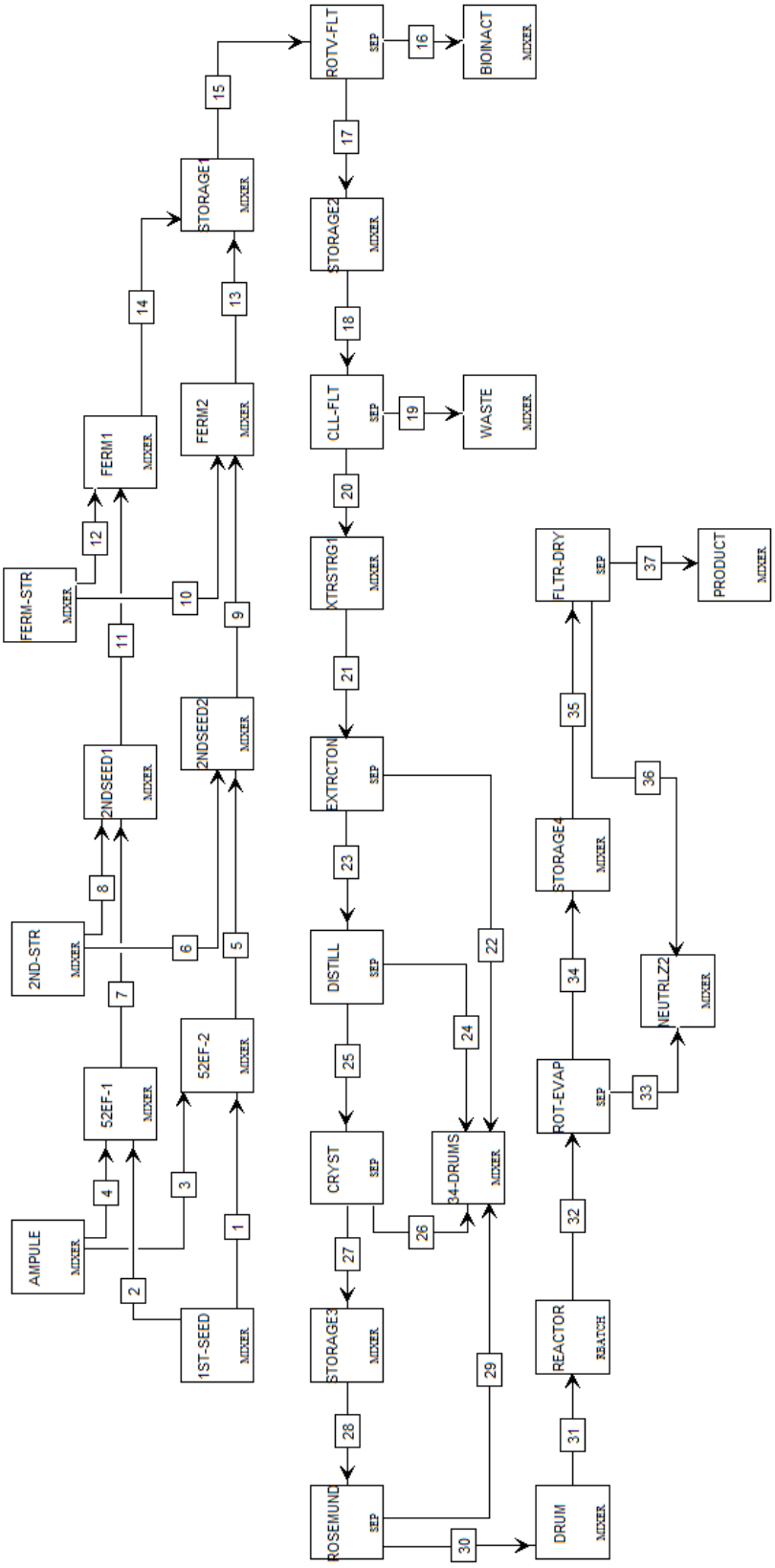


Figure 7.1. Block diagram of tanespimycin production.

7.1 Geldanamycin Upstream Process

Upstream processing consists of three fermentation steps, each at 28°C and successive 25x scale-up. The fermentation is expected to produce 48.684 kg geldanamycin/batch requiring subsequent isolation and purification.

Input materials include serum-free media and the natural organism Streptomyces hygroscopicus in a 10 mg/mL solution stored at -80°C. This process treats the organism's doubling time as 1.4 days with a yield coefficient of 0.13. Literature reports of 1.4-2 day doubling time and a yield coefficient of 0.1708 show that these parameters in this process are on the conservative side, potentially allowing for even greater yields (Subhasish Dutta, 2013).

The ensuing description gives numbers for operation of one of the two fermentation trains, as each operates in alternating 5 day periods. Additionally, page references to descriptions of each piece of equipment in Chapter 9 are bracketed at the end of each equipment/step subsection.

7.1.1 Primary Seed Media Preparation

Primary media preparation consists of mixing glucose monohydrate, yeast extract, and peptone extract for a total volume of (52x2) L in a (65x2) L vessel every 10 days, starting on day 5 of operation. 1 L of the media will be dispensed into fifty-two 2 L erlenmeyer flasks, which will then be autoclaved for 45 minutes and subsequently cooled for approximately 30 minutes. Each erlenmeyer flask will be sealed with a membrane cap by DURANO.

7.1.2 Inoculation

Following cooling, each flask will be inoculated with 1 L of an ampule culture (10 mg/mL, 1.4 day doubling time) of Streptomyces hygroscopicus variety geldanus variety nova (NRRL 3602). The culture should be previously cultured in primary seed medium, mixed with 15% glycerol, and stored at -80°C. Each of the fifty-two 2 L flasks will then be incubated for 3 days at 28°C on a rotary shaker, after

which the flasks' contents will be transferred along with secondary seed medium to an 1750 L fermenter. Cleaning time for the fifty-two 2 L erlenmeyer flasks is approximately 4 hours.

7.1.3 Secondary Seed Preparation

Secondary seed media preparation consists of mixing glucose monohydrate, yeast extract, peptone extract, and PEG for a total volume of (1300x2) L in a (1600x2) L tank every 10 days starting on day 8 of operation.

7.1.4 Secondary Fermenter

Half of the secondary media storage vessel content along with all material from the fifty two 2 L erlenmeyer flasks will be transferred to an 1750 L fermenter. The reactor is maintained at 28°C without pH control, at 7 psi backpressure, 200 SLM, and 250 rpm. Incubation will occur for 3 days before all material is transferred to the final 50,000 L fermenter. Cleaning time is approximately 4 hours.

7.1.5 Fermentation Media Preparation

The fermentation media consists of mixing soy flour, corn starch, ammonium sulfate, calcium carbonate, cobalt chloride dihydrate, ferrous sulfate heptahydrate, alpha amylase, soybean oil for a total volume of (32,500x2) in an 82,000 L tank every 10 days starting on day 11. Polyalkylene Glycol is added to help minimize foam before transfer to a 50,0000 L fermentor.

7.1.6 Fermentation

Half of the secondary media storage vessel content along with all material from the secondary fermenter will be transferred to a 50,000 L fermenter. The fermentation is maintained at 28°C and the pH is controlled between 6.25 and 7.75. The back pressure is maintained between 7 and 20 psi with stirring between 180-220 rpm, and aeration between 1000-5000 SLM. The fermentation will run for 9.75 days, and receive 1460 L water shots on days 6, 7, 8, and 9.. At harvest, the entire contents of the fermenter tank are pushed to a 50,000 L storage tank for cooling, and then isolation. Cleaning time for the fermenter will be 6 hours.

7.1.7 Storage/Cooling

The resulting product from the 50,000 L fermenter will be transferred to a 50,000 L storage tank which will cool the material to 5°C over a 3 hour period.

7.2 Geldanamycin Downstream Process

The isolation and purification of a fermentation product is essential to any commercial process. Since the chemical nature of a fermentation broth is complex, and extremely high purity is required for a pharmaceutical product intended for patients as tanespimycin is, recovery and purification requires many processing steps. (Shuler & Kargi, 2002) In this design, isolation and purification of tanespimycin are a combination of batch and continuous processes, in contrast to the original patent in which all steps were batch. Continuous processing was employed when possible to exploit: lack of vessel size restrictions, less costly and time consuming cleaning/rinsing cycle, no time loss filling and emptying tanks, and less manual operation (Miteco, 2015). Storage tanks are used when a switch from batch to continuous or vice versa is required.

7.2.1 Rotary Vacuum Filtration: Biomass Removal

The rotary vacuum filter is operates through a revolving drum; each revolution of the drum consists of cake formation, cake washing (if needed), dewatering or drying, and cake discharge. As the drum rotates under vacuum, a thin layer of cells will adhere to the drum. A vacuum maintained in the drum will provide the driving force for liquid flow (Shuler & Kargi, 2002, pg 332).

A mixture of diatomaceous earth produced by Eagle-Picher Industries in Reno, NV and diatomaceous earth produced by Celite Corporation in Lompac, CA filter aids (1/1) will coat the rotary vacuum filter drum, in an amount of 4 kg filter aid/100 L of fermentation medium. The fermentation medium will be filtered continuously over a period of 3.5 hours. The solid cake that forms, comprised of biomass and filter aid, will be scraped off the vacuum filtration unit as the drum rotates and discarded into a biowaste tank containing water where they will mix to create a liquid that can be pumped to the

facility's built-in biowaste inactivation system. The filtrate containing the geldanamycin product will be transferred to a 50,000 L storage vessel (STORAGE2/V102) to aid the switch from continuous to batch processing, and cooled to 5°C in approximately 3 hours. [,]

7.2.2 Cellulose-Based Filtration: Crude Crystals Isolation

The filtrate obtained from rotary vacuum filtration/storage vessel will be contacted with cellulose-based filter media of type 10A produced by Cuno Incorporated, Meriden, CT in a batch-processing step that will take approximately 5 hours. The clarified filtrate obtained will be discarded into an 11,355 L neutralization tank. Crude geldanamycin crystals along with cellulose-based filter media will be subsequently transferred to a 8500 L storage tank (XTRSTRG1/V-105) to avoid the need to stop the process if the extractor in the next step, whose contents often emulsify, needs to be adjusted. Material will be transferred to the storage tank with a pump, as enough liquid fermentation media will be present and flow at >5 ft/sec which will keep the solids flowing.

7.2.3 Extraction with Methylene Chloride

The crude geldanamycin crystals and cellulose-based filter media will be contacted with methylene chloride in a 10,000 L extractor to extract the filter media continuously. The extractor will have two stages which operate in reverse flow. Each of the two phases will be fed into the respective opposite stage with a metering pump and run through the system due to the conveyance effect of the stirrers. The overflow phases will be collected in two receivers.

The methylene chloride will be recycled through the filter elements for 2 hours. In contrast to many liquid liquid extractions in which multiple steps are used to maximize product recovery, only one step will be used in this solid-liquid extraction. The filter media will be discarded into several 55 gallon drums that will be removed by a contracted waste management company. Geldanamycin will be obtained dissolved in an unsaturated solution of methylene chloride.

7.2.4 Concentration with Distillation

Excess methylene chloride will be removed with continuous distillation lasting approximately 7 hours. Continuous distillation technology used will be provided by Armfield, Inc. and suitable for at least 500 L of material. The product obtained from this process will still be liquid methylene chloride with dissolved geldanamycin, but at a higher, still unsaturated, concentration which will allow for better crystallization of product in the next step. Evaporated methylene chloride will be transferred to 55 gallon drums that will be removed by a contracted waste management company. (BP Geldanamycin = 783.86 °C, BP Methylene Chloride = 39.6 °C)

7.2.5 Crystallization

The dissolved geldanamycin is continuously crystallized by mixing with isooctane over 7 hours, maintaining a temperature of 35-40°C. (MP Geldanamycin = 255°C, MP Isooctane = 107.32 °C) Methylene chloride and isooctane will be transferred to 55 gallon drums that will be removed by a contracted waste management company. The crystal slurry will be transferred with a conveyer to a 65 L storage tank (STORAGE3/V-101) and then cooled to 5°C (3 hours) once all product from the crystallization is processed.

7.2.6. Rosenmund Filter/Drying

Instead of tray drying as specified by the original patent (Gillespie, 2004), this design will use a Rosenmund Nutsche filter to dry the crystals and purify the geldanamycin to increase efficiency in washing and drying, allow for quick turn around, and enable visual and physical inspection of product. The Rosenmund unit will have an internal agitator which will go in one direction to "plow up" the crystals for washing and drying and reverse to discharge the crystals through a side chute.

The batch washing and drying of the geldanamycin crystal cake will take 14 hours. Methylene chloride and isooctane will be discarded into 55 gallon drums that will be removed by a contracted waste management company. The geldanamycin crystals will be collected in drums and dumped or conveyed

(with a Schutte-Koerting solids ejector or a pneumatic unit from DeDietrich) into each of the next 18 reactors.

7.3 Tanespimycin Production

The goal of the last part of the process is to convert isolated and purified geldanamycin to tanespimycin, which will then be isolated and purified. The process consists of a reaction taking place simultaneously in 18 reactors, which then feed into one train of two isolation/purification steps, the first being continuous and the second being batch. A storage tank aids the switch.

7.3.1 Reaction Conversion of Geldanamycin to Tanespimycin

The purified and dried geldanamycin will be transferred in equal amounts to 18 identical stainless steel 60 L reactors along with THF (solvent). Allyl amine dissolved in THF will be added over a period of 4.5 days - the entire reaction time. ~95% of the geldanamycin will react to give tanespimycin and reaction completion will be verified with a TLC column. The entire reactors content will be pushed to isolation.

7.3.2 Rotary Evaporation

A rotary evaporator suitable for 750 L of liquid will be used to continuously remove solvent over a period of 2 hours. The liquid to be processed in the rotary evaporator is fed directly into the rotary flask by a feed pipe conducted through the condenser part. Evaporation takes place in the externally heated rotary flask, and the rotational movement of the piston ensures a good intermixing of the medium, thus providing regular temperature distribution (De Dietrich, 2014). The THF will be discarded into a 1040.9L neutralization tank before passing through the facility's built-in neutralization system. The rest of the reactor contents will be transferred to a 100 L storage tank (STORAGE4 / V-102) to aid the switch from continuous to batch before Rosenmund drying.

7.3.3 Rosenmund: Filter/Drying

Instead of tray drying, as specified by the original patent (Gillespie, 2004), this design will use a Rosenmund Nutsche filter to dry the crystals and purify the geldanamycin to increase efficiency in

washing and drying, allow for quick turn around, and enable visual and physical inspection of product. The Rosenmund here will have a filtration area of 5.6 sq. ft., and a 32" diameter suitable for ~250 L of material.

Filtering/drying will remove any unreacted geldanamycin and allylamine, and the rest of the THF in a batch-wise manner for approximately 10 hours. Discarded material will be transferred to the same 1040.9L neutralization tank before passing through the facility's built-in neutralization system. H20 will be added to aid precipitation and crystallization of the tanespimycin. The Rosenmund will be positioned above the the nitrogen blanket for direct discharge into that next vessel for storage of the final product. Tanespimycin will be obtained as a solid at 99.99% purity.

8.0 Utility Requirements

The primary requirements of the plant are electricity, steam, and process water. Of these, electricity is most expensive, making up 96.5% of the total utility cost per year. These calculations are based off a $0.08 per kWh rate from NSTAR, a Massachusetts energy provider. Of the electricity-requiring processes, the HVAC process consumes 36.3% of the total energy required. The other major energy consumers are the distillation column (37.3%) and the production bioreactors (9.75% for both). The table shown in the next section shows the exact amounts of energy listed for each energy-consuming portion of the plant.

Steam and process water are the other two main contributors to the utility costs. The plant will need roughly 40,000 lb of steam and 230,000 gal of cooling water per year. The steam will be used in the steam-in-place setup, while the cooling water will be used in the upstream process to offset the heat released by the growing organisms in the fermentor. The larger heat duty needed for downstreams process will be covered by roughly 120,000 kg of propylene glycol per year, which has a much lower freezing point. At a rate of $0.543 per 1000 L from the Aquarion Water Company in Massachusetts, water will cost less than $500 per year.

Table 8.1: Utility Costs Per Unit Equipment

Electricity Costs ($/kWh)	Amount (kWh/batch)	Cost ($/batch)	Cost/yr ($)
UPSTREAM			
52-2L, EF (2)	2.67	$0.21	$11.73
2ND-SEED (2)	193.75	$15.50	$852.50
FERMENTR (2)	4276.62	$342.13	$18,817.13
Total		**$357.84**	**$19,681.36**
DOWNSTREAM			
ROTV-FLT	143.80	$11.50	$632.72
CLL-FLT	3.97	$0.32	$17.47
EXTRCTON	18.50	$1.48	$81.40
DISTILL	16349.00	$1,307.92	$71,935.60
CRYST	110.00	$8.80	$484.00
ROSEMUND	30.00	$2.40	$132.00
Total		**$1,332.42**	**$73,283.19**
TANESPIMYCIN PROD			
ROT-EVAP	143.80	$11.50	$632.72
FLTR-DRY	30.00	$2.40	$132.00
Total		**$13.90**	**$764.72**
OTHER			
HVAC	15927.30	$1,274.18	$70,080.12
Incubators	49.92	$3.99	$219.65
CIP/SIP	163.97	$13.12	$721.46
Water Treatment	734.09	$58.73	$3,230.00
WFI	2391.59	$191.33	$10,523.00
Waste Neutralization	1145.20	$91.62	$5,038.88
Clean Steam	938.48	$75.08	$4,129.31
Cooling Systems	1345.24	$107.62	$5,919.07
Total		**$1,815.66**	**$99,861.48**
GRAND TOTAL		**$3,161.99**	**$173,909.39**

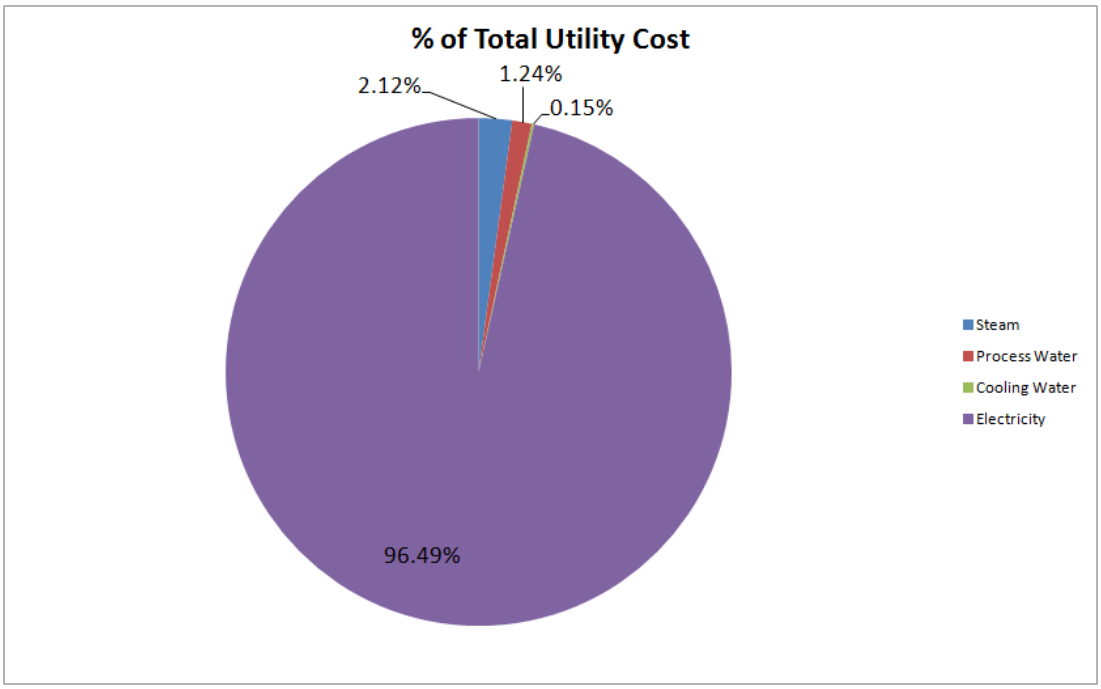


Figure 8.1 Percent of Total Utility Cost

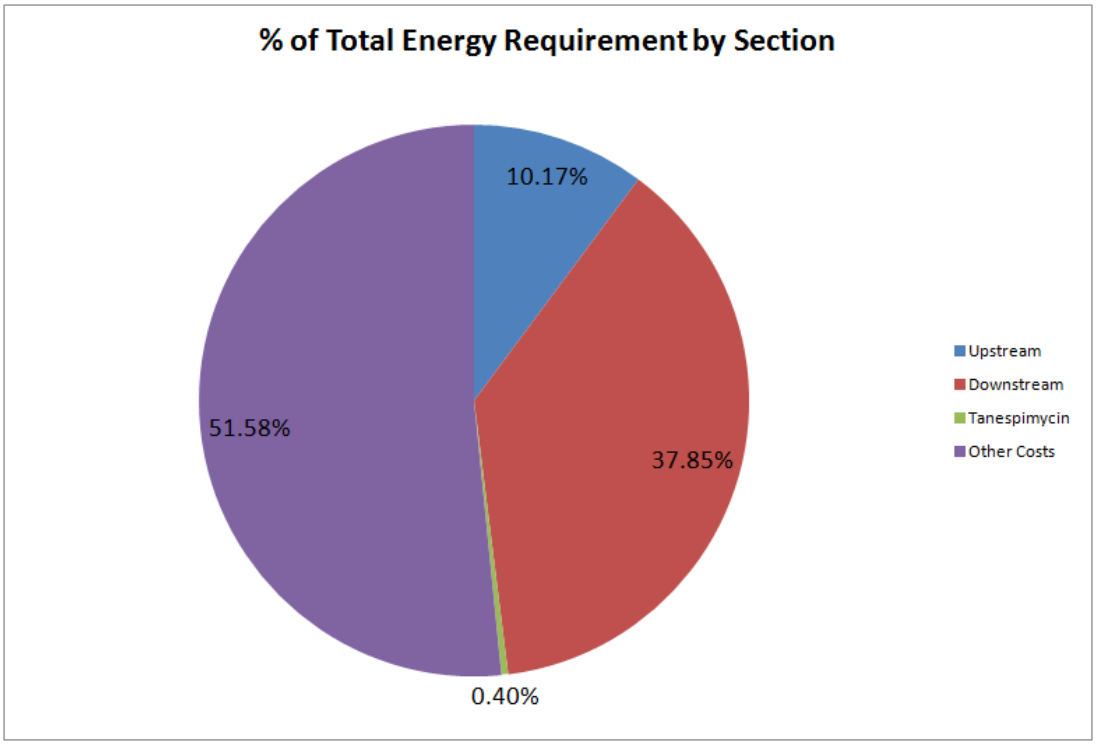


Figure 8.2: Percent of Total Energy Requirement by Section of Process

9.0 Equipment List and Unit Descriptions

9.1 Equipment List

Equipment Description	Process Unit	Vendor
Geldanamycin Upstream Process Equipment		
Primary Seed Media Prep Tank (130L)	1ST-SEED/V-102	Sharpsville Container
Secondary Seed Media Prep Tank (3250L)	2ND-TRG/V-103	Sharpsville Container
Fermentation Media Prep Tank (81,150L)	FERM-STR/V-104	Sharpsville Container
2L Erlenmeyer Flasks (104)	52EF-1 SFR-104 & 52EF-2 SFR-101	DURAN
1750 L Secondary Fermentor	2ND-SEED1/SFR-105 & 2NDSEED2/SFR-103	ABEC
50000L Fermentor	FERM1-FR-102 & FERM2/FR-101	ABEC
Media Filters (6)	S-1, S-2, S-8, S-6, S-12, S-10	Sartorius Stedim Biotech
Upstream Pumps (8)	S-8, S-6, S-12, S-10, S-14, S-13, S-11, S-9	Watson-Marlow
50000L Surge Tank	STORAGE`1/V-101	Sharpsville Container
Geldanamycin Downstream Process Equipment		
RotaryVacuum Filter	ROTV-FLT/RVF-102	Komline-Sanderson
Storage Tank (50,000L)	STORAGE2/V-102	Sharpsville Container
Cellulose-based filter	CLL-FLT/CL-101	Ertel Alsop
Storage Tank	XTRSTRG1/V-105	Sharpsville Container
Extraction Unit	(EXTRCTON/V-103)	Sulzer Chemtech
Distillation Unit	DISTILL/V-104	Amfield, Inc.
Crystallization Unit	CRYST/CR-101	Conair Group
Storage Tank (65L)	STORAGE3/V-101	Sharpsville Container
Rosenmund Filter	ROSENMUND/GBX-101	De Dietrich Process

		Systems
Downstream Pumps (14)	S-15, S-16, S-17, S-18, S-20, S-21, S-22, S-23, S-24, S-25, S-26, S-27, S-28, S-29	Watson-Marlow
Storage Tubs	DRUM/V-101	Sharpsville Container
Tanespimycin Production		
60L Reactor (18)	REACTOR/PFR-101	ABEC
Rotarry Evaporator	ROT-EVAP/RVF-101	De Dietrich Process Systems
Storage	STORAGE4/V-102	Sharpsville Container
Rosenmund Filter	FLTR-DRY/GVX-101	De Dietrich Process Systems
Pumps (14)	S-32 (x10), S-33, S-34, S-35, S-36	Watson-Marlow
Additional Equipment		
Biosafety Cabinet	Assumed in existing BMS facility	Thermo Scientific
Cell Bank	Assumed in existing BMS facility	LabRepCo
Air Generator	Assumed in existing BMS facility	BMS
Clean Steam Generator	Assumed in existing BMS facility	BMS
CIP Skids	Assumed in existing BMS facility	SaniMatic
Filter Integrity Tester	Assumed in existing BMS facility	Millipore
WFI Still	Assumed in existing BMS facility	Paul Mueller Co.
Biowaste Inactivation and Neutralization Tanks	BIOINACT/LD-101 NEUTRLZ1/LD-101 & NEUTRALZ2/LD-102	Sharpsville Container, Zurn
Biowaste Inactivation System	Assumed in existing BMS facility	BMS
Waste Neutralization System	Assumed in existing BMS facility	BMS
Methylene Chloride Drumming	34-DRUMS/LD-103	Clean Harbors
Quality Control Laboratory	Assumed in existing BMS facility	BMS
Portable Pumps on Cart (7)	n/a	Watson-Marlow
Final Packaging	Assumed in existing BMS facility	BMS

9.2 Equipment Selection

Equipment units were selected based on the maximum efficiency of the process with advice from industrial consultants as well as specific vendors. Units were chosen to optimize careful preservation of the product as well as maximum yield while complying with GMP regulations.

9.3 Common Units

9.3.1 Pumps

A peristaltic pump is used to transfer fluid from throughout the process. The pump can be purchased from Watson Marlow and is the 825 Peristaltic Pump. In both the stirred tank and fluidized bioreactor processes, the power of the pump ranges from 1.5-5.0 hp. The pumps operate at room temperature and a 50 psi (3.5 bar) pressure drop with maximum flow rate of 33.3 L/min. The pump will be sterilized and are purchased from Watson Marlow for the cost of $13,000 per pump. Watson Marlow Bioprene sterile tubing is used to transfer the fluid through the variety of processes. There are a total of 8 pumps in the upstream processing (S-8, S-6, S-12, S-10, S-14, S-13, S-11, S-9), 14 pumps in the downstream processing (S-15, S-16, S-17, S-18, S-20, S-21, S-22, S-23, S-24, S-25, S-26, S-27, S-28, S-29) , 14 pumps in the final processing for 17-AAG (S-32 (x10), S-33, S-34, S-35, S-36), and 7 spare pumps accounted for. The resulting prices for pumping for upstream, downstream, final processing, and spares respectively are $104000, $182000, $182000, and $91000.

9.3.2 Media Sterilization Filters

The 0.2 micron filter is used to purify the media by removing any impurities and toxins before introduction to the bioreactors. The filter is 30 inches in size and the filtration area is 1.8m2 (18ft2). The membrane filter material is Polyethersulfone (PES) and operates at room temperature with a max differential pressure of 0.5 bar. The filters require a type of housing for security that requires a one-time purchase from Sartorius Stedim Biotech for the cost of $2,000. The filters are disposable and replaced after every batch. They are purchased from Sartorious Stedim Biotech under the model name Sartopore 2 for the cost of $700/unit. The filters are disposable, but SIP is required for the housing unit.

9.4 Upstream Equipment

9.4.1 Primary Seed Media Preparation Tank (1ST-SEED/V-102)

The Primary Seed Media tank (130L) is used to mix the primary seed media composed of Glucose Monohydrate, Yeast Extract, and Peptone Extract. This tank is required to ensure proper mixing of the media before it is fed through a sterile filter and added to the Initial Ampule in 2 L flasks (52EF-1 SFR-104 & 52EF-2 SFR-101). The tank is made from stainless steel 316 with a volume of 130L and working capacity of 80%. It is elecro-polished and equipment with an agitator with hydrofoil impellers and a dimple style jacket . For sterilization, CIP and SIP are used each time the tank is fully emptied (every 2 batches). The tank operates at room temperature and 1 bar. The tank is fabricated by Sharpsville Container and has a purchase cost of $19,765.

9.4.2 Secondary Seed Media Preparation Tank (2ND-TRG/V-103)

The Secondary Seed Media tank (3250L) is used to mix the primary seed media composed of Glucose Monohydrate, Yeast Extract, Peptone Extract, and PEG/L. This tank is required to ensure proper mixing of the media before it is fed through a sterile filter and added along with the primary flask broth to each Secondary Seed Fermentor (2ND-SEED1/SFR-105 & 2NDSEED2/SFR-103). The tank is made from stainless steel 316 with a volume of 3250L and working capacity of 80%. It is elecro-polished and equipment with an agitator with hydrofoil impellers and a dimple style jacket. For sterilization, CIP and SIP are used each time the tank is fully emptied (every 2 batches). The tank operates at room temperature and 1 bar. The tank is fabricated by Sharpsville Container and has a purchase cost of $51,995.

9.4.3 Fermentation Media Preparation Tank (FERM-STR/V-104)

The Fermentation Media tank (81,150L) is used to mix the primary seed media composed of Glucose Monohydrate, Yeast Extract, and PEG/L. This tank is required to ensure proper mixing of the media before it is fed through a sterile filter and added to each Fermentor (FERM1-FR-102 & FERM2/FR-101). The tank is made from stainless steel 316 with a volume of 50,000L and working capacity of 80%. It is elecro-polished and equipment with an agitator with hydrofoil impellers and a

dimple style jacket. For sterilization, CIP and SIP are used each time the tank is fully emptied (every 2 batches). The tank operates at room temperature and 1 bar. The tank is fabricated by Sharpsville Container and has a purchase cost of $302,765.

9.4.4 Erlenmeyer Flasks (52 x 2) (52EF-1 SFR-104 & 52EF-2 SFR-101)

The Erlenmeyer Flasks are used to grow the Initial Ampule of bacteria. This flask is required to ensure proper growth of the bacteria in primary media before it is added to the Secondary Fermentor (2ND-SEED1/SFR-105 & 2NDSEED2/SFR-103). Each flask will be inoculated with 1L of primary seed media and 0.3L of ampule. The glass flasks have an easy-to-read scale and large labelling field for easy marking in fired-on, highly durable, white ceramic. The flasks will also have membrane caps, as they allow for a more definable and reproducible gas exchange than a cotton cap. For sterilization, the flasks will be autoclaved, as the membrane cap allows pressure equalization and tight sealing, greatly reducing the risk of contamination. After inoculation, the flasks will be incubated for 3 days at 28℃ on a rotary shaker. The tank is fabricated by DURANO and has a purchase cost of about $40 per flask.

9.4.5 Secondary Fermentor (2ND-SEED1/SFR-105 & 2NDSEED2/SFR-103)

The Seed Fermentor (1750L) is used to grow the Primary Seed to Flask bacteria/media mixture. This fermentor is required to ensure proper growth of the bacteria before it is added to the production fermentor (FERM1-FR-102 & FERM2/FR-101). The unit is made of stainless steel and finished by electro-polishing. The pH, temperature, and oxygen levels are controlled with PID controls. The tank has a volume of 1750L and a working volume of 1366L. The tank is fabricated by ABEC and has a purchase cost of $925,848.50 each, which is $1,851,697 for 2 fermentors.

9.4.6 Production Fermentor (FERM1-FR-102 & FERM2/FR-101)

The Production Fermentor is used to grow the Seed to Fermentor bacteria/media mixture. This fermentor is required to ensure proper growth of the bacteria and production of geldanamycin for purification. The unit is made of stainless steel and finished by electro-polishing. The pH, temperature, and oxygen levels are controlled with PID controls. The tank has a volume of 50,000L and a working

volume of 39664.9L. The tank is fabricated by ABEC and has a purchase cost of $8,461,649.5 each, which amounts to $16,923,299 for 2 fermentors.

9.4.7 Surge Tank (STORAGE 1/V-101)

The outputs from both production fermentors (staggered) are stored into the 50,000L surge tank before downstream processing and isolation. The surge tank will keep at 5℃ to ensure the stability of the product as well as the bacteria still present in the solution. It is elecro-polished and equipment with an agitator with hydrofoil impellers and a dimple style jacket. The tank is fabricated by Sharpsville Container and has a purchase cost of $501431.

9.5 Downstream Equipment

The specific vessels utilized for downstream processing were chosen to optimize efficiency as well as specificity of the separation process. In this design, isolation and purification of tanespimycin are a combination of batch and continuous processes.

9.5.2 Rotary Drum Vacuum Filtration Unit (ROTV-FLT/RVF-102)

The Rotary Vacuum Filtration unit is used to separate unwanted solids from the geldanamycin product. This process is required to eliminate extraneous biological wastes in order to isolate the desired drug. The unit is fabricated by Komline-Sanderson and has a purchase cost of $150,000. The rotary vacuum filter will have a filtering area of 200 sq. ft., corresponding to a K-S drum filter diameter of 8 ft. The Komline-Sanderson Rotary Drum Vacuum Filter specifically provides continuous liquid/solid separation with minimal operator attention and low maintenance and will be specifically designed for this process.

9.5.3 Storage Tank (50,000L) (STORAGE2/V-102)

The 50,000L jacketed storage tank will store the the filtrate containing the geldanamycin product from the rotary drum vacuum filtration unit. This unit will aid the switch from continuous to batch processing and will cooled to 5℃ to ensure the stability of its contents. The tank is made of electro-

polished 316L stainless steel and is equipment with an agitator with hydrofoil impellers and a dimple style jacket. The tank is fabricated by Sharpsville Container and has a purchase cost of $501,431.

9.5.4 Cellulose-Based Filtratio (CLL-FLT/CL-101)

This Clarifier is used to separate solid geldanamycin from liquid filtrate. This process is required to purify the geldanamycin for entrance into the Extraction vessel. The unit is fabricated by Ertel Alsop and has a purchase cost of $500,000.

9.5.5 Storage Tank (8500L) (XTRSTRG1/V-105)

The 8500L jacketed storage tank will store the the filtrate containing the output from the cellulose filtration unit before further downstream processing. This unit will avoid the need to stop the process if the extractor in the next step needs to be adjusted to emulsification. The tank is made of electro-polished 316L stainless steel and is equipment with an agitator with hydrofoil impellers and a dimple style jacket. The tank is fabricated by Sharpsville Container and has a purchase cost of $100,000.

9.5.6 Extraction Vessel (EXTRCTON/V-103)

This Extraction vessel (10,000L) is used to dissolve geldanamycin into dichloromethane. This process is required to amass the crude geldanamycin for further purification. The glass unit provided by De Dietrich will ensure inertness and allow for observation of the mixing and separation process, enabling their easy optimization. The unit is fabricated by Sulzer Chemtech and has a purchase cost of $500,000.

9.5.7 Distillation Vessel (DISTILL/V-104)

This Distillation Column used to condense the dissolved geldanamycin in methylene chloride. This continuous process is required to allow for higher yield upon crystallization in the Crystallizer (CRYST/CR-101). The unit is suitable for 500L of material and is made out of stainless steel. The unit is fabricated by Armfield, Inc. and the specific model used is UOP3CC with a purchase cost of $500,000.

9.5.8 Crystallizer (CRYST/CR-101)

This Crystallizer is used to precipitate and isolate the geldanamycin product. The unit is fabricated by Conair Group. The specific unit chosen for this process is the CR135 made of PET with a purchase cost of $500,000.

9.5.9 Storage Tank (65L) (STORAGE3/V-101)

The 65L jacketed storage tank will store the crystal slurry from the crystallizer (CRYST/CR-101). The tank is made of electro-polished 316L stainless steel and is equipment with an agitator with hydrofoil impellers and a dimple style jacket. The tank is fabricated by Sharpsville Container and has a purchase cost of $15,000.

9.5.10 Rosenmund Filter Dryer (ROSENMUND/GBX-101)

This Rosenmund Filter Dryer used to dry 22kg of geldanamycin product. Rosenmund filters demonstrate high efficiency in washing and isolate pharmaceuticals. A few upgraded features of this system include side discharge including a side discharge valve for pressure-tight closure after each product discharge to insure no contamination. In addition, this vessel contains a three-blade agitator for efficient agitation and discharge. The total discharge system with the gas knife allows for product discharge without manual intervention, therefore increasing efficiency and reliability. The equipment also allows for efficient CIP/WIP and SIP cleaning. The application of specialised spray systems and sterilisation methods validation of the vessel preparation process. The vessel has a filtration area of 0.16 sq ft and a 18'' diameter for about 50L of material. The unit is fabricated by De Dietrich and has a purchase cost of 500,000.

9.5.11 Tubs for geldanamycin product (DRUM/V-101)

The geldanamycin crystals from the Rosenmund Filter will be collected in drums and manually deposited into each of the 18 reactors.

9.6 Tanespimycin Production Equipment

9.6.1 Reactor (REACTOR/PFR-101)

18 60L reactors will be used for the reaction of geldanamycin and allyl amine to produce 17-AAG. The unit is fabricated by Biomashin, Inc and has a purchase cost of $24,000 per reactor, which amounts to $432,000 for all eighteen reactors. Biomashin's pharmaceutical-grade reactor complies with the highest requirements in accordance with GMP and accompanied by validation documentation IQ, OQ, FAT, SAT inclusively. The reactor is made of stainless steel AISI 316L with surfaces in contact with the product Ra 1.6÷0.4um. The vessel is insulated with PU-foam covered with fully welded insulation cladding. The piece of equipment also includes safety armature and electro-sensors for the control of the process.

9.6.2 Rotary Evaporator (ROT-EVAP/RVF-101)

The rotary evaporator continuously removes remaining solvent to further purify 17-AAG. The unit is specifically named the QVF Rotary Evaporator has a working volume of 750L and is made of borosilicate 3.3 glass and PTFE, offering the following benefits: 1) proper observability of all process 2) total chemical resistance against nearly all mediums 3) careful evaporation. In addition, the QVC Rotary Evaporator features robust driving of the rotary flask by a PTFE-lined steel sleeve shaft. This unit is fabricated by De Dietrich Process Systems, Inc and has a purchase cost of $500,000.

9.6.3 Storage Tank (100L) (STORAGE4/V-102)

The 100L jacketed storage tank will store the product from the Rotary Evaporator (ROT-EVAP/RVF-101) to aid the switch from continuous to batch prior to final isolation through Rosenmund drying. The tank is made of electro-polished 316L stainless steel and is equipment with an agitator with hydrofoil impellers and a dimple style jacket. The tank is fabricated by Sharpsville Container and has a purchase cost of $12,000.

9.6.4 Rosenmund Filter (FLTR-DRY/GBX-101)

This Rosenmund Filter Dryer used to recrystallize the geldanamycin final product. Rosenmund filters demonstrate high efficiency in washing and isolate pharmaceuticals. A few upgraded features of this system include side discharge including a side discharge valve for pressure-tight closure after each product discharge to insure no contamination. In addition, this vessel contains a three-blade agitator for efficient agitation and discharge. The total discharge system with the gas knife allows for product discharge without manual intervention, therefore increasing efficiency and reliability. The equipment also allows for efficient CIP/WIP and SIP cleaning and the application of specialized spray systems and sterilization methods as a method of validation of the vessel preparation process. This specific vessel has a filtration area of 5.6 sq ft and a 32" diameter, suitable for about 250L of material. The unit is fabricated by De Dietrich and has a purchase cost of $500,000.

9.7 Additional Equipment

9.7.1 Biosafety Cabinet

Biosafety cabinets are required to provide a sterile environment to prepare ampule and inoculate the primary seed medium. Five biosafety cabinets will be needed in order to prepare ampule at a concentration of 10mg/mL. 104 2L flasks containing 1L primary seed medium will then be inoculated with 0.3 of this ampule. These biosafety cabinets are standard issue manufactured by Thermo Scientific™. These cabinets can be assumed to be preexisting within the BMS facility and thus incur no additional cost.

9.7.2 Cell Bank

The bacteria will initially be purchased from ATCC for a one-time cost of $354. Cells will then be grown to a final cell density of $1x10^8$ cells/mL and then placed in 2 ml vials. These vials will be placed stored in a liquid nitrogen cryogenic sample storage vessel in order to create a cell bank. This freezer can be obtained from LabRepCo for $2,070.

9.7.3 Air Generator (HVAC Equipment)

Purified air will be the source of oxygen throughout the process and will be provided by an HVAC system. The system will supply clean air to fermenters, clean rooms, and other process equipment with oxygen requirements. The air generator can be assumed to be preexisting within the BMS facility and thus incur no additional cost.

9.7.4 Clean Steam Generator

The clean steam generator is used to produce steam from WFI for SIP procedures. The clean steam generator can be assumed to be preexisting within the BMS facility therefore the cost of this system is just its utilities, which are accounted for in annual expenses.

9.7.5 CIP Skids

Clean-In-Place (CIP) is a technique used to clean equipment. A CIP skid is portable and contains the necessary equipment and cleaning solution in order for proper cleaning. In order to clean all the unit operations and storage tanks, fifteen CIP skids will be needed for this process. These skids can be assumed to be preexisting within the BMS facility and thus incur no additional cost.

9.7.6 Filter Integrity Tester

Disposable filters are used throughout this process; however, due to quality standards, they must be tested before each use to ensure they are not clogged, torn, or unusable. This testing will also prevent loss of product. This tester can be obtained from Millipore, although it can be assumed to be preexisting within the BMS facility and thus incur no additional cost.

9.7.7 WFI Still

A WFI still is used to purify water for use with cell culture. WFI water is used to both ensure the sterility of the product and to prevent and eliminate cross-contamination issues. The still can be obtained by the Paul Mueller Co. although the still can be assumed to be preexisting within the BMS facility and thus incur no additional cost.

9.7.8 Biowaste and Neutralization Tanks

Two different types of tanks will be used to collect the waste generated by the process. If waste contains live culture it must be sent to a biowaste tank. All other waste, with the exception of that containing methylene chloride, is sent to neutralization tanks. The only bioactive waste in this process is the biomass disposed of after the rotary vacuum filtration. The biomass will be mixed with water in a biowaste tank

All waste containing bioactive matter must be treated properly before disposal. The biomass that is removed after rotary vacuum filtration contains live bacterial culture and is therefore transported to the biowaste tank where it is mixed with water to create a liquid that can be pumped to the biowaste inactivation system. This tank must be 1,000L to sufficiently hold the approximately 60kg of biomass produced per batch and necessary water for mixing. This tank can be bought from Sharpsville Container for $125,000.

All other waste, excluding that containing methylene chloride, is pumped directly to neutralization tanks. 8,150L of waste is produced from the cellulose-based filtration and an additional 920L from the reaction process. A 3,000 gallon (11,355L) and 275 gallon (1040.9L) neutralization tanks can be purchased from Zurn for $90,000 and $18,000 respectively.

9.7.9 Biowaste Inactivation System

This system kills any live mass remaining in the biowaste tank. This system includes the CIP and SIP washes. The system heats the waste to 80C for one minute to inactivate living cell cultures. This system can be assumed to be preexisting within the BMS facility and thus incur no additional cost.

9.7.10 Waste Neutralization System

The system operates by adjusting the waste to a pH to 7.0. This allows the waste to be sent to the sewer. This system can be assumed to be preexisting within the BMS facility and thus incur no additional cost.

9.7.11 Methylene Chloride Drumming

Methylene chloride is a health hazard and therefore must be removed by a specialty waste company. The waste streams from the extraction, distillation, and crystallization/drying processes all contain methylene chloride. This waste can be sent to fill 55 gallon drums. Clean Harbors a specialty waste disposal company can then safely dispose of these drums for $290 per drum. There is an additional $30 transport cost per drum and a diesel surcharge price of 11.5% of the total invoice. Empty drums can also be delivered by Clean Harbors for $30 a drum. A total of 34 drums are filled for each batch.

9.7.12 Quality Control Lab

A quality control lab will be needed to test the all factors involved in production. Samples will be taken throughout the process in order to test for a specific set of quality assurance criteria. This lab can be assumed to be preexisting within the BMS facility and thus incur no additional cost.

9.7.13 Portable Pump on Cart

In preparation for pump malfunction, 7 extra replacement pumps will be stored on portable carts. These pumps will be that same 825 Peristaltic pumps used in the process costing $13,000 per pump and can be acquired from Watson Marlow.

9.7.14 Final Packaging

The final product from this process will not be ready for direct administration, for it is not separated in the proper dosing increments nor placed in final packaging. The tanespimycin must be packaged and shipped to doctors or hospitals where it will be administered to patients intravenously. BMS has an internal department that can finalize the packaging requirements for this drug. An estimated $10 will be spent to package and ship each treatment of tanespimycin yielding an additional $1.1 million expense for this process. The packaging must be non-reactive, clean, and sanitized, and records must be kept for each shipment of product. Packaging labels must also include special transport and storage conditions. A system must also be in place to permit a recall if necessary.

10.0 Specification Sheets

Primary Seed Media Preparation Tank
(1ST-SEED/V102)

Description and Function:	130L Tank used to store and mix the primary seed media prior to being pumped through a sterile filter and used to seed the ampule in 2 L flasks.	
Vendor:	Sharpsville Container	
Operation:	Batch	
Materials Handled:	Input	Quantity
	Glucose Monohydrate	1.039 kg
	Yeast Extract	0.260 kg
	Peptone Extract	1.039 kg
	Total	2.338 kg
Characteristics:	Material:	316 L Stainless Steel Electro-polished Agitator with Hydrofoil Impellers
	Working Volume:	Dimple Style Jacket
	Total Volume:	104L
	Sterilization:	130 WIP/CIP
Operating Conditions	Temp:	25℃
	Pressure:	1 bar
Purchase Cost	$19,765	
Reference Page		

Secondary Seed Media Preparation Tank
(2ND-TRG/V-103)

Description and Function:	3250L Tank used to store and mix the primary seed media prior to being pumped through a sterile filter and into the secondary seed ferment or.	
Vendor:	Sharpsville Container	
Operation:	Batch	
Materials Handled:	Input	Quantity
	Glucose Monohydrate	12.983 kg
	Yeast Extract	3.246 kg
	Peptone Extract	12.983 kg
	PEG	2.343 kg
	Total	31.554 kg
Characteristics:	Material:	316 L Stainless Steel Electro-polished Agitator with Hydrofoil Impellers Dimple Style Jacket
	Working Volume:	2597 L
	Total Volume:	3250 L
	Sterilization:	SIP/CIP
Operating Conditions	Temp:	25℃
	Pressure:	1 bar
Purchase Cost	$51,995	
Reference Page		

Fermentation Media Preparation Tank
(FERM-STR/V-104)

Description and Function:	81,150L Tank used to store and mix the Fermentation media prior to being pumped through a sterile filter and into the 50,000 L Ferment or.	
Vendor:	Sharpsville Container	
Operation:	Batch	

Materials Handled:

Input	Quantity (kg)
Soy flour	1217.137
Corn Starch	2839.987
Ammonium Sulfate	81.142
Calcium Carbonate	243.427
Cobalt Chloride Dihydrate	0.325
Ferrous Sulfate Heptahydrate	3.651
Alpha Amylase	1.623
Soybean Oil	0.0006
Polyalkylene glycol	5.193
Total	4392.487

Characteristics:	Material:	316 L Stainless Steel Electro-polished Agitator with Hydrofoil Impellers Dimple Style Jacket
	Working Volume:	64,914 L
	Total Volume:	81,150 L
	Sterilization:	SIP/CIP
Operating Conditions	Temp:	25℃
	Pressure:	1 bar
Purchase Cost	$302,765	
Reference Page		

2 L Erlenmeyer Flasks (104)
(52EF-1 SFR-104 & 52EF-2 SFR-101)

Description and Function:	DURAN Erlenmeyer flask with DIN threads and closed with membrane cap to allow for gas exchange. Flasks will be used for initial bacterial seeding and placed on a rotary shaker in an incubator at 37℃.	
Vendor:	DURAN Group	
Operation:	Batch	
Materials Handled:	Input	Quantity
	Medium	7.7g
	Biomass	0.42g
	Water	250g
	Total	258.1g
Characteristics:	Model:	2L EF
	Material:	Glass
	Flask Type:	Sterile
	Working Volume:	1L
	Total Volume:	2L
	Sterilization:	Autoclave
Operating Conditions	Temp:	28℃
	pH:	6.25-7.75
Purchase Cost	$4,160	(104 flasks)
Reference Page		

1750L Secondary Seed Fermenter (2)
(2ND-SEED1/SFR-105 & 2NDSEED2/SFR-103)

Description and Function:	1750L Secondary Seed Fermenter. Charged with filtered secondary seed media and cell solution from the 2L flasks	
Vendor:	ABEC	
Operation:	Batch	
Materials Handled:	Input	Quantity (kg)
	Primary Seed with cells	1.341
	Secondary Seed Media	31.554
	Total	32.896
Characteristics:	Material:	Stainless Steel Electropolished
	Working Volume:	1365.9L
	Total Volume:	1750L
	Sterilization:	CIP/SIP
Operating Conditions	Temp:	28℃
	Pressure:	7psi backpressure
	Speed:	250 rpm
	pH:	6.25-7.75
	Aeration:	200 slm
Purchase Cost	$925,848.50 each $1,851,697 for 2 fermenters	(Includes jacketed tank with controls, agitators, filters, TCM)
Reference Page		

50,000L Fermenter (2)
(FERM1-FR-102 & FERM2/FR-101)

Description and Function:	50,000L Fermenter.		
Vendor:	ABEC		
Operation:	Batch		
Materials Handled:	Input		Quantity (kg)
	Secondary Seed (incl cells and product)		32.896
	Fermentation Media		4392.487
	WFI		5842.259
	Total		10267.642
Characteristics:	Working Volume:	39664.9L	
	Total Volume:	50,000L	
	Sterilization:	CIP/SIP	
Operating Conditions	Temp:	28℃	
	Pressure:	7psi backpressure	
	Speed:	180-220 rpm	
	pH:	6.25-7.75	
	aeration:	1000-5000 slm	
Purchase Cost	$8,461,649.5 each $16,923,299 for 2 fermenters	(Includes jacketed tank with controls, agitators, filters, TCM)	
Reference Page			

Media Preparation Sterile Filtration

Description and Function:	Sterilization filters 0.2um to remove bacteria and other impurities from media prior to feeding the flasks and fermenters. A onetime purchase of the housing unit must be made and then the filter capsule membranes are disposable and refilled for every use.	
Vendor:	Sartorius Stedim Biotech	
Operation:	Batch	
Characteristics:	Model:	Sartopore 1 0.2 um
	Material:	Polyethersulfone (PES)
	Size:	30''
	Filtration area:	1.8m^2
	Max. Differential Pressure:	5 bar at 20℃
	Membrane Unit Sterilization:	SIP
	Membrane Sterilization:	Disposable
Operating Conditions	Temp:	25℃
	Pressure:	0.5 bar
Purchase Cost	$2,000	Filter Housing (one-time purchase)
	$700	Filter Membrane, one-time use (included in materials price)

Reference Page

Surge Tank
(STORAGE`1/V-101)

Description and Function:	50,000L cooled surge tank to store output of 50,000L fermenter before downstream processing of geldanamycin. Contents of storage tank cooled to 5℃ with cooling water running through the tank jacket.	
Vendor:	Sharpsville Container	
Operation:	Batch	
Materials Handled:	Input	Quantity (kg)
	Fermentation Broth	10367.939
	Total	10367.939
Characteristics:	Material:	316 L Stainless Steel Electro-polished Flat Top and Sloped Bottom Dimple Style Jacket
	Working Volume:	39664.9L
	Total Volume:	50,000L
	Sterilization:	CIP/SIP
Operating Conditions	Temp:	5℃ (cooling)
Purchase Cost	$501,431	Jacketed with TCM and spray ball
Reference Page		

Upstream Pumps
S-8, S-6, S-12, S-10, S-14, S-13, S-11, S-9

Description and Function:	Pump to transfer fluid. High-flow hygienic pumps that are designed for low-shear sanitary pumping. They are ideal for viscous or shear sensitive products.	
Vendor:	Watson-Marlow	
Operation:	Batch	
Characteristics:	Model:	825 Peristaltic Pump
	Material:	304 Stainless Steel
	Flow Rate:	33.3 L/min
	Max Pressure:	3.5 bar
	Tubing	Bioprene, 25 mm
Operating Conditions	Temp:	25C
	Pressure Change:	5 psi
	Power:	1.5-5.0 hp
Purchase Cost	$13,000	per pump
	$104,000 total	(8 upstream pumps)

Reference Page

Rotary Vacuum Filtration
(ROTV-FLT/RVF-102)

Description and Function:	The rotary vacuum filter will be fed by the surge tank (STORAGE`1/V-101) in order to separate out the biomass from the fermentation broth.	
Vendor:	Komline-Sanderson	
Operation:	Continuous	

Materials Handled:

Input	Quantity(kg/h)
Fermentation Media	2874.44
Biomass	106.33
Geldanamycin	13.910
Filter Aid	386.546
Total	3381.226

Characteristics:	Material:	Electro-polished stainless steel
	Filter area:	200 sq ft
	Diameter:	8ft
	Sterilization:	SIP/CIP
Operating Conditions	Temp:	5℃
Purchase Cost	$150,000	
Reference Page		

Storage Tank
(STORAGE2/V-102)

Description and Function:	50,000L cooled storage tank to store output of rotary vacuum filter before further downstream processing of geldanamycin. Contents of storage tank cooled to 5℃ with cooling water running through the tank jacket.	
Vendor:	Sharpsville Container	
Operation:	Batch	
Materials Handled:	Input	Quantity (kg)
	Fermentation Media	10060.55
	Geldanamycin	38.948
	Total	10099.49
Characteristics:	Material:	316 L Stainless Steel Electro-polished Flat Top and Sloped Bottom Dimple Style Jacket
	Total Volume:	50,000L
	Sterilization:	CIP/SIP
Operating Conditions	Temp:	5℃ (cooled)
Purchase Cost	$501,431	Jacketed with TCM and spray ball
Reference Page		

Cellulose-Based Filter
(CLL-FLT/CL-101)

Description and Function:	Cellulose-Based Filter for clarification	
Vendor:	Ertel Alsop	
Operation:	Batch	
Materials Handled:	Input	Quantity (kg)
	Fermentation Media	10060.55
	Geldanamycin	38.948
	Cellulose-Based Filter Media	1352.912
	Total	11482.674
Characteristics:	Sterilization:	SIP/CIP
Purchase Cost	$500,000	
Reference Page		

Storage Tank
(XTRSTRG1/V-105)

Description and Function:	8500L cooled storage tank to store output of cellulose based filtration before further downstream processing of geldanamycin. Contents of storage tank cooled to 5℃ with cooling water running through the tank jacket.	
Vendor:	Sharpsville Container	
Operation:	Batch	
Materials Handled:	Input	Quantity (kg)
	Fermentation Broth	2018.163
	Geldanamycin	35.054
	Cellulose-based Filter Media	1352.912
	Total	3406.129
Characteristics:	Material:	316 L Stainless Steel Electro-polished Flat Top and Sloped Bottom Dimple Style Jacket
	Working Volume:	39664.9L
	Total Volume:	50,000L
	Sterilization:	CIP/SIP
Operating Conditions	Temp:	5℃
Purchase Cost	$100,000	Jacketed with TCM and spray ball
Reference Page		

Extraction Vessel
(EXTRCTON/V-103)

Description and Function:	Liquid extraction with methylene chloride to remove excess media from cellulose-based filtration.	
Vendor:	Sulzer Chemtech	
Operation:	Continuous	
Materials Handled:	Input	Quantity (kg/hr)
	Fermentation Media	1006.055
	Geldanamycin	17.527
	Methylene Chloride	1732.325
	Cellulose-based Filter Media	676.456
	Total	3432.36
Characteristics:	Material:	Glass shell; Titanium, zirconium, PVDF internals
	Working Volume:	8000L
	Total Volume:	10000L
	Sterilization:	SIP/CIP
Operating Conditions	Temp:	25℃
Purchase Cost	$500,000	
Reference Page		

Distillation Tank (DISTILL/V-104)

Description and Function:	The product will be further concentrated by heating off the Methylene chloride.		
Vendor:	Armfield Inc.		
Operation:	Continuous		
Materials Handled:	Input		Quantity (kg/hr)
	Geldanamycin		3.505
	Methylene Chloride		494.00
	Total		497.505
Characteristics:	Model:	UOP3CC	
	Material:		
	Working Volume:	2800 L	
	Total Volume:	3500 L	
	Sterilization:	SIP/CIP	
Operating Conditions	Temp:	40℃	
Purchase Cost	$500,000		
Reference Page			

Crystallization/Drying Vessel (CRYST/CR-101)

Description and Function:	The product will be crystallized in order to be stored and reacted to form the tanespimycin product further downstream		
Vendor:	Conair Group		
Operation:	Continuous		
Materials Handled:	Input		Quantity (kg/hr)
	Geldanamycin		3.505
	Methylene Chloride		475.000
	Isooctane		246.429
	Total		724.934
Characteristics:	Model:	CR135	
	Material:	PET	
	Working Volume:	3823 L	
	Total Volume:	48132 L	
	Sterilization:	CIP/SIP	
Operating Conditions	Temp:	35-40℃	
Purchase Cost	$500,000		

Storage Tank
(STORAGE3/V-101)

Description and Function:	65L cooled storage tank to store crystal slurry from the crystallizer before further downstream processing of geldanamycin. Contents of storage tank cooled to 5℃ with cooling water running through the tank jacket.	
Vendor:	Sharpsville Container	
Operation:	Batch	
Materials Handled:	Input	Quantity (kg)
	Fermentation Broth	10367.939
	Total	10367.939
Characteristics:	Material:	316 L Stainless Steel Electro-polished Flat Top and Sloped Bottom Dimple Style Jacket
	Total Volume:	65L
	Sterilization:	CIP/SIP
Operating Conditions	Temp:	5℃
Purchase Cost	$15,000	Jacketed with TCM and spray ball
Reference Page		

Rosenmund Filter
(ROSENMUND/GBX-101)

Description and Function:	The Rosenmund filter is used to dry 22kg of geldanamycin. The use of the Rosenmund filter increases efficiency and allows for easy and sterile discharge of the product with no manual intervention.
Vendor:	De Dietrich Process Systems
Operation:	Continuous

Materials Handled:	Input	Quantity (kg)
	Geldanamycin	22.084
	Methylene Chloride	33.250
	Isooctane	17.250
	Total	72.584

Characteristics:	Material:	Stainless Steel
	Filtration area:	.16 sq ft
	Diameter:	18”
	Sterilization:	SIP/CIP
Operating Conditions	Temp:	5℃
Purchase Cost	$500,000	
Reference Page		

Downstream Pumps
(S-15, S-16, S-17, S-18, S-20, S-21, S-22, S-23, S-24, S-25, S-26, S-27, S-28, S-29)

Description and Function:	Pumps to transfer fluid. High-flow hygienic pumps that are designed for low-shear sanitary pumping. They are ideal for viscous or shear sensitive products.	
Vendor:	Watson-Marlow	
Operation:	Batch	
Characteristics:	Model:	825 Peristaltic Pump
	Material:	304 Stainless Steel
	Flow Rate:	33.3 L/min
	Max Pressure:	3.5 bar
	Tubing	Bioprene, 25 mm
Operating Conditions	Temp:	25C
	Pressure Change:	5 psi
	Power:	1.5-5.0 hp
Purchase Cost	$13,000	per pump
	$182,000 total	(14 downstream pumps)

Reference Page

60L Reactor (x18)
(REACTOR/PFR-101)

Description and Function:	Reaction of geldanamycin and allylamine to produce tanespimycin.	
Vendor:	Biomashin	
Operation:	Batch	

Materials Handled: (per each reactor)	Input (per reactor)	Quantity (kg)
	Geldanamycin	1.217
	THF	34.846
	Allylamine in ethanol	1.927
	Total	37.990

Characteristics:	Material:	Stainless steel AISI 316L
	Working Volume:	48 L
	Total Volume:	60 L
	Sterilization:	CIP/SIP

Purchase Cost	$100,000	per reactor
	$1,800,000	for 18 reactors

Reference Page

Rotary Evaporator
(ROT-AVAP/RVF-101)

Description and Function:

Vendor: De Dietrich Process Systems

Operation: Continuous

Materials Handled:

Input	Quantity (kg/hr)
Geldanamycin	0.548
THF	313.616
Allylamine	16.002
Tanespimycin	10.871
Total	341.037

Characteristics:

Model:	R100
Material:	Corrosion-resistant borosilicate 3.3 glass
Working Volume:	750 L
Sterilization:	SIP-CIP

Purchase Cost $500,000

Reference Page

Storage Tank
(STORAGE4/V-102)

Description and Function:	100L cooled storage tank to store product from Rotary Evaporator before further downstream processing of 17-AAG. Contents of storage tank cooled to 5℃ with cooling water running through the tank jacket.	
Vendor:	Sharpsville Container	
Operation:	Batch	
Materials Handled:	Input	Quantity (kg)
	Geldanamycin	0.333
	THF	6.68
	Allylamine	3.23
	Tanespimycin	43.48
	Water	409.35
	Total	463.08
Characteristics:	Material:	316 L Stainless Steel Electro-polished Flat Top and Sloped Bottom
	Total Volume:	Dimple Style Jacket 100L
	Sterilization:	CIP/SIP
Operating Conditions	Temp:	5℃
Purchase Cost	$12,000	Jacketed with TCM and spray ball
Reference Page		

Rosenmund Filter
(FLTR-DRY/GBX-101)

Description and Function:	The Rosenmund filter is used to dry 19.717 kg of Tanespimycin. The use of the Rosenmund filter increases efficiency and allows for easy and sterile discharge of the product with no manual intervention.	
Vendor:	De Dietrich Process Systems	
Operation:	Batch	
Materials Handled:	Input	Quantity (kg/batch)
	Geldanamycin	1.095
	THF	18.817
	Allylamine	32.005
	Tanespimycin	21.742
	WFI	204.475
	Total	289.134
Characteristics:	Material:	Stainless Steel
	Filtration Area:	5.6 sq ft
	Diameter:	32”
	Working Volume	250L
	Sterilization:	SIP/CIP
Purchase Cost	$500,000	
Reference Page		

Pumps for 17-AAG Process
(S-32 (x10), S-33, S-34, S-35, S-36)

Description and Function:	Pumps to transfer fluid. High-flow hygienic pumps that are designed for low-shear sanitary pumping. They are ideal for viscous or shear sensitive products.	
Vendor:	Watson-Marlow	
Operation:	Batch	
Characteristics:	Model:	825 Peristaltic Pump
	Material:	304 Stainless Steel
	Flow Rate:	33.3 L/min
	Max Pressure:	3.5 bar
	Tubing	Bioprene, 25 mm
Operating Conditions	Temp:	25C
	Pressure Change:	5 psi
	Power:	1.5-5.0 hp
Purchase Cost	$13,000	per pump
	$182,000 total	(14 pumps)

Reference Page

Spare Pumps (7)

Description and Function:	Spare pumps in case there is a malfunction. Pumps to transfer fluid. High-flow hygienic pumps that are designed for low-shear sanitary pumping. They are ideal for viscous or shear sensitive products.	
Vendor:	Watson-Marlow	
Operation:	Batch	
Characteristics:	Model:	825 Peristaltic Pump
	Material:	304 Stainless Steel
	Flow Rate:	33.3 L/min
	Max Pressure:	3.5 bar
	Tubing	Bioprene, 25 mm
Operating Conditions	Temp:	25C
	Pressure Change:	5 psi
	Power:	1.5-5.0 hp
Purchase Cost	$13,000	per pump
	$91,000 total	7 spare pumps

Reference Page

Biowaste Tank
(BIOINACT/LD-101)

Description and Function:

Vendor:

Operation:	Batch	
Materials Handled:	Input	Quantity (kg/batch)
	Biomass	36.612
Characteristics:	Material:	
	Working Volume:	
	Total Volume:	
	Sterilization:	
Operating Conditions	Temp:	
Purchase Cost	$125,000	

Reference Page

Neutralization Tank 1
(NEUTRLZ1/LD-102)

Description and Function:	11,355L Neutralization tank used to store waste exiting the cellulose-based filtration unit in the geldanamycin production process. All contents of this tank will be pumped to a neutralization system before being disposed of through the sewage.	
Vendor:	Zurn	
Operation:	Batch	
Materials Handled:	Input	Quantity (kg)
	Fermentation Media	8,153.305
	Geldanamycin	3.895
	Total	8,157.200
Characteristics:	Model:	Z9A-NT
	Material:	High density polyethylene
	Working Volume:	8,150L
	Total Volume:	11,355L
Operating Conditions	Temp:	25C
	Pressure:	1 bar
Purchase Cost	$90,000	
Reference Page		

Neutralization Tank 2
(NEUTRLZ2/LD-101)

Description and Function:	1040.9L Neutralization tank used to store waste from the rotary evaporation and filter/drying units in tanespimycin production process. All contents of this tank will be pumped to a neutralization system before being disposed of through the sewage.	
Vendor:	Zurn	
Operation:	Batch	
Materials Handled:	Input	Quantity (kg)
	Ethanol	577.422
	Geldanamycin	0.116
	Allylamine	1.613
	Tanespimycin	2.025
	Water	184.231
Characteristics:	Model:	Z9A-NT
	Material:	High density polyethylene
	Working Volume:	920L
	Total Volume:	1,040.9L
Operating Conditions	Temp:	25C
	Pressure:	1 bar
Purchase Cost	$18,000	
Reference Page		

11.0 Equipment Cost Summary

This chapter contains a table with each equipment unit in the process flow diagram (Chapter 6) including the unit number, purchase cost of 1 unit, the number of units, as well as the vendor. Price estimations were obtained from the individual vendors unless otherwise noted. Vendor sheets as well as individual quotes are included in the Appendix. Note that additional equipment assumed to be part of the existing BMS facility are not included here since they are not included in the cost analysis, but are included in Chapter 9, Equipment list and Unit Descriptions.

11.1 Geldanamycin Upstream Process Equipment

Equipment Description	Unit number	Purchase Cost (1 unit)	Number of Units	Vendor
Primary Seed Media Prep Tank (130L)	1ST-SEED/V-102	$19,765	1	Sharpsville Container
Secondary Seed Media Prep Tank (3250L)	2ND-TRG/V-103	$51,995	1	Sharpsville Container
Fermentation Media Prep Tank (81,150L)	FERM-STR/V-104	$302,765	1	Sharpsville Container
2L Erlenmeyer Flasks (104)	52EF-1 SFR-104 & 52EF-2 SFR-101	$40	104	DURAN
1750 L Secondary Fermenter	2ND-SEED1/SFR-105 & 2NDSEED2/SFR-103	$925,849	2	ABEC (quote: consultants)
50000L Fermenter	FERM1-FR-102 & FERM2/FR-101	$8,461,649	2	ABEC (Quote: consultants)
Media Filters (6)	S-1, S-2, S-8, S-6, S-12, S-10	$2,000	6	Sartorious Stedim Biotech
Upstream Pumps (8)	S-8, S-6, S-12, S-10, S-14, S-13, S-11, S-9	$13,000	8	Watson-Marlow
50000L Surge Tank	STORAGE`1/V-101	$501,431	1	Sharpsville Container

11.2 Downstream Process Equipment

Equipment Description	Unit number	Purchase Cost (1 unit)	Number of Units	Vendor
Rotary Vacuum	ROTV-FLT/RVF-102	$150,000	1	Komline-

Filter				Sanderson
Storage Tank (50,000L)	STORAGE2/V-102	$501,431	1	Sharpsville Container
Cellulose-based filter	CLL-FLT/CL-101	$500,000	1	Ertel Alsop
Storage Tank	XTRSTRG1/V-105	$100,000	1	Sharpsville Container
Extraction Unit	(EXTRCTON/V-103)	$500,000	1	Sulzer Chemtech
Distillation Unit	DISTILL/V-104	$500,000	1	Armfield, Inc.
Crystallization Unit	CRYST/CR-101	$500,000	1	Conair Group
Storage Tank (65L)	STORAGE3/V-101	$15,000	1	Sharpsville Container
Rosenmund Filter	ROSENMUND/GBX-101	$500,000	1	De Dietrich Process System
Downstream Pumps (14)	S-15, -16, -17, -18, -20, -21, -22, -23, -24, -25, -26, -27, -28, -29	$13000	14	Watson-Marlow
Storage Tubs	DRUM/V-101	$20	1	Sharpsville Container

11.3 Tanespimycin Reaction Process Equipment

Equipment Description	**Unit number**	**Purchase Cost (1 unit)**	**Number of Units**	**Vendor**
60L Reactor (18)	REACTOR/PFR-101	$100,000	18	ABEC
Rotary Evaporator	ROT-EVAP/RVF-101	$500,000	1	De Dietrich Process Systems
Storage Tank	STORAGE4/V-102	$12,000	1	Sharpsville Container
Rosenmund Filter	FLTR-DRY/GVX-101	$500,000	1	De Dietrich Process Systems
Pumps (14)	S-32 (x10), S-33, S-34, S-35, S-36	$13,000	14	Watson-Marlow

11.4 Additional Equipment

Equipment Description	Unit number	Purchase Cost (1 unit)	Number of Units	Vendor
Spare Pumps (7)	n/a	$13,000	7	Watson-Marlow
Biowaste Tank	BIOINACT/LD-101	$125,000	1	Sharpsville Container
Neutralization Tank 1	NEUTRLZ1/LD-102	$90,000	1	Zurn
Neutralization Tank 2	NEUTRLZ2/LD-101	$18,000	1	Zurn

12.0 Fixed Capital Investment

This chapter will describe the fixed capital investment; including the equipment bare module costs and the total permanent investment, which accounts for the cost of site preparations, service facilities, contingencies and contractor fees, and plant start-up. To perform the economic analysis of the outlined production of tanespimycin, the Profitability Analysis-4.0.xls spreadsheet by Brian K. Downey (2008) was used. While the inputs are explained in this chapter, the results from the profitability analysis as well as an input summary are included in Chapter 15.

12.1 Equipment Costs

12.1.1 Unit Purchase Costs and Bare Module Costs

Purchases costs for each unit of equipment were determined either from the respective vendor or industrial consultants (More information in Chapter 11) and bare module costs were calculated by multiplying by specific bare module factors, as explained in section 12.1.2. The majority of the equipment bare module costs is from the geldanamycin upstream process equipment, which amounts to $116,673,310. The total geldanamycin downstream process equipment bare module cost is $13,604,500, while the Total 17-AAG reaction process Bare Module Costs is $12,287,120, and the Total Additional Equipment Bare Module Costs is $1,048,230. The bare module costs by unit are presented in Tables 12.1, 12.2, 12.3, and 12.4. The total bare module cost, $143,613,160, is used to determine the cost of site preparations, service facilities, contingencies and contractor fees, and plant start-up.

Table 12.1 Geldanamycin Upstream Process Equipment

Equipment Description	Unit number	Purchase Cost (1 unit)	Number of Units	Bare Module Factor	Bare Module Cost (total # units)	Vendor
Primary Seed Media Prep Tank (130L)	1ST-SEED/V-102	$19,765	1	4.16	$82,222	Sharpsville Container
Secondary Seed	2ND-TRG/V-103	$51,995	1	4.16	$216,299	Sharpsville

Media Prep Tank (3250L)						Container
Fermentation Media Prep Tank (81,150L)	FERM-STR/V-104	$302,765	1	4.16	$1,259,502	Sharpsville Container
2L Erlenmeyer Flasks (104)	52EF-1 SFR-104 & 52EF-2 SFR-101	$40	104	1.1	$8,320	DURAN
1750 L Secondary Fermenter	2ND-SEED1/SFR-105 & 2NDSEED2/SFR-103	$925,849	2	6.00	$11,110,182	ABEC (quote: consultants)
50000L Fermenter	FERM1-FR-102 & FERM2/FR-101	$8,461,649	2	6.00	$101,539,792	ABEC (Quote: consultants)
Media Filters (6)	S-1, S-2, S-8, S-6, S-12, S-10	$2,000	6	2.32	$27,840	Sartorious Stedim Biotech
Upstream Pumps (8)	S-8, S-6, S-12, S-10, S-14, S-13, S-11, S-9	$13,000	8	3.30	$343,200	Watson-Marlow
50000L Surge Tank	STORAGE`1/V-101	$501,431	1	4.16	$2,085,953	Sharpsville Container
Total Geldanamycin Upstream Process Equipment Bare Module Costs: $116,673,310						

Table 12.2 Geldanamycin Downstream Process Equipment

Equipment Description	**Unit number**	**Purchase Cost (1 unit)**	**Number of Units**	**Bare Module Factor**	**Bare Module Cost (total # units)**	**Vendor**
Rotary Vacuum Filter	ROTV-FLT/RVF-102	$150,000	1	4.16	$624,000	Komline-Sanderson
Storage Tank (50,000L)	STORAGE2/V-102	$501,431	1	3.21	$1,609,594	Sharpsville Container
Cellulose-based filter	CLL-FLT/CL-101	$500,000	1	4.16	$2,080,000	Ertel Alsop
Storage Tank	XTRSTRG1/V-105	$100,000	1	3.21	$321,000	Sharpsville Container
Extraction Unit	(EXTRCTON/V-103)	$500,000	1	4.16	$2,080,000	Sulzer Chemtech
Distillation	DISTILL/V-104	$500,000	1	4.16	$2,080,000	Armfield,

Unit						Inc.
Crystallization Unit	CRYST/CR-101	$500,000	1	4.16	$2,080,000	Conair Group
Storage Tank (65L)	STORAGE3/V-101	$15,000	1	3.21	$48,150	Sharpsville Container
Rosenmund Filter	ROSENMUND/GBX-101	$500,000	1	4.16	$2,080,000	De Dietrich Process System
Downstream Pumps (14)	S-15, -16, -17, -18, -20, -21, -22, -23, -24, -25, -26, -27, -28, -29	$13000	14	3.3	$600,600	Watson-Marlow
Storage Tubs	DRUM/V-101	$20	1	3.3	$1,156	Sharpsville Container
Total Geldanamycin Downstream Process Equipment Bare Module Costs: $13,604,500						

Table 12.3 Tanespimycin Reaction Process

Equipment Description	Unit number	Purchase Cost (1 unit)	Number of Units	Bare Module Factor	Bare Module Cost (total # units)	Vendor
60L Reactor (18)	REACTOR/PFR-101	$100,000	18	4.16	$7,488,000	ABEC
Rotary Evaporator	ROT-EVAP/RVF-101	$500,000	1	4.16	$2,080,000	De Dietrich Process Systems
Storage Tank	STORAGE4/V-102	$12,000	1	3.21	$38,520	Sharpsville Container
Rosenmund Filter	FLTR-DRY/GVX-101	$500,000	1	4.16	$2,080,000	De Dietrich Process Systems
Pumps (14)	S-32 (x10), S-33, S-34, S-35, S-36	$13,000	14	3.3	$600,600	Watson-Marlow
Total Tanespimycin Reaction Process Equipment Bare Module Costs: $12,287,120						

Table 12.4 Additional Equipment

Equipment Description	Unit number	Purchase Cost (1 unit)	Number of Units	Bare Module Factor	Bare Module Cost (total # units)	Vendor

Spare Pumps (7)	n/a	$13,000	7	3.3	$300,300	Watson-Marlow
Biowaste Tank	BIOINACT/LD-101	$125,000	1	3.21	$401,250	Sharpsville Container
Neutralization Tank 1	NEUTRLZ1/LD-102	$90,000	1	3.21	$288,900	Zurn
Neutralization Tank 2	NEUTRLZ2/LD-101	$18,000	1	3.21	$57,780	Zurn
Total Additional Equipment Bare Module Costs: $1,048,230						

12.1.2 Bare Module Factor Assumptions

Bare module factors were chosen as per guidance from the faculty advisors and industrial consultants. Table 12.3.1 indicates the assumed bar module factors for each type of equipment. The default in the profitability spreadsheet calculates a bare module factor of 3.21. This calculation is shown in Table 12.3.2. This value was used for the general storage tanks and neutralization/biowaste tanks. A bare module factor of 6 was used for the fermenters, as the consultants noted that pharmaceutical grade products that are involved in cell expansion and growth require additional care for installation and materials. The other values were selected based on Chapter 22 of Product *and Process Design Principles* (Seider, et al.).

Table 12.5 Assumed Bare Module Factors for Equipment Units

Equipment	**Assumed Bare Module Factor**
Media Prep Tanks	4.14
Erlenmeyer Flasks	2
Fermenters	6
Surge Tank & Storage Tanks & Waste Tanks	3.21
Pumps	3.3
Sterile Filters	2.32
Downstream Processing Equipment	4.14

Table 12.6 Bare Module Factor Calculator from profitability Spreadsheet

Bare Module Factor Calculator:

Use the tool below to calculate a particular bare module factor, then input in the required column to the left:

(Note, if no bare module factor is entered, the default of 3.21 will be used)

Cost of Installation Materials:	**71%**	of Equipment Purchase Cost
Cost of Installation Labor:	**54%**	of Equipment Purchase Cost
Cost for Freight, Insurances, and Taxes:	**9%**	of Equipment Purchase Cost
Cost of Construction Overhead:	**57%**	of Equipment Purchase Cost
Cost of Contractor Engineering Expenses:	**30%**	of Equipment Purchase Cost
Total Derived Bare Module Factor:	***3.21***	of Equipment Purchase Cost

12.2 Permanent Investment Costs

This section includes permanent investment costs related to Site Preparation, Facilities, Contingencies and Contractor Fees.

As indicated in Table 12.7, the Total Permanent Investment inputs from the profitability spreadsheet, the cost of site preparations is set to 1.00%, of the total bare module costs, as the equipment will all be installed in an existing pharmaceutical manufacturing facility. In addition, the cost of service facilities will be 5.0% of the Total Bare Module cost, the cost of contingencies and contractor fees will be 10.0% of the Total Depreciable Capital. Since this manufacturing facility will be within an existing manufacturing facility, there are no costs associated with the land or plant start-up. An overall view of the results from the profitability analysis will be included and analyzed in chapter 15.

Table 12.7 Total Permanent Investment Table

Total Permanent Investment					
		% of Total Permanent Investment			
Year:	**2021**	100%		(default is first year of Construction, otherwise over-ride this year)	
	2022	0%			
	2023	0%			
	2024	0%			
			Cost of Site Preparations:	1.00%	of Total Bare Module Costs
			Cost of Service Facilities:	5.00%	of Total Bare Module Costs
			Allocated Costs for utility plants and related facilities:	$0	
			Cost of Contingencies and Contractor Fees:	10.00%	of Direct Permanent Investment
			Cost of Land:	0.00%	of Total Depreciable Capital
			Cost of Royalties:	$0	
			Cost of Plant Start-Up:	0.00%	of Total Depreciable Capital

12.3 The cost of Clinical Trial

An assumed clinical trial sunk cost of $2billion is assumed, as explained further in Chapter 3.

13.0 Operating Cost- Cost of Manufacture: Input Summary

This chapter will describe the various operating costs involved in the economic analysis of the outlined production of tanespimycin. To perform the economic analysis of the outlined production of tanespimycin, the Profitability Analysis-4.0.xls spreadsheet by Brian K. Downey (2008) was used. While the inputs are explained in this chapter, the results from the profitability analysis as well as an input summary are included in Chapter 15.

13.1 Raw Materials

The purchase cost of all raw materials was determined by contact with vendors and consultants (More information in Chapter 5). The cost of raw materials per kg of Tanespimycin is about $43,698.

Table 13.1 Raw Material Costs per kg of Tanespimycin.

Raw Materials

	Raw Material:	Unit:	Required Ratio:		Cost of Raw Material:	
1	Primary Seed Media	amount per 1kg	1	amount per 1kg per kg of Tanespimycin	$15.318	per amount per 1kg
2	Secondary Seed Media	amount per 1kg	1	amount per 1kg per kg of Tanespimycin	$199.31	per amount per 1kg
3	Fermentation Media	amount per 1kg	1	amount per 1kg per kg of Tanespimycin	$4,840.59	per amount per 1kg
4	WFI	amount per 1kg	1	amount per 1kg per kg of Tanespimycin	$1.45	per amount per 1kg
5	Filter Aid	amount per 1kg	1	amount per 1kg per kg of Tanespimycin	$1,604.59	per amount per 1kg
6	Methylene Chloride	amount per 1kg	1	amount per 1kg per kg of Tanespimycin	$4,352.78	per amount per 1kg
7	Isooctane	amount per 1kg	1	amount per 1kg per kg of Tanespimycin	$29,587.73	per amount per 1kg
8	Allylamine	amount per 1kg	1	amount per 1kg per kg of Tanespimycin	$437.14	per amount per 1kg
9	THF	amount per 1kg	1	amount per 1kg per kg of Tanespimycin	$2,658.57	per amount per 1kg
	Total Weighted Average:				$43697.478	per kg of Tanespimycin

13.2 Utilities

The utility requirements can be found in the Utility summary from the profitability spreadsheet. Utilities demand about $929.346 per kg of 17-AAG produced. This utility calculation includes high pressure steam, process water, cooling water, electricity, propylene glycol for cooling, as well as the estimated cost of disposing of specific wastes throughout the process.

Table 13.2: Utility Costs per kg of Tanespimycin

Utilities

	Utility:	Unit:	Required Ratio		Utility Cost	
1	High Pressure Steam	lb	711	lb per kg of Tanespimycin	$0.010	per lb
2	Low Pressure Steam	lb	0	lb per kg of Tanespimycin	$0.000E+00	per lb
3	Process Water	gal	1110	gal per kg of Tanespimycin	$2.055E-03	per gal
4	Cooling Water	lb	127	lb per kg of Tanespimycin	$2.250E-03	per lb
5	Electricity	kWh	2.22E+03	kWh per kg of Tanespimycin	$0.080	per kWh
6	Wastes	total waste	1	total waste per kg of Tanespimycin	$657.000	per total wa
7	Propylene Glycol	total amount	1	total amount per kg of Tanespimycin	$85.070	per total am
8						
9						
10						
	Total Weighted Average:				$929.347	per kg of Ta

13.3 Fixed Costs

For the upstream and downstream geldanamycin process, a total of 13 employees per shift are required: 1 employee for fifty-two 2 L fermenters of both trains who will have a break every 5 days to monitor downstream, 1 employee for secondary fermenter of both trains who will have a break every 5 days to monitor downstream, 1 employee on each of the 50,000 L bioreactors at all times, and 1 employee at each of the downstream. For the tanespimycin production process, 11 employees per shift are required: 9 total employees for the 18 reactors, 1 employee for downstream and 1 employee for maintenance. Assuming four 8-hour shifts/day, full time salary is required for 96 employees. Each employee will be paid $47,000/year (Bureau of Labor Statistics, 2014), for a total employee cost of $4,512,000/year.

Maintenance and quality control personnel must also be accounted for in order to manage all CIP, SIP, and waste management procedures. For the facilities, regulatory personnel are also needed. Lastly, management positions will be needed to manage the engineering, financial, and human resources related issues.

Since this process is being developed in an existing BMS facility, technical assistance to manufacturing and a control laboratory are not taken into account in this profitability analysis. Many of the defaults remain the same in the spreadsheet, as indicated in the fixed cost summary, but property taxes and insurance were set to zero to the existence of the facility.

Table 13.3 Fixed Costs, Profitability Spreadsheet

Fixed Costs			
Operations			
	Operators per Shift:	24	(assuming 4 shifts)
	Direct Wages and Benefits:	$40	/operator hour
	Direct Salaries and Benefits:	15%	of Direct Wages and Benefits
	Operating Supplies and Services:	6%	of Direct Wages and Benefits
	Technical Assistance to Manufacturing:	$0.00	per year, for each Operator per Shift
	Control Laboratory:	$0.00	per year, for each Operator per Shift
Maintenance			
	Wages and Benefits:	4.50%	of Total Depreciable Capital
	Salaries and Benefits:	25.00%	of Maintenance Wages and Benefits
	Materials and Services:	100.00%	of Maintenance Wages and Benefits
	Maintenance Overhead:	5.00%	of Maintenance Wages and Benefits
Operating Overhead			
	General Plant Overhead:	7.10%	of Maintenance and Operations Wages and Benefits
	Mechanical Department Services:	2.40%	of Maintenance and Operations Wages and Benefits
	Employee Relations Department	5.90%	of Maintenance and Operations Wages and Benefits
	Business Services	7.40%	of Maintenance and Operations Wages and Benefits

Property Taxes and Insurance

Property Taxes and Insurance:	0.00%	of Total Depreciable Capital

Straight Line Depreciation

Direct Plant:	8.00%	of Total Depreciable Capital, less		1.18	times the Allocated Costs for Utility Plants and Related Facilities
Allocated Plant:	6.00%	of	1.18	times the Allocated Costs for Utility Plants and Related Facilities	

Other Annual Expenses

Rental Fees (Office and Laboratory Space):	$0
Licensing Fees:	$0
Miscellaneous:	$0

Depletion Allowance

Annual Depletion Allowance:	$0

Moreover, the spreadsheet allows for the specification of the percentages of product sales charged for selling/transfer expenses, direct research, allocated research, administrative expenses, and management incentives compensation. It was assumed that about 1.5% of sales would be spent on selling/transfer expenses with 0.5% of sales allocated to direct research and 4% of sales to allocated research. It was also assumed that the administrative expenses and management incentive compensation were both about 1.00% of sales.

The working capital is defined as the sum of the cash reserves, inventory, and accounts receivable, minus the accounts payable. The cash reserves is set to include 30 days of raw materials, utilities operation, and maintenance.4 days of product inventory and 2 days of raw material inventory has also been assumed.

Table 13.4 Other Variable Costs and Working Capital, Profitability Spreadsheet

Other Variable Costs

General Expenses

Selling / Transfer Expenses:	1.50%	of Sales
Direct Research:	0.50%	of Sales
Allocated Research:	4.00%	of Sales

Administrative Expense:	1.00%	of Sales
Management Incentive Compensation:	1.00%	of Sales

Working Capital

Accounts Receivable	⇨	**30**	**Days**
Cash Reserves (excluding Raw Materials)	⇨	**30**	**Days**
Accounts Payable	⇨	**30**	**Days**
Tanespimycin (17-AAG) Inventory	⇨	**4**	**Days**
Raw Materials	⇨	**2**	**Days**

14.0 Other Important Considerations

In the designing of an economical production process for tanespimycin, efforts were made to address environmental concerns and follow good manufacturing practices (GMP) and FDA regulations. Additionally, an IP expert was consulted to prevent intellectual property infringement due to the pre-existing patents.

14.1 Environmental Concerns

Environmental concerns for the process are governed by the biological and non-biological wastes produced. The biological waste, including the biomass removed from the rotary vacuum filtration, is considered class II biohazard and must be treated by a biowaste inactivation package. The package heats the contents to 80C for one minute to inactivate any living cells. After inactivation, the biomass which was previously mixed with water in order to allow it to be pumped is transferred and combined with the non-biological waste in the waste neutralization tanks. These tanks neutralize all contained contents to a pH of 7 and discharges neutralized waste to the sewage system.

Due to their adverse health and environmental effects, special care must be taken when disposing of methylene chloride and isooctane. In order to eliminate potential human contact with these chemicals,

methylene chloride and isooctane are directly pumped into 55 gallon drums, followed by removal by Clean Harbors - the contracted waste management company which will disposes the contents according to EPA regulated protocols.

No disposable equipment is used in this process; instead large equipment is cleaned using CIP measures, and small equipment is autoclaved. Additionally, limited landfill waste helps reduce the carbon footprint of this plant.

14.2 Good Manufacturing Practices

Current good manufacturing practices (cGMP) are a set of principles and procedures that must be followed by manufactures for therapeutic goods in order to ensure that the final product has the required quality.

First the plant must be reviewed by a quality management team to approve that the plant complies with regulations. These standards will be met by accounting for the needs such as WFI, CIP, SIP, adequate ventilation, and quality materials. Additionally, there must always be an adequate number of workers and personnel who are versed on the hygiene standards and trained with sufficient experience at the plant to perform their assigned tasks.

Final quality assurance testing of the product is not sufficient to ensure quality consistent with FDA regulations. Instead sampling and testing of in-process materials and drug products must be completed at different checkpoints throughout the process to insure batch uniformity and integrity of drug products. Checkpoints will be placed at the commencement or completion of all significant phases or after storage for long periods. Samples will be taken from transfer streams and tested for identity, strength, quality, and purity as appropriate. In addition, all raw materials will be checked by quality control personnel before moving to the production floor.

Storage tanks are put in place after each process in the upstream and downstream production. These tanks can be utilized in the case that the output of a process produces a product that fails quality control testing resulting in rejected materials. Once the rejected materials are pumped into the tank, the contents will be disposed of according to FDA regulation and not further processed. These tanks will limit

the downtime between failed batches and further costs associated with processing an unsatisfactory product.

A final quality check will be performed at the end of the process before transport to the internal BMS packaging branch. The packaging branch will also abide by cGMP. The packaging must be non-reactive, clean, and sanitized. Detailed labeling practices must be followed such as all labels must include details of the contents, strength, and dose form. Shipments with obsolete, insufficient, or outdated labels shall be destroyed.

All relevant information regarding these procedures as well as detailed descriptions of each practice are found in the Code of Federal Regulation 21 Part 211 (21 CFR 211) available electronically through the FDA website.

14.3 Intellectual Property/Patent Considerations

The production process for geldanamycin and tanespimycin presented in this report uses information and data from a 2003 geldanamycin production application patent and a 2009 tanespimycin production patent. To better understand the qualifications for infringement of the intellectual property protected by these patents, Dr. Brandt, a patent agent at Johnson and Johnson was consulted.

This report's process design for geldanamycin uses information from Upjohn Pharmaceuticals' 2003 patent application from Upjohn Pharmaceuticals. As a patent application is merely a pending request at the patent office, any aspects of the process described in the application are not protected by patent law, eliminating concerns of infringement.

This report's process design for tanespimycin uses a 2009 patent from Conforma. Upon consultation with Dr. Brandt, it became clear that the extreme specificity of the inventions described in the patent rendered infringement highly unlikely (unless an exact replica of the described process was pursued.) Thus, upon scale up modifications, equipment adjustments, and a shift from several batch to continuous processing steps, we are confident that the proposed design does not bear any infringement concerns.

15.0 Profitability Analysis

To determine the profitability of the outlined production of tanespimycin, the Profitability Analysis-4.0.xls spreadsheet by Brian K. Downey (2008) was used. However, because this costing estimation does not have the ability to account for the Phase III clinical trial cost of $2 billion, the most significant expense, additional calculation were conducted in order to account for this cost in year 2020 in the net present value (NPV) and internal rate of return (IRR).

15.1.0 Profitability Analysis

For the profitability analysis, it is assumed that the plant's effective tax rate is 37%, and that the cost of capital for the plant will be 15%. The economic analysis shows that the process for the final case has a net present value (at 15% and a life of 14 years) of about $3.2 billion and an internal rate of return (IRR) of 33 percent. The NPV and IRR are greatly dependent upon the cost the Phase III clinical trial estimate, and selling price of tanespimycin. A sensitivity analysis is performed at the end of this chapter in order to illustrate their dependency of these costs and values.

While the spreadsheet does not conveniently allow for integration of the Phase III trial cost into the spreadsheet, the IRR and NPV values were calculated independently and are included in section 15.1.1. Table 15.1 summarizes the end of the year cash flows each year as well as the cumulative net present value calculated per year. Excel's IRR function was used to determine the calculated 33 percent and included each year's cash flow incorporating the negative $2 billion in year 2020 incurred due to the Phase III clinical trial cost.

Profitability Measures

The Internal Rate of Return (IRR) for this project is 33.00%

The Net Present Value (NPV) of this project in 2020 is $3,172,265,206.53

ROI Analysis (Third Production Year)

Annual Sales	**2,200,427,350**
Annual Costs	**(253,163,493)**
Depreciation	**(14,686,597)**
Income Tax	**(715,053,586)**
Net Earnings	**1,217,523,674**
Total Capital Investment	**387,535,769**
ROI	**314.17%**

Table 15.1 End of year cash flows in each year and corresponding cumulative net present worth using a discount rate of 15%.

Year	Cash Flow (Billions)	Cumulative NPV (Billions)
2020	-2.00	-2.00
2021	-0.29	-2.25
2022	0.56	-1.82
2023	0.88	-1.24
2024	1.24	-0.53
2025	1.23	0.08
2026	1.23	0.62
2027	1.23	1.08
2028	1.23	1.48
2029	1.23	1.83
2030	1.23	2.13

2031	1.23	2.39
2032	1.23	2.62
2033	1.23	2.82
2034	1.23	3.00
2035	1.43	3.17

15.1.2 Price of Tanespimycin

As stated in the Market and Competitive Analysis, the cost of a full course of Herceptin treatment costs about $70,000 reported by Medical News Daily. Because tanespimycin will be used in conjunction with this treatment its price must be lower for it is not directly competing with Herceptin, but rather sharing the patient market. Also the patent on Herceptin expires in 2014 in Europe and in 2019 in the United States. Normally this would result in the production of a chemically identical generic version of the drug, which may be sold at a much lower price, for research and trial costs do not need to be recouped by generic manufacturers. However, Herceptin is a monoclonal antibody, which is a unique large-molecule drug. The manufacturing is complex and subject to lack of uniformity by nature (Mulcahy, 2013). Therefore, a chemically identical generic is impossible to produce, and instead, a biosimilar can be synthesized. This process is much more difficult and currently only combination therapies are been proposed rather than substitution therapies for Herceptin. Thus the patent expiration will not have the significant price dropping implications that usually occur in the pharmaceutical market. Additionally a conservative selling price is used because breast cancer is a popular field of research. With all the previously mentioned factors considered, a selling price of $20,000 per treatment will be utilized. Thus tanespimycin will cost approximately $2,137,000 per kilogram.

15.1.3 Plant Life

The new facility is expected to have a life of about 14 years. While most of the capital investment could technically have a longer lifespan, the marketing life of the drug can assumed to be less. Fourteen years is used as a conservative estimation of the number of years of production, but it could be more. General patent protection lasts 20 years. With a conservative guess, that the patent protection begins before the clinical trial begins, and assuming a clinical trial of 5 years and then an additional year for FDA paperwork and final approval, it is estimated that there will be 14 years that the drug can be produced under patent protection before generics jump into the market. While this may be longer (due to method of treatment patents filed during clinical trials or shorter clinical trials), for the purposes of the economic calculations, it is assumed that the plant will operate for 14 years with 2 additional years for design and construction. Since phase three clinical trials still need to be performed, the analysis is also based on the premise that installation of the equipment will begin in 2020, allowing for at least 5 years of the clinical trial to be underway before proceeding. In addition, it is important to note that the profitability analysis included here takes into account a $2billion phase III trial accounted for in 2020.

15.1.4 Input and Cost Summaries

Input and cost summaries generated from the profitability spreadsheet are included below. Assumptions are explained in Chapter 12 for fixed-capital investment, and chapter 13 for operating costs. The primary costs are capital investment and variable costs totaling $344 million and $233 million respectively, and fixed costs only total $31 million.

General Information

Process Title:	**The production of Tanespimycin: Final Case**
Product:	**Tanespimycin (17-AAG)**
Plant Site Location:	**Philadelphia**
Site Factor:	**1.10**
Operating Hours per Year:	**7919**
Operating Days Per Year:	**330**
Operating Factor:	**0.9040**

Product Information

This Process will Yield

0	kg of Tanespimycin (17-AAG) per hour
3	kg of Tanespimycin (17-AAG) per day
1,084	kg of Tanespimycin (17-AAG) per year

Price **$2,136,752.14** **/kg**

Chronology

Year	Action	Distribution of Permanent Investment	Production Capacity	Depreciation 5 year MACRS	Product Price
2020	Design		0.0%		
2021	Construction	100%	0.0%		
2022	Production	0%	47.5%	20.00%	$2,136,752.14
2023	Production	0%	71.3%	32.00%	$2,136,752.14
2024	Production	0%	95.0%	19.20%	$2,136,752.14
2025	Production		95.0%	11.52%	$2,136,752.14
2026	Production		95.0%	11.52%	$2,136,752.14
2027	Production		95.0%	5.76%	$2,136,752.14
2028	Production		95.0%		$2,136,752.14
2029	Production		95.0%		$2,136,752.14
2030	Production		95.0%		$2,136,752.14
2031	Production		95.0%		$2,136,752.14

2032	Production	95.0%	$2,136,752.14
2033	Production	95.0%	$2,136,752.14
2034	Production	95.0%	$2,136,752.14
2035	Production	95.0%	$2,136,752.14

Variable Cost Summary

Variable Costs at 100% Capacity:

General Expenses

	Selling / Transfer Expenses:		$ 34,743,590
	Direct Research:		$ 11,581,197
	Allocated Research:		$ 92,649,573
	Administrative Expense:		$ 23,162,393
	Management Incentive Compensation:		$ 23,162,393
Total General Expenses			$ 185,299,145
Raw Materials	$43,697.477811	per kg of Tanespimycin (17-AAG)	$47,368,066
Byproducts	$0.000000	per kg of Tanespimycin (17-AAG)	$0
Utilities	$929.347332	per kg of Tanespimycin (17-AAG)	$1,007,413
Total Variable Costs			**$233,674,624**

Fixed Cost Summary

Operations

Direct Wages and Benefits	$ 7,987,200
Direct Salaries and Benefits	$ 1,198,080
Operating Supplies and	$ 479,232

	Services		
	Technical Assistance to Manufacturing	$	-
	Control Laboratory	$	-
	Total Operations	**$**	**9,664,512**
Maintenance			
	Wages and Benefits	$	7,510,191
	Salaries and Benefits	$	1,877,548
	Materials and Services	$	7,510,191
	Maintenance Overhead	$	375,510
	Total Maintenance	**$**	**17,273,440**
Operating Overhead			
	General Plant Overhead:	$	1,318,684
	Mechanical Department Services:	$	445,752
	Employee Relations Department:	$	1,095,808
	Business Services:	$	1,374,403
	Total Operating Overhead	**$**	**4,234,648**
Property Taxes and Insurance			
	Property Taxes and Insurance:	$	-
Other Annual Expenses			
	Rental Fees (Office and Laboratory Space):	$	-
	Licensing Fees:	$	-
	Miscellaneous:	$	-
	Total Other Annual Expenses	**$**	**-**
Total Fixed Costs		**$**	**31,172,601**

Investment Summary

Total Bare Module Costs:		
Fabricated Equipment	$ 140,474,801	
Process Machinery	$ 1,501,500	
Spares	$ -	
Storage	$ 1,156,756	
Other Equipment	$ -	
Catalysts	$ -	
Computers, Software, Etc.	$ -	
Total Bare Module Costs:		**$ 143,133,057**
Direct Permanent Investment		
Cost of Site Preparations:	$ 1,431,331	
Cost of Service Facilities:	$ 7,156,653	
Allocated Costs for utility plants and related facilities:	$ -	
Direct Permanent Investment		**$ 151,721,040**
Total Depreciable Capital		
Cost of Contingencies & Contractor Fees	$ 15,172,104	
Total Depreciable Capital		**$ 166,893,144**
Total Permanent Investment		
Cost of Land:	$ -	
Cost of Royalties:	$ -	
Cost of Plant Start-Up:	$ -	
Total Permanent Investment - Unadjusted		$ 166,893,144
Site Factor		1.10
Total Permanent Investment		**$ 183,582,459**

Working Capital

	2021	2022	2023

Accounts Receivable	$ 90,428,521	$ 45,214,261	$ 45,214,261	
Cash Reserves	$ 1,256,343	$ 628,171	$ 628,171	
Accounts Payable	$ (1,888,632)	$ (944,316)	$ (944,316)	
Tanespimycin (17-AAG) Inventory	$ 12,057,136	$ 6,028,568	$ 6,028,568	
Raw Materials	$ 123,287	$ 61,643	$ 61,643	
Total		**$ 101,976,655**	**$ 50,988,328**	**$ 50,988,328**
Present Value at 15%		*$ 88,675,353*	*$ 38,554,501*	*$ 33,525,653*
Total Capital Investment				**$ 344,337,965**

Although these costs are all important to consider ensuring that this process is economical, the dominating cost is the $2 billion clinical trial cost in 2020. Due to its importance, a sensitivity analysis of the trial expense is presenting in the following section.

15.2.0 Sensitivity Analysis

A sensitivity analysis must be preformed for critical price parameters and values including the Phase III clinical trial price estimate and the selling price for tanespimycin treatment. This analysis will dictate which price estimations and considerations are worth altering based of the desired NPV and IRR.

15.2.1 Phase III Clinical Trial Cost Estimate

As discussed in Chapter 3, a conservative $2 billion Phase III clinical trial cost estimate was used to include the cost of the treating trial patients and adjust for the associated risk and opportunity cost of the trial investment. This cost trumps all other expenses involved, for the second largest expense is the equipment costs, which are on the order of millions. A less conservative Phase III clinical trial cost would therefore considerably impact both the NPV and IRR. NPV will vary linearly with the trial cost, for this expense is a present value sunk cost in year zero. Figure 15.1 demonstrates this linear NPV relationship as

well as the IRR relation to clinical trial cost. This IRR is more sensitive to trial cost when it is less than $1 billion, for once it exceeds $1 billion the trial cost trumps all other expenses and the IRR is less affected by additional increase.

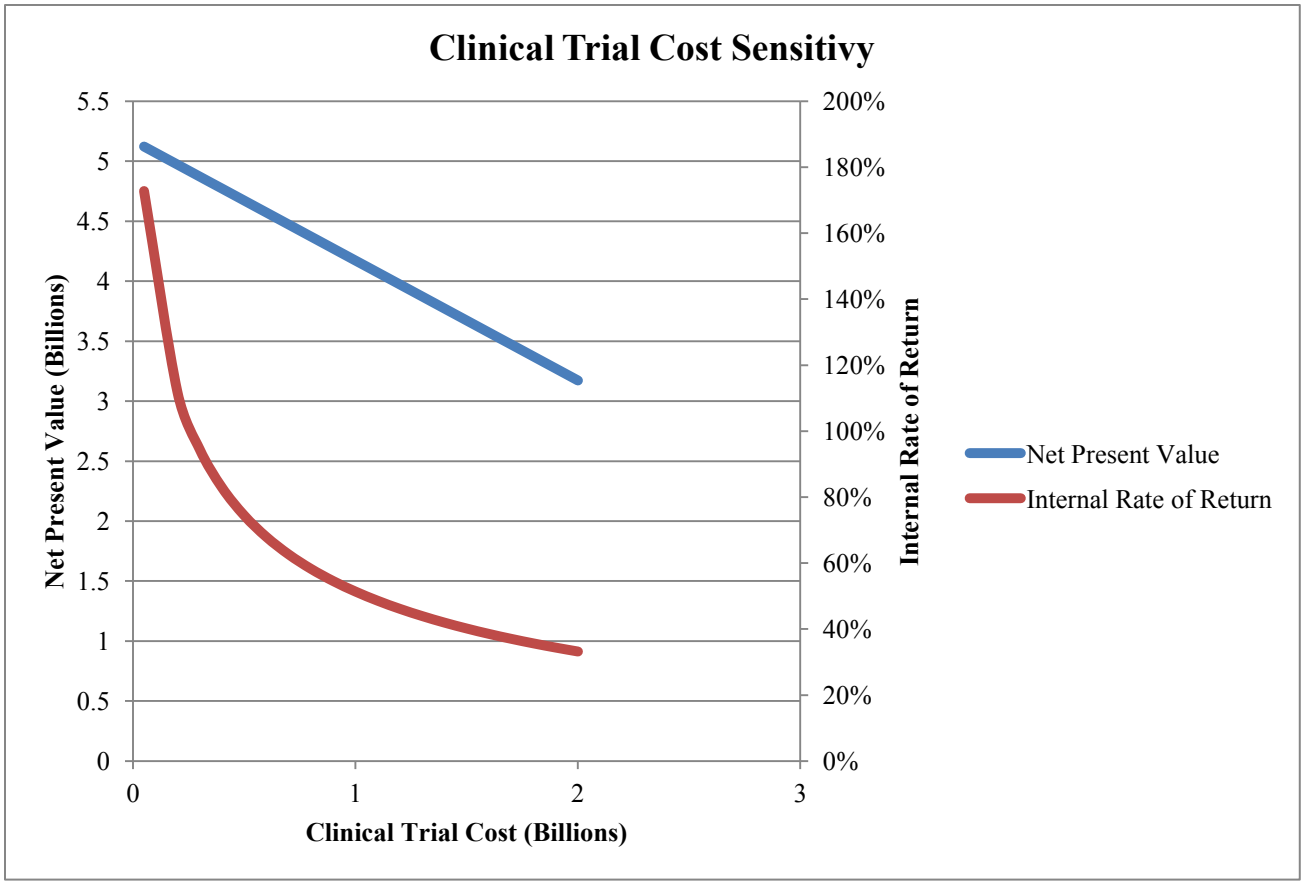


Figure15.1 Sensitivity analysis of the Phase III clinical trial cost on NPV and IRR.

15.2.2 Selling Price of Tanespimycin

As discussed in 15.1.2 the selling price of tanespimycin will be set at $20,000 per treatment after considering Herceptin pricing and recent patent expiration. This price is also subject to alteration due to the assumptions and estimations used in its calculation. Figure 15.2, illustrates that the NPV linearly increases as the selling price of tanespimycin increases. It is critical to note that the break even selling price per treatment is $7,833, for a negative NPV is achieved if sold below this minimum. The IRR also increases with the selling price; the IRR is more sensitive to price change below $40,000 and sensitivity decreases in the higher pricing regime, although this change in sensitivity is not significant.

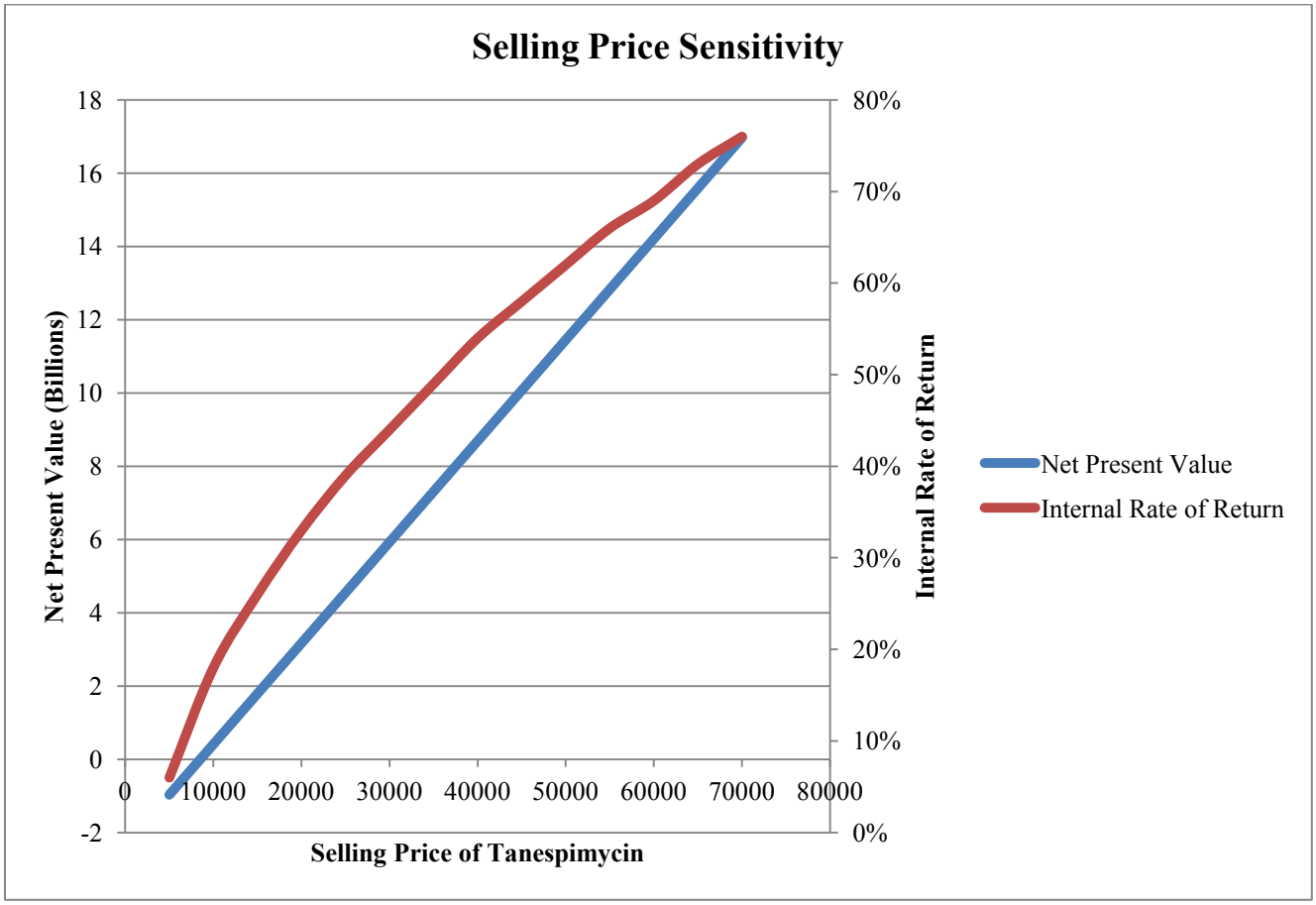


Figure 15.2 Sensitivity analysis of the selling price of tanespimycin on NPV and IRR.

16.0 Conclusions and Recommendations

This report describes an economical, scaled-up process design for the production of tanespimycin. The proposed facility requires full operation for 293 days/year, with fermentation yielding 21.9 kg/batch geldanamycin and subsequent reaction with allylamine at 90% yield giving 19.7 kg tanespimycin/ batch. Abiding by the timing and scheduling presented in Chapter 7 and the Appendix, 55 batches/year should produce 1030 kg of usable tanespimycin per year (95% of total tanespimycin produced), adequately meeting market demands.

From a financial standpoint, it is highly recommended that BMS move forward with this process design. Selling tanespimycin at a price of $20,000/kg, corresponding to a price of _____/treatment, BMS can expect an NPV of _____, an IRR of _____, and a ____% ROI after ____ years. This financial analysis has taken into account the cost of Phase III FDA clinical trials, as well as a price decrease for the proposed method of treatment with Herceptin, which will be going off-patent in the United States in 2019 (Mulcahy). Thus, these numbers motivate further investigation and investment in this project by BMS, as a financially feasible design for a cancer therapeutic with tremendous market potential will prove to be a great asset to the company. However, in order to adequately carry out the outlined proposal, it is highly recommended that BMS conserve initial capital by allowing Phase III clinical trials to use drug created by a CMO. Once tanespimycin has been approved by the FDA, it is recommended that BMS use an existing laboratory, such as the laboratory in Devens, Massachusetts, to begin production.

17.0 Acknowledgements

We would like to acknowledge the help and support that we received from several individuals who have made this project possible. We greatly appreciate the time, efforts, and suggestions of all of the industry consultants whom we have met with weekly over the past few months.

In particular, we would like to thank Mr. Edward Steve, a retired industrial consultant from the bio-pharmaceutical field, for his contributions to this project. Mr. Steve went above and beyond what we could have expected from an industry consultant. Mr. Steve was especially helpful in responding to emails in an extremely quick and thorough manner, answering all questions about process timing and scheduling, providing sources for us to find desired information, referring us to several companies for equipment pricing/sizing information, and offering his own expertise in the pharmaceutical industry. We are very grateful that we had Mr. Steve as a source of knowledge and advice throughout the entire process.

We would also like to thank several other consultants and professors who contributed to different areas of our project. Dr. Brandt was very helpful in providing insight into important IP considerations, particularly with the Geldanamycin 2003 production patent and the Tanespimycin 2009 production patent. Dr. Wattenbarger was a useful source in providing guidance on energy calculations and consultation regarding our geldanamycin-producing natural organism.

Additionally, we warmly acknowledge and appreciate Dr. Crocker for his crucial role in the development of this project. Dr. Crocker attended our weekly meetings throughout the semester, and was instrumental to our week-to-week progress. Dr. Crocker was especially helpful in revising, adjusting, and refining the project statement, and providing guidance on how to proceed after each advancement to reach our project goals.

Finally, we would like to thank Professor Fabiano for defining the scope of our project and providing clear expectations for us to meet throughout the semester. Additionally, we appreciate the resources he provided us with, including past projects, useful papers, and knowledgeable consultants.

18.0 Bibliography

2.0

Powers, M. V., & Workman, P. (2007). Inhibitors of the heat shock response: biology and pharmacology. FEBS letters, 581(19), 3758-3769.

J.C. Young, V.R. Agashe, K. Siegers, F.U. Hartl. Pathways of chaperone-mediated protein folding in the cytosol. Nat. Rev. Mol. Cell Biol., 5 (2004), pp. 781–791

L. Whitesell, S.L. Lindquist. HSP90 and the chaperoning of cancer. Nat. Rev. Cancer, 5 (2005), pp. 761–772

NCI: Developmental Therapeutics Program of the National Cancer Institute (in folder): http://dtp.nci.nih.gov/timeline/posters/AGG_Geldamycin.pdf

Bisht, K. S., Bradbury, C. M., Mattson, D., Kaushal, A., Sowers, A., Markovina, S., ... & Gius, D. (2003). Geldanamycin and 17-allylamino-17-demethoxygeldanamycin potentiate the in vitro and in vivo radiation response of cervical tumor cells via the heat shock protein 90-mediated intracellular signaling and cytotoxicity. Cancer research, 63(24), 8984-8995.

Amiri-Kordestani, Laleh, and Tito Fojo. "Why Do Phase III Clinical Trials in Oncology Fail so Often?" JNCI J Natl Cancer Inst 104.8 (2012): 568-69.Why Do Phase III Clinical Trials in Oncology Fail so Often? Web. 05 Apr. 2015.

Hurrell, Tracey, and Kim Outhuff. "Human Epidermal Growth Factor Receptor 2-positive Breast Cancer: Which | OTT." OncoTargets and Therapy 2013:6 (2013): 693-701. Human Epidermal Growth Factor Receptor 2-positive Breast Cancer: Which | OTT. Web. 05 Apr. 2015.

3.0

Nordqvist, Christian. "One Year On Herceptin For Breast Cancer Ideal." *Medical News Today*. MediLexicon, Intl., 1 Oct. 2012. Web. 6 Apr. 2015. <http://www.medicalnewstoday.com/articles/250912.php>

4.0

"Geldanamycin Analogs." Geldanamycin Analogs. Developmental Therapeutics Program of the National Cancer Institute, 8 May 2013. Web. 6 Apr. 2015.

Gillespie, Donald, John Ceglarek, Christopher Rysenga, Gregory Mannes, Omar Salman, and Kevin Short. "Patent EP1483395A1 - Process to Prepare and Isolate Geldanamycin." US Patent Office, 8 Dec. 2004. Web. 6 Apr. 2015.

Zhang, Lin, Marcus Boehm, and Siead Zegar. "Patent US7579462 - Reacting Allyl Amine and Geldanamycin in Volatile Aprotic Solvent (tetrahydrofuran), Concentrating by Evaporation, Adding Volatile Protic Solvent (iisopropanol), Removing Protic Solvent to Purify, Then Filtering; Making 17-allylamino-ge." US Patent Office, 25 Aug. 2009. Web. 6 Apr. 2015.

7.0

"May 2014 National Occupational Employment and Wage Estimates." U.S. Bureau of Labor Statistics. U.S. Bureau of Labor Statistics, 15 May 2014. Web. 6 Apr. 2015.

Dutta, S., Basak, B., Bhunia, B., Chakraborty, S., & Dey, A. (2013, December 1). Kinetics of rapamycin production by Streptomyces hygroscopicus MTCC 4003. Retrieved April 6, 2015

"Continuous Production." Continuous Production Methods Provide Great Benefits in Beverage Production Plants · Miteco AG. Web. 7 Apr. 2015. <http://www.miteco.com/technology-continuous-production.html>

Shuler, Michael L., and Fikret Kargi. Bioprocess Engineering: Basic Concepts. 2nd ed. Upper Saddle River, NJ: Prentice Hall, 2002. 329-332. Print.

14.0

Food and Drug Administration: CFR - Code of Federal Regulations Title 21, Current Good Manufacturing Practice for Finished Pharmaceuticals. Web. 7 Apr. 2015. <http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm?cfrpart=211>

15.0

Mulcahy, Nick. (2013, December 13). As Herceptin Goes Off Patent, 'Biosimilars' Emerge. Web. 6 Apr. 2015. <http://www.medscape.com/viewarticle/817812>

16.0

Dutta, S., Basak, B., Bhunia, B., Chakraborty, S., & Dey, A. (2013, December 1). Kinetics of rapamycin production by Streptomyces hygroscopicus MTCC 4003. Web. 6 Apr. 2015. <http://link.springer.com/article/10.1007/s13205-013-0189-2/fulltext.html>

Mulcahy, Nick. (2013, December 13). "As Herceptin Goes Off Patent, Biosimilars Emerge" Medscape. Web. 6 Apr. 2015. <http://www.medscape.com/viewarticle/817812>

Appendix A - Calculations

Growth Rate

Doubling time $(h) = \tau_d = \frac{ln(2)}{\mu_{net}}$

Specific growth rate $(h^{-1}) = \mu_{net} = \frac{1}{X}\frac{dX}{dt}$ where X is cell concentration in g/L.

For Streptomyces hygroscopicus, an average doubling time of 1.2 days was used to calculate the amount of cell throughout the process.

Heat Generation from Biomass

Heat generation $(kJ) = Q_G = m_{cell}\mu_{net}\frac{1}{Y_H}$ where Y_H is 0.42 for glucose media.

Coolant Flow Rates and Pipe Sizing

Heat per mass $(kJ) = Q = mc\Delta T$, where c is the specific heat of the cooling material (water $= 4.184$ kJ/kg/K and propylene glycol $= 2.173$ kJ/kg/K)

For the upstream process, cooling water will enter at 5^oC. For the downstream, propylene glycol will enter at -20^oC.

Diameter of pipe $(in) = D = \sqrt{\frac{4m}{\rho\pi u}}$, where u is the velocity of pipe flow, taken to be 5 m/s.

Using these formulas, one can find that for the two processes, a nominal pipe size of 0.25 in and 3.5 in should be used.

Vessel Sizing

In order to scale up to vessel size V from a price p_0 defined for a size V_0, the following relationship can be used to find the new price: $p = (\frac{V}{V_0})^{\frac{2}{3}} * p_0$

4.04 Tanespimycin Base Design & Scale Up

Reactor Volume Increase: $\frac{4\text{ hr reaction time}}{.045\text{ kg geld.}} = \frac{X/24\text{ day reaction time}}{24\text{ kg geld.}}$

$X = 88.9$ day reaction time

Assuming linear scale-up, 88.9 days would be required to react ~24 kg geld/batch produced in geld production process. However, the decrease in surface area available/mass ratio at the bigger scale indicates the required reaction time would possibly be >88.9 days.

Reactor Number Increase: Assuming linear scale-up applies for estimation purposes

$\frac{4\text{ hr reaction time}}{.045\text{ kg geld}} = \frac{5(24)\text{ hr desired reaction time}}{X\text{ kg geld.}}$

$X = 1.35$ kg geld/reactor

Total kg geld/batch = 24 kg

Reactor # required = 24 kg/1.35 kg geld/reactor = 17.7 reactors

* The maximum 5 day reaction time was chosen so as not to make the reaction step the bottleneck of the process (which would change the number of batches produced/year.

6.0 Process Flow Diagram & Material Balance

Biomass production: the mass of cells after each fermentation was calculated by using a doubling time of 1.4 days for Streptomyces Hygroscopicus

1st Fermentation: 3 day incubation in Erlenmeyer Flasks

Total input cell mass for all EF = 0.173 kg (displayed in 6.1.2)

output cell mass = 0.173 · 2^(3/1.4) = 0.764 kg biomass

2nd Fermentation: 3 day incubation

output cell mass = 0.978 · 2^(3/1.4) = 3.373 kg biomass

3rd Fermentation: 9.5 day incubation

output cell mass = 3.373 · 2^(9.5/1.4) = 372.139 kg biomass

6.2.2 Material Balances by Vessel

Material flow rates for continuous processing steps were calculated by dividing component mass/batch by the time duration of the processing step

Fisher Scientific

Part of Thermo Fisher Scientific

Material Safety Data Sheet

Creation Date 27-Jan-2010 **Revision Date** 27-Oct-2014 **Revision Number** 1

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name **Methylene chloride**

Cat No. : **D37-1; D37-4; D37-20; D37-200; D37-200LC; D37-500; D37FB-19; D37FB-50; D37FB-115; D37FB-200; D37POP-19; D37POPB-50; D37POPB-200; D37RB-19; D37RB-50; D37RB-115; D37RB-200; D37RS-19; D37RS-28; D37RS-50; D37RS-115; D37RS-200; D37SK-4; D37SK-4LC; D37SS-28; D37SS-50; D37SS-115; D37SS-200; D37SS-1350**

Synonyms Dichloromethane; DCM

Recommended Use Laboratory chemicals

Company
Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Emergency Telephone Number
CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 001-703-527-3887

2. HAZARDS IDENTIFICATION

WARNING

Emergency Overview

Possible cancer hazard. May cause cancer based on animal data. Irritating to eyes and skin. May be harmful if inhaled. May cause irritation of respiratory tract. Inhalation may cause central nervous system effects. WARNING! This product contains a chemical known in the State of California to cause birth defects or other reproductive harm. Very toxic: danger of very serious irreversible effects in contact with skin. Flammable. Harmful if swallowed. May cause allergic respiratory reaction. Toxic to aquatic organisms.

Appearance Colorless **Physical State** Liquid **Odor** sweet

Target Organs Skin, Eyes, Central nervous system (CNS), Blood, Liver, Kidney, Central Vascular System (CVS)

Potential Health Effects

Acute Effects
Principle Routes of Exposure

Eyes Irritating to eyes. Contact with eyes may cause irritation.

Skin Irritating to skin. May be harmful in contact with skin. May cause eye/skin irritation.

Inhalation May be harmful if inhaled. Inhalation may cause central nervous system effects. May cause irritation of respiratory tract.

Ingestion May be harmful if swallowed. Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhea. Ingestion may cause irritation to mucous membranes.

Chronic Effects
Avoid repeated exposure

Aggravated Medical Conditions Central nervous system disorders. Preexisting eye disorders. Skin disorders. Kidney disorders. Liver disorders.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Component	CAS-No	Weight %
Methylene chloride	75-09-2	>99.5
Methyl alcohol	67-56-1	0 - 0.4
Cyclohexene	110-83-8	0 - 0.01 0 -
2-Methyl-2-butene	513-35-9	0.01

4. FIRST AID MEASURES

Eye Contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Obtain medical attention.

Skin Contact Wash off immediately with plenty of water for at least 15 minutes. Obtain medical attention.

Inhalation Move to fresh air. If breathing is difficult, give oxygen. Obtain medical attention.

Ingestion Clean mouth with water and drink afterwards plenty of water.

Notes to Physician Treat symptomatically

5. FIRE-FIGHTING MEASURES

Flash Point No information available No
Method - information available

Autoignition Temperature 556 °C / 1032.8 °F

Explosion Limits
Upper 23 vol % 13 vol
Lower %

Suitable Extinguishing Media Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

Unsuitable Extinguishing Media No information available

Hazardous Combustion Products No information available.

Sensitivity to Mechanical Impact No information available No
Sensitivity to Static Discharge information available

Specific Hazards Arising from the Chemical
Thermal decomposition can lead to release of irritating gases and vapors. Keep product and empty container away from heat and sources of ignition.

Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

NFPA **Health** 2 **Flammability** 1 **Instability** 0 **Physical hazards** N/A

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions Use personal protective equipment. Ensure adequate ventilation.

Environmental Precautions Should not be released into the environment. See Section 12 for additional ecological information.

Methods for Containment and Clean Up Soak up with inert absorbent material. Keep in suitable, closed containers for disposal.

7. HANDLING AND STORAGE

Handling Wear personal protective equipment. Ensure adequate ventilation. Do not get in eyes, on skin, or on clothing. Avoid ingestion and inhalation.

Storage Keep containers tightly closed in a dry, cool and well-ventilated place.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Measures Use only under a chemical fume hood. Ensure adequate ventilation, especially in confined areas. Ensure that eyewash stations and safety showers are close to the workstation location.

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH
Methylene chloride	TWA: 50 ppm	(Vacated) TWA: 500 ppm (Vacated) STEL: 2000 ppm (Vacated) Ceiling: 1000 ppm TWA: 25 ppm STEL: 125 ppm	IDLH: 2300 ppm
Methyl alcohol	TWA: 200 ppm STEL: 250 ppm Skin	(Vacated) TWA: 200 ppm (Vacated) TWA: 260 mg/m³ (Vacated) STEL: 250 ppm (Vacated) STEL: 325 mg/m³ Skin TWA: 200 ppm TWA: 260 mg/m³	IDLH: 6000 ppm TWA: 200 ppm TWA: 260 mg/m³ STEL: 250 ppm STEL: 325 mg/m³
Cyclohexene	TWA: 300 ppm	(Vacated) TWA: 300 ppm (Vacated) TWA: 1015 mg/m³ TWA: 300 ppm TWA: 1015 mg/m³	IDLH: 2000 ppm TWA: 300 ppm TWA: 1015 mg/m³

Component	Quebec	Mexico OEL (TWA)	Ontario TWAEV
Methylene chloride	TWA: 50 ppm TWA: 174 mg/m³	TWA: 100 ppm TWA: 330 mg/m³ STEL: 500 ppm STEL: 1740 mg/m³	TWA: 50 ppm
Methyl alcohol	TWA: 200 ppm TWA: 262 mg/m³ STEL: 250 ppm STEL: 328 mg/m³ Skin	TWA: 200 ppm TWA: 260 mg/m³ STEL: 250 ppm STEL: 310 mg/m³	TWA: 200 ppm STEL: 250 ppm Skin
Cyclohexene	TWA: 300 ppm TWA: 1010 mg/m³	TWA: 300 ppm TWA: 1015 mg/m³	TWA: 300 ppm

Legend

NIOSH IDLH: *The National Institute for Occupational Safety and Health Immediately Dangerous to Life or Health*

Personal Protective Equipment

Eye/face Protection Tightly fitting safety goggles. Face-shield. Long sleeved clothing.
Skin and body protection
Respiratory Protection Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State Liquid
Appearance Colorless
Odor sweet
Odor Threshold No information available
pH Not applicable

Vapor Pressure 20 mmHg @ 3502°C
Vapor Density 2.93 (Air = 1.0)

Viscosity	No information available
Boiling Point/Range	39 °C / 102.2 °F
Melting Point/Range	-97 °C / -142.6 °F
Decomposition Temperature	No information available No
Flash Point	information available No
Evaporation Rate	information available
Specific Gravity	1.33
Solubility	No information available
log Pow	No data available
Molecular Weight	84.93
Molecular Formula	C H2 Cl2

10. STABILITY AND REACTIVITY

Stability Stable under normal conditions.

Conditions to Avoid Incompatible products. Excess heat.

Incompatible Materials Strong oxidizing agents, Strong acids, Amines

Hazardous Decomposition Products Carbon monoxide (CO), Carbon dioxide (CO_2), Hydrogen chloride gas, Phosgene

Hazardous Polymerization Hazardous polymerization does not occur.

Hazardous Reactions None under normal processing.

11. TOXICOLOGICAL INFORMATION

Acute Toxicity

Product Information

Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Methylene chloride	> 2000 mg/kg (Rat)	> 2000 mg/kg (Rat)	53 mg/L (Rat) 6 h
Methyl alcohol	6200 mg/kg (Rat)	Not listed	22500 ppm (Rat) 8 h
Cyclohexene	Not listed	>200 mg/kg (Rat)	>21.6 mg/L/4h (rat)
2-Methyl-2-butene	700-2600 mg/kg (Rat)	>2000 mg/kg (Rat)	61000 ppm (Rat) 4 h

Irritation Irritating to eyes and skin

Toxicologically Synergistic Products No information available

Chronic Toxicity

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	ACGIH	IARC	NTP	OSHA	Mexico
Methylene chloride	A3	Group 2B	Reasonably Anticipated	X	A3

ACGIH: (American Conference of Governmental Industrial Hygienists)
A1 - Known Human Carcinogen
A2 - Suspected Human Carcinogen
A3 - Animal Carcinogen
ACGIH: (American Conference of Governmental Industrial Hygienists)

IARC: (International Agency for Research on Cancer)
IARC: (International Agency for Research on Cancer)
Group 1 - Carcinogenic to Humans
Group 2A - Probably Carcinogenic to Humans Group 2B -
Possibly Carcinogenic to Humans
NTP: (National Toxicity Program)
NTP: (National Toxicity Program)
Known - Known Carcinogen
Reasonably Anticipated - Reasonably Anticipated to be a Human Carcinogen
Mexico - Occupational Exposure Limits - Carcinogens
Mexico - Occupational Exposure Limits - Carcinogens
A1 - Confirmed Human Carcinogen A2 -
Suspected Human Carcinogen A3 - Confirmed
Animal Carcinogen
A4 - Not Classifiable as a Human Carcinogen A5 - Not
Suspected as a Human Carcinogen

Sensitization No information available

Mutagenic Effects Mutagenic effects have occured in microorganisms.

Reproductive Effects Experiments have shown reproductive toxicity effects on laboratory animals.

Developmental Effects Developmental effects have occurred in experimental animals.

Teratogenicity No information available.

Other Adverse Effects Tumorigenic effects have been reported in experimental animals. See actual entry in RTECS for complete information.

Endocrine Disruptor Information No information available

12. ECOLOGICAL INFORMATION

Ecotoxicity .

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Methylene chloride	EC50:>660 mg/L/96h	Pimephales promelas: LC50:193 mg/L/96h	EC50: 1 mg/L/24 h	EC50: 140 mg/L/48h
Methyl alcohol	Not listed	Pimephales promelas: LC50 > 10000 mg/L 96h	EC50: 2.88 mg/L/15 min EC50 = 39000 mg/L 25 min	EC50 > 10000 mg/L 24h
Cyclohexene	Not listed	Poecillia reticulata: 7.1 mg/L/96h	EC50 = 40000 mg/L 15 min EC50 = 43000 mg/L 5 min Not listed	Daphnia: EC50: 5.3 mg/L/48h
2-Methyl-2-butene	Not listed	Not listed	Not listed	3 mg/L EC50 = 48 h

Persistence and Degradability .

Bioaccumulation/ Accumulation No information available.

Mobility Will likely be mobile in the environment due to its volatility.

Component	log Pow
Methylene chloride	1.25
Methyl alcohol	-0.74
Cyclohexene	3.27

13. DISPOSAL CONSIDERATIONS

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

Component	RCRA - U Series Wastes	RCRA - P Series Wastes
Methylene chloride - 75-09-2	U080	-
Methyl alcohol - 67-56-1	U154	-

14. TRANSPORT INFORMATION

DOT

UN-No UN1593
Proper Shipping Name DICHLOROMETHANE
Hazard Class 6.1
Packing Group III

TDG

UN-No UN1593
Proper Shipping Name DICHLOROMETHANE
Hazard Class 6.1
Packing Group III

IATA

UN-No UN1593
Proper Shipping Name Dichloromethane
Hazard Class 6.1
Packing Group III

IMDG/IMO

UN-No UN1593
Proper Shipping Name Dichloromethane
Hazard Class 6.1
Packing Group III

15. REGULATORY INFORMATION

All of the components in the product are on the following Inventory lists: X = listed

International Inventories

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	IECSC	KECL
Methylene chloride	X	X	-	200-838-9	-		X	X	X	X	X
Methyl alcohol	X	X	-	200-659-6	-		X	X	X	X	X
Cyclohexene	X	X	-	203-807-8	-		X	X	X	X	X
2-Methyl-2-butene	X	X	-	208-156-3	-		X	X	X	X	X

Legend:

X - Listed

E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.

F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.

N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.

P - Indicates a commenced PMN substance

R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.

S - Indicates a substance that is identified in a proposed or final Significant New Use Rule

T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.

XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B).

Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.

Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations

TSCA 12(b)

SARA 313

Component	CAS-No	Weight %	SARA 313 - Threshold Values %
Methylene chloride	75-09-2	>99.5	0.1
Methyl alcohol	67-56-1	0 - 0.4	1.0

SARA 311/312 Hazardous Categorization

Acute Health Hazard	Yes
Chronic Health Hazard	Yes
Fire Hazard	No
Sudden Release of Pressure Hazard	No
Reactive Hazard	No

Clean Water Act

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Methylene chloride 75-09-2 (>99.5)	-	-	X	X

Clean Air Act

Component	HAPS Data	Class 1 Ozone Depletors	Class 2 Ozone Depletors
Methylene chloride 75-09-2 (>99.5)	X		-
Methyl alcohol 67-56-1 (0 - 0.4)	X		-

OSHA Occupational Safety and Health Administration

Not applicable

Component	Specifically Regulated Chemicals	Highly Hazardous Chemicals

Methylene chloride 75-09-2 (>99.5)	125 ppm STEL 12.5 ppm Action Level 25 ppm TWA	-

CERCLA

This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Methylene chloride	1000 lb 1 lb	-
Methyl alcohol	5000 lb	-

California Proposition 65

This product contains the following Proposition 65 chemicals:

Component	CAS-No	California Prop. 65	Prop 65 NSRL	Category
Methylene chloride	75-09-2	Carcinogen	200 µg/day 50 µg/day	Carcinogen
Methyl alcohol	67-56-1	Developmental	-	Developmental

State Right-to-Know

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Methylene chloride	X	X	X	X	X
Methyl alcohol	X	X	X	X	X
Cyclohexene	X	X	X	-	X
2-Methyl-2-butene	X	X	X	-	-

U.S. Department of Transportation

Reportable Quantity (RQ): YDOT
Marine Pollutant NDOT
Severe Marine Pollutant N

U.S. Department of Homeland Security

This product does not contain any DHS chemicals.

Other International Regulations

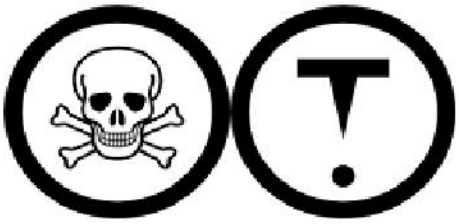
Mexico - Grade No information available

Canada

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR

WHMIS Hazard Class

D1B Toxic materials
D2A Very toxic materials



16. OTHER INFORMATION

Prepared By	Regulatory Affairs Thermo Fisher Scientific Email: EMSDS.RA@thermofisher.com
Creation Date	27-Jan-2010
Print Date	27-Oct-2014

Revision Summary
(M)SDS sections updated 2

Disclaimer
The information provided on this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guide for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered as a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other material or in any process, unless specified in the text.

End of MSDS

Fisher Scientific

Part of Thermo Fisher Scientific

Material Safety Data Sheet

Creation Date 22-Jun-2009 **Revision Date** 23-Sep-2009 **Rev** **Revision Number** 1

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name **Isooctane**

Cat No. **O296-1; O296-4; O296RS-28; O296RS-115; O296SK-1; O296SK-4; O296SS-28; O296SS-50; O296SS-115; O296SS-200; O297-4; O299-1; O299-4; O299FB-50; O299FB-200; O299RS-115; O299SS-28; O299SS-50; O299SS-115; O299SS-200; O300-1; O300-4; O301-1; O301-4**

Synonyms 2,2,4-Trimethylpentane; Isobutyltrimethylmethane (HPLC/Pesticide/Certified ACS/Spectranalyzed/Optima)

Recommended Use Laboratory chemicals

Company
Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Emergency Telephone Number
CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 703-527-3887

2. HAZARDS IDENTIFICATION

DANGER!

Emergency Overview

Flammable liquid and vapor. Causes eye, skin, and respiratory tract irritation. Vapors may cause drowsiness and dizziness. Aspiration hazard if swallowed - can enter lungs and cause damage. Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Appearance Colorless **Physical State** Liquid **odor** Petroleum distillates

Target Organs Kidney, Central nervous system (CNS), Eyes, Skin, Respiratory system

Potential Health Effects

Acute Effects
Principle Routes of Exposure

Eyes Irritating to eyes.
Skin Irritating to skin. May be harmful in contact with skin.
Inhalation Irritating to respiratory system. May be harmful if inhaled. Inhalation may cause central nervous system effects.

Ingestion May be harmful if swallowed. Aspiration hazard. Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhea.

Chronic Effects Mutagenic effects have occurred in experimental animals.. May cause adverse kidney effects.

See Section 11 for additional Toxicological information.

Aggravated Medical Conditions No information available.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Haz/Non-haz

Component	CAS-No	Weight %
Isooctane	540-84-1	99

4. FIRST AID MEASURES

Eye Contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Obtain medical attention.

Skin Contact Wash off immediately with plenty of water for at least 15 minutes. Obtain medical attention.

Inhalation Move to fresh air. If breathing is difficult, give oxygen. Do not use mouth-to-mouth resuscitation if victim ingested or inhaled the substance; induce artificial respiration with a respiratory medical device. Obtain medical attention.

Ingestion Do not induce vomiting. Call a physician or Poison Control Center immediately.

Notes to Physician Treat symptomatically.

5. FIRE-FIGHTING MEASURES

Flash Point -12°C / 10.4°F

Method No information available.

Autoignition Temperature 417°C / 782.6°F

Explosion Limits
Upper 6.0 vol % 1.1 vol
Lower %

Suitable Extinguishing Media CO_2, dry chemical, dry sand, alcohol-resistant foam. Use water spray to cool unopened containers.

Unsuitable Extinguishing Media Water may be ineffective, Do not use a solid water stream as it may scatter and spread fire

Hazardous Combustion Products No information available.

Sensitivity to mechanical impact No information available.
Sensitivity to static discharge No information available.

Specific Hazards Arising from the Chemical
Flammable. Risk of ignition. Vapors may form explosive mixtures with air. Vapors may travel to source of ignition and flash back. Containers may explode when heated.

Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear. Thermal decomposition can lead to release of irritating gases and vapors.

NFPA **Health** 1 **Flammability** 3 **Instability** 0 **Physical hazards** N/A

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions Use personal protective equipment. Remove all sources of ignition. Take precautionary measures against static discharges. Do not get in eyes, on skin, or on clothing.

Environmental Precautions Should not be released into the environment.

Methods for Containment and Clean Up Remove all sources of ignition. Soak up with inert absorbent material. Take precautionary measures against static discharges. Keep in suitable and closed containers for disposal.

7. HANDLING AND STORAGE

Handling Use only under a chemical fume hood. Use explosion-proof equipment. Wear personal protective equipment. Keep away from open flames, hot surfaces and sources of ignition. Take precautionary measures against static discharges.

Storage Keep away from open flames, hot surfaces and sources of ignition. Keep containers tightly closed in a dry, cool and well-ventilated place. Flammables area.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering Measures Use only under a chemical fume hood. Use explosion-proof electrical/ventilating/lighting/equipment. Ensure that eyewash stations and safety showers are close to the workstation location.

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH
Isooctane	TWA: 300 ppm		

NIOSH IDLH: *Immediately Dangerous to Life or Health*

Personal Protective Equipment

Eye/face Protection Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin and body protection Wear appropriate protective gloves and clothing to prevent skin exposure.

Respiratory Protection Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State	Liquid
Appearance	Colorless
odor	Petroleum distillates
Odor Threshold	No information available.

9. PHYSICAL AND CHEMICAL PROPERTIES

pH	Not applicable
Vapor Pressure	51 mbar @ 20 °C
Vapor Density	3.94 (Air = 1.0)
Viscosity	0.51 mPa s at 22 °C
Boiling Point/Range	98 - 99°C / 208.4 - 210.2°F@ 760 mmHg
Melting Point/Range	-107°C / -160.6°F
Decomposition temperature	No information available.
Flash Point	-12°C / 10.4°F
Evaporation Rate	No information available.
Specific Gravity	0.690
Solubility	Insoluble in water No
log Pow	data available
Molecular Weight	114.23 C8
Molecular Formula	H18

10. STABILITY AND REACTIVITY

Stability	Stable under normal conditions.
Conditions to Avoid	Incompatible products. Heat, flames and sparks.
Incompatible Materials	Strong oxidizing agents, Strong acids, Strong bases
Hazardous Decomposition Products	Carbon monoxide (CO), Carbon dioxide (CO_2)
Hazardous Polymerization	Hazardous polymerization does not occur.
Hazardous Reactions .	None under normal processing..

11. TOXICOLOGICAL INFORMATION

Acute Toxicity

Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Isooctane	2500 mg/kg (Rat)	Not listed	34.7 mg/L (Rat) 4 h 47.4 mg/L (Rat) 1 h

Irritation Irritating to eyes, respiratory system and skin

Toxicologically Synergistic Products No information available.

Chronic Toxicity

Carcinogenicity There are no known carcinogenic chemicals in this product

Sensitization	No information available.
Mutagenic Effects	Mutagenic effects have occurred in experimental animals.
Reproductive Effects	No information available.
Developmental Effects	No information available.
Teratogenicity	No information available.
Other Adverse Effects	The toxicological properties have not been fully investigated.. See actual entry in RTECS for complete information.
Endocrine Disruptor Information	No information available

12. ECOLOGICAL INFORMATION

Ecotoxicity

Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Persistence and Degradability	No information available
Bioaccumulation/ Accumulation	No information available
Mobility	No information available

13. DISPOSAL CONSIDERATIONS

Waste Disposal Methods	Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification

14. TRANSPORT INFORMATION

DOT

UN-No	UN1262
Proper Shipping Name	OCTANES
Hazard Class	3II
Packing Group	

TDG

	UN1262
UN-No	OCTANES
Proper Shipping Name	3II
Hazard Class	
Packing Group	

IATA

14. TRANSPORT INFORMATION

UN-No UN1262
Proper Shipping Name OCTANES
Hazard Class 3
Packing Group II

IMDG/IMO

UN-No UN1262
Proper Shipping Name OCTANES
Hazard Class 3II
Packing Group

15. REGULATORY INFORMATION

International Inventories

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	CHINA	KECL
Isooctane	X	X	-	208-759-1	-		X	X	X	X	KE-34634 X

Legend:
X - Listed
E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA. F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.
N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.
P - Indicates a commenced PMN substance
R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.
S - Indicates a substance that is identified in a proposed or final Significant New Use Rule T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.
XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B).
Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.
Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations

TSCA 12(b) Not applicable

SARA 313
Not applicable

SARA 311/312 Hazardous Categorization

Acute Health Hazard Yes
Chronic Health Hazard No
Fire Hazard Yes No No
Sudden Release of Pressure Hazard
Reactive Hazard

Clean Water Act
Not applicable

Clean Air Act

Component	HAPS Data	Class 1 Ozone Depletors	Class 2 Ozone Depletors
Isooctane	X		-

OSHA
Not applicable

CERCLA
This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Isooctane	1000 lb	-

California Proposition 65
This product does not contain any Proposition 65 chemicals.

State Right-to-Know

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Isooctane	X	X	X	X	-

U.S. Department of Transportation

Reportable Quantity (RQ):	Y
DOT Marine Pollutant	NDOT
Severe Marine Pollutant	N

U.S. Department of Homeland Security
This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade Serious risk, Grade 3

Canada

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.

WHMIS Hazard Class
B2 Flammable liquid

16. OTHER INFORMATION

Prepared By	Regulatory Affairs Thermo Fisher Scientific Tel: (412) 490-8929
Creation Date	22-Jun-2009
Print Date	23-Sep-2009
Revision Summary	"***", and red text indicates revision

Disclaimer

The information provided on this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guide for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered as a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other material or in any process, unless specified in the text.

End of MSDS

Fisher Scientific

Part of Thermo Fisher Scientific

Material Safety Data Sheet

Creation Date 24-Apr-2009 **Revision Date** 23-Oct-2014 **Revision Number** 1

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name **Molecular Biology Grade Ethanol**

Cat No. : **BP2818-4, BP2818-100, BP2818-500**

Synonyms Ethyl alcohol; Absolute ethanol

Recommended Use Laboratory chemicals

Company
Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Emergency Telephone Number
CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 001-703-527-3887

2. HAZARDS IDENTIFICATION

WARNING

Emergency Overview

Extremely flammable liquid and vapor. Vapor may cause flash fire. Aspiration hazard if swallowed - can enter lungs and cause damage. Harmful by inhalation, in contact with skin and if swallowed. Irritating to eyes. Cancer hazard. This substance has caused adverse reproductive and fetal effects in humans. Hygroscopic.

Appearance Clear, Colorless **Physical State** Liquid **Odor** sweet, Characteristic

Target Organs Eyes, Central nervous system (CNS), Reproductive System, Liver, Kidney, Blood

Potential Health Effects

Acute Effects
Principle Routes of Exposure

Eyes	Irritating to eyes.
Skin	May cause irritation. Harmful in contact with skin.
Inhalation	May cause irritation of respiratory tract. Inhalation may cause central nervous system effects. Harmful by inhalation.
Ingestion	Harmful if swallowed. Aspiration hazard if swallowed - can enter lungs and cause damage. Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhea.

Chronic Effects

Cancer hazard: This substance has caused adverse reproductive and fetal effects in humans: Substances known to cause developmental toxicity in humans: Tumorigenic effects have been reported in experimental animals: May cause adverse liver effects: May cause adverse kidney effects

Aggravated Medical Conditions Central nervous system disorders. Preexisting eye disorders. Liver disorders. Skin disorders.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Component	CAS-No	Weight %
Ethyl alcohol	64-17-5	99-100

4. FIRST AID MEASURES

Eye Contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Obtain medical attention.

Skin Contact Wash off immediately with plenty of water for at least 15 minutes. Get medical attention if symptoms occur.

Inhalation Move to fresh air. If breathing is difficult, give oxygen. Get medical attention immediately if symptoms occur.

Ingestion Do not induce vomiting. Obtain medical attention.

Notes to Physician Treat symptomatically

5. FIRE-FIGHTING MEASURES

Flash Point 12 °C / 53.6 °F

Method - No information available

Autoignition Temperature 363 °C / 685.4 °F

Explosion Limits
Upper 19 vol %
Lower 3.3 vol %

Suitable Extinguishing Media Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide. Use water spray to cool unopened containers. Cool closed containers exposed to fire with water spray.

Unsuitable Extinguishing Media Water may be ineffective, Do not use a solid water stream as it may scatter and spread fire

Hazardous Combustion Products No information available.

Sensitivity to Mechanical Impact No information available
Sensitivity to Static Discharge No information available

Specific Hazards Arising from the Chemical
Flammable. Risk of ignition. Vapors may form explosive mixtures with air. Vapors may travel to source of ignition and flash back. Containers may explode when heated. Vapors may form explosive mixtures with air.

Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear. Thermal decomposition can lead to release of irritating gases and vapors.

NFPA	Health 2	Flammability 3	Instability 0	Physical hazards N/A

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions Use personal protective equipment. Ensure adequate ventilation. Remove all sources of ignition. Take precautionary measures against static discharges. Do not get in eyes, on skin, or on clothing.

Environmental Precautions Should not be released into the environment.

Methods for Containment and Clean Up Remove all sources of ignition. Soak up with inert absorbent material. Keep in suitable, closed containers for disposal. Take precautionary measures against static discharges. Use spark-proof tools and explosion-proof equipment.

7. HANDLING AND STORAGE

Handling Wear personal protective equipment. Ensure adequate ventilation. Keep away from open flames, hot surfaces and sources of ignition. Take precautionary measures against static discharges. Do not breathe vapors or spray mist. Do not get in eyes, on skin, or on clothing. Do not ingest. Use spark-proof tools and explosion-proof equipment.

Storage Keep containers tightly closed in a dry, cool and well-ventilated place. Keep away from open flames, hot surfaces and sources of ignition. Flammables area.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Measures Ensure adequate ventilation, especially in confined areas. Use explosion-proof electrical/ventilating/lighting/equipment. Ensure that eyewash stations and safety showers are close to the workstation location.

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH
Ethyl alcohol	STEL: 1000 ppm	(Vacated) TWA: 1000 ppm (Vacated) TWA: 1900 mg/m³ TWA: 1000 ppm TWA: 1900 mg/m³	IDLH: 3300 ppm TWA: 1000 ppm TWA: 1900 mg/m³
Component	**Quebec**	**Mexico OEL (TWA)**	**Ontario TWAEV**
Ethyl alcohol	TWA: 1000 ppm TWA: 1880 mg/m³	TWA: 1000 ppm TWA: 1900 mg/m³	STEL: 1000 ppm

Legend

NIOSH IDLH: *The National Institute for Occupational Safety and Health Immediately Dangerous to Life or Health*

Personal Protective Equipment

Eye/face Protection Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin and body protection Wear appropriate protective gloves and clothing to prevent skin exposure.

Respiratory Protection Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State	Liquid
Appearance	Clear, Colorless
Odor	sweet, Characteristic
Odor Threshold	No information available No information available
pH	
Vapor Pressure	No information available No information available No information available
Vapor Density	
Viscosity	
Boiling Point/Range	78 °C / 172.4 °F
Melting Point/Range	-114 °C / -173.2 °F
Decomposition Temperature	No information available
Flash Point	12 °C / 53.6 °F
Evaporation Rate	No information available No information available No information available
Specific Gravity	
Solubility	
log Pow	No data available
Molecular Weight	46.07
Molecular Formula	C2 H6 O

10. STABILITY AND REACTIVITY

Stability Hygroscopic.

Conditions to Avoid Incompatible products. Heat, flames and sparks. Keep away from open flames, hot surfaces and sources of ignition.

Incompatible Materials Strong oxidizing agents, Strong acids, Acid anhydrides, Acid chlorides

Hazardous Decomposition Products Carbon monoxide (CO), Carbon dioxide (CO_2)

Hazardous Polymerization Hazardous polymerization does not occur.

Hazardous Reactions None under normal processing.

11. TOXICOLOGICAL INFORMATION

Acute Toxicity

Product Information

Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Ethyl alcohol	3450 mg/kg (Mouse)	Not listed	20000 ppm/10H (Rat)

Irritation Irritating to eyes

Toxicologically Synergistic Products No information available

Chronic Toxicity

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	ACGIH	IARC	NTP	OSHA	Mexico
Ethyl alcohol	A3	Group 1	Not listed	X Not listed	

ACGIH: (American Conference of Governmental Industrial Hygienists)
A1 - Known Human Carcinogen
A2 - Suspected Human Carcinogen
A3 - Animal Carcinogen
ACGIH: (American Conference of Governmental Industrial Hygienists)
OSHA: (Occupational Safety & Health Administration)
OSHA: (Occupational Safety & Health Administration)
X - Present
Mexico - Occupational Exposure Limits - Carcinogens
Mexico - Occupational Exposure Limits - Carcinogens
A1 - Confirmed Human Carcinogen A2 -
Suspected Human Carcinogen A3 - Confirmed
Animal Carcinogen
A4 - Not Classifiable as a Human Carcinogen A5 - Not
Suspected as a Human Carcinogen

Sensitization No information available

Mutagenic Effects Mutagenic effects have occurred in humans.

Reproductive Effects Adverse reproductive effects have occurred in humans.

Developmental Effects Substances known to cause developmental toxicity in humans.

Teratogenicity Teratogenic effects have occurred in humans.

Other Adverse Effects Tumorigenic effects have been reported in experimental animals. See actual entry in RTECS for complete information.

Endocrine Disruptor Information No information available

12. ECOLOGICAL INFORMATION

Ecotoxicity .

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Ethyl alcohol	EC50 (72h) = 275 mg/l (Chlorella vulgaris)	Fathead minnow (Pimephales promelas) LC50 = 14200 mg/l/96h	Photobacterium phosphoreum:EC50 = 34634 mg/L/30 min Photobacterium phosphoreum:EC50 = 35470 mg/L/5 min	EC50 = 9268 mg/L/48h EC50 = 10800 mg/L/24h

Persistence and Degradability Readily biodegradable.

Bioaccumulation/ Accumulation No information available.

Mobility Will likely be mobile in the environment due to its water solubility.

Component	log Pow
Ethyl alcohol	-0.32

13. DISPOSAL CONSIDERATIONS

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. TRANSPORT INFORMATION

DOT

UN-No UN1170
Proper Shipping Name ETHANOL
Hazard Class 3
Packing Group II

TDG

UN-No UN1170
Proper Shipping Name ETHANOL
Hazard Class 3
Packing Group II

IATA

UN-No UN1170
Proper Shipping Name ETHANOL
Hazard Class 3II
Packing Group

IMDG/IMO UN1170
UN-No ETHANOL
Proper Shipping Name 3II
Hazard Class
Packing Group

15. REGULATORY INFORMATION

International Inventories

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	IECSC	KECL
Ethyl alcohol	X	X	-	200-578-6	-		X	X	X	X	X

Legend:

X - Listed

E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.

F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.

N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.

P - Indicates a commenced PMN substance

R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.

S - Indicates a substance that is identified in a proposed or final Significant New Use Rule

T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.

XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B).

Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.

Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations

TSCA 12(b) Not applicable

SARA 313
Not applicable

SARA 311/312 Hazardous Categorization

Acute Health Hazard	Yes
Chronic Health Hazard	Yes Yes No
Fire Hazard	No
Sudden Release of Pressure Hazard	
Reactive Hazard	

Clean Water Act
Not applicable

Clean Air Act Not applicable

OSHA Occupational Safety and Health Administration
Not applicable

CERCLA
Not applicable

California Proposition 65

This product contains the following Proposition 65 chemicals: Ethyl alcohol is only a considered a Proposition 65 developmental hazard when it is ingested as an alcoholic beverage

Component	CAS-No	California Prop. 65	Prop 65 NSRL	Category
Ethyl alcohol	64-17-5	Developmental	-	Developmental Carcinogen

State Right-to-Know

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Ethyl alcohol	X	X	X	X	X

U.S. Department of Transportation

Reportable Quantity (RQ): NDOT
Marine Pollutant NDOT
Severe Marine Pollutant N

U.S. Department of Homeland Security

This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade Serious risk, Grade 3

Canada

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR

WHMIS Hazard Class
B2 Flammable liquid
D2A Very toxic materials
D2B Toxic materials

16. OTHER INFORMATION

Prepared By Regulatory Affairs
Thermo Fisher Scientific
Email: EMSDS.RA@thermofisher.com

Creation Date 24-Apr-2009

Print Date 23-Oct-2014

Revision Summary
(M)SDS sections updated 2 3

Disclaimer

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End of MSDS

Material Safety Data Sheet

Allylamine, 97%

MSDS# 87403

Section 1 - Chemical Product and Company Identification

MSDS Name:	Allylamine, 97%
Catalog Numbers:	AC220730000, AC220730010, AC220730500, AC220732500
Synonyms:	3-Amino-1-propene;3-aminopropylene;2-propen-1-amine
Company Identification:	Acros Organics BVBA Janssen Pharmaceuticalaan 3a 2440 Geel, Belgium
Company Identification: (USA)	Acros Organics One Reagent Lane Fair Lawn, NJ 07410
For information in the US, call:	800-ACROS-01 +32
For information in Europe, call:	14 57 52 11 +32 14
Emergency Number, Europe:	57 52 99
Emergency Number US:	201-796-7100
CHEMTREC Phone Number, US:	800-424-9300
CHEMTREC Phone Number, Europe:	703-527-3887

Section 2 - Composition, Information on Ingredients

CAS#:	107-11-9
Chemical Name:	Allylamine
%:	97.0
EINECS#:	203-463-9

Hazard Symbols: TF

Risk Phrases: 11 23/24/25

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Danger! May be fatal if absorbed through the skin. Causes severe eye and skin burns. Harmful if inhaled or swallowed. Causes digestive and respiratory tract irritation with possible burns. Extremely flammable liquid and vapor. Vapor may cause flash fire. Target Organs: Eyes, skin, mucous membranes.

Potential Health Effects

Eye: Causes severe eye burns. Vapor or mist may cause irritation and severe burns. May cause conjunctivitis. Lachrymator (substance which increases the flow of tears).

Skin: May be fatal if absorbed through the skin. Causes severe burns.

Ingestion: Harmful if swallowed. May cause irritation of the digestive tract.

Inhalation: May be fatal if inhaled. Exposure to high concentrations may produce narcosis, nausea and loss of consciousness. Causes respiratory tract irritation with possible burns. May cause severe tearing, conjunctivitis, corneal edema, coughing, nausea, and pulmonary edema.

Chronic: No information found.

Section 4 - First Aid Measures

Eyes: Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid immediately. Do NOT allow victim to rub eyes or keep eyes closed.

Skin: Get medical aid immediately. Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Remove contaminated clothing and shoes.

Ingestion: Do not induce vomiting. If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid immediately.

Inhalation: Get medical aid immediately. Remove from exposure and move to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen.

Notes to Physician:

Section 5 - Fire Fighting Measures

General Information: As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Vapors may form an explosive mixture with air. Vapors can travel to a source of ignition and flash back. Combustion generates toxic fumes. Use water spray to keep fire-exposed containers cool. Extremely flammable liquid and vapor. Vapors may be heavier than air. They can spread along the ground and collect in low or confined areas. Will be easily ignited by heat, sparks or flame. Containers may explode when heated.

Extinguishing Media: For small fires, use dry chemical, carbon dioxide, water spray or alcohol-resistant foam. Use water spray to cool fire-exposed containers. Water may be ineffective. For large fires, use water spray, fog or alcohol-resistant foam. Do NOT use straight streams of water. Cool containers with flooding quantities of water until well after fire is out.

Autoignition Temperature: 705 deg F (373.89 deg C)

Flash Point: -20 deg C (-4.00 deg F)

Explosion Limits: Lower: 2.0 vol %

Explosion Limits: Upper: 22.00 vol %

NFPA Rating: health: 3; flammability: 3; instability: 0;

Section 6 - Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.

Spills/Leaks: Absorb spill with inert material (e.g. vermiculite, sand or earth), then place in suitable container. Remove all sources of ignition. A vapor suppressing foam may be used to reduce vapors. Water spray may reduce vapor but may not prevent ignition in closed spaces.

Section 7 - Handling and Storage

Handling: Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Ground and bond containers when transferring material. Do not get in eyes, on skin, or on clothing. Empty containers retain product residue, (liquid and/or vapor), and can be dangerous. Keep container tightly closed. Keep away from heat, sparks and flame. Do not ingest or inhale. Use only in a chemical fume hood. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose empty containers to heat, sparks or open flames.

Storage: Keep away from heat, sparks, and flame. Keep away from sources of ignition. Store in a tightly closed container. Keep from contact with oxidizing materials. Store in a cool, dry, well-ventilated area away from incompatible substances. Keep away from acids.

Section 8 - Exposure Controls, Personal Protection

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Allylamine	none listed	none listed	none listed

OSHA Vacated PELs: Allylamine: None listed

Engineering Controls:

Use only under a chemical fume hood.

Exposure Limits

Personal Protective Equipment

Eyes: Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin: Wear appropriate protective gloves to prevent skin exposure.

Clothing: Wear appropriate protective clothing to prevent skin exposure.

Respirators: Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Section 9 - Physical and Chemical Properties

Physical State: Liquid

Color: clear light yellow

Odor: Strong ammoniacal odor

pH: Not available

Vapor Pressure: 242 mm Hg @25C

Vapor Density: 1.97

Evaporation Rate: Not available

Viscosity: 0.44 cP 25 deg C

Boiling Point: 55-58C

Freezing/Melting Point: -123 deg C (-189.40 F)

Decomposition Temperature: Not available

Solubility in water: soluble

Specific Gravity/Density: .7610g/cm3

Molecular Formula: C3H7N

Molecular Weight: 57.09

Section 10 - Stability and Reactivity

Chemical Stability: Stable under normal temperatures and pressures.

Conditions to Avoid: High temperatures, incompatible materials, ignition sources.

Incompatibilities with Other Materials: Metals, oxidizing agents, acids, amines, halogenated agents, alkalies, chlorine, hypochlorite.

Hazardous Decomposition Products: Carbon monoxide, oxides of nitrogen, carbon dioxide.

Hazardous Polymerization: May occur.

Section 11 - Toxicological Information

RTECS#: CAS# 107-11-9: BA5425000

RTECS:

LD50/LC50:
CAS# 107-11-9: Draize test, rabbit, skin: 500 mg/24H Severe;
Inhalation, rat: LC50 = 177 ppm/8H;
Oral, mouse: LD50 = 57 mg/kg;
Oral, rat: LD50 = 102 mg/kg;
Skin, rabbit: LD50 = 35 mg/kg; .

Carcinogenicity: Allylamine - Not listed as a carcinogen by ACGIH, IARC, NTP, or CA Prop 65. See actual entry in RTECS for complete information.

Other:

Section 12 - Ecological Information

Ecotoxicity: Bacteria: Phytobacterium phosphoreum: EC50 = 16 mg/L; 5, 15 minutes; Microtox test; 14.9-15.1 degrees C

Section 13 - Disposal Considerations

Dispose of in a manner consistent with federal, state, and local regulations.

Section 14 - Transport Information

US DOT

Shipping Name: ALLYLAMINE

Hazard Class: 6.1
UN Number: UN2334
Packing Group: I
Canada TDG
Shipping Name: Not available
Hazard Class: UN
Number:
Packing Group:

Section 15 - Regulatory Information

European/International Regulations

European Labeling in Accordance with EC Directives

Hazard Symbols: T F

Risk Phrases:

R 11 Highly flammable.

R 23/24/25 Toxic by inhalation, in contact with skin and if swallowed.

Safety Phrases:

S 9 Keep container in a well-ventilated place.

S 16 Keep away from sources of ignition - No smoking. S

24/25 Avoid contact with skin and eyes.

S 45 In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

S 61 Avoid release to the environment. Refer to special instructions/safety data sheets.

WGK (Water Danger/Protection)

CAS# 107-11-9: 2

Canada

CAS# 107-11-9 is listed on Canada's DSL List

Canadian WHMIS Classifications: B2

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all of the information required by those regulations.

CAS# 107-11-9 is listed on Canada's Ingredient Disclosure List

US Federal

TSCA

CAS# 107-11-9 is listed on the TSCA Inventory.

Section 16 - Other Information

MSDS Creation Date: 5/10/1999

Revision #5 Date 7/20/2009

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantibility or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no event shall the company be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential, or exemplary damages howsoever arising, even if the company has been advised of the possibility of such damages.

MATERIAL SAFETY DATA SHEET

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND THE COMPANY/UNDERTAKING

Pfizer Inc
Pfizer Pharmaceuticals Group
235 East 42nd Street
New York, New York 10017
1-212-573-2222

Emergency telephone number:
CHEMTREC (24 hours): 1-800-424-9300
Contact E-Mail: pfizer-MSDS@pfizer.com

Pfizer Ltd
Ramsgate Road
Sandwich, Kent
CT13 9NJ
United Kingdom
+00 44 (0)1304 616161
Emergency telephone number:
International CHEMTREC (24 hours): +1-703-527-3887

Material Name: Water for injection, USP

Trade Name: Not established
Chemical Family: Not applicable
Intended Use: Pharmaceutical product

2. HAZARDS IDENTIFICATION

Appearance: Clear, colorless liquid

Statement of Hazard: Non-hazardous in accordance with international standards for workplace safety.

EU Indication of danger: Not classified

Australian Hazard Classification (NOHSC): Non-Hazardous Substance. Non-Dangerous Goods.

Note: This document has been prepared in accordance with standards for workplace safety, which require the inclusion of all known hazards of the active substance or its intermediates regardless of the potential risk. The precautionary statements and warnings included may not apply in all cases. Your needs may vary depending upon the potential for exposure in your workplace.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Ingredient	CAS Number	EU EINECS/ELINCS List	EU Classification	%
Water for injection	7732-18-5	231-791-2	Not Listed	100

Additional Information: Ingredient(s) indicated as hazardous have been assessed under standards for workplace safety.

4. FIRST AID MEASURES

Eye Contact: Due to the nature of this material first aid is not normally required.

Skin Contact: Due to the nature of this material first aid is not normally required.

Ingestion: Due to the nature of this material first aid is not normally required.

Inhalation: Not an expected route of exposure.

5. FIRE FIGHTING MEASURES

Extinguishing Media: As for primary cause of fire.

Hazardous Combustion Products: Not applicable

Fire Fighting Procedures: Not applicable

Fire / Explosion Hazards: Not applicable

6. ACCIDENTAL RELEASE MEASURES

Health and Safety Precautions: Not applicable

Measures for Cleaning / Collecting: Wipe up with a damp cloth and place in container for disposal.

Measures for Environmental Protections: None

Additional Consideration for Large Spills: None

Additional Information: No special measures are required.

7. HANDLING AND STORAGE

General Handling: No special handling requirements for normal use of this material.
Storage Conditions: Store as directed by product packaging.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

No Occupational Exposure Limit (OEL) or Short Term Exposure Limit (STEL) has been identified.

Engineering Controls: Engineering controls should be used as the primary means to control exposures.
Environmental Exposure Controls: Refer to specific Member State legislation for requirements under Community environmental legislation.
Personal Protective Equipment: Refer to applicable national standards and regulations in the selection and use of personal protective equipment (PPE).

Hands: Not required for the normal use of this product. Not
Eyes: required under normal conditions of use.
Skin: Not required for the normal use of this product. None
Respiratory protection: required under normal conditions of use.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Liquid	**Color:**	Colorless
Odor:	None	**Molecular Formula:**	H2O
Molecular Weight:	18.02		

pH:	7
Melting/Freezing Point (°C):	0
Boiling Point (°C):	100

10. STABILITY AND REACTIVITY

Chemical Stability:	Stable
Conditions to Avoid:	None
Incompatible Materials:	None

11. TOXICOLOGICAL INFORMATION

12. ECOLOGICAL INFORMATION

Environmental Overview: No harmful effects to aquatic organisms are expected.

13. DISPOSAL CONSIDERATIONS

Waste Treatment Methods: Dispose of waste in accordance with all applicable laws and regulations. Member State specific and Community specific provisions must be considered. Considering the relevant known environmental and human health hazards of the material, review and implement appropriate technical and procedural waste water and waste disposal measures to prevent occupational exposure and environmental release. It is recommended that waste minimization be practiced. The best available technology should be utilized to prevent environmental releases. This may include destructive techniques for waste and wastewater.

14. TRANSPORT INFORMATION

The following refers to all modes of transportation unless specified below.

Not regulated for transport under USDOT, EUADR, IATA, or IMDG regulations.

15. REGULATORY INFORMATION

EU Indication of danger: Not classified

15. REGULATORY INFORMATION

OSHA Label:
Non-hazardous in accordance with international standards for workplace safety.

Canada - WHMIS: Classifications

WHMIS hazard class:
None required

Water for injection

Inventory - United States TSCA - Sect. 8(b)	Present
Australia (AICS):	Present
REACH - Annex IV - Exemptions from the obligations of Register:	Present
EU EINECS/ELINCS List	231-791-2

16. OTHER INFORMATION

Data Sources: Publicly available toxicity information.

Reasons for Revision: Updated Section 1 - Identification of the Substance/Preparation and the Company/Undertaking.

Prepared by: Product Stewardship Hazard Communication
Pfizer Global Environment, Health, and Safety Operations

Pfizer Inc believes that the information contained in this Material Safety Data Sheet is accurate, and while it is provided in good faith, it is without warranty of any kind, expressed or implied. If data for a hazard are not included in this document there is no known information at this time.

End of Safety Data Sheet

Material Safety Data Sheet

Catalog Number: 960024
Revision date: 26-Apr-2006

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND COMPANY INFORMATION

Catalog Number: 960024

Product name: SOY FLOUR

Supplier:
MP Biomedicals, LLC
29525 Fountain Parkway
Solon, OH 44139 tel: 440-
337-1200

Emergency telephone number: CHEMTREC: 1-800-424-9300 (1-703-527-3887)

2. COMPOSITION/INFORMATION ON INGREDIENTS

Components	CAS Number	Weight %	ACGIH Exposure Limits:	OSHA Exposure Limits:
SOY FLOUR	N/A	90 - 100%	None	None

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW: May cause skin irritation and/or dermatitis

Principle routes of exposure: Skin
Inhalation: May cause irritation of respiratory tract
Ingestion: May be harmful if swallowed.
Skin contact: May cause allergic skin reaction
Eye contact: Avoid contact with eyes

Statements of hazard MAY CAUSE ALLERGIC SKIN REACTION.
Statement of Spill or Leak - ANSI Label Eliminate all ignition sources. Absorb and/or contain spill with inert materials (e.g., sand, vermiculite). Then place in appropriate container. For large spills, use water spray to disperse vapors, flush spill area. Prevent runoff from entering waterways or sewers.

4. FIRST AID MEASURES

General advice: In the case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
Inhalation: Move to fresh air. Call a physician immediately.
Skin contact: Rinse immediately with plenty of water and seek medical advice
Ingestion: Do not induce vomiting without medical advice.
Eye contact: In the case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
Protection of first-aiders: No information available
Medical conditions aggravated by exposure: None known

5. FIRE FIGHTING MEASURES

Suitable extinguishing media: Use dry chemical, CO2, water spray or "alcohol" foam
Specific hazards: Burning produces irritant fumes.
Unusual hazards: None known
Special protective equipment for firefighters: As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear
Specific methods: Water mist may be used to cool closed containers.
Flash point: Not determined Not
Autoignition temperature: determined
NFPA rating:

NFPA Health:	0
NFPA Flammability:	00
NFPA Reactivity:	

6. ACCIDENTAL RELEASE MEASURES

Use personal protective equipment.
Personal precautions: Prevent product from entering drains.
Environmental precautions: Sweep up and shovel into suitable containers for disposal.
Methods for cleaning up:

7. HANDLING AND STORAGE

Storage:
ROOM TEMPERATURE COOL & DRY

Handling: Use only in area provided with appropriate exhaust ventilation.
Safe handling advice: Wear personal protective equipment.
Incompatible products: Oxidising and spontaneously flammable products

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering measures: Ensure adequate ventilation.
PERSONAL PROTECTIVE EQUIPMENT
Respiratory protection: Breathing apparatus only if aerosol or dust is formed.
Hand protection: Pvc or other plastic material gloves
Skin and body protection: Usual safety precautions while handling the product will provide adequate protection against this potential effect.
Eye protection: Safety glasses with side-shields
Hygiene measures: Handle in accordance with good industrial hygiene and safety practice.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical state: Powder
Formula: Not applicable
Melting point/range: No data available at this time.
Boiling point/range: No Data available at this time.
Density: No data available
Vapor pressure: No data available
Evaporation rate: No data available
Vapor density: No data available

Solubility (in water):	No data available
Flash point:	Not determined
Autoignition temperature:	Not determined

10. STABILITY AND REACTIVITY

Stability:	Stable under recommended storage conditions.
Polymerization:	None under normal processing.
Hazardous decomposition products:	Thermal decomposition can lead to release of irritating gases and vapours such as carbon oxides.
Materials to avoid:	Strong oxidising agents
Conditions to avoid:	Exposure to air or moisture over prolonged periods.

11. TOXICOLOGICAL INFORMATION

Product Information

Acute toxicity

Components	RTECS Number:	Selected LD50s and LC50s
SOY FLOUR	Not Available	Not Determined

Chronic toxicity:	Chronic exposure may cause nausea and vomiting, higher exposure causes unconsciousness.
Local effects:	Symptoms of overexposure may be headache, dizziness, tiredness, nausea and vomiting.
Specific effects:	May include moderate to severe erythema (redness) and moderate edema (raised skin), nausea, vomiting, headache.
Primary irritation:	No data is available on the product itself. No
Carcinogenic effects:	data is available on the product itself. No data
Mutagenic effects:	is available on the product itself. No data is
Reproductive toxicity:	available on the product itself.

12. ECOLOGICAL INFORMATION

Mobility:	No data available No
Bioaccumulation:	data available No data
Ecotoxicity effects:	available
Aquatic toxicity:	May cause long-term adverse effects in the aquatic environment.

Components	U.S. DOT - Appendix B - Marine Pollutan	U.S. DOT - Appendix B - Severe Marine Pollutants	United Kingdom - The Red List:
SOY FLOUR	Not Listed	Not Listed	Not Listed

Components	Germany VCI (WGK)	World Health Organization (WHO) - Drinking Water	Ecotoxicity - Fish Species Data
SOY FLOUR	Not Listed	Not Listed	Not Listed

Components	Ecotoxicity - Freshwater Algae Data	Ecotoxicity - Microtox Data	Ecotoxicity - Water Flea Data
SOY FLOUR	Not Listed	Not Listed	Not Listed

Components	EPA - ATSDR Priority List	EPA - HPV Challenge Program Chemical List	California - Priority Toxic Pollutants
SOY FLOUR	Not Listed	Not Listed	Not Listed

Components	California - Priority Toxic Pollutants	California - Priority Toxic Pollutants
SOY FLOUR	Not Listed	Not Listed

13. DISPOSAL CONSIDERATIONS

Waste from residues / unused products: Waste disposal must be in accordance with appropriate Federal, State, and local regulations. This product, if unaltered by use, may be disposed of by treatment at a permitted facility or as advised by your local hazardous waste regulatory authority. Residue from fires extinguished with this material may be hazardous.

Contaminated packaging: Do not re-use empty containers

14. TRANSPORT INFORMATION

UN/Id No: Not regulated

DOT:

Proper shipping name: Not Regulated

Components	U.S. DOT - Appendix A Table 1 - Reportable Quantities
SOY FLOUR	Not Listed

TDG (Canada):

WHMIS hazard class: Non-controlled

IMDG/IMO

IMDG - Hazard Classifications Not Applicable

Components	U.S. DOT - Appendix B - Marine Pollutan	U.S. DOT - Appendix B - Severe Marine Pollutants
SOY FLOUR	Not Listed	Not Listed

IMO-labels:

15. REGULATORY INFORMATION

International Inventories

Components
SOY FLOUR
Inventory - United States TSCA - Sect. 8(b) Not Listed
Canada DSL Inventory List - Not Listed

U.S. regulations:

Components	California Proposition 65 -	Massachusetts Right to Know List:	New Jersey Right to Know List:	Pennsylvania Right to Know List:
SOY FLOUR	Not Listed	Not Listed	Not Listed	Not Listed

Components	Florida substance List:	Rhode Island Right to Know List:	Illinois - Toxic Air Contaminants	Connecticut - Hazardous Air Pollutants
SOY FLOUR	Not Listed	Not Listed	Not Listed	Not Listed

Components	SARA 313 Emission reporting/Toxic Release 302 Extremely Haz of Chemicals	CERCLA/SARA - Section NTP:		IARC:
SOY FLOUR	Not Listed	Not Listed	None	None

SARA 313 Notification:

The above is your notification as to the SARA 313 listing for this product(s) pursuant to Section 313 of Title III of the Superfund Ammendments and Reauthorization Act of 1986 and 40 CFR Part 372.

If you are unsure if you are subject to the reporting requirements of Section 313, or need more information, please call the EPA Emergency Planning and Community Right-To-Know Information Hotline: (800) 535-0202 or (202) 479-2499 (in Washington, DC or Alaska).

State Notification:

The above information is your notice as to the Right-to-Know listings of the stated product(s). Individual states will list chemicals for a variety of reasons including, but not limited to, the compounds toxicity; carcinogenic, tumorigenic and/or reproductive hazards; and the compounds environmental impact if accidentally released.

16. OTHER INFORMATION

Prepared by: Health & Safety
Disclaimer: The information and recommendations contained herein are based upon tests believed to be reliable. However, MP Biomedicals does not guarantee the accuracy or completeness NOR SHALL ANY OF THIS INFORMATION CONSTITUTE A WARRANTY, WHETHER EXPRESSED OR IMPLIED, AS TO THE SAFETY OF THE GOODS, THE MERCHANTABILITY OF THE GOODS, OR THE FITNESS OF THE GOODS FOR A PARTICULAR PURPOSE. Adjustment to conform to actual conditions of usage maybe required. MP Biomedicals assumes no responsibility for results obtained or for incidental or consequential damages, including lost profits arising from the use of these data. No warranty against infringement of any patent, copyright or trademark is made or implied.

End of Safety Data Sheet

Safety Data Sheet
acc. to OSHA HCS

Printing date 01/16/2013 Reviewed on 01/16/2013

1 Identification of the substance/mixture and of the company/undertaking

- **Product identifier**
- **Trade name: Soybean Oil**
- **Article number:** 104687
- **CAS Number:**
8001-22-7
- **EC number:**
232-274-4
- **Details of the supplier of the safety data sheet**
- **Manufacturer/Supplier:**
MP Biomedicals, LLC
29525 Fountain Parkway
Solon, OH 44139
United States
www.mpbio.com
- **Information department:** Product safety department
- **Emergency telephone number:** CHEMTREC: 1-800-424-9300 (1-703-527-3887)

2 Hazards identification

- **Classification of the substance or mixture**
The substance is not classified according to the Globally Harmonized System (GHS).
- **Classification according to Directive 67/548/EEC or Directive 1999/45/EC** Not applicable.
- **Information concerning particular hazards for human and environment:** Not applicable.
- **Label elements**
- **GHS label elements** Void • **Hazard pictograms** Void
- **Signal word** Void
- **Hazard statements** Void
- **Additional information:** Void
- **Classification system:**
- **NFPA ratings (scale 0 - 4)**

Health = 0
Fire = 1
Reactivity = 0

- **HMIS-ratings (scale 0 - 4)**

Health = 0
Fire = 1
Reactivity = 0

- **Other hazards**
- **Results of PBT and vPvB assessment** • **PBT:**
Not applicable. • **vPvB:** Not applicable.

3 Composition/information on ingredients

- **Chemical characterization: Substances**
- **CAS No. Description**
8001-22-7 Soybean Oil

(Contd. on page 2)

Safety Data Sheet
acc. to OSHA HCS

Trade name: Soybean Oil

(Contd. of page 1)

• **Identification number(s)**
• **EC number:** 232-274-4

4 First aid measures

• **Description of first aid measures**
• **General information:** No special measures required.
• **After inhalation:** Supply fresh air; consult doctor in case of complaints. • **After skin contact:** Generally the product does not irritate the skin.
• **After eye contact:** Rinse opened eye for several minutes under running water. • **After swallowing:** If symptoms persist consult doctor.
• **Information for doctor:**
• **Most important symptoms and effects, both acute and delayed** No further relevant information available.
• **Indication of any immediate medical attention and special treatment needed**
No further relevant information available.

5 Firefighting measures

• **Extinguishing media**
• **Suitable extinguishing agents:** Use fire fighting measures that suit the environment.
• **Special hazards arising from the substance or mixture** No further relevant information available.
• **Advice for firefighters**
• **Protective equipment:** No special measures required.

6 Accidental release measures

• **Personal precautions, protective equipment and emergency procedures** Not required. • **Environmental precautions:** No special measures required.
• **Methods and material for containment and cleaning up:**
Absorb with liquid-binding material (sand, diatomite, acid binders, universal binders, sawdust).
• **Reference to other sections**
No dangerous substances are released.
See Section 7 for information on safe handling.
See Section 8 for information on personal protection equipment. See Section 13 for disposal information.

7 Handling and storage

• **Handling:**
• **Precautions for safe handling** No special measures required.
• **Information about protection against explosions and fires:** No special measures required.

• **Conditions for safe storage, including any incompatibilities**
• **Storage:** 15-30 °C
• **Requirements to be met by storerooms and receptacles:** No special requirements. • **Information about storage in one common storage facility:** Not required. • **Further information about storage conditions:** None.
• **Specific end use(s)** No further relevant information available.

(Contd. on page 3)

Safety Data Sheet
acc. to OSHA HCS

Printing date 01/16/2013 Reviewed on 01/16/2013

Trade name: Soybean Oil

(Contd. of page 2)

8 Exposure controls/personal protection

- **Additional information about design of technical systems:** No further data; see item 7.
- **Control parameters**
- **Components with limit values that require monitoring at the workplace:** Not required.
- **Additional information:** The lists that were valid during the creation were used as basis.
- **Exposure controls**
- **Personal protective equipment:**
- **General protective and hygienic measures:**
The usual precautionary measures for handling chemicals should be followed.
- **Breathing equipment:** Not required.
- **Protection of hands:**
The glove material has to be impermeable and resistant to the product/ the substance/ the preparation.
Due to missing tests no recommendation to the glove material can be given for the product/ the preparation/ the chemical mixture.
Selection of the glove material on consideration of the penetration times, rates of diffusion and the degradation
- **Material of gloves**
The selection of the suitable gloves does not only depend on the material, but also on further marks of quality and varies from manufacturer to manufacturer.
- **Penetration time of glove material**
The exact breakthrough time has to be found out by the manufacturer of the protective gloves and has to be observed.
- **Eye protection:** Goggles recommended during refilling.

9 Physical and chemical properties

• **Information on basic physical and chemical properties**	
• **General Information**	
• **Appearance:**	
Form:	Fluid
Color:	Not determined.
• **Odor:**	Characteristic
• **Odour threshold:**	Not determined.
• **pH-value:**	Not determined.
• **Change in condition**	
Melting point/Melting range:	Undetermined.
Boiling point/Boiling range:	Undetermined.
• **Flash point:**	282 °C (540 °F) Not
• **Flammability (solid, gaseous):**	applicable.
• **Ignition temperature:**	
Decomposition temperature:	Not determined.
• **Auto igniting:**	Not determined.
• **Danger of explosion:**	Product does not present an explosion hazard.
• **Explosion limits:**	
Lower:	Not determined. Not
Upper:	determined.

(Contd. on page 4)

Safety Data Sheet
acc. to OSHA HCS

Trade name: Soybean Oil

(Contd. of page 3)

• **Vapor pressure:**	Not determined.
• **Density at 20 °C (68 °F):**	0.917 g/cm³ (7.652 lbs/gal)
• **Relative density**	Not determined.
Vapour density	Not determined.
• **Evaporation rate**	Not determined.
• **Solubility in / Miscibility with**	
Water:	Not miscible or difficult to mix.
• **Partition coefficient (n-octanol/water):**	Not determined.
• **Viscosity:**	
Dynamic:	Not determined.
Kinematic:	Not determined.
Organic solvents:	0.0%
• **Other information**	No further relevant information available.

10 Stability and reactivity

• **Reactivity**
• **Chemical stability**
• **Thermal decomposition / conditions to be avoided:** No decomposition if used according to specifications. • **Possibility of hazardous reactions** No dangerous reactions known. • **Conditions to avoid** No further relevant information available.
• **Incompatible materials:** No further relevant information available.
• **Hazardous decomposition products:** No dangerous decomposition products known.

11 Toxicological information

• **Information on toxicological effects**
• **Acute toxicity:**
• **Primary irritant effect:**
• **on the skin:** No irritant effect. • **on the eye:** No irritating effect.
• **Sensitization:** No sensitizing effects known.
• **Additional toxicological information:**
When used and handled according to specifications, the product does not have any harmful effects according to our experience and the information provided to us. The substance is not subject to classification.

• **Carcinogenic categories**

• **IARC (International Agency for Research on Cancer)**
Substance is not listed.

• **NTP (National Toxicology Program)**
Substance is not listed.

12 Ecological information

• **Toxicity**
• **Aquatic toxicity:** No further relevant information available.

(Contd. on page 5)

Safety Data Sheet
acc. to OSHA HCS

Printing date 01/16/2013 Reviewed on 01/16/2013

Trade name: Soybean Oil

(Contd. of page 4)

- **Persistence and degradability** No further relevant information available.
- **Behavior in environmental systems:**
- **Bioaccumulative potential** No further relevant information available.
- **Mobility in soil** No further relevant information available.
- **Additional ecological information:**
- **General notes:** Generally not hazardous for water
- **Results of PBT and vPvB assessment**
- **PBT:** Not applicable.
- **vPvB:** Not applicable.
- **Other adverse effects** No further relevant information available.

13 Disposal considerations

- **Waste treatment methods**
- **Recommendation:** Smaller quantities can be disposed of with household waste.
- **Uncleaned packagings:**
- **Recommendation:** Disposal must be made according to official regulations.

14 Transport information

- **UN-Number**
- **DOT, ADR, IMDG, IATA** Void
- **UN proper shipping name**
- **DOT, ADR, IMDG, IATA** Void
- **Transport hazard class(es)**

DOT, ADR, IMDG, IATA
- **Class** Void
- **Packing group**
- **DOT, ADR, IMDG, IATA** Void
- **Environmental hazards:**
- **Marine pollutant:** No
- **Special precautions for user** Not applicable.
- **Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code** Not applicable.
- **UN "Model Regulation":** -

15 Regulatory information

- **Safety, health and environmental regulations/legislation specific for the substance or mixture**
- **Sara**
- **Section 355 (extremely hazardous substances):**

Substance is not listed.

- **Section 313 (Specific toxic chemical listings):**

Substance is not listed.

(Contd. on page 6)

Safety Data Sheet
acc. to OSHA HCS

Trade name: Soybean Oil

(Contd. of page 5)

- **TSCA (Toxic Substances Control Act):**
  Substance is listed.
- **Proposition 65**
- **Chemicals known to cause cancer:**
  Substance is not listed.
- **Chemicals known to cause reproductive toxicity for females:**
  Substance is not listed.
- **Chemicals known to cause reproductive toxicity for males:**
  Substance is not listed.
- **Chemicals known to cause developmental toxicity:**
  Substance is not listed.
- **Carcinogenic categories**
- **EPA (Environmental Protection Agency)**
  Substance is not listed.
- **TLV (Threshold Limit Value established by ACGIH)**
  Substance is not listed.
- **NIOSH-Ca (National Institute for Occupational Safety and Health)**
  Substance is not listed.
- **OSHA-Ca (Occupational Safety & Health Administration)**
  Substance is not listed.
- **GHS label elements** Void
- **Hazard pictograms** Void
- **Signal word** Void
- **Hazard statements** Void
- **Chemical safety assessment:** A Chemical Safety Assessment has not been carried out.

16 Other information

This information is based on our present knowledge. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.

- **Department issuing MSDS:** Product safety department
- **Abbreviations and acronyms:**
  ADR: Accord européen sur le transport des marchandises dangereuses par Route (European Agreement concerning the International Carriage of Dangerous Goods by Road)
  ACGIH: American Conference of Governmental Industrial Hygienists
  EINECS: European Inventory of Existing Commercial Chemical Substances
  CAS: Chemical Abstracts Service (division of the American Chemical Society)
  NFPA: National Fire Protection Association (USA)
  HMIS: Hazardous Materials Identification System (USA)

SAFETY DATA SHEET

Version 5.3
Revision Date 12/22/2014
Print Date 03/30/2015

1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product identifiers

Product name : Poly(ethylene glycol)

Product Number : 81280 Fluka
Brand :
CAS-No. : 25322-68-3

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses : Laboratory chemicals, Manufacture of substances

1.3 Details of the supplier of the safety data sheet

Company : Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO 63103
USA

Telephone : +1 800-325-5832
Fax : +1 800-325-5052

1.4 Emergency telephone number

Emergency Phone # : (314) 776-6555

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

Not a hazardous substance or mixture.

2.2 GHS Label elements, including precautionary statements

Not a hazardous substance or mixture.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

Synonyms : PEG

Formula : (C2H4O)nH2O CAS-No.
: 25322-68-3 EC-No.
: 500-038-2

Hazardous components

Component	Classification	Concentration
PEG 10000		
		<= 100 %

4. FIRST AID MEASURES

4.1 Description of first aid measures

If inhaled

If breathed in, move person into fresh air. If not breathing, give artificial respiration.

In case of skin contact
Wash off with soap and plenty of water.

In case of eye contact
Flush eyes with water as a precaution.

If swallowed
Never give anything by mouth to an unconscious person. Rinse mouth with water.

4.2 Most important symptoms and effects, both acute and delayed
The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed
No data available

5. FIREFIGHTING MEASURES

5.1 Extinguishing media

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture
Carbon oxides
Nature of decomposition products not known.
Carbon oxides

5.3 Advice for firefighters
Wear self-contained breathing apparatus for firefighting if necessary.

5.4 Further information
No data available

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Avoid dust formation. Avoid breathing vapours, mist or gas. For personal protection see section 8.

6.2 Environmental precautions
Do not let product enter drains.

6.3 Methods and materials for containment and cleaning up
Sweep up and shovel. Keep in suitable, closed containers for disposal.

6.4 Reference to other sections
For disposal see section 13.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Provide appropriate exhaust ventilation at places where dust is formed.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities
Keep container tightly closed in a dry and well-ventilated place.

7.3 Specific end use(s)
Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 Control parameters

Components with workplace control parameters

Component	CAS-No.	Value	Control parameters	Basis
PEG 10000	25322-68-3	TWA	10.000000 mg/m3	USA. Workplace Environmental Exposure Levels (WEEL)
		TWA	10.000000 mg/m3	USA. Workplace Environmental Exposure Levels (WEEL)

8.2 Exposure controls

Appropriate engineering controls

General industrial hygiene practice.

Personal protective equipment

Eye/face protection

Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection

Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested:Dermatril® (KCL 740 / Aldrich Z677272, Size M)

Splash contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested:Dermatril® (KCL 740 / Aldrich Z677272, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Body Protection

Choose body protection in relation to its type, to the concentration and amount of dangerous substances, and to the specific work-place., The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection

Respiratory protection is not required. Where protection from nuisance levels of dusts are desired, use type N95 (US) or type P1 (EN 143) dust masks. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Control of environmental exposure

Do not let product enter drains.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: solid
b)	Odour	No data available No
c)	Odour Threshold	data available No
d)	pH	data available
e)	Melting point/freezing point	Melting point/range: 62 - 65 °C (144 - 149 °F)

f)	Initial boiling point and boiling range	No data available
g)	Flash point	No data available h)
	Evaporation rate	No data available
i)	Flammability (solid, gas)	No data available
j)	Upper/lower flammability or explosive limits	No data available
k)	Vapour pressure	No data available
l)	Vapour density	No data available
m)	Relative density	No data available
n)	Water solubility	No data available No data
o)	Partition coefficient: n-octanol/water	available
p)	Auto-ignition temperature	No data available
q)	Decomposition temperature	No data available
r)	Viscosity	No data available
s)	Explosive properties	No data available No data
t)	Oxidizing properties	available

9.2 Other safety information
No data available

10. STABILITY AND REACTIVITY

10.1 Reactivity
No data available

10.2 Chemical stability
Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions
No data available

10.4 Conditions to avoid
No data available

10.5 Incompatible materials
Strong oxidizing agents

10.6 Hazardous decomposition products
Other decomposition products - No data available
In the event of fire: see section 5

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity
LD50 Oral - Rat - 50,000 mg/kg
Remarks: Kidney, Ureter, Bladder:Other changes.

Inhalation: No data available

Dermal: No data available

No data available

Skin corrosion/irritation
No data available

Serious eye damage/eye irritation
No data available

Respiratory or skin sensitisation
No data available

Germ cell mutagenicity
No data available

Carcinogenicity

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

ACGIH: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.

NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity
No data available

No data available

Specific target organ toxicity - single exposure
No data available

Specific target organ toxicity - repeated exposure
No data available

Aspiration hazard
No data available

Additional Information
RTECS: Not available

12. ECOLOGICAL INFORMATION

12.1 Toxicity
No data available

12.2 Persistence and degradability
No data available

12.3 Bioaccumulative potential
No data available

12.4 Mobility in soil
No data available

12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Other adverse effects

No data available

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Product
Offer surplus and non-recyclable solutions to a licensed disposal company.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
Not dangerous goods

IMDG
Not dangerous goods

IATA
Not dangerous goods

15. REGULATORY INFORMATION

SARA 302 Components
No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards
No SARA Hazards

Massachusetts Right To Know Components
No components are subject to the Massachusetts Right to Know Act.

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
PEG 10000	25322-68-3	

New Jersey Right To Know Components

	CAS-No.	Revision Date
PEG 10000	25322-68-3	

California Prop. 65 Components
This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

HMIS Rating

Health hazard:	0
Chronic Health Hazard:	
Flammability:	0Physical
Hazard	0

NFPA Rating

Health hazard:	0Fire
Hazard:	0Reactivity
Hazard:	0

Further information
Copyright 2014 Sigma-Aldrich Co. LLC. License granted to make unlimited paper copies for internal use only.
The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

Preparation Information
Sigma-Aldrich Corporation
Product Safety - Americas Region
1-800-521-8956

Version: 5.3 Revision Date: 12/22/2014 Print Date: 03/30/2015

Safety Data Sheet
acc. to OSHA HCS

Printing date 04/04/2013 Reviewed on 04/04/2013

1 Identification of the substance/mixture and of the company/undertaking

- **Product identifier**
- **Trade name: Polyethylene Glycol, MW 8000**
- **Article number:** 195445
- **CAS Number:**
25322-68-3
- **NLP Number:**
500-038-2
- **Details of the supplier of the safety data sheet**
- **Manufacturer/Supplier:**
MP Biomedicals, LLC
29525 Fountain Parkway
Solon, OH 44139
United States
www.mpbio.com
- **Information department:** Product safety department
- **Emergency telephone number:** CHEMTREC: 1-800-424-9300 (1-703-527-3887)

2 Hazards identification

- **Classification of the substance or mixture**
The substance is not classified according to the Globally Harmonized System (GHS).
- **Classification according to Directive 67/548/EEC or Directive 1999/45/EC** Not applicable.
- **Information concerning particular hazards for human and environment:** Not applicable.
- **Label elements**
- **GHS label elements** Void • **Hazard pictograms** Void
- **Signal word** Void
- **Hazard statements** Void
- **Classification system:**
- **NFPA ratings (scale 0 - 4)**

Health = 0
Fire = 1
Reactivity = 0

- **HMIS-ratings (scale 0 - 4)**

Health = 0
Fire = 1
Reactivity = 0

- **Other hazards**
- **Results of PBT and vPvB assessment** • **PBT:**
Not applicable. • **vPvB:** Not applicable.

[illegible]

- **Chemical characterization: Substances**
- **CAS No. Description**
25322-68-3 Polyethylene glycol

(Contd. on page 2)

Safety Data Sheet
acc. to OSHA HCS

Trade name: Polyethylene Glycol, MW 8000

(Contd. of page 1)

• **Identification number(s)** •
NLP Number: 500-038-2

4 First aid measures

• **Description of first aid measures**
• **General information:** No special measures required.
• **After inhalation:** Supply fresh air; consult doctor in case of complaints. • **After skin contact:** Generally the product does not irritate the skin.
• **After eye contact:** Rinse opened eye for several minutes under running water. • **After swallowing:** If symptoms persist consult doctor.
• **Information for doctor:**
• **Most important symptoms and effects, both acute and delayed** No further relevant information available.
• **Indication of any immediate medical attention and special treatment needed**
No further relevant information available.

5 Firefighting measures

• **Extinguishing media**
• **Suitable extinguishing agents:** Use fire fighting measures that suit the environment.
• **Special hazards arising from the substance or mixture** No further relevant information available.
• **Advice for firefighters**
• **Protective equipment:** No special measures required.

6 Accidental release measures

• **Personal precautions, protective equipment and emergency procedures** Not required.
• **Environmental precautions:** Do not allow to enter sewers/ surface or ground water. • **Methods and material for containment and cleaning up:** Pick up mechanically.
• **Reference to other sections**
No dangerous substances are released.
See Section 7 for information on safe handling.
See Section 8 for information on personal protection equipment. See Section 13 for disposal information.

7 Handling and storage

• **Handling:**
• **Precautions for safe handling** No special measures required.
• **Information about protection against explosions and fires:** No special measures required.

• **Conditions for safe storage, including any incompatibilities**
• **Storage:** 15-30 °C
• **Requirements to be met by storerooms and receptacles:** No special requirements. • **Information about storage in one common storage facility:** Not required. • **Further information about storage conditions:** None.
• **Specific end use(s)** No further relevant information available.

(Contd. on page 3)

Safety Data Sheet
acc. to OSHA HCS

Printing date 04/04/2013 Reviewed on 04/04/2013

Trade name: Polyethylene Glycol, MW 8000

(Contd. of page 2)

8 Exposure controls/personal protection

- **Additional information about design of technical systems:** No further data; see item 7.
- **Control parameters**

• **Components with limit values that require monitoring at the workplace:**	
25322-68-3 Polyethylene glycol	
WEEL	10 mg/m³ (H); MW>200

- **Additional information:** The lists that were valid during the creation were used as basis.
- **Exposure controls**
- **Personal protective equipment:**
- **General protective and hygienic measures:**
The usual precautionary measures for handling chemicals should be followed.
- **Breathing equipment:** Not required.
- **Protection of hands:**
The glove material has to be impermeable and resistant to the product/ the substance/ the preparation.
Due to missing tests no recommendation to the glove material can be given for the product/ the preparation/ the chemical mixture.
Selection of the glove material on consideration of the penetration times, rates of diffusion and the degradation
- **Material of gloves**
The selection of the suitable gloves does not only depend on the material, but also on further marks of quality and varies from manufacturer to manufacturer.
- **Penetration time of glove material**
The exact breakthrough time has to be found out by the manufacturer of the protective gloves and has to be observed.
- **Eye protection:** Not required.

9 Physical and chemical properties

• **Information on basic physical and chemical properties**	
• **General Information**	
• **Appearance:**	
Form:	Solid
Color:	Not determined.
• **Odor:**	Characteristic
• **Odour threshold:**	Not determined.
• **pH-value:**	Not applicable.
• **Change in condition**	
Melting point/Melting range:	Undetermined.
Boiling point/Boiling range:	Undetermined.
• **Flash point:**	199 °C (390 °F)
• **Flammability (solid, gaseous):**	Product is not flammable.
• **Ignition temperature:**	
Decomposition temperature:	Not determined.
• **Auto igniting:**	Not determined.

(Contd. on page 4)

Safety Data Sheet
acc. to OSHA HCS

Printing date 04/04/2013 Reviewed on 04/04/2013

Trade name: Polyethylene Glycol, MW 8000

(Contd. of page 3)

• **Danger of explosion:**	Product does not present an explosion hazard.
• **Explosion limits:**	
Lower:	Not determined. Not
Upper:	determined.
• **Vapor pressure:**	Not applicable. Not
• **Density:**	determined.
• **Relative density** •	Not determined. Not
Vapour density	applicable. Not
• **Evaporation rate**	applicable.
• **Solubility in / Miscibility with**	
Water:	Soluble.
• **Partition coefficient (n-octanol/water):** Not determined.	
• **Viscosity:**	
Dynamic:	Not applicable.
Kinematic:	Not applicable.
Organic solvents:	0.0%
Solids content:	100.0%
• **Other information**	No further relevant information available.

10 Stability and reactivity

• **Reactivity**
• **Chemical stability**
• **Thermal decomposition / conditions to be avoided:** No decomposition if used according to specifications. • **Possibility of hazardous reactions** No dangerous reactions known. • **Conditions to avoid** No further relevant information available.
• **Incompatible materials:** No further relevant information available.
• **Hazardous decomposition products:** No dangerous decomposition products known.

11 Toxicological information

• **Information on toxicological effects**
• **Acute toxicity:**
• **Primary irritant effect:**
• **on the skin:** No irritant effect. • **on the eye:** No irritating effect.
• **Sensitization:** No sensitizing effects known.
• **Additional toxicological information:**
When used and handled according to specifications, the product does not have any harmful effects according to our experience and the information provided to us. The substance is not subject to classification.

• **Carcinogenic categories**

• **IARC (International Agency for Research on Cancer)**
Substance is not listed.

(Contd. on page 5)

Safety Data Sheet
acc. to OSHA HCS

Trade name: Polyethylene Glycol, MW 8000

(Contd. of page 4)

• **NTP (National Toxicology Program)**
Substance is not listed.

12 Ecological information

• **Toxicity**
• **Aquatic toxicity:** No further relevant information available.
• **Persistence and degradability** No further relevant information available.
• **Behavior in environmental systems:**
• **Bioaccumulative potential** No further relevant information available. •
Mobility in soil No further relevant information available.
• **Additional ecological information:**
• **General notes:**
Water hazard class 1 (Self-assessment): slightly hazardous for water
Do not allow undiluted product or large quantities of it to reach ground water, water course or sewage system.
• **Results of PBT and vPvB assessment**
• **PBT:** Not applicable. • **vPvB:**
Not applicable.
• **Other adverse effects** No further relevant information available.

13 Disposal considerations

• **Waste treatment methods**
• **Recommendation:** Smaller quantities can be disposed of with household waste.
• **Uncleaned packagings:**
• **Recommendation:** Disposal must be made according to official regulations.

14 Transport information

• **UN-Number**	
• **DOT, ADR, ADN, IMDG, IATA**	Void
• **UN proper shipping name**	
• **DOT, ADR, ADN, IMDG, IATA**	Void
• **Transport hazard class(es)**	
• **DOT, ADR, ADN, IMDG, IATA**	
• **Class**	Void
• **Packing group**	
• **DOT, ADR, IMDG, IATA**	Void
• **Environmental hazards:**	
• **Marine pollutant:**	No
• **Special precautions for user**	Not applicable.
• **Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code**	Not applicable.

(Contd. on page 6)

Safety Data Sheet
acc. to OSHA HCS

Printing date 04/04/2013 Reviewed on 04/04/2013

Trade name: Polyethylene Glycol, MW 8000

(Contd. of page 5)

• **UN "Model Regulation":** -

15 Regulatory information

• **Safety, health and environmental regulations/legislation specific for the substance or mixture**
• **Sara**

• **Section 355 (extremely hazardous substances):**
Substance is not listed.

• **Section 313 (Specific toxic chemical listings):**
Substance is not listed.

• **TSCA (Toxic Substances Control Act):**
Substance is listed.

• **Proposition 65**

• **Chemicals known to cause cancer:**
Substance is not listed.

• **Chemicals known to cause reproductive toxicity for females:**
Substance is not listed.

• **Chemicals known to cause reproductive toxicity for males:**
Substance is not listed.

• **Chemicals known to cause developmental toxicity:**
Substance is not listed.

• **Carcinogenic categories**

• **EPA (Environmental Protection Agency)**
Substance is not listed.

• **TLV (Threshold Limit Value established by ACGIH)**
Substance is not listed.

• **NIOSH-Ca (National Institute for Occupational Safety and Health)**
Substance is not listed.

• **OSHA-Ca (Occupational Safety & Health Administration)**
Substance is not listed.

• **GHS label elements** Void
• **Hazard pictograms** Void
• **Signal word** Void
• **Hazard statements** Void
• **Chemical safety assessment:** A Chemical Safety Assessment has not been carried out.

16 Other information

This information is based on our present knowledge. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.

• **Department issuing MSDS:** Product safety department
• **Abbreviations and acronyms:**
ADR: Accord européen sur le transport des marchandises dangereuses par Route (European Agreement concerning the International Carriage of Dangerous Goods by Road)
IMDG: International Maritime Code for Dangerous Goods

(Contd. on page 7)

Safety Data Sheet
acc. to OSHA HCS

Printing date 04/04/2013 *Reviewed on 04/04/2013*

Trade name: Polyethylene Glycol, MW 8000

(Contd. of page 6)

DOT: US Department of Transportation
IATA: International Air Transport Association
ACGIH: American Conference of Governmental Industrial Hygienists
EINECS: European Inventory of Existing Commercial Chemical Substances
CAS: Chemical Abstracts Service (division of the American Chemical Society)
NFPA: National Fire Protection Association (USA)
HMIS: Hazardous Materials Identification System (USA)

SAFETY DATA SHEET

according to the (US) Hazard Communication Standard (29 CFR 1910.1200)

Revision Date 06/05/2014 Version 1.2

SECTION 1. Identification

Product identifier

Product number	103965
Product name	Iron(II) sulfate heptahydrate for analysis EMSURE® ACS,ISO,Reag. Ph Eur
CAS-No.	7782-63-0

Relevant identified uses of the substance or mixture and uses advised against

Identified uses	Reagent for analysis

Details of the supplier of the safety data sheet

Company	EMD Millipore Corporation | 290 Concord Road, Billerica, MA 01821, United States of America | General Inquiries: +1-978-715-4321 | Monday to Friday, 9:00 AM to 4:00 PM Eastern Time (GMT-5)
Emergency telephone	800-424-9300 CHEMTREC (USA) +1-703-527-3887 CHEMTREC (International) 24 Hours/day; 7 Days/week

SECTION 2. Hazards identification

GHS Classification

Acute toxicity, Category 4, Oral, H302
Skin irritation, Category 2, H315 Eye irritation, Category 2, H319

For the full text of the H-Statements mentioned in this Section, see Section 16.

GHS-Labeling

Hazard pictograms

Signal Word
Warning

Hazard Statements
H302 Harmful if swallowed. H315 Causes skin irritation.

H319 Causes serious eye irritation.

Precautionary Statements
P302 + P352 IF ON SKIN: Wash with plenty of soap and water.
P305 + P351 + P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

OSHA Hazards
This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200). This information is based on 29 CFR 1910.1200 criteria prior to adoption of the GHS and may deviate from the GHS information.

Other hazards
None known.

SECTION 3. Composition/information on ingredients

Formula	$FeSO_4 * 7H_2O$	$FeO_4S * 7H_2O$ (Hill)
Molar mass	278.02 g/mol	

Hazardous ingredients
Chemical Name (Concentration)
CAS-No.
Iron(II) sulphate heptahydrate (>= 90 % - <= 100 %)
7782-63-0
Exact percentages are being withheld as a trade secret.

SECTION 4. First aid measures

Description of first-aid measures

Inhalation
After inhalation: fresh air.

Skin contact
After skin contact: wash off with plenty of water. Remove contaminated clothing.

Eye contact
After eye contact: rinse out with plenty of water. Call in ophthalmologist.

Ingestion
After swallowing: immediately make victim drink water (two glasses at most). Consult a physician.

Never give anything by mouth to an unconscious person.

Most important symptoms and effects, both acute and delayed
Diarrhea, Bloody vomiting, irritant effects
The following applies to soluble iron compounds: nausea and vomiting after swallowing. The absorption of large quantities is followed by cardiovascular disorders. Toxic effect on liver and kidneys.

Indication of any immediate medical attention and special treatment needed
No information available.

SECTION 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media

Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable extinguishing media

For this substance/mixture no limitations of extinguishing agents are given.

Special hazards arising from the substance or mixture

Not combustible.
Ambient fire may liberate hazardous vapors.
Fire may cause evolution of:
Sulfur oxides

Advice for firefighters

Special protective equipment for fire-fighters

Stay in danger area only with self-contained breathing apparatus. Prevent skin contact by keeping a safe distance or by wearing suitable protective clothing.

Further information

Suppress (knock down) gases/vapors/mists with a water spray jet. Prevent fire extinguishing water from contaminating surface water or the ground water system.

SECTION 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

Advice for non-emergency personnel: Avoid inhalation of dusts. Avoid substance contact. Ensure adequate ventilation. Evacuate the danger area, observe emergency procedures, consult an expert.

Advice for emergency responders: Protective equipment see section 8.

Environmental precautions

Do not empty into drains.

Methods and materials for containment and cleaning up

Cover drains. Collect, bind, and pump off spills.
Observe possible material restrictions (see sections 7 and 10).
Take up dry. Dispose of properly. Clean up affected area. Avoid generation of dusts.

SECTION 7. Handling and storage

Precautions for safe handling

Observe label precautions.

Conditions for safe storage, including any incompatibilities

Tightly closed. Dry. Protected from light.

Store at +15°C to +25°C (+59°F to +77°F).

SECTION 8. Exposure controls/personal protection

Exposure limit(s)

Ingredients

Basis	Value	Threshold limits	Remarks
Iron(II) sulphate heptahydrate 7782-63-0			
ACGIH	Time Weighted Average (TWA):	1 mg/m³	Expressed as: as Fe
NIOSH/GUIDE	Recommended exposure limit (REL):	1 mg/m³	Expressed as: as Fe
Z1A	Time Weighted Average (TWA):	1 mg/m³	Expressed as: as Fe

Engineering measures

Technical measures and appropriate working operations should be given priority over the use of personal protective equipment.

Individual protection measures

Protective clothing should be selected specifically for the workplace, depending on concentration and quantity of the hazardous substances handled. The chemical resistance of the protective equipment should be inquired at the respective supplier.

Hygiene measures

Immediately change contaminated clothing. Apply skin- protective barrier cream. Wash hands and face after working with substance.

Eye/face protection

Safety glasses

Hand protection

Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary.

Other protective equipment:

protective clothing

Respiratory protection

required when dusts are generated.

Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

SECTION 9. Physical and chemical properties

Physical state	solid
Color	blue green
Odor	odorless
Odor Threshold	not applicable

pH	3-4 at 50 g/l 68 °F (20 °C)
Melting point	> 60 °C Elimination of water of crystallization
Boiling point	No information available.
Flash point	does not flash
Evaporation rate	No information available.
Flammability (solid, gas)	No information available.
Lower explosion limit	not applicable
Upper explosion limit	not applicable
Vapor pressure	No information available.
Relative vapor density	No information available.
Density	1.89 g/cm³ at 68 °F (20 °C)
Relative density	No information available.
Water solubility	ca. 400 g/l at 68 °F (20 °C)
Partition coefficient: n-octanol/water	No information available.
Autoignition temperature	No information available.
Decomposition temperature	> 572 °F (> 300 °C)
Viscosity, dynamic	not applicable
Explosive properties	Not classified as explosive.
Oxidizing properties	none
Ignition temperature	not combustible
Bulk density	ca. 600 kg/m³

SECTION 10. Stability and reactivity

Reactivity

See below

Chemical stability
Sensitivity to light
releases water of crystallization when heated.

Possibility of hazardous reactions
increased reactivity with:
Bases, Oxidizing agents

Conditions to avoid
Exposure to moisture.

Incompatible materials
no information available

Hazardous decomposition products
in the event of fire: See section 5.

SECTION 11. Toxicological information

Information on toxicological effects

Likely route of exposure
Eye contact, Skin contact, Ingestion

Acute oral toxicity
LD50 rat: 319 mg/kg (anhydrous substance) (Lit.)

absorption

Acute inhalation toxicity

Symptoms: Possible damages:, mucosal irritations

Skin irritation
Causes skin irritation.

Eye irritation
Causes serious eye irritation.

Sensitization
In animal experiments:
Result: negative
(IUCLID)

Genotoxicity in vitro
Ames test
Result: negative
(Lit.)

Specific target organ systemic toxicity - single exposure
The substance or mixture is not classified as specific target organ toxicant, single exposure.

Specific target organ systemic toxicity - repeated exposure
The substance or mixture is not classified as specific target organ toxicant, repeated exposure.

Aspiration hazard
Regarding the available data the classification criteria are not fulfilled.

Carcinogenicity

IARC	No ingredient of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
OSHA	No ingredient of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.
NTP	No ingredient of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
ACGIH	No ingredient of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.

Further information
Systemic effects:
After swallowing of large amounts:
Bloody vomiting, Diarrhea, drop in blood pressure
The following applies to soluble iron compounds: nausea and vomiting after swallowing. The absorption of large quantities is followed by cardiovascular disorders. Toxic effect on liver and kidneys.
Other dangerous properties can not be excluded.
Handle in accordance with good industrial hygiene and safety practice.

SECTION 12. Ecological information

Ecotoxicity

Toxicity to fish
LC50 Poecilia retiaculata (guppy): 925 mg/l; 96 h (IUCLID)

Toxicity to daphnia and other aquatic invertebrates
EC50 Daphnia magna (Water flea): 152 mg/l; 48 h (anhydrous substance) (IUCLID)

Toxicity to bacteria
EC0 Pseudomonas fluorescens: 100 mg/l; 24 h (anhydrous substance) (IUCLID)

Persistence and degradability
No information available.

Bioaccumulative potential
No information available.

Mobility in soil
No information available.

Additional ecological information
Discharge into the environment must be avoided.

SECTION 13. Disposal considerations

The information presented only applies to the material as supplied. The identification based on characteristic(s) or listing may not apply if the material has been used or otherwise contaminated. It is the responsibility of the waste generator to determine the toxicity and physical properties of the material generated to determine the proper waste identification and disposal methods in compliance with applicable regulations. Disposal should be in accordance with applicable regional, national and local laws and regulations.

SECTION 14. Transport information

Land transport (DOT)

Not classified as dangerous in the meaning of transport regulations.

Air transport (IATA)

Not classified as dangerous in the meaning of transport regulations.

Sea transport (IMDG)

Not classified as dangerous in the meaning of transport regulations.

SECTION 15. Regulatory information

United States of America

OSHA Hazards

Toxic by ingestion

Skin irritant Eye irritant

This information is based on 29 CFR 1910.1200 criteria prior to adoption of the GHS, and may deviate from the GHS information on the label and in section 2.

SARA 311/312 Hazards

Acute Health Hazard

SARA 313

SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 302

SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

Clean Water Act

The following Hazardous Substances are listed under the U.S. CleanWater Act, Section 311, Table 116.4A:

Ingredients
Iron(II) sulphate heptahydrate

The following Hazardous Chemicals are listed under the U.S. CleanWater Act, Section 311, Table 117.3:

Ingredients
Iron(II) sulphate heptahydrate

DEA List I

Not listed

DEA List II

Not listed

US State Regulations

Massachusetts Right To Know

Ingredients
Iron(II) sulphate heptahydrate

Pennsylvania Right To Know

Ingredients
Iron(II) sulphate heptahydrate

New Jersey Right To Know

Ingredients
Iron(II) sulphate heptahydrate

California Prop 65 Components

This product does not contain any chemicals known to the State of California to cause cancer, birth, or any other reproductive defects.

Notification status

TSCA:	All components of the product are listed in the TSCA-inventory.
DSL:	All components of this product are on the Canadian DSL.

SECTION 16. Other information

Training advice
Provide adequate information, instruction and training for operators.

Full text of H-Statements referred to under sections 2 and 3.

H302	Harmful if swallowed.
H315	Causes skin irritation.
H319	Causes serious eye irritation.

Key or legend to abbreviations and acronyms used in the safety data sheet
Used abbreviations and acronyms can be looked up at www.wikipedia.org.

Revision Date06/05/2014

The information contained herein is based on the present state of our knowledge. It characterizes the product with regard to appropriate safety precautions. It does not represent a warranty of any product properties and we assume no liability for any loss or injury which may result from the use of this information. Users should conduct their own investigations to determine the suitability of the information.

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MATERIAL SAFETY DATA SHEET

according to the Hazard Communication Standard (29 CFR 1910.1200)

Date of issue: 09/17/2012 Version 1.0

SECTION 1. Identification

Product identifier

Product number	108342
Product name	D(+)-Glucose monohydrate for microbiology

Relevant identified uses of the substance or mixture and uses advised against

Identified uses	Reagent for analysis

Details of the supplier of the safety data sheet

Company	EMD Millipore Corporation | 290 Concord Road, Billerica, MA 01821, United States of America | SDS Phone Support: +1-978-715-1335 | General Inquiries: +1-978-751-4321 | Monday to Friday, 9:00 AM to 4:00 PM Eastern Time (GMT-5) e-mail: mm_sds@merckgroup.com
Emergency telephone	800-424-9300 CHEMTREC (USA) +1-703-527-3887 CHEMTREC (International) 24 Hours/day; 7 Days/week

SECTION 2. Hazards identification

GHS-Labeling

Not a dangerous substance according to GHS.

OSHA Hazards

While this material is not considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200), this MSDS contains valuable information critical to the safe handling and proper use of the product. This MSDS should be retained and available for employees and other users of this product.

Other hazards

None known.

SECTION 3. Composition/information on ingredients

Formula	$C_6H_{12}O_6 * H_2O$ (Hill) CAS-
No.	14431-43-7
Molar mass	198.17 g/mol

Remarks No hazardous ingredients according to the OSHA Hazard Communication Standard 29 CFR 1910.1200.

SECTION 4. First aid measures

Description of first-aid measures

Inhalation

After inhalation: fresh air.

Skin contact

After skin contact (particles, dusts): Rinse with water.

Eye contact

After eye contact: rinse out with plenty of water.

Ingestion

After swallowing (large amounts): consult doctor if feeling unwell.

Never give anything by mouth to an unconscious person.

Most important symptoms and effects, both acute and delayed

We have no description of any toxic symptoms.

Indication of any immediate medical attention and special treatment needed

No information available.

SECTION 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media

Water, Carbon dioxide (CO_2), Foam, Dry powder

Unsuitable extinguishing media

For this substance/mixture no limitations of extinguishing agents are given.

Special hazards arising from the substance or mixture

Combustible material

Advice for firefighters

Special protective equipment for fire-fighters

In the event of fire, wear self-contained breathing apparatus.

SECTION 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

Advice for non-emergency personnel: Avoid inhalation of dusts. Evacuate the danger area, observe emergency procedures, consult an expert.

Advice for emergency responders: Protective equipment see section 8.

Environmental precautions

No special precautionary measures necessary.

Methods and materials for containment and cleaning up

Observe possible material restrictions (see sections 7 and 10).
Take up dry. Dispose of properly. Clean up affected area. Avoid generation of dusts.

SECTION 7. Handling and storage

Precautions for safe handling

Observe label precautions.

Conditions for safe storage, including any incompatibilities

Tightly closed. Dry.

Store at +15°C to +25°C (+59°F to +77°F).

SECTION 8. Exposure controls/personal protection

Exposure limit(s)

Contains no substances with occupational exposure limit values.

Engineering measures

Technical measures and appropriate working operations should be given priority over the use of personal protective equipment.

Individual protection measures

Protective clothing should be selected specifically for the workplace, depending on concentration and quantity of the hazardous substances handled. The chemical resistance of the protective equipment should be inquired at the respective supplier.

Hygiene measures

Change contaminated clothing. Wash hands after working with substance.

Eye/face protection

Safety glasses

Hand protection

Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary.

Recommended:

full contact:

Glove material:	Nitrile rubber
Glove thickness:	0.11 mm
Break through time:	> 480 min

splash contact:

Glove material:	Nitrile rubber
Glove thickness:	0.11 mm
Break through time:	> 480 min

Respiratory protection

required when dusts are generated.

Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

SECTION 9. Physical and chemical properties

Physical state	solid
Color	colorless
Odor	odorless
Odor Threshold	No information available.
pH	6-7 at 100 g/l 68 °F (20 °C)
Melting point	ca. 181 °F (83 °C)
Boiling point	No information available.
Flash point	No information available.
Evaporation rate	No information available.
Flammability (solid, gas)	No information available.
Lower explosion limit	No information available.
Upper explosion limit	No information available.
Vapor pressure	No information available.
Relative vapor density	No information available.
Relative density	No information available.
Water solubility	1,000 g/l at 68 °F (20 °C)
Partition coefficient: n-octanol/water	log Pow: -3.29 (anhydrous substance) Bioaccumulation is not expected (log Pow <1).
Autoignition temperature	No information available.
Decomposition temperature	No information available.
Viscosity, dynamic	No information available.
Ignition temperature	ca. 932 °F (500 °C)
Bulk density	ca. 630 kg/m³

SECTION 10. Stability and reactivity

Reactivity
Risk of dust explosion.

Chemical stability
releases water of crystallization when heated.

Possibility of hazardous reactions
Strong oxidizing agents

Conditions to avoid
no information available

Incompatible materials
no information available

Hazardous decomposition products
no information available

SECTION 11. Toxicological information

Information on toxicological effects

Likely route of exposure
Eye contact, Skin contact, Ingestion

Acute oral toxicity
LD50 rat: 25,800 mg/kg (anhydrous substance) (RTECS)

Specific target organ systemic toxicity - single exposure
The substance or mixture is not classified as specific target organ toxicant, single exposure.

Specific target organ systemic toxicity - repeated exposure
The substance or mixture is not classified as specific target organ toxicant, repeated exposure.

Aspiration hazard
Regarding the available data the classification criteria are not fulfilled.

Carcinogenicity

IARC	No ingredient of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
OSHA	No ingredient of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.
NTP	No ingredient of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
ACGIH	No ingredient of this product present at levels greater than or

equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.

Further information

Our own experience has provided no indication of any hazardous potential.
Further data:
Substances which occur in nature
Handle in accordance with good industrial hygiene and safety practice.
Substance which occurs in the human body under physiological conditions.

SECTION 12. Ecological information

Ecotoxicity

Toxicity to fish
LC0 fish: 60,000 mg/l (anhydrous substance) (External MSDS)

Persistence and degradability

Biodegradability
48 %; 5 d
OECD Test Guideline 301D
(External MSDS)

Readily biodegradable.

Bioaccumulative potential

Partition coefficient: n-octanol/water
log Pow: -3.29
(anhydrous substance) Bioaccumulation is not expected (log Pow <1).

Mobility in soil

No information available.

Other adverse effects

Additional ecological information
No ecological problems are to be expected when the product is handled and used with due care and attention.

SECTION 13. Disposal considerations

The information presented only applies to the material as supplied. The identification based on characteristic(s) or listing may not apply if the material has been used or otherwise contaminated. It is the responsibility of the waste generator to determine the toxicity and physical properties of the material generated to determine the proper waste identification and disposal methods in compliance with applicable regulations. Disposal should be in accordance with applicable regional, national and local laws and regulations.

SECTION 14. Transport information

Land transport (DOT)

Not classified as dangerous in the meaning of transport regulations.

Air transport (IATA)

Not classified as dangerous in the meaning of transport regulations.

Sea transport (IMDG)

Not classified as dangerous in the meaning of transport regulations.

SECTION 15. Regulatory information

United States of America

OSHA Hazards

No OSHA Hazards

This information is based on 29 CFR 1910.1200 criteria prior to adoption of the GHS, and may deviate from the GHS information on the label and in section 2.

SARA 311/312 Hazards

No SARA Hazards

Clean Water Act

This product does not contain any Hazardous Substances listed under the U.S. CleanWater Act, Section 311, Table 116.4A.

This product does not contain any Hazardous Chemicals listed under the U.S. CleanWater Act, Section 311, Table 117.3.

Massachusetts Right To Know

Remarks

No components are subject to the Massachusetts Right to Know Act.

Pennsylvania Right To Know

Ingredients

D-(+)-glucose
water of crystallization

New Jersey Right To Know

Ingredients

D-(+)-glucose
water of crystallization

California Prop 65 Components

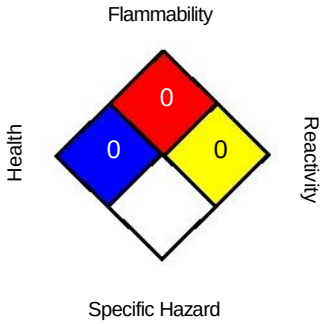
This product does not contain any chemicals known to the State of California to cause cancer, birth, or any other reproductive defects.

Notification status

TSCA:	On TSCA Inventory
DSL:	All components of this product are on the Canadian DSL.

SECTION 16. Other information

National Fire Protection Association (U.S.A)



Training advice
Provide adequate information, instruction and training for operators.

Key or legend to abbreviations and acronyms used in the safety data sheet
Used abbreviations and acronyms can be looked up at www.wikipedia.org.

The information contained herein is based on the present state of our knowledge. It characterizes the product with regard to appropriate safety precautions. It does not represent a warranty of any product properties and we assume no liability for any loss or injury which may result from the use of this information. Users should conduct their own investigations to determine the suitability of the information.

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Fisher Scientific

Part of Thermo Fisher Scientific

Creation Date 02-Feb-2010 **Material**ision Date 08-Nov-2012 **Sheet** **Revision Number** 2

Safety Data

Rev

Product Name

Cat No.

1. PRODUCT AND COMPANY IDENTIFICATION

Synonyms **Calcium carbonate**

Recommended Use **C63-10, C63-3**

Precipitated chalk; Aragonite; Agricultural limestone

Laboratory chemicals

Company
Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Emergency Telephone Number
CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 001-703-527-3887

WARNING!

2. HAZARDS IDENTIFICATION

Appearance Off-white **odor** odorless

Emergency Overview

Irritating to eyes and skin. May cause irritation of respiratory tract.

Physical State Solid

Target Organs

Potential Health Effects

Acute Effects
Principle Routes of Exposure Skin, Eyes

Eyes Irritating to eyes.
Skin Irritating to skin. May be harmful in contact with skin.
Inhalation May cause irritation of respiratory tract. May be harmful if inhaled.
Ingestion May be harmful if swallowed. Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhea.

Chronic Effects None known.

See Section 11 for additional Toxicological information.

Aggravated Medical Conditions Preexisting eye disorders. Skin disorders.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Haz/Non-haz

Component	CAS-No	Weight %
Calcium carbonate	471-34-1	>95

4. FIRST AID MEASURES

Eye Contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Obtain medical attention.

Skin Contact Wash off immediately with plenty of water for at least 15 minutes. Obtain medical attention.

Inhalation Move to fresh air. If breathing is difficult, give oxygen. Get medical attention immediately if symptoms occur.

Ingestion Do not induce vomiting. Obtain medical attention.

Notes to Physician Treat symptomatically.

5. FIRE-FIGHTING MEASURES

Flash Point Not applicable
Method No information available.

Autoignition Temperature No information available.
Explosion Limits
Upper No data available No
Lower data available

Suitable Extinguishing Media Substance is nonflammable; use agent most appropriate to extinguish surrounding fire..

Unsuitable Extinguishing Media No information available.

Hazardous Combustion Products No information available.

Sensitivity to mechanical impact No information available.
Sensitivity to static discharge No information available.

Specific Hazards Arising from the Chemical
Thermal decomposition can lead to release of irritating gases and vapors.

Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

NFPA **Health** 1 **Flammability** 0 **Instability** 0 **Physical hazards** N/A

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions Ensure adequate ventilation. Use personal protective equipment. Avoid dust formation.

Environmental Precautions Should not be released into the environment.

Methods for Containment and Clean Up Sweep up or vacuum up spillage and collect in suitable container for disposal. Avoid dust formation.

7. HANDLING AND STORAGE

Handling Wear personal protective equipment. Ensure adequate ventilation. Do not get in eyes, on skin, or on clothing. Avoid ingestion and inhalation. Avoid dust formation.

Storage Keep containers tightly closed in a dry, cool and well-ventilated place.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Measures Ensure that eyewash stations and safety showers are close to the workstation location. Ensure adequate ventilation, especially in confined areas.

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH
Calcium carbonate			TWA: 10 mg/m³ TWA: 5 mg/m³

Component	Quebec	Mexico OEL (TWA)	Ontario TWAEV
Calcium carbonate	TWA: 10 mg/m³		

NIOSH IDLH: *Immediately Dangerous to Life or Health*

Personal Protective Equipment

Eye/face Protection Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin and body protection Wear appropriate protective gloves and clothing to prevent skin exposure.

Respiratory Protection Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State	Solid
Appearance	Off-white
odor	odorless
Odor Threshold	No information available.
pH	8-9
Vapor Pressure	No information available. No
Vapor Density	information available. No
Viscosity	information available. No
Boiling Point/Range	information available.
Melting Point/Range	825°C / 1517°F
Decomposition temperature	825 °C
Flash Point	Not applicable
Evaporation Rate	No information available. No
Specific Gravity	information available.
Solubility	Slightly soluble in water
log Pow	No data available
Molecular Weight	100.09

9. PHYSICAL AND CHEMICAL PROPERTIES

Molecular Formula C Ca O3

10. STABILITY AND REACTIVITY

Stability Stable under normal conditions.

Conditions to Avoid Incompatible products. Excess heat. Avoid dust formation.

Incompatible Materials Strong oxidizing agents, Acids

Hazardous Decomposition Products Carbon monoxide (CO), Carbon dioxide (CO_2), Calcium oxides

Hazardous Polymerization Hazardous polymerization does not occur.

Hazardous Reactions . None under normal processing..

11. TOXICOLOGICAL INFORMATION

Acute Toxicity

Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation (Dust)
Calcium carbonate	6450 mg/kg (Rat)	Not listed	Not listed

Irritation Irritating to eyes and skin

Toxicologically Synergistic Products No information available.

Chronic Toxicity

Carcinogenicity There are no known carcinogenic chemicals in this product

Sensitization No information available.

Mutagenic Effects No information available.

Reproductive Effects No information available.

Developmental Effects No information available.

Teratogenicity No information available.

Other Adverse Effects The toxicological properties have not been fully investigated.. See actual entry in RTECS for complete information.

Endocrine Disruptor Information No information available

12. ECOLOGICAL INFORMATION

Ecotoxicity

Do not empty into drains

Persistence and Degradability No information available

Bioaccumulation/ Accumulation No information available

Mobility No information available

13. DISPOSAL CONSIDERATIONS

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. TRANSPORT INFORMATION

DOT Not regulated

TDG Not regulated

IATA Not regulated

IMDG/IMO Not regulated

15. REGULATORY INFORMATION

International Inventories

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	CHINA	KECL
Calcium carbonate	X	X	-	207-439-9	-		X	X	X	X	X

Legend:
X - Listed
E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA. F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.
N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.
P - Indicates a commenced PMN substance
R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.
S - Indicates a substance that is identified in a proposed or final Significant New Use Rule T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.

XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B).
Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.
Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations

TSCA 12(b) Not applicable

SARA 313
Not applicable

SARA 311/312 Hazardous Categorization

Acute Health Hazard	Yes
Chronic Health Hazard	No
Fire Hazard	No
Sudden Release of Pressure Hazard	No
Reactive Hazard	No

Clean Water Act
Not applicable

Clean Air Act Not applicable

OSHA
Not applicable

CERCLA
Not Applicable

California Proposition 65
This product does not contain any Proposition 65 chemicals.

State Right-to-Know
Not applicable

U.S. Department of Transportation

Reportable Quantity (RQ):	N
DOT Marine Pollutant	NDOT
Severe Marine Pollutant	N

U.S. Department of Homeland Security

This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade No information available

Canada

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.

WHMIS Hazard Class
Non-controlled

16. OTHER INFORMATION

Prepared By	Regulatory Affairs Thermo Fisher Scientific Email: EMSDS.RA@thermofisher.com
Creation Date	02-Feb-2010
Print Date	08-Nov-2012
Revision Summary	(M)SDS sections updated 2

Disclaimer

The information provided on this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guide for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered as a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other material or in any process, unless specified in the text.

End of MSDS

SAFETY DATA SHEET

according to the (US) Hazard Communication Standard (29 CFR 1910.1200)

Revision Date 10/14/2014 Version 1.3

SECTION 1. Identification

Product identifier

Product number	101217
Product name	Ammonium sulfate for analysis EMSURE® ACS,ISO,Reag. Ph Eur CAS-
No.	7783-20-2

Relevant identified uses of the substance or mixture and uses advised against

Identified uses	Reagent for analysis

Details of the supplier of the safety data sheet

Company	EMD Millipore Corporation | 290 Concord Road, Billerica, MA 01821, United States of America | General Inquiries: +1-978-715-4321 | Monday to Friday, 9:00 AM to 4:00 PM Eastern Time (GMT-5)
Emergency telephone	800-424-9300 CHEMTREC (USA) +1-703-527-3887 CHEMTREC (International) 24 Hours/day; 7 Days/week

SECTION 2. Hazards identification

GHS-Labeling

Not a dangerous substance according to GHS.

Other hazards

None known.

SECTION 3. Composition/information on ingredients

Formula	$(NH_4)_2SO_4$	$H_8N_2O_4S$ (Hill)
Molar mass	132.14 g/mol	
Remarks	No hazardous ingredients according to the OSHA Hazard Communication Standard 29 CFR 1910.1200.	

SECTION 4. First aid measures

Description of first-aid measures

Inhalation

After inhalation: fresh air.

Skin contact
In case of skin contact: Take off immediately all contaminated clothing. Rinse skin with water/ shower.

Eye contact
After eye contact: rinse out with plenty of water.

Ingestion
After swallowing: make victim drink water (two glasses at most). Consult doctor if feeling unwell.

Never give anything by mouth to an unconscious person.

Most important symptoms and effects, both acute and delayed
The following applies to ammonium salts in general: after swallowing: local irritation symptoms, nausea, vomiting, diarrhea. Systemic effect: after the uptake of very large qantities: drop in blood pressure, collapse, CNS disorders, spasms, narcotic conditions, respiratory paralysis, hemolysis.

Indication of any immediate medical attention and special treatment needed
No information available.

SECTION 5. Fire-fighting measures

Extinguishing media
Suitable extinguishing media
Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable extinguishing media
For this substance/mixture no limitations of extinguishing agents are given.

Special hazards arising from the substance or mixture
Not combustible.
Ambient fire may liberate hazardous vapors.
Fire may cause evolution of:
nitrogen oxides, Sulfur oxides

Advice for firefighters
Special protective equipment for fire-fighters
In the event of fire, wear self-contained breathing apparatus.

Further information
Suppress (knock down) gases/vapors/mists with a water spray jet. Prevent fire extinguishing water from contaminating surface water or the ground water system.

SECTION 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures
Advice for non-emergency personnel: Avoid inhalation of dusts. Evacuate the danger area, observe emergency procedures, consult an expert.

Advice for emergency responders: Protective equipment see section 8.

Environmental precautions
Do not empty into drains.

Methods and materials for containment and cleaning up

Cover drains. Collect, bind, and pump off spills.
Observe possible material restrictions (see sections 7 and 10).
Take up dry. Dispose of properly. Clean up affected area. Avoid generation of dusts.

SECTION 7. Handling and storage

Precautions for safe handling

Observe label precautions.

Conditions for safe storage, including any incompatibilities

Tightly closed. Dry.

Store at +5°C to +30°C (+41°F to +86°F).

SECTION 8. Exposure controls/personal protection

Exposure limit(s)

Contains no substances with occupational exposure limit values.

Engineering measures

Technical measures and appropriate working operations should be given priority over the use of personal protective equipment.

Individual protection measures

Protective clothing should be selected specifically for the workplace, depending on concentration and quantity of the hazardous substances handled. The chemical resistance of the protective equipment should be inquired at the respective supplier.

Hygiene measures

Change contaminated clothing. Wash hands after working with substance.

Eye/face protection

Safety glasses

Hand protection

Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary.

Respiratory protection

required when dusts are generated.

Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

SECTION 9. Physical and chemical properties

Physical state	solid
Color	colorless
Odor	odorless
Odor Threshold	Not applicable

pH	ca. 5 at 100 g/l
Melting point	(decomposition), Not applicable
Boiling point/boiling range	Not applicable
Flash point	does not flash
Evaporation rate	No information available.
Flammability (solid, gas)	No information available.
Lower explosion limit	Not applicable
Upper explosion limit	Not applicable
Vapor pressure	No information available.
Relative vapor density	Not applicable
Density	1.77 g/cm³ at 68 °F (20 °C)
Relative density	No information available.
Water solubility	754 g/l at 68 °F (20 °C)
Partition coefficient: n-octanol/water	No information available.
Autoignition temperature	No information available.
Decomposition temperature	> 455 °F (> 235 °C)
Viscosity, dynamic	No information available.
Explosive properties	Not classified as explosive.
Oxidizing properties	none
Ignition temperature	Not applicable
Bulk density	ca. 850 kg/m³

SECTION 10. Stability and reactivity

Reactivity

See below

Chemical stability

hygroscopic

Possibility of hazardous reactions

Exothermic reaction with:

chlorates, with, heat nitrates,

with, Heat.

Risk of explosion with:

chlorates, with, Acids

nitrates, with, Potassium

nitrates, with, Acids

nitrites, sodium hypochlorite

Generates dangerous gases or fumes in contact with:

alkalines, Possible formation of:, Ammonia

Conditions to avoid

Strong heating (decomposition).

Incompatible materials

no information available

Hazardous decomposition products

in the event of fire: See section 5.

SECTION 11. Toxicological information

Information on toxicological effects

Likely route of exposure

Eye contact, Skin contact, Ingestion

Acute oral toxicity

LD50 Rat: 2,840 mg/kg (IUCLID)

Skin irritation

Rabbit

Result: No irritation

(IUCLID)

Eye irritation

Rabbit

Result: No eye irritation

(IUCLID)

Genotoxicity in vitro

Ames test

Result: negative

Method: OECD Test Guideline 471

Mutagenicity (mammal cell test): chromosome aberration.

Result: negative

(IUCLID)

Specific target organ systemic toxicity - single exposure
The substance or mixture is not classified as specific target organ toxicant, single exposure.

Specific target organ systemic toxicity - repeated exposure
The substance or mixture is not classified as specific target organ toxicant, repeated exposure.

Aspiration hazard
Regarding the available data the classification criteria are not fulfilled.

Carcinogenicity

IARC	No ingredient of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
OSHA	No ingredient of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.
NTP	No ingredient of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
ACGIH	No ingredient of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.

Further information
The following applies to ammonium salts in general: after swallowing: local irritation symptoms, nausea, vomiting, diarrhea. Systemic effect: after the uptake of very large qantities: drop in blood pressure, collapse, CNS disorders, spasms, narcotic conditions, respiratory paralysis, hemolysis.
Further hazardous properties cannot be excluded but unlikely when the product is handled appropriately.
Handle in accordance with good industrial hygiene and safety practice.

SECTION 12. Ecological information

Ecotoxicity

Toxicity to fish
LC50 Danio rerio (zebra fish): 420 mg/l; 96 h (IUCLID)

Toxicity to daphnia and other aquatic invertebrates
EC50 Daphnia magna (Water flea): 129 mg/l; 48 h (IUCLID)

Persistence and degradability
No information available.

Bioaccumulative potential
No information available.

Mobility in soil
No information available.

Additional ecological information
Biological effects:

Fertilizing effect possible.
Discharge into the environment must be avoided.

SECTION 13. Disposal considerations

The information presented only applies to the material as supplied. The identification based on characteristic(s) or listing may not apply if the material has been used or otherwise contaminated. It is the responsibility of the waste generator to determine the toxicity and physical properties of the material generated to determine the proper waste identification and disposal methods in compliance with applicable regulations. Disposal should be in accordance with applicable regional, national and local laws and regulations.

SECTION 14. Transport information

Land transport (DOT)

Not classified as dangerous in the meaning of transport regulations.

Air transport (IATA)

Not classified as dangerous in the meaning of transport regulations.

Sea transport (IMDG)

Not classified as dangerous in the meaning of transport regulations.

SECTION 15. Regulatory information

United States of America

SARA 313

The following components are subject to reporting levels established by SARA Title III, Section 313:

Ingredients		
ammonium sulphate	7783-20-2	100 %

SARA 302

No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

Clean Water Act

This product does not contain any Hazardous Substances listed under the U.S. CleanWater Act, Section 311, Table 116.4A.

This product does not contain any Hazardous Chemicals listed under the U.S. CleanWater Act, Section 311, Table 117.3.

DEA List I

Not listed

DEA List II

Not listed

US State Regulations

Massachusetts Right To Know

Ingredients

ammonium sulphate

Pennsylvania Right To Know

Ingredients
ammonium sulphate

New Jersey Right To Know

Ingredients
ammonium sulphate

California Prop 65 Components

This product does not contain any chemicals known to the State of California to cause cancer, birth, or any other reproductive defects.

Notification status

TSCA:	All components of the product are listed in the TSCA-inventory.
DSL:	All components of this product are on the Canadian DSL.

SECTION 16. Other information

Training advice
Provide adequate information, instruction and training for operators.

Key or legend to abbreviations and acronyms used in the safety data sheet
Used abbreviations and acronyms can be looked up at www.wikipedia.org.

Revision Date10/14/2014

The information contained herein is based on the present state of our knowledge. It characterizes the product with regard to appropriate safety precautions. It does not represent a warranty of any product properties and we assume no liability for any loss or injury which may result from the use of this information. Users should conduct their own investigations to determine the suitability of the information.
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Safety Data Sheet
acc. to OSHA HCS

Printing date 03/10/2014 Reviewed on 03/10/2014

1 Identification

- **Product identifier**
- **Trade name: alpha-Amylase**
- **Article number:** 100447
- **CAS Number:**
9000-90-2
- **EC number:**
232-565-6
- **Index number:**
647-015-00-4
- **Details of the supplier of the safety data sheet**
- **Manufacturer/Supplier:**
MP Biomedicals, LLC
29525 Fountain Parkway
Solon, OH 44139
United States
www.mpbio.com
- **Information department:** Product safety department
- **Emergency telephone number:** CHEMTREC: 1-800-424-9300 (1-703-527-3887)

2 Hazard(s) identification

- **Classification of the substance or mixture**

GHS08 Health hazard

Resp. Sens. 1 H334 May cause allergy or asthma symptoms or breathing difficulties if inhaled.

- **Classification according to Directive 67/548/EEC or Directive 1999/45/EC**

Harmful

May cause sensitisation by inhalation.

- **Information concerning particular hazards for human and environment:** Not applicable.

- **Label elements**
- **GHS label elements** The substance is classified and labeled according to the Globally Harmonized System (GHS).
- **Hazard pictograms**

GHS08

- **Signal word** Danger
- **Hazard-determining components of labeling:**
Amylase, alpha-
- **Hazard statements**
May cause allergy or asthma symptoms or breathing difficulties if inhaled.
- **Precautionary statements**
If medical advice is needed, have product container or label at hand.
Keep out of reach of children. Read label
before use.
In case of inadequate ventilation wear respiratory protection. Avoid
breathing dust/fume/gas/mist/vapours/spray.

(Contd. on page 2)

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acc. to OSHA HCS

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Trade name: alpha-Amylase

(Contd. of page 1)

If experiencing respiratory symptoms: Call a POISON CENTER or doctor/physician.
IF INHALED: If breathing is difficult, remove victim to fresh air and keep at rest in a position comfortable for breathing.
Dispose of contents/container in accordance with local/regional/national/international regulations.

• **Classification system:**
• **NFPA ratings (scale 0 - 4)**

Health = 0
Fire = 0
Reactivity = 0

• **HMIS-ratings (scale 0 - 4)**

Health = *0
Fire = 0
Reactivity = 0

• **Other hazards**
• **Results of PBT and vPvB assessment** • **PBT:** Not applicable. • **vPvB:** Not applicable.

• **Chemical characterization: Substances**
• **CAS No. Description**
9000-90-2 Amylase, alpha-
• **Identification number(s)**
• **EC number:** 232-565-6
• **Index number:** 647-015-00-4

• **Description of first aid measures**
• **After inhalation:** Supply fresh air; consult doctor in case of complaints. • **After skin contact:** Generally the product does not irritate the skin.
• **After eye contact:** Rinse opened eye for several minutes under running water. • **After swallowing:** If symptoms persist consult doctor.
• **Information for doctor:**
• **Most important symptoms and effects, both acute and delayed** No further relevant information available.
• **Indication of any immediate medical attention and special treatment needed**
No further relevant information available.

• **Extinguishing media**
• **Suitable extinguishing agents:**
CO2, extinguishing powder or water spray. Fight larger fires with water spray or alcohol resistant foam.
• **Special hazards arising from the substance or mixture** No further relevant information available.

(Contd. on page 3)

Safety Data Sheet
acc. to OSHA HCS

Printing date 03/10/2014 Reviewed on 03/10/2014

Trade name: alpha-Amylase

(Contd. of page 2)

- ***Advice for firefighters***
- ***Protective equipment:*** *No special measures required.*

6 Accidental release measures

- ***Personal precautions, protective equipment and emergency procedures*** *Not required.*
- ***Environmental precautions:*** *Do not allow to enter sewers/ surface or ground water.*
- ***Methods and material for containment and cleaning up:***
Dispose contaminated material as waste according to item 13.
- ***Reference to other sections***
See Section 7 for information on safe handling.
See Section 8 for information on personal protection equipment. See Section 13 for disposal information.

7 Handling and storage

- ***Handling:***
- ***Precautions for safe handling***
Ensure good ventilation/exhaustion at the workplace.
Prevent formation of dust.
- ***Information about protection against explosions and fires:*** *No special measures required.*
- ***Conditions for safe storage, including any incompatibilities***
- ***Storage:*** *2-8 °C*
- ***Requirements to be met by storerooms and receptacles:*** *No special requirements.* •
Information about storage in one common storage facility: *Not required.*
- ***Further information about storage conditions:***
Store in dry conditions.
Protect from humidity and water.
- ***Specific end use(s)*** *No further relevant information available.*

8 Exposure controls/personal protection

- ***Additional information about design of technical systems:*** *No further data; see item 7.*
- ***Control parameters***
- ***Components with limit values that require monitoring at the workplace:*** *Not required.*
- ***Additional information:*** *The lists that were valid during the creation were used as basis.*
- ***Exposure controls***
- ***Personal protective equipment:***
- ***General protective and hygienic measures:***
Keep away from foodstuffs, beverages and feed.
Wash hands before breaks and at the end of work.
- ***Breathing equipment:***
In case of brief exposure or low pollution use respiratory filter device. In case of intensive or longer exposure use respiratory protective device that is independent of circulating air.
- ***Protection of hands:***

Protective gloves

(Contd. on page 4)

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acc. to OSHA HCS

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Trade name: alpha-Amylase

(Contd. of page 3)

The glove material has to be impermeable and resistant to the product/ the substance/ the preparation.
Due to missing tests no recommendation to the glove material can be given for the product/ the preparation/ the chemical mixture.
Selection of the glove material on consideration of the penetration times, rates of diffusion and the degradation

- **Material of gloves**
The selection of the suitable gloves does not only depend on the material, but also on further marks of quality and varies from manufacturer to manufacturer.
- **Penetration time of glove material**
The exact breakthrough time has to be found out by the manufacturer of the protective gloves and has to be observed.
- **Eye protection:** Not required.

9 Physical and chemical properties

• **Information on basic physical and chemical properties**	
• **General Information**	
• **Appearance:**	
Form:	Solid
Color:	Not determined.
• **Odor:**	Characteristic
• **Odour threshold:**	Not determined.
• **pH-value:**	Not applicable.
• **Change in condition**	
Melting point/Melting range:	Undetermined.
Boiling point/Boiling range:	Undetermined.
• **Flash point:**	Not applicable.
• **Flammability (solid, gaseous):**	Product is not flammable.
• **Ignition temperature:**	
Decomposition temperature:	Not determined.
• **Auto igniting:**	Not determined.
• **Danger of explosion:**	Product does not present an explosion hazard.
• **Explosion limits:**	
Lower:	Not determined. Not
Upper:	determined.
• **Vapor pressure:**	Not applicable. Not
• **Density:**	determined.
• **Relative density** •	Not determined. Not
Vapour density	applicable. Not
• **Evaporation rate**	applicable.
• **Solubility in / Miscibility with**	
Water:	Soluble.
• **Partition coefficient (n-octanol/water):** Not determined.	
• **Viscosity:**	
Dynamic:	Not applicable.
Kinematic:	Not applicable.

(Contd. on page 5)

Safety Data Sheet
acc. to OSHA HCS

Trade name: alpha-Amylase

(Contd. of page 4)

Organic solvents:	0.0%
Solids content:	100.0%
• **Other information**	No further relevant information available.

10 Stability and reactivity

• **Reactivity**
• **Chemical stability**
• **Thermal decomposition / conditions to be avoided:** No decomposition if used according to specifications. • **Possibility of hazardous reactions** No dangerous reactions known. • **Conditions to avoid** No further relevant information available.
• **Incompatible materials:** No further relevant information available.
• **Hazardous decomposition products:** No dangerous decomposition products known.

11 Toxicological information

• **Information on toxicological effects**
• **Acute toxicity:**
• **Primary irritant effect:**
• **on the skin:** No irritant effect. • **on the eye:** No irritating effect.
• **Sensitization:** Sensitization possible through inhalation.
• **Additional toxicological information:**

• **Carcinogenic categories**

• **IARC (International Agency for Research on Cancer)**
Substance is not listed.

• **NTP (National Toxicology Program)**
Substance is not listed.

12 Ecological information

• **Toxicity**
• **Aquatic toxicity:** No further relevant information available.
• **Persistence and degradability** No further relevant information available.
• **Behavior in environmental systems:**
• **Bioaccumulative potential** No further relevant information available. • **Mobility in soil** No further relevant information available.
• **Additional ecological information:**
• **General notes:**
Water hazard class 1 (Self-assessment): slightly hazardous for water
Do not allow undiluted product or large quantities of it to reach ground water, water course or sewage system.
• **Results of PBT and vPvB assessment**
• **PBT:** Not applicable. • **vPvB:** Not applicable.
• **Other adverse effects** No further relevant information available.

(Contd. on page 6)

Safety Data Sheet
acc. to OSHA HCS

Trade name: alpha-Amylase

(Contd. of page 5)

13 Disposal considerations

- **Waste treatment methods**
- **Recommendation:**
  Must not be disposed of together with household garbage. Do not allow product to reach sewage system.
- **Uncleaned packagings:**
- **Recommendation:** Disposal must be made according to official regulations.
- **Recommended cleansing agent:** Water, if necessary with cleansing agents.

14 Transport information

• **UN-Number**	
• **DOT, ADR, ADN, IMDG, IATA**	Void
• **UN proper shipping name**	
• **DOT, ADR, ADN, IMDG, IATA**	Void
• **Transport hazard class(es)**	
• **DOT, ADR, ADN, IMDG, IATA**	
• **Class**	Void
• **Packing group**	
• **DOT, ADR, IMDG, IATA**	Void
• **Environmental hazards:**	
• **Marine pollutant:**	No
• **Special precautions for user**	Not applicable.
• **Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code**	Not applicable.
• **UN "Model Regulation":**	-

15 Regulatory information

- **Safety, health and environmental regulations/legislation specific for the substance or mixture**
- **Sara**

- **Section 355 (extremely hazardous substances):**
  Substance is not listed.

- **Section 313 (Specific toxic chemical listings):**
  Substance is not listed.

- **TSCA (Toxic Substances Control Act):**
  Substance is listed.

- **Proposition 65**

- **Chemicals known to cause cancer:**
  Substance is not listed.

- **Chemicals known to cause reproductive toxicity for females:**
  Substance is not listed.

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Trade name: alpha-Amylase

(Contd. of page 6)

- **Chemicals known to cause reproductive toxicity for males:**
  Substance is not listed.
- **Chemicals known to cause developmental toxicity:**
  Substance is not listed.
- **Carcinogenic categories**
- **EPA (Environmental Protection Agency)**
  Substance is not listed.
- **TLV (Threshold Limit Value established by ACGIH)**
  Substance is not listed.
- **NIOSH-Ca (National Institute for Occupational Safety and Health)**
  Substance is not listed.
- **OSHA-Ca (Occupational Safety & Health Administration)**
  Substance is not listed.
- **GHS label elements** The substance is classified and labeled according to the Globally Harmonized System (GHS).
- **Hazard pictograms**

GHS08

- **Signal word** Danger
- **Hazard-determining components of labeling:**
  Amylase, alpha-
- **Hazard statements**
  May cause allergy or asthma symptoms or breathing difficulties if inhaled.
- **Precautionary statements**
  If medical advice is needed, have product container or label at hand.
  Keep out of reach of children. Read label
  before use.
  In case of inadequate ventilation wear respiratory protection. Avoid
  breathing dust/fume/gas/mist/vapours/spray.
  If experiencing respiratory symptoms: Call a POISON CENTER or doctor/physician.
  IF INHALED: If breathing is difficult, remove victim to fresh air and keep at rest in a position comfortable for breathing.
  Dispose of contents/container in accordance with local/regional/national/international regulations.
- **Chemical safety assessment:** A Chemical Safety Assessment has not been carried out.

Thisinformationisbasedonourpresentknowledge.However,thisshallnotconstituteaguaranteeforany specific product features and shall not establish a legally valid contractual relationship.

- **Department issuing MSDS:** Product safety department
- **Date of preparation / last revision** 03/10/2014 / -
- **Abbreviations and acronyms:**
  ADR:Accordeuropéensurletransportdesmarchandisesdangereusesparroute(EuropeanAgreementconcerningtheInternational Carriage of Dangerous Goods by Road)
  ACGIH: American Conference of Governmental Industrial Hygienists
  EINECS: European Inventory of Existing Commercial Chemical Substances
  CAS: Chemical Abstracts Service (division of the American Chemical Society)

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Safety Data Sheet
acc. to OSHA HCS

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Trade name: alpha-Amylase

(Contd. of page 7)

NFPA: National Fire Protection Association (USA)
HMIS: Hazardous Materials Identification System (USA)
Resp. Sens. 1: Sensitisation - Respirat., Hazard Category 1

SAFETY DATA SHEET
17-AAG

Revision: 06/06/2013
Supersedes Revision: 10/15/2012

Cayman Chemical Company 1180 E.
Ellsworth Rd. Ann Arbor, MI 48108

Section 1. Identification of the Substance/Mixture and of the

1.1 Product Code: 11039

Product Name: 17-AAG

Synonyms: 17-demethoxy-17-(2-propenylamino)-geldanamycin; BMS 722782; CP 127374; KOS 953; NSC 330507; Tanespimycin;

1.2 Relevant identified uses of the substance or mixture and uses advised against

Relevant identified uses: For research use only, not for human or veterinary use.

1.3 Details of the Supplier of the Safety Data Sheet

Company Name: Cayman Chemical Company

Emergency Contact: CHEMTREC Within USA and Canada: +1 (800)424-9300

Alternate Emergency Contact: CHEMTREC Outside USA and Canada: +1 (703)527-3887

Information: Cayman Chemical Company +1 (734)971-3335

Web site address: www.caymanchem.com

Section 2. Hazards Identification

GHS Classification	Placard	Key word	GHS hazard phrase
Flammable Liquids, Category 2	Flame	Danger	Highly flammable liquid and vapor
Acute Toxicity: Inhalation, Category 3	Skull and crossbones	Danger	Toxic if inhaled
Acute Toxicity: Oral, Category 3	Skull and crossbones	Danger	Toxic if swallowed
Acute Toxicity: Skin, Category 3	Skull and crossbones	Danger	Toxic in contact with skin
Target Organ Systemic Toxicity (single exposure), Category 1	Health hazard	Danger	Causes damage to organs {eyes}.

GHS Hazard Phrases: H225: Highly flammable liquid and vapor.
H331: Toxic if inhaled.
H301: Toxic if swallowed.
H311: Toxic in contact with skin.
H370: Causes damage to organs {eyes}.

GHS Precaution Phrases: P210: Keep away from {heat/sparks/open flames/hot surfaces}. - No smoking.
P280: Wear {protective gloves/protective clothing/eye protection/face protection}.
P261: Avoid breathing {dust/fume/gas/mist/vapours/spray}. P264: Wash {hands} thoroughly after handling.
P361+364: Take off immediately all contaminated clothing and wash it before reuse.
P260: Do not breathe {dust/fume/gas/mist/vapours/spray}.

GHS Response Phrases: P303+361+353: IF ON SKIN (or hair): Remove/take off immediately all contaminated clothing. Rinse skin with water/shower.
P304+340: IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P311: Call a {POISON CENTER/doctor/...}.
P301+310: IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician.
P330: Rinse mouth.
P302+352: IF ON SKIN: Wash with plenty of soap and water.
P312: Call a {POISON CENTER/doctor/...} if you feel unwell.
P321: Specific treatment {see ... on this label}.
P307+311: IF exposed: Call a POISON CENTER or doctor/physician.

GHS Storage and Disposal Phrases: Please refer to Section 7 for Storage and Section 13 for Disposal information.

2.3 Adverse Human Health Effects and Symptoms: Cannot be made nonpoisonous.
Harmful vapors.
Material may be irritating to the mucous membranes and upper respiratory tract.
May be fatal or cause blindness if swallowed.
May cause eye, skin, or respiratory system irritation.
Toxic if swallowed, inhaled, or absorbed through the skin.
Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed.
To the best of our knowledge, the toxicological properties have not been thoroughly investigated.

Target Organs: Central nervous system, Eyes, Gastrointestinal System, Respiratory system, Skin.

LD 50 / LC 50: Please refer to Section 11.

Medical Conditions Generally Aggravated By Exposure: No data available.

Section 3. Composition/Information on Ingredients

Hazardous Components (Chemical Name)	CAS #	Concentration	EC#	Risk Phrases	RTECS #
1. 17-AAG	75747-14-7	0.1 %	NA	No phrases apply.	LX8932000
2. Methanol	67-56-1	99.9 %	200-659-6	R11-23/24/25-39/23 P /24/25	C1400000

Section 4. First Aid Measures

4.1 Description of First Aid Measures: Overexposure may cause: confusion, dermatitis, headache, drowsiness, dizziness, gastrointestinal disturbance, optic nerve damage (blindness), nausea, unconsciousness, vomiting, visual disturbance, weakness. May cause convulsions.
Once methanol is absorbed into the body, it is very slowly eliminated.

4.1.1 In Case of Inhalation: Remove to fresh air. If not breathing, give artificial respiration or give oxygen by trained personnel. Get immediate medical attention.

4.1.2 In Case of Skin Contact: Immediately wash skin with soap and plenty of water for at least 20 minutes. Remove contaminated clothing. Get medical attention if symptoms occur. Wash clothing before reuse.

4.1.3 In Case of Eye Contact: Hold eyelids apart and flush eyes with plenty of water for at least 20 minutes. Have eyes examined and tested by medical personnel.

4.1.4 In Case of Ingestion: Wash out mouth with water provided person is conscious. Never give anything by mouth to an unconscious person. Get medical attention. Do NOT induce vomiting unless directed to do so by medical personnel.

4.2 Important Symptoms and Effects, Both Acute and Delayed: No data available.

4.3 Indication of any immediate medical attention and special treatment needed: No data available.

Section 5. Fire Fighting Measures

5.1 Suitable Extinguishing Media: Use alcohol-resistant foam, carbon dioxide, water, or dry chemical spray.
Use water spray to cool fire-exposed containers.

Unsuitable Extinguishing Media: A solid water stream may be inefficient.

5.2 Flammable Properties and Hazards: Can release vapors that form explosive mixtures at temperatures at or above the flashpoint.
Container explosion may occur under fire conditions.
Emits toxic fumes under fire conditions. Sensitive to static discharge.
Vapors can travel to a source of ignition and flash back.

Flash Pt: 11.00 C Method Used: Closed Cup

Autoignition Pt: 385.00 C

Explosive Limits: LEL: 6.0% at 25.0 C UEL: 36.0 at 25.0 C

Hazardous Combustion Products: No data available.

5.3 Fire Fighting Instructions: As in any fire, wear self-contained breathing apparatus pressure-demand (NIOSH approved or equivalent), and full protective gear to prevent contact with skin and eyes.
Note: Flammable as diluted in methanol.

Section 6. Accidental Release Measures

6.1 Protective Precautions, Protective Equipment and Emergency Procedures: Avoid breathing vapors and provide adequate ventilation.
As conditions warrant, wear a NIOSH approved self-contained breathing apparatus, or respirator, and appropriate personal protection (rubber boots, safety goggles, and heavy rubber gloves).

6.2 Environmental Precautions: Take steps to avoid release into the environment, if safe to do so.

6.3 Methods and Material For Containment and Cleaning Up: Contain spill and collect, as appropriate.
Transfer to a chemical waste container for disposal in accordance with local regulations.

Section 7. Handling and Storage

7.1 Precautions To Be Taken in Handling: Avoid breathing dust/fume/gas/mist/vapours/spray.
Avoid prolonged or repeated exposure. Keep away from sources of ignition.
Take precautionary measures against static discharge.

7.2 Precautions To Be Taken in Storing: Keep away from heat, sparks, and flame.
Keep container tightly closed.
Store in accordance with information listed on the product insert.

Hazard Label Information: Avoid contact with skin and eyes. Do not reuse this container. Use with adequate ventilation.
Wash thoroughly after handling.

Section 8. Exposure Controls/Personal Protection

Hazardous Components (Chemical Name)	CAS #	OSHA PEL	ACGIH TWA	Other Limits
1. 17-AAG	75747-14-7	No data.	No data.	No data.
2. Methanol	67-56-1	PEL: 200 ppm	TLV: 200 ppm STEL: 250 ppm	No data.

Hazardous Components (Chemical Name)	CAS #	Britain EH40	France VL	Europe
1. 17-AAG	75747-14-7	No data.	No data.	No data.
2. Methanol	67-56-1	TWA: 266 mg/m3 (200 ppm) STEL: 333 mg/m3 (250 ppm)	TWA: 260 mg/m3 (200 ppm) STEL: 1300 mg/m3 (1000 ppm)	TWA: 260 mg/m3

Protective Equipment Summary - Hazard Label Information: Compatible chemical-resistant gloves Eye wash station in work area Lab coat Safety glasses Safety shower in work area Vent Hood

8.2.1 Engineering Controls (Ventilation etc.): Use process enclosures, local exhaust ventilation, or other engineering controls to control airborne levels below recommended exposure limits.

8.2.2.1 Eye Protection: Safety glasses

8.2.2.2 Protective Gloves: Compatible chemical-resistant gloves

Other Protective Clothing: Lab coat

8.2.2.3 Respiratory Equipment (Specify Type): NIOSH approved respirator, as conditions warrant.

Work/Hygienic/Maintenance Practices: Do not take internally.
Facilities storing or utilizing this material should be equipped with an eyewash and a safety shower.
Wash thoroughly after handling.

8.2.3 Environmental Exposure Controls: No data available.

Section 9. Physical and Chemical Properties

9.1 Information on Basic Physical and Chemical Properties

Physical States: [ ] Gas [X] Liquid [ ] Solid

Appearance and Odor: Solution

Melting Point: No data.

Boiling Point: No data.

Flash Pt: 11.00 C Method Used: Closed Cup

Evaporation Rate: No data.

Explosive Limits: LEL: 6.0% at 25.0 C UEL: 36.0 at 25.0 C

Vapor Pressure (vs. Air or mm Hg): 96 MM_HG at 20.0 C No data.

Vapor Density (vs. Air = 1): No data. No data. 385.00 C

Specific Gravity (Water = 1): No data available. No data

Solubility in Water: available.

Autoignition Pt:

Explosive Properties:

Oxidizing Properties:

9.2 Other Information

Percent Volatile: No data.

Formula: C31H43N3O8

Molecular Weight: 585.70

Section 10. Stability and Reactivity

10.1 Reactivity: No data available.

10.2 Stability: Unstable [ ] Stable [X]

10.3 Stability Note(s): Stable if stored in accordance with information listed on the product insert.

10.4 Conditions To Avoid: heat, flames and sparks

10.3 Polymerization: Will occur [ ] Will not occur [X]

10.5 Incompatibility - Materials To Avoid: acids
acid anhydrides
acid chlorides alkali
metals
oxidizing agents reducing
agents

10.6 Hazardous Decomposition Or Byproducts: carbon dioxide
carbon monoxide

Section 11. Toxicological Information

11.1 Information on Toxicological Effects: The toxicological effects of this product have not been thoroughly studied.

Methanol - Toxicity Data: Oral LD50 (rat): 5,600 mg/kg; Oral LD50 (rabbit): 14,200 mg/kg; Inhalation LC50 (rat): 64,000 ppm (4h); Inhalation LC50 (mouse): 61,100 ppm (134 m); Skin LD50 (rabbit): 15,800 mg/kg; Oral LDLO (human): 143 mg/kg;
Methanol - Irritation Data: Skin (rabbit): 20 mg (24h) moderate; Eyes (rabbit): 40 mg moderate; Eyes (rabbit): 100 mg (24h) moderate;

Chronic Toxicological Effects: Methanol - Investigated as a mutagen and reproductive effector.
Only select Registry of Toxic Effects of Chemical Substances (RTECS) data is presented here.
See actual entry in RTECS for complete information.
Methanol RTECS Number: PC1400000

Hazardous Components (Chemical Name)	CAS #	NTP	IARC	ACGIH	OSHA
1. 17-AAG	75747-14-7	n.a.	n.a.	n.a.	n.a.
2. Methanol	67-56-1	n.a.	n.a.	n.a.	n.a.

Section 12. Ecological Information

12.1 Toxicity: Avoid release into the environment.
Runoff from fire control or dilution water may cause pollution.

Section 13. Disposal Considerations

13.1 Waste Disposal Method: Dispose in accordance with local, state, and federal regulations.

Section 14. Transport Information

14.1 LAND TRANSPORT (US DOT)

DOT Proper Shipping Name Methanol Solution

DOT Hazard Class: 3 (6.1)

DOT Hazard Label: COMBUSTIBLE LIQUID, POISON

UN/NA Number: 1230

Packing Group: II

14.1 LAND TRANSPORT (European ADR/RID)

ADR/RID Shipping Name Methanol Solution

UN Number: 1230

Hazard Class: 3 (6.1) - COMBUSTIBLE LIQUID, POISON

Packing Group: II

14.3 AIR TRANSPORT (ICAO/IATA)

ICAO/IATA Shipping Name Methanol Solution

UN Number: 1230

Hazard Class: 3 (6.1) - COMBUSTIBLE LIQUID, POISON

Packing Group: II

IATA Classification: 3, 6.1

Additional Transport Information: Transport in accordance with local, state, and federal regulations.

Section 15. Regulatory Information

European Community Hazard Symbol codes F: Highly Flammable; T: Toxic

European Community Risk and Safety Phrases

R11 - Highly flammable.
R39/23/24/25 - Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed.
S7 - Keep container tightly closed.
S16 - Keep away from sources of ignition.
S24/25 - Avoid contact with skin and eyes.
S33 - Take precautionary measures against static discharges.
S36/37/39 - Wear suitable protective clothing, gloves and eye/face protection.
S45 - In case of accident or if you feel unwell, seek medical advice immediately (show the label whenever possible.)

US EPA SARA Title III

Hazardous Components (Chemical Name)	CAS #	Sec.302 (EHS)	Sec.304 RQ	Sec.313 (TRI)	Sec.110
1. 17-AAG	75747-14-7	No	No	No	No

Hazardous Components (Chemical Name)	CAS #	Sec.302 (EHS)	Sec.304 RQ	Sec.313 (TRI)	Sec.110
2. Methanol	67-56-1	No	Yes 5000 LB	Yes	No

Other US EPA or State Lists

Hazardous Components (Chemical Name)	CAS #	CAA HAP,ODC	CWA NPDES	TSCA	CA PROP.65
1. 17-AAG	75747-14-7	No	No	No	No
2. Methanol	67-56-1	HAP	No	Inventory	Yes

Regulatory Information Statement: This SDS was prepared in accordance with Regulation (EC) No.1272/2008 and European Directive 67/548/EEC as amended.

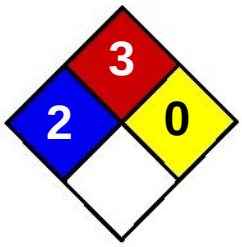
Section 16. Other Information

Revision Date: 06/06/2013

Company Policy or Disclaimer

DISCLAIMER: This information is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes.

N.A.=Not available, N.P.=Not applicable, N.D.=Not determined, N.E.=Not established, N.R.=Not required



Health	2
Fire	3
Reactivity	0
Personal Protection	E

Material Safety Data Sheet
Ethyl alcohol 200 Proof MSDS

Section 1: Chemical Product and Company Identification

Product Name: Ethyl alcohol 200 Proof

Catalog Codes: SLE2248, SLE1357

CAS#: 64-17-5

RTECS: KQ6300000

TSCA: TSCA 8(b) inventory: Ethyl alcohol 200 Proof

CI#: Not applicable.

Synonym: Ethanol; Absolute Ethanol; Alcohol; Ethanol 200 proof; Ethyl Alcohol, Anhydrous; Ethanol, undenatured; Dehydrated Alcohol; Alcohol

Chemical Name: Ethyl Alcohol

Chemical Formula: CH3CH2OH

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Ethyl alcohol 200 Proof	64-17-5	100

Toxicological Data on Ingredients: Ethyl alcohol 200 Proof: ORAL (LD50): Acute: 7060 mg/kg [Rat]. 3450 mg/kg [Mouse]. VAPOR (LC50): Acute: 20000 ppm 8 hours [Rat]. 39000 mg/m 4 hours [Mouse].

Section 3: Hazards Identification

Potential Acute Health Effects:
Hazardous in case of skin contact (irritant), of eye contact (irritant), of inhalation. Slightly hazardous in case of skin contact (permeator), of ingestion.

Potential Chronic Health Effects:
Slightly hazardous in case of skin contact (sensitizer). CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH. MUTAGENIC EFFECTS: Mutagenic for mammalian somatic cells. Mutagenic for bacteria and/or yeast. TERATOGENIC EFFECTS: Classified PROVEN for human. DEVELOPMENTAL TOXICITY: Classified Development toxin [PROVEN]. Classified Reproductive system/toxin/female, Reproductive system/toxin/male [POSSIBLE]. The substance is toxic to blood, the reproductive system, liver, upper respiratory tract, skin, central nervous system (CNS). Repeated or prolonged exposure to the substance can produce target organs damage.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Get medical attention.

Skin Contact:
In case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Cold water may be used.Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention if symptoms appear.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Flammable.

Auto-Ignition Temperature: 363°C (685.4°F)

Flash Points: CLOSED CUP: 12.78°C (55°F). OPEN CUP: 17.78°C (64°F) (Cleveland).

Flammable Limits: LOWER: 3.3% UPPER: 19%

Products of Combustion: These products are carbon oxides (CO, CO2).

Fire Hazards in Presence of Various Substances:
Highly flammable in presence of open flames and sparks, of heat. Slightly flammable to flammable in presence of oxidizing materials.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available. Slightly explosive in presence of open flames and sparks, of heat, of oxidizing materials, of acids.

Fire Fighting Media and Instructions:
Flammable liquid, soluble or dispersed in water. SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use alcohol foam, water spray or fog.

Special Remarks on Fire Hazards:
Containers should be grounded. CAUTION: MAY BURN WITH NEAR INVISIBLE FLAME Vapor may travel considerable distance to source of ignition and flash back. May form explosive mixtures with air. Contact with Bromine pentafluoride is likely to cause fire or explosion. Ethanol ignites on contact with chromyl chloride. Ethanol ignites on contact with iodine heptafluoride gas. It ignites than explodes upon contact with nitrosyl perchlorate. Additon of platinum black catalyst caused ignition.

Special Remarks on Explosion Hazards:
Ethanol has an explosive reaction with the oxidized coating around potassium metal. Ethanol ignites and then explodes on contact with acetic anhydride + sodium hydrosulfate (ignites and may explode), disulfuric acid + nitric acid, phosphorous(III) oxide platinum, potassium-tert-butoxide+ acids. Ethanol forms explosive products in reaction with the following compound :

ammonia + silver nitrate (forms silver nitride and silver fulminate), iodine + phosphorus (forms ethane iodide), magnesium perchlorate (forms ethyl perchlorate), mercuric nitrate, nitric acid + silver (forms silver fulminate) silver nitrate (forms ethyl nitrate) silver(I) oxide + ammonia or hydrazine (forms silver nitride and silver fulminate), sodium (evolves hydrogen gas). Sodium Hydrazide + alcohol can produce an explosion. Alcohols should not be mixed with mercuric nitrate, as explosive mercuric fulminate may be formed. May form explosive mixture with manganese perchlorate + 2,2-dimethoxypropane. Addition of alcohols to highly concentrate hydrogen peroxide forms powerful explosives. Explodes on contact with calcium hypochlorite

Section 6: Accidental Release Measures

Small Spill:
Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container.

Large Spill:
Flammable liquid. Keep away from heat. Keep away from sources of ignition. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not touch spilled material. Prevent entry into sewers, basements or confined areas; dike if needed. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep locked up.. Keep away from heat. Keep away from sources of ignition. Ground all equipment containing material. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, acids, alkalis, moisture.

Storage:
Store in a segregated and approved area. Keep container in a cool, well-ventilated area. Keep container tightly closed and sealed until ready for use. Avoid all possible sources of ignition (spark or flame). Do not store above 23°C (73.4°F).

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:
Splash goggles. Lab coat. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Use a respirator if the exposure limit is exceeded.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
TWA: 1900 (mg/m3) from OSHA (PEL) [United States] TWA: 1000 (ppm) from OSHA (PEL) [United States] TWA: 1900 (mg/m3) from NIOSH [United States] TWA: 1000 (ppm) from NIOSH [United States] TWA: 1000 (ppm) [United Kingdom (UK)] TWA: 1920 (mg/m3) [United Kingdom (UK)] TWA: 1000 STEL: 1250 (ppm) [Canada]Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid. (Liquid.)

Odor:

Mild to strong, rather pleasant; like wine or whiskey. Alcohol-like; Ethereal, vinous.

Taste: Pungent. Burning.

Molecular Weight: 46.07 g/mole

Color: Colorless. Clear

pH (1% soln/water): Not available.

Boiling Point: 78.5°C (173.3°F)

Melting Point: -114.1°C (-173.4°F)

Critical Temperature: 243°C (469.4°F)

Specific Gravity: 0.789 (Water = 1) **Vapor**

Pressure: 5.7 kPa (@ 20°C)

Vapor Density: 1.59 (Air = 1) **Volatility:**

Not available.

Odor Threshold: 100 ppm

Water/Oil Dist. Coeff.: The product is more soluble in water; log(oil/water) = -0.3

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water, methanol, diethyl ether, acetone.

Solubility:
Easily soluble in cold water, hot water. Soluble in methanol, diethyl ether, acetone.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Incompatible materials, heat, sources of ignition.

Incompatibility with various substances: Reactive with oxidizing agents, acids, alkalis.

Corrosivity: Non-corrosive in presence of glass.

Special Remarks on Reactivity:
Ethanol rapidly absorbs moisture from the air. Can react vigorously with oxiders. The following oxidants have been demonstrated to undergo vigorous/explosive reaction with ethanol: barium perchlorate, bromine pentafluoride, calcium hypochlorite, chloryl perchlorate, chromium trioxide, chromyl chloride, dioxygen difluoride, disulfuryl difluoride, fluorine nitrate, hydrogen peroxide, iodine heptafluoride, nitric acid nitrosyl perchlorate, perchloric acid permanganic acid, peroxodisulfuric acid, potassium dioxide, potassium perchlorate, potassium permanganate, ruthenium(VIII) oxide, silver perchlorate, silver peroxide, uranium hexafluoride, uranyl perchlorate. Ethanol reacts violently/expodes with the following compounds: acetyl bromide (evolves hydrogen bromide) acetyl chloride, aluminum, sesquibromide ethylate, ammonium hydroxide & silver oxide, chlorate, chromic anhydride, cyanuric acid + water, dichloromethane + sulfuric acid + nitrate (or) nitrite, hydrogen peroxide + sulfuric acid, iodine + methanol + mercuric oxide, manganese perchlorate + 2,2-dimethoxy propane, perchlorates, permanganates + sulfuric acid, potassium superoxide, potassium tert-butoxide, silver & nitric acid, silver perchlorate, sodium hydrazide, sulfuric acid + sodium dichromate, tetrachlorisilane + water. Ethanol is also incompatible with platinium, and sodium. No really safe conditions exist under which ethyl alcohol and chlorine oxides can be handled. Reacts vigorously with acetyl chloride

Special Remarks on Corrosivity: Not available.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Dermal contact. Eye contact. Inhalation. Ingestion.

Toxicity to Animals:
WARNING: THE LC50 VALUES HEREUNDER ARE ESTIMATED ON THE BASIS OF A 4-HOUR EXPOSURE. Acute oral toxicity (LD50): 3450 mg/kg [Mouse]. Acute toxicity of the vapor (LC50): 39000 mg/m3 4 hours [Mouse].

Chronic Effects on Humans:
CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH. MUTAGENIC EFFECTS: Mutagenic for mammalian somatic cells. Mutagenic for bacteria and/or yeast. TERATOGENIC EFFECTS: Classified PROVEN for human. DEVELOPMENTAL TOXICITY: Classified Development toxin [PROVEN]. Classified Reproductive system/toxin/female, Reproductive system/toxin/male [POSSIBLE]. Causes damage to the following organs: blood, the reproductive system, liver, upper respiratory tract, skin, central nervous system (CNS).

Other Toxic Effects on Humans:
Hazardous in case of skin contact (irritant), of inhalation. Slightly hazardous in case of skin contact (permeator), of ingestion.

Special Remarks on Toxicity to Animals:
Lowest Published Dose/Conc: LDL[Human] - Route: Oral; Dose: 1400 mg/kg LDL[Human child] - Route: Oral; Dose: 2000 mg/kg LDL[Rabbit] - Route: Skin; Dose: 20000 mg/kg

Special Remarks on Chronic Effects on Humans:
May affect genetic material (mutagenic) Causes adverse reproductive effects and birth defects (teratogenic) , based on moderate to heavy consumption. May cause cancer based on animal data. Human: passes through the placenta, excreted in maternal milk.

Special Remarks on other Toxic Effects on Humans:
Acute potential health effects: Skin: causes skin irritation Eyes: causes eye irritation Ingestion: May cause gastrointestinal tract irritation with nausea, vomiting, diarrhea, and alterations in gastric secretions. May affect behavior/central nervous system (central nervous system depression - amnesia, headache, muscular incoordination, excitation, mild euphoria, slurred speech, drowsiness, staggaring gait, fatigue, changes in mood/personality, excessive talking, dizziness, ataxia, somnolence, coma/narcosis, hallucinations, distorted perceptions, general anesthetic), peripherial nervous system (spastic paralysis)vision (diplopia). Moderately toxic and narcotic in high concentrations. May also affect metabolism, blood, liver, respiration (dyspnea), and endocrine system. May affect respiratory tract, cardiovascular(cardiac arrhythmias, hypotension), and urinary systems. Inhalation: May cause irritation of the respiratory tract and affect behavior/central nervous system with symptoms similar to ingestion. Chronic Potential Health Effects: Skin: Prolonged or repeated skin contact may casue dermatitis, an allergic reaction. Ingestion: Prolonged or repeated ingestion will have similiar effects as acute ingestion. It may also affect the brain.

Section 12: Ecological Information

Ecotoxicity: Ecotoxicity in water (LC50): 14000 mg/l 96 hours [Rainbow trout]. 11200 mg/l 24 hours [fingerling trout].

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The product itself and its products of degradation are not toxic.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: CLASS 3: Flammable liquid.

Identification: : Ethanol UNNA: 1170 PG: II

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:
California prop. 65: This product contains the following ingredients for which the State of California has found to cause cancer, birth defects or other reproductive harm, which would require a warning under the statute: Ethyl alcohol 200 Proof (in alcoholic beverages) California prop. 65: This product contains the following ingredients for which the State of California has found to cause birth defects which would require a warning under the statute: Ethyl alcohol 200 Proof (in alcoholic beverages) Connecticut hazardous material survey.: Ethyl alcohol 200 Proof Illinois toxic substances disclosure to employee act: Ethyl alcohol 200 Proof Rhode Island RTK hazardous substances: Ethyl alcohol 200 Proof Pennsylvania RTK: Ethyl alcohol 200 Proof Florida: Ethyl alcohol 200 Proof Minnesota: Ethyl alcohol 200 Proof Massachusetts RTK: Ethyl alcohol 200 Proof Massachusetts spill list: Ethyl alcohol 200 Proof New Jersey: Ethyl alcohol 200 Proof Tennessee: Ethyl alcohol 200 Proof California - Directors List of Hazardous Substances (8 CCR 339): Ethyl alcohol 200 Proof TSCA 8(b) inventory: Ethyl alcohol 200 Proof

Other Regulations:
OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200). EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:

WHMIS (Canada):
CLASS B-2: Flammable liquid with a flash point lower than 37.8°C (100°F). CLASS D-2A: Material causing other toxic effects (VERY TOXIC).

DSCL (EEC):
R11- Highly flammable. S7- Keep container tightly closed. S16- Keep away from sources of ignition - No smoking.

HMIS (U.S.A.):

Health Hazard: 2

Fire Hazard: 3

Reactivity: 0

Personal Protection: E

National Fire Protection Association (U.S.A.):

Health: 2

Flammability: 3

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves. Lab coat. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Splash goggles.

Section 16: Other Information

References:
-SAX, N.I. Dangerous Properties of Indutrial Materials. Toronto, Van Nostrand Reinold, 6e ed. 1984. -Material safety data sheet emitted by: la Commission de la Santé et de la Sécurité du Travail du Québec. -Hawley, G.G.. The Condensed Chemical Dictionary, 11e ed., New York N.Y., Van Nostrand Reinold, 1987. -The Sigma-Aldrich Library of Chemical Safety Data, Edition II. HSDB, RTECS, and LOLI databases.

Other Special Considerations: Not available.

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Last Updated: 05/21/2013 12:00 PM

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MATERIAL SAFETY DATA SHEET

Cat# 1564-1, -5, Geldanamycin **MSDS DATE: Feb 21, 2012**

SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: **Geldanamycin**

PRODUCT CODES: **Cat# 1564-1, -5**

MANUFACTURER: **BioVision, Inc.**
ADDRESS: **155 S. Milpitas Boulevard, Milpitas, CA 95035**

EMERGENCY PHONE: 858-373-8066
CHEMTREC PHONE:
OTHER CALLS: **408-493-1800**
FAX PHONE: **408-493-1801**

SECTION 2: COMPOSITION/INFORMATION ON INGREDIENTS

Component	Description	Volume	Safety Information
Geldanamycin	Solid	1564-1: 1 mg 1564-5: 5 mg	See below

SECTION 3: HAZARDS IDENTIFICATION

Product Name/Chemical Name	CAS Number	EC-No.	MW	Chemical Formula
Geldanamycin	30562-34-6	–	560.64	$C_{29}H_{40}N_2O_9$

Geldanamycin:
Emergency Overview
OSHA Hazards: Target organ effect, Carcinogen, Teratogen
Target Organs: Liver, Pancreas, Kidney, Gastrointestinal tract, Skeletal muscle
GHS Classification: Acute toxicity, Oral (Category 5)
GHS Label elements, including precautionary statements
Pictogram:

Signal word: Warning
Hazard statement(s): H303 May be harmful if swallowed.
Precautionary statement(s): none
HMIS Classification
- **Health hazard**: 1
- **Chronic Health Hazard:** *
- **Flammability**: 0
- **Physical hazards**: 0

NFPA Rating
- **Health Hazard:** 1
- **Fire**: 0
- **Reactivity Hazard**: 0

Potential Health Effects
- **Inhalation:** May be harmful if inhaled. May cause respiratory tract irritation. **Skin:** May be harmful if absorbed through skin. May cause skin irritation. **Eyes:** May cause eye irritation.
- **Ingestion:** May be harmful if swallowed.

SECTION 4: FIRST AID MEASURES

General advice: Consult a physician. Show this safety data sheet to the doctor in attendance. Move out of dangerous area.
If inhaled: If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician. **In case of skin contact:** Wash off with soap and plenty of water. Consult a physician. **In case of eye contact:** Flush eyes with water as a precaution.
If swallowed: Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

5: FIRE-FIGHTING MEASURES

Condition of flammability: Not flammable or combustible.
Suitable extinguishing media: Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.
Special protective equipment for fire-fighters: Wear self-contained breathing apparatus for firefighting if necessary.
Hazardous combustion products: Hazardous decomposition products formed under fire conditions— carbon oxides, nitrogen oxides.

SECTION 6: ACCIDENTAL RELEASE MEASURES

Personal precautions: Use personal protective equipment. Avoid dust formation. Avoid breathing vapors, mist, gas, or dust. Ensure adequate ventilation. Evacuate personnel to safe areas.
Environmental precautions: Prevent further leakage or spillage if safe to do so. Do not let product enter drains.
Methods for cleaning up: Pick up and arrange disposal without creating dust. Sweep up and shovel. Keep in suitable, closed containers for disposal.

SECTION 7: HANDLING AND STORAGE

Precautions for safe handling
Avoid formation of dust and aerosols. Provide appropriate exhaust ventilation at places where dust is formed.
Conditions for safe storage
Keep container tightly closed in a dry and well-ventilated place.
Recommended storage temperature: -20 °C

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

Contains no substances with occupational exposure limit values.
Personal protective equipment

Respiratory protection
Respiratory protection is not required. Where protection from nuisance levels of dusts are desired, use type N95 (US) or type P1 (EN 143) dust masks. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Hand protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Eye protection
Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin and body protection
Choose body protection in relation to its type, to the concentration and amount of dangerous substances, and to the specific work-place. The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Hygiene measures
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of the workday.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Property	Geldanamycin
Appearance:	Yellow to orange solid
pH:	No data available No
Water Solubility:	data available No data
Specific Gravity (g/ml):	available No data
Boiling Point (°C):	available No data
Melting Point (°C):	available No data
Flash Point (°C):	available No data
Ignition Temperature (°C):	available No data
Density	available

SECTION 10: STABILITY AND REACTIVITY

Property	Geldanamycin
Chemical stability	Stable under recommended storage conditions
Conditions to avoid:	No data available
Materials to avoid:	Strong oxidizing agents
Hazardous decomposition products:	Carbon oxides, nitrogen oxides

SECTION 11: TOXICOLOGICAL INFORMATION

Geldanamycin:
Acute toxicity: LD50 Oral - rat - 2,500 mg/kg
Skin corrosion/irritation: no data available
Serious eye damage/eye irritation: no data available
Respiratory or skin sensitization: no data available
Germ cell mutagenicity: Genotoxicity in vitro - mouse - lymphocyte: DNA inhibition

Carcinogenicity:

This is or contains a component that has been reported to be carcinogenic based on its IARC, OSHA, ACGIH, NTP, or EPA classification.

- IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
- ACGIH: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.
- NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
- OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity: no data available
Teratogenicity: Possible risk of congenital malformation in the fetus.
Specific target organ toxicity - single exposure (GHS): no data available
Specific target organ toxicity - repeated exposure (GHS): no data available
Aspiration hazard: no data available
Potential Health Effects

Inhalation: May be harmful if inhaled. May cause respiratory tract irritation. **Skin:** May be harmful if absorbed through skin. May cause skin irritation. **Eyes:** May cause eye irritation.
Ingestion: May be harmful if swallowed.

Signs and Symptoms of Exposure: Effects may be delayed. Pulmonary edema, irregular breathing, stomach/intestinal disorders, nausea, vomiting, dizziness, drowsiness, increased liver enzymes, and/or weakness. Heavy or prolonged skin exposure may result in the absorption of harmful amounts of material.
Synergistic effects: no data available
Additional information: RTECS: LX8920000

SECTION 12: ECOLOGICAL INFORMATION

Geldanamycin:
Persistence and degradability: no data available
Toxicity: no data available
Bioaccumulative potential: no data available
Mobility in soil: no data available
PBT and vPvB assessment: no data available
Other adverse effects: no data available

SECTION 13: DISPOSAL CONSIDERATIONS

Product: Offer surplus and non-recyclable solutions to a licensed disposal company. Contact licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.
Contaminated packaging: Dispose of as unused product.

SECTION 14: TRANSPORT INFORMATION

Geldanamycin:
DOT (US): Not dangerous goods. **IMDG:** Not dangerous goods. **IATA:** Not dangerous goods.

SECTION 15: REGULATORY INFORMATION

Geldanamycin:
OSHA Hazards: Target organ effect, Carcinogen, Teratogen
SARA 302 Components: SARA 302: No chemical in this material are subject to the reporting requirements of SARA Title III, Section 302.
SARA 313 Components: SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title II, Section 313.
SARA 311/312 Hazards: Chronic Health Hazard
Massachusetts Right To Know Components: No components are subject to the Massachusetts Right to Know Act.
Pennsylvania Right To Know Components: Geldanamycin, CAS-No. 30562-34-6
New Jersey Right To Know Components: Geldanamycin, CAS-No. 30562-34-6
California Prop. 65 Components: This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

EU regulations

Component	Risk Phrases	Safety Phrases
Geldanamycin	R22, R68	S22, S24/25, S36/37/39

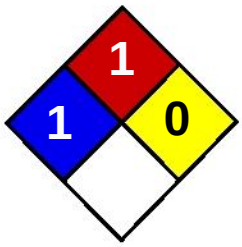
SECTION 16: OTHER INFORMATION

OTHER INFORMATION:

PREPARATION INFORMATION:

DISCLAIMER:

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. BioVision, Inc., shall not be held liable for any damage resulting from handling or from contact with the above product. See reverse side of invoice or packing slip for additional terms and conditions of sale.



Health	1
Fire	1
Reactivity	0
Personal Protection	E

Material Safety Data Sheet
Yeast extract MSDS

Section 1: Chemical Product and Company Identification

Product Name: Yeast extract

Catalog Codes: SLY1108

CAS#: 8013-01-2

RTECS: ZF6610000

TSCA: TSCA 8(b) inventory: Yeast extract

CI#: Not available.

Synonym:

Chemical Name: Not available.

Chemical Formula: Not available.

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Yeast extract	8013-01-2	100

Toxicological Data on Ingredients: Not applicable.

Section 3: Hazards Identification

Potential Acute Health Effects: Slightly hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation.

Potential Chronic Health Effects:
Slightly hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation. CARCINOGENIC EFFECTS: Not available. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available.

Section 4: First Aid Measures

Eye Contact: Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Cold water may be used.

Skin Contact:

After contact with skin, wash immediately with plenty of water. Gently and thoroughly wash the contaminated skin with running water and non-abrasive soap. Be particularly careful to clean folds, crevices, creases and groin. Cold water may be used. Cover the irritated skin with an emollient. If irritation persists, seek medical attention. Wash contaminated clothing before reusing.

Serious Skin Contact: Not available.

Inhalation: Allow the victim to rest in a well ventilated area. Seek immediate medical attention.

Serious Inhalation: Not available.

Ingestion:
Do not induce vomiting. Loosen tight clothing such as a collar, tie, belt or waistband. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek immediate medical attention.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: May be combustible at high temperature.

Auto-Ignition Temperature: Not available. **Flash**

Points: Not available.

Flammable Limits: Not available.

Products of Combustion: Not available.

Fire Hazards in Presence of Various Substances: Not available.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available.

Fire Fighting Media and Instructions:
SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use water spray, fog or foam. Do not use water jet.

Special Remarks on Fire Hazards: Not available.

Special Remarks on Explosion Hazards: Not available.

Section 6: Accidental Release Measures

Small Spill:
Use appropriate tools to put the spilled solid in a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and dispose of according to local and regional authority requirements.

Large Spill:
Use a shovel to put the material into a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system.

Section 7: Handling and Storage

Precautions:
Keep away from heat. Keep away from sources of ignition. Empty containers pose a fire risk, evaporate the residue under a fume hood. Ground all equipment containing material. Do not breathe dust.

Storage:
Keep container dry. Keep in a cool place. Ground all equipment containing material. Keep container tightly closed. Keep in a cool, well-ventilated place. Combustible materials should be stored away from extreme heat and away from strong oxidizing agents.

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

Personal Protection: Safety glasses. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits: Not available.

Section 9: Physical and Chemical Properties

Physical state and appearance: Solid. (Granular solid.)

Odor: Characteristic. **Taste:** Not available.

Molecular Weight: Not available. **Color:** Yellowish.

pH (1% soln/water): Not available. **Boiling Point:** Not available. **Melting Point:** Decomposes.

Critical Temperature: Not available. **Specific Gravity:** Not available. **Vapor Pressure:** Not applicable. **Vapor Density:** Not available.

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: Not available. **Ionicity (in Water):** Not available.

Dispersion Properties: See solubility in water.

Solubility: Easily soluble in cold water.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Not available.

Incompatibility with various substances: Not available.

Corrosivity: Non-corrosive in presence of glass.

Special Remarks on Reactivity: Not available.

Special Remarks on Corrosivity: Not available.

Polymerization: No.

Section 11: Toxicological Information

Routes of Entry: Not available.

Toxicity to Animals:
LD50: Not available. LC50: Not available.

Chronic Effects on Humans: Not available.

Other Toxic Effects on Humans: Slightly hazardous in case of skin contact (irritant), of ingestion, of inhalation.

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans: Not available.

Special Remarks on other Toxic Effects on Humans: Nuisance dust.

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are more toxic.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:

Section 14: Transport Information

DOT Classification: Not a DOT controlled material (United States).

Identification: Not applicable.

Special Provisions for Transport: Not applicable.

Section 15: Other Regulatory Information

Federal and State Regulations: TSCA 8(b) inventory: Yeast extract

Other Regulations: Not available..

Other Classifications:

WHMIS (Canada): Not controlled under WHMIS (Canada).

DSCL (EEC):

This product is not classified according to the EU regulations.

HMIS (U.S.A):

Health Hazard: 1

Fire Hazard: 1

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Gloves. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Safety glasses.

Section 16:

Other Information

References
: Not
available.

Other Special

Considerations: Not

available.

Created:

10/10/2005

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Last Updated:

05/21/2013 12:00 PM

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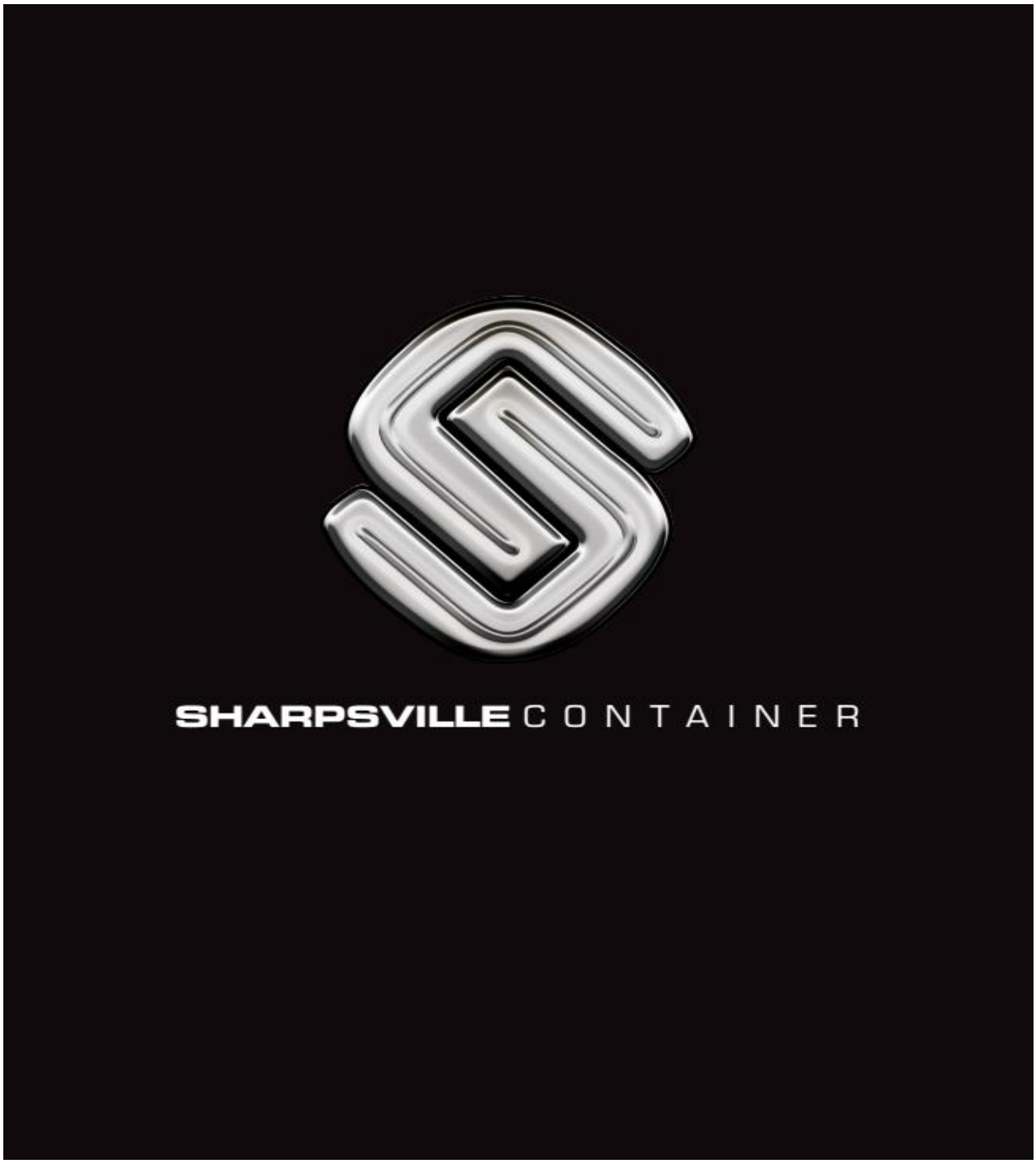
Appendix C – Vendor Sheets



Specific Equpiment Specifications & Pricing:

130L, Dished Top and Bottom Heads, 316L Stainless Steel, 10-15 Ra ID, Electropolished, welds ground smooth and flush. 32 Ra AVG OD with welds ground smooth and flush. Top head has (2) 2” Tri-Clamp Ferrules, (1) 1” Ferrule, and (1) 6”

Hand Hole. Agitator Flange is (1) 6” 150# RFSO Flange for LIGHTNIN XP650 Agitator with Hydrofoil Impellers. Vessel is ASME Rated for 30 psig @ 250F, Jacket is Dimple Style and rated for 150 psig @ 250°F

$19,765.00……lead time is 10-12 weeks ARAD

3250L, Dished Top and Bottom Heads, 316L Stainless Steel, 10-15 Ra ID, Electropolished, welds ground smooth and flush. 32 Ra AVG OD with welds ground smooth and flush. Top head has (2) 2” Tri-Clamp Ferrules, (1) 1” Ferrule, and (1) 18” Manway. Agitator Flange is (1) 8” 150# RFSO Flange for LIGHTNIN XP650 Agitator with Hydrofoil Impellers. Vessel is ASME Rated for 30 psig @ 250F, Jacket is Dimple Style and rated for 150 psig @ 250°F

$51,995.00……lead time is 18-20 weeks ARAD

Add Bottom Entry STERIDOSE Magnetic Drive Mixer……..$16,795.00

80,000L Dished Top and Bottom Heads, 316L Stainless Steel, 10-15 Ra ID, Electropolished, welds ground smooth and flush. 32 Ra AVG OD with welds ground smooth and flush. Top head has (8) 2” Tri-Clamp Ferrules, (7) 1” Ferrule, and (1) 24” Manway. Agitator Flange is (1) 12” 150# RFSO Flange for LIGHTNIN XP Agitator with Hydrofoil Impellers. Vessel is ASME Rated for 30 psig @ 250F, Jacket is Dimple Style and rated for 150 psig @ 250°F
$302,765.00……lead time is 24-26 weeks ARAD
80,000L (Storage Vessel) Flat Top and Sloped Bottom, 316L Stainless Steel, 32 Ra AVG ID, welds ground smooth and flush. 32 Ra AVG OD with welds ground smooth and flush. Top head has (8) 2” Tri-Clamp Ferrules, (10) 1” Ferrule, and (1) 24” Manway
$79,650.00……lead time is 16-18 weeks ARAD

Harris E. Rogner- Sales Engineering Manager
Sharpsville Container Corporation |hrogner@scacon.com
600 Main St. Sharpsville, PA 16150 | (C) 330.647.8205 (P) 724.962.1100 x 105 | (F) 724.962.1169

Media Filters
http://www.sartorius.us/us/product/product-detail/5442507i2/

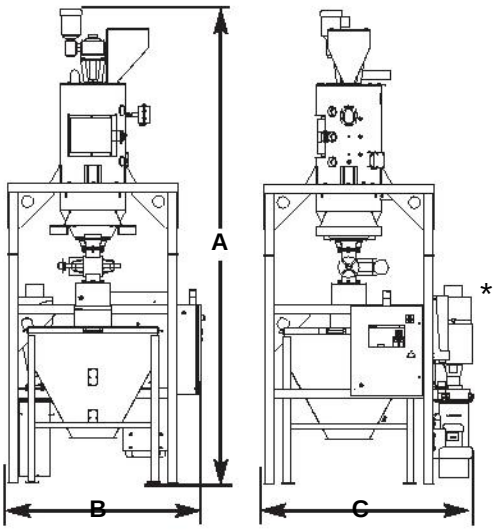
CR Series

CONVERT AMORPHOUS PET TO USABLE CRYSTALLINE MATERIAL

RELIABLE, HIGH-QUALITY MATERIAL OUTPUT

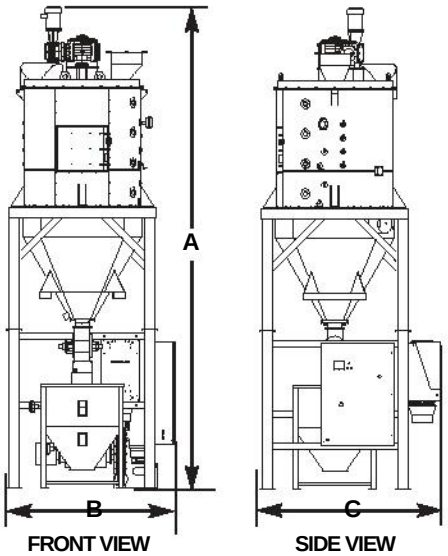
SPECIFICATIONS

Model CR4 and CR10



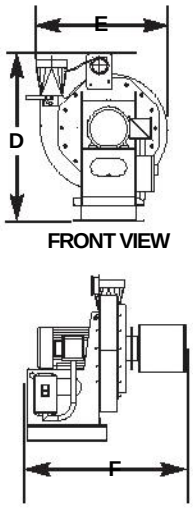
FRONT VIEW SIDE VIEW

Model CR21 - CR135



FRONT VIEW SIDE VIEW

Blower



FRONT VIEW SIDE VIEW

MODELS	CR4†	CR10†	CR21†	CR42†	CR85†	CR135†
Performance characteristics						
Throughput ft³/hr {l/hr}	4 {113}	10 {283}	21 {595}	42 {1189}	85 {2407}	135 {3823}
Heater energy source	electric or natural gas	electric or natural gas	electric or natural gas	electric or natural gas	electric or natural gas	electric or natural gas
Air circuit	open or closed loop	open or closed loop	open or closed loop	open or closed loop	open or closed loop	open or closed loop
Dimensions inches {mm}						
A - Overall crystallizer height	159.2 {4043.7}	169.0 {4292.6}	192.5 {4889.5}	226.8 {5760.7}	261.8 {6649.7}	281.1 {7139.9}
B - Overall crystallizer width	66.0 {1676.4}	66.0 {1676.4}	69.0 {1752.6}	79.1 {2009.1}	86.3 {2192.0}	98.3 {2496.8} C
- Overall crystallizer depth	70.5 {1790.7}	75.0 {1905.0}	70.1 {1780.5}	81.4 {2067.6}	94.2 {2392.7}	106.3 {2700.0}
D - Blower height†	NA NA	37.8 {960.1}	37.8 {960.1}	37.8 {960.1}	45.8 {1163.3} E - Blower width†	
	NA NA	32.5 {825.5}	32.5 {825.5}	32.5 {825.5}	37.5 {952.5} F - Blower depth†	
	NA NA	68.4 {1734.4}	70.4 {1788.2}	77.5 {1968.5}	80.6 {2047.2}	
Approximate weight lbs {kg}						
Crystallizer installed	2863 {1299}	3130 {1420}	3315 {1504}	4422 {2006}	6590 {2989}	7754 {3517}
Surge bin installed	270 {122}	270 {122}	650 {295}	650 {295}	650 {295}	650 {295}
Blower installed	NA NA	700 {318}	800 {363}	900 {408}	1100 {499}	
Voltage total amps						
230V/3 phase/60 Hz	38.8	NA	NA	NA	NA	NA
400V/3 phase/50 Hz	22.3	55.6	107.5	159.1	292.5	305.3
460V/3 phase/60 Hz	19.3	48.4	93.5	138.4	254.4	265.5
575V/3 phase/60 Hz	15.5	38.7	74.8	110.7	203.5	212.4
Discharge type (via rotary air lock)						
Surge bin 10 ft³ {281 l/hr}	standard	standard	standard	NA	NA	NA
Surge bin 17 ft³ {481 l/hr}	NA	NA	NA	standard	standard	standard
Blower noise level						
	<90 dbA @5 ft.					

OPTIONS

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SPECIFICATION NOTES:

* Shown with optional cyclone mounted on stand this applies to model CR4 only.

† The blowers on models CR4 and CR10 are located on the stand. Blowers on models CR21, CR42, CR85 and CR135 are independent of the stand, adequate space will need to be planned for positioning of the blower on these models.

Specifications may change without notice. Consult a Conair representative for the most current information.

200 West Kensinger Drive. Cranberry Township, PA 16066. 724-584-5500. fax 724-584-5299. www.conairgroup.com

DISCOVE with armfield

uoP series: Heat & mass transfer oPerations

Distillation Columns - uOP3

NEW & IMPROVED UOP3CC + UOP3BM

- **New: LabVIEW™ software options**
- **Unique* eight point sample & feed sieve plate column sections**
- **Sample&feedpointsateverytray**
- **Columncanuseflammablesolvents**
- **ColumnsectionsavailableasaretrofittoexistingUOP3units**

Considerable advances in the instrumentation and control of distillation columns have been made in recent years, prompted by the advent of computer-linked systems supported by software packages for handling plant operating data. To reflect these advances, Armfield has developed two new state-of-the-art laboratory-based distillation columns that enable safe hands-on practical training for student engineers and plant operators:-

> A continuous or batch operation, computer-compatible column (model reference UOP3CC), which enables a full range of demonstrations from the introductory stages of a process engineering course through to the more complex demonstrations of modern control strategies.

> A batch-only operated version (model reference UOP3BM) manually controlled, permits comprehensive study of the basic principles of distillation.

> Both units are designed for safe options using flammable solvents.

The Armfield UOP3CC and UOP3BM have been significantly improved with the addition of sampling ports on each of the trays.

Previously, the thermocouple was removed in order to take a sample. The new sampling ports enable vapour or liquid samples to be drawn from each of the sieve plates by simply inserting a hypodermic needle into the septum seal whilst the distillation is in full, continuous operation. In addition, sample ports can be utilised as additional feed positions on each sieve plate.

The ports are now fitted as standard, and are available as a retrospective install to existing UOP3CC & UOP3BM units.

Contact Armfield for more details.

Above: Computer interfaced distillation column UOP3CC shown with safe area console

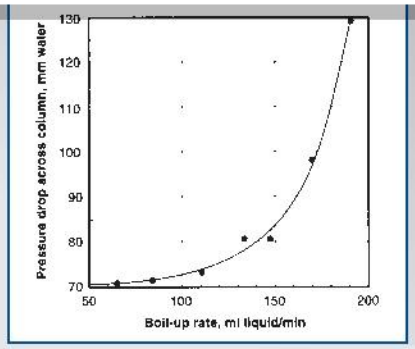


Fig. 1: Column pressure drop as a function of boil-up rate

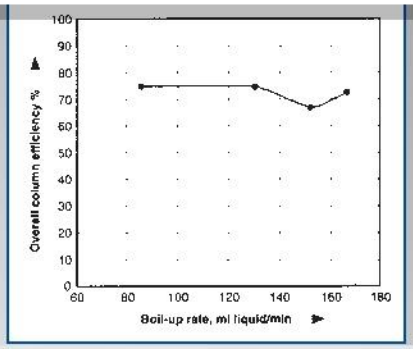


Fig. 2: Column overall efficiency as a function of boil-up rate

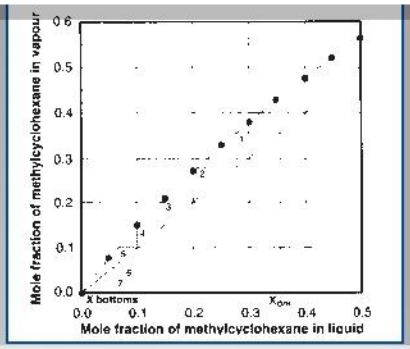


Fig. 3: McCabe-Thiele construction for batch distillation at total reflux (methylcyclohexane-toluene mixture, atmospheric pressure, boiler power 1.0kW)

LABORATORY WORK ASSIGNMENT CAPABILITIES

For Batch Distillation Column UOP3BM - under manual control:

- pressure drop across the column as a function of boil-up rate (Fig. 1)
- column efficiency as a function of boil-up rate, at total reflux (Fig. 2)
- plate-to-plate temperature profiles along the column
- McCabe-Thiele construction of operating line (Fig. 3)
- distillation at constant reflux ratio: variation of top product composition with time (Fig. 4)
- mass balance across the system
- manual control of reflux ratio, for example to achieve a top product of specified composition
- comparison of packed column with sieve plate column performance

Note: These capabilities can also be performed with UOP3CC.

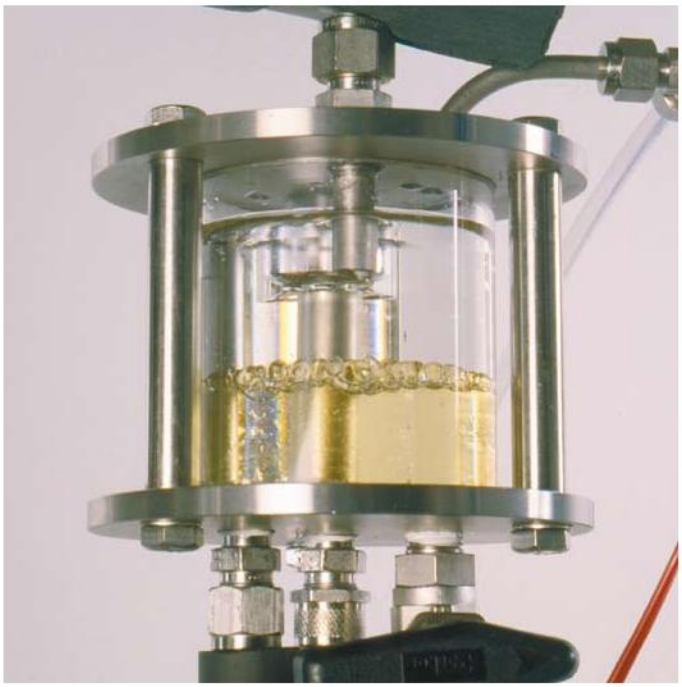
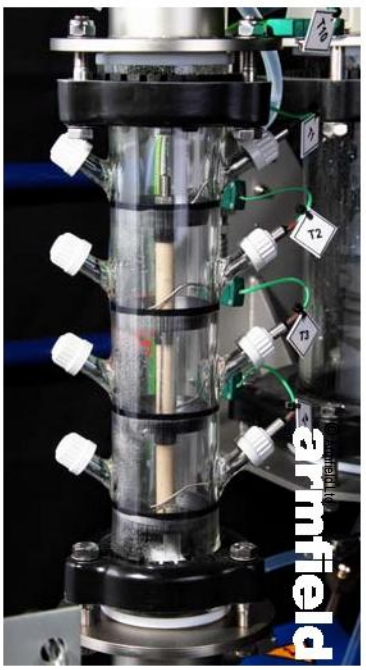


Fig. 7: Reflux separator during azeotropic distillation of a water/organics mixture

Training on the UOP3CC.
One-to-one and group training is available at Armfield or at point of installation.



Close-up of new column section

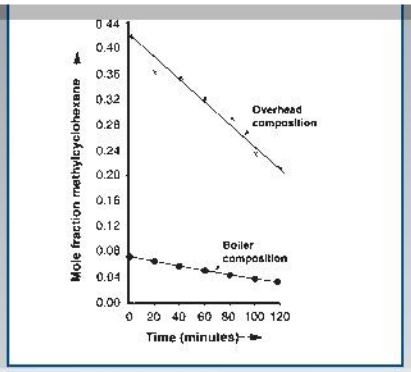


Fig. 4: Batch distillation:
variation of composition with time at fixed reflux ratio of 5:1 (methylcyclohex-ane-toluene mixture, atmospheric pressure, boiler power 1.1kW)

UOP3CC Safe area console

For Computer-Interfaced Distillation Column UOP3CC only
- continuous operation, manual or computer operation:

n includes all demonstrations listed for UOP3BM under 'Batch Distillation Column'

n continuous, steady state distillation including temperature profiles and McCabe-Thiele analysis

n distillation under reduced pressure conditions (Fig. 5 - page 6)

n comparison of packed and plate column continuous operation (Table 1)

n effect of feed pre-heat (Fig. 6)

n effect of feed position (Table 2)

n demonstration of azeotropic distillation (Fig. 7)

n computer control assignments:

- the on-line use of mimic diagrams (Fig. 8)
- setting up data logging and subsequent analyses of captured data, including use of spreadsheets (Fig. 9)
- batch distillation at constant reflux ratio (Fig. 10 - page 6) or varying with time
- batch distillation with reflux ratio control from a column temperature (Fig. 11 - page 6)
- continuous distillation with three-term control of reboiler heater from a column temperature
- continuous distillation with top temperature controlling reflux ratio
- continuous distillation with temperature control of reboiler heater and reflux ratio (two- loop control system)
- optimum controller settings for changes in feed rate, composition or temperature
- alternative, user-originated control algorithms
- process dynamics e.g. monitoring and controlling plant start-up/shut down for continuous operation

n proprietary controller demonstrations:

- PLC control of reboiler heater and/or reflux ratio and alarm functioning (requires Armfield PCT19BR unit incorporating an industry-standard PLC) (Figs. 13 & 14)
- demonstration of PC supervision of PLC and PID controllers - an introduction to distributed control systems
- PID analog control of reboiler heater from column temperature (requires Armfield PCT20H unit incorporating an industry-standard controller

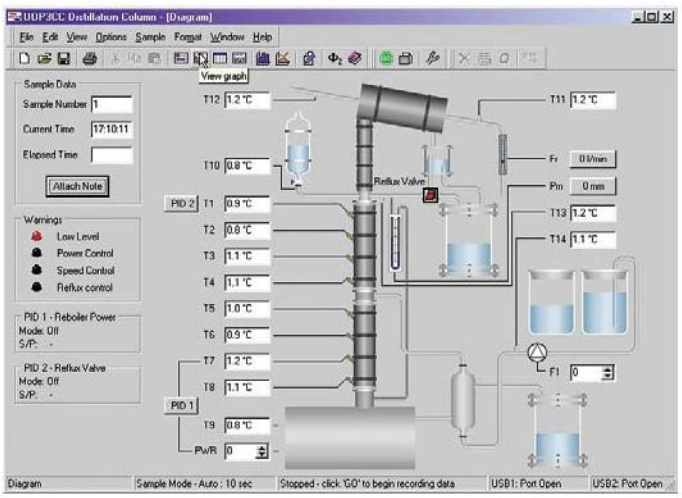


Fig. 8: On-line mimic diagram during batch distillation at constant reflux ratio

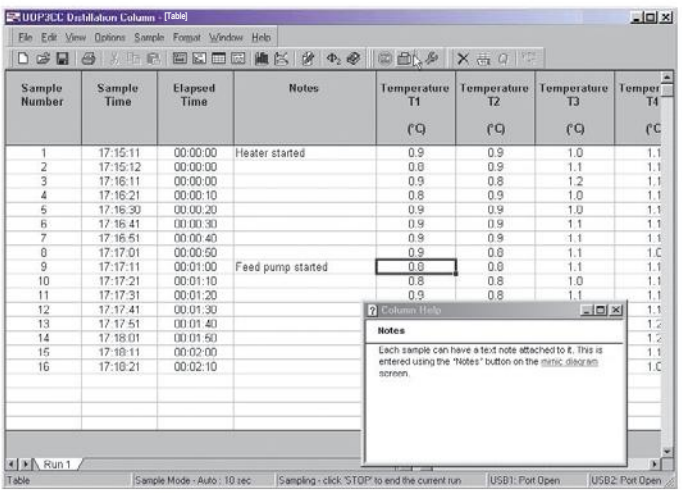


Fig. 9: Typical results displayed in tabular format

Acknowledgements:
Figs 1, 2, 3 and 4 and Table 2: Results taken from Armfield UOP3CC Distillation Column in the Process Laboratories of the Department of Chemical Engineering, University of Aston, U.K. courtesy of Dr. J. D. Jenkins

DESCRIPTION

Batch Distillation Column (Manual) UOP3BM

The unit is a self-contained and fully instrumented distillation facility, suitable for practical laboratory work relevant to the teaching of unit operations.

The equipment employs galvanically isolated intrinsically safe circuits and flameproof devices as appropriate, to enable safe distillation of standard test mixtures such as methylcyclohexane-toluene, methyl alcohol-water etc.

The equipment consists of two interconnected units: a floor standing process unit and a bench-mounted control console.

The following features are included:

Process Unit

n a 50mm diameter plate distillation column containing eight sieve plates and downcomers. Every plate includes a temperature sensor positioned to measure accurately the temperature of the liquid on each plate. The sheaths of each plate temperature sensor are not more than 1.5mm diameter, to ensure rapid dynamic response.

n a 50mm packed column supplied as a separate item, but readily interchangeable with the plate column by the user, for comparative studies of the two types of distillation column.

n electrically heated reboiler of sufficient capacity for up to two hours of batch operation. The reboiler heater is protected against overheating and by a low level alarm.

n an overhead condenser with cooling water flow measurement and adjustment.

n a condensate collecting vessel, equipped with double overflow weirs and exit pipes to enable separation of immiscible liquids.

n a reflux return valve, solenoid operated, to provide for 0%-100% reflux, adjustable by electrical signal.

n a differential manometer connected to the top and bottom of the column, to monitor column pressure drop.

n a vacuum system with gauge to enable distillation studies at reduced pressures down to 200mbar(abs).

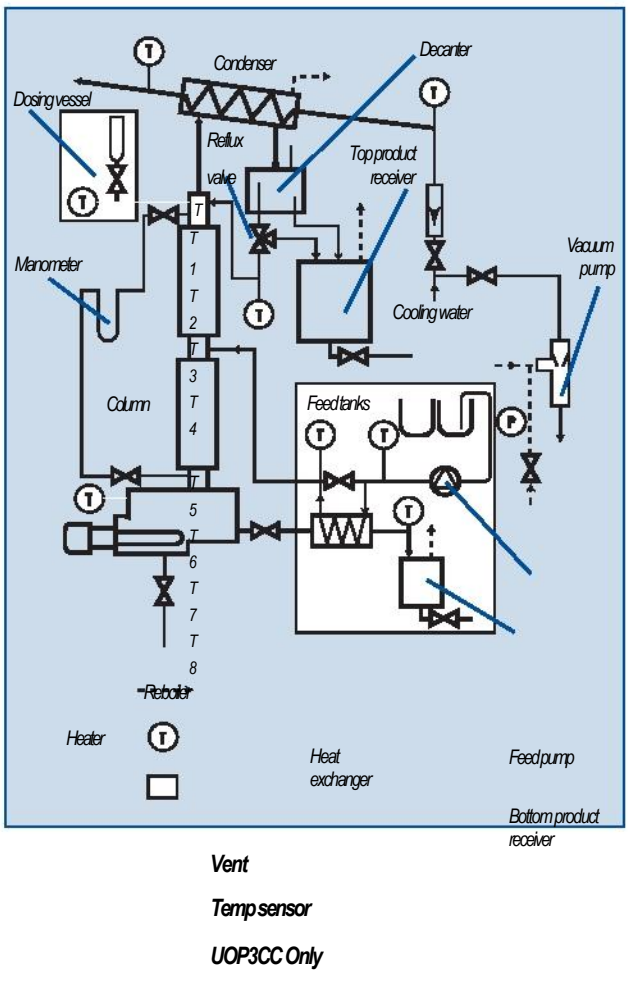
n sampling points throughout the system for composition analyses.

n materials of construction for surfaces in contact with the process fluids are; glass, stainless steel, PTFE or similar solvent-resistant materials.

n overall height of the process unit does not exceed 2.5 metres (8.2ft).

n lagging is provided, although it is possible to see at least one plate in operation with distillation in progress.

n maximum operating temperature inside the column operation is at least 130 ˚C.



Schematic diagram of Armfield distillation columns

Control Console

n monitoring and selectable display of at least 13 system temperatures, including those of the liquid on each tray, the reboiler and across the condenser.

n monitoring, display and manual adjustment of:
i) the electrical power to the reboiler heater.
ii) the reflux ratio setting.

n front panel connections to enable the user to connect 0-5 Volt industry-standard analog or programmable logic controllers, to provide on-line control of the boil-up rate or reflux ratio from chosen column temperature measurements. The connection points also permit the use of standard laboratory chart recorders and data loggers. (Up to two temperature measurements simultaneously).

n mains power connection (single phase 3kW max. supply) protected by Residual Current Device. No-volt protection safety circuits to prevent unintentional start-up.

n individual circuits protected against excess current with resetable circuit breakers.

DESCRIPTION

Computer-Interfaced Distillation Column UOP3CC

This unit incorporates all the features of the manually operated batch column described on opposite page (UOP3BM) but includes the following additional items:

Process Unit

n two 5 litre feed vessels, with rapid changeover to permit step changes in feed composition to be made.

n peristaltic feed pump, range 0-0.25 litres/minute adjustable by voltage input variation to the pump motor controller.

n electrically heated reboiler of sufficient capacity for one-two hours of batch operation, but equipped with an internal overflow when continuous operation is required.

n a bottoms product heat exchanger which may either be water cooled or used as a (variable) feed pre-heater.

n alternative column feed points and the ability to vary the inlet feed temperature to the column.

n dosing feed vessel, connected to the column for the continuous addition of a third liquid component, which, together with the condensate phase separator vessel, enables the study of azeotropic distillation.

n temperature sensors in each flow stream entering and leaving the condenser and of the feed, product system and reboiler temperatures.

Control Console

n monitoring and selectable display of at least 14 system temperatures, including those of the liquid on each tray, the reboiler, across the condenser, and of the feed and product streams.

n monitoring, display and manual adjustment of:

i) the electrical power to the reboiler heater.

ii) the reflux ratio setting. iii) the feed rate setting.

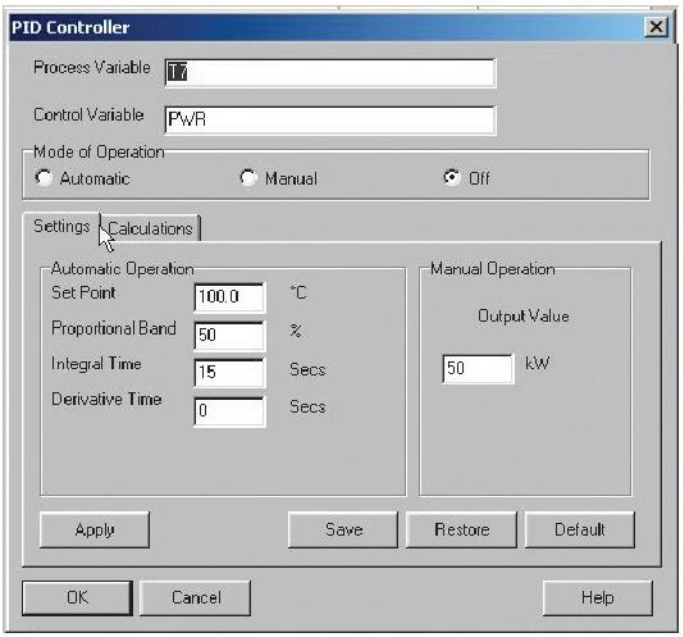
n ribbon cable connector at rear of the console allows the use of standard laboratory chart recorders and data loggers (all measurements simultaneously).

n USB connector at the rear of the unit allows connection to a user supplied PC, via the integral USB interface.

n remote/manual switch is provided on the front panel of the console to enable simple changeover from PC to front panel control to be made by the operator.

n power and motor control circuits shut down automatically with loss of computer control signals (when in computer control mode).

SOfTWARE



PID controller screen from Armfield software

Armsoft 306 software included as standard

n bespoke Armsoft-306 Windows based software, enables real time data acquisition via USB port, mimic diagram of process tabular and graphical display of results, and export to external spreadsheet.

n fully configurable, multiple loop control strategies.

control options include:

i) manual control of feed rate, reboiler power and reflux ratio.

ii) alarm setting.

iii) adjustable PID control of the power to the reboiler heater from a temperature sensor.

iv) alternative algorithms for controlling the reflux ratio, in particular by programmed variation with time and from a column temperature.

v) 'two point' temperature control of reboiler power and reflux ratio simultaneously.

n full help facilities including presentation screen to provide a brief overview of the equipment, and detailed texts giving all the information required to run the experiments.

LabVIEW software

n as an alternative to the Armsoft-306 software, the software to control the UOP3CC can be supplied in the LabVIEW™ format. Two versions are available:

- UOP3CC-LV-RT is a run time version of the software. It does not require that LabVIEW™ is installed on the computer and requires no further license to run the software.
- UOP3CC-LV-SC is aimed at experienced LabVIEW™ developers. It includes all the source files so that users can amend the software and optimise it to their own requirements. To use UOP3CC-LV-SC, the National Instruments LabView development program must be installed on the computer (i.e.. NI Developer Suite 2012), complete with all appropriate licenses. (Armfield do not supply the National Instruments software).

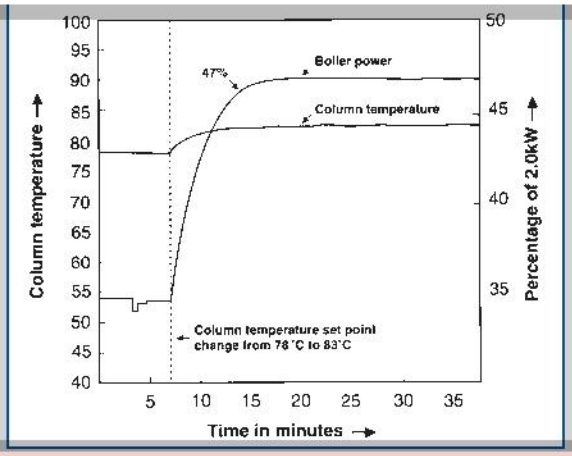


Fig. 14: Hard copy of results

Distillation column control using an Armfield PCT19BR Industrial PLC Unit

Comparison of batch distillation for different reflux ratio control strategies

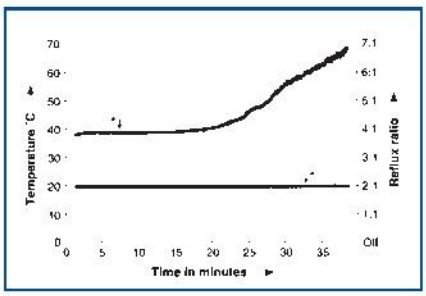


Fig. 10: Constant reflux ratio

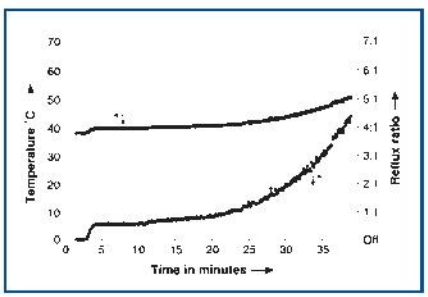


Fig. 11: Reflux ratio controlled by top plate temperature

Effect of operating parameters on column temperature profile (Feed rate of 60ml/min, 60% trichlorethylene/40% methylene chloride, boiler power 0.75kW, reflux ratio 2:1)

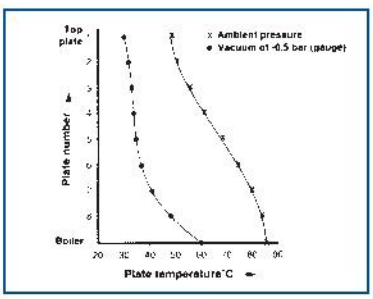


Fig. 5: Effect of reduced pressure

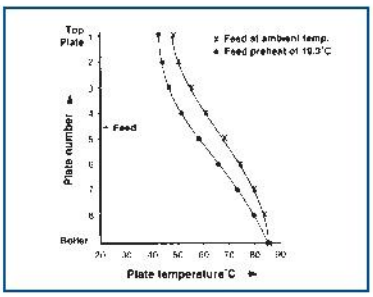


Fig. 6: Effect of feed pre-heat

Measurements in	Temp. of top plate	Temp. of boiler
Packed column	*48.4°C*	*82.5 °C*
Plate column	*48.0°C*	*85.0 °C*

Conditions:
Feed: *60ml/min of 60:40 trichlorethylene/methylene chloride*
Reboiler power: *0.75kW*
Reflux ratio: *2:1*
Ambient feed temperature: *17°C*
Atmospheric pressure.

Table 1: Comparison of temperatures across packed and plate columns

feed to top of column

Time	Compositions, m.f. MCH			Power	Reflux	Temperatures, °C		
	Feed	Overheads	Bottoms	Input, kW	Ratio	Reboiler	O/H Line	Top Plate
13.40	0.293							
15.00				0.79	2:1	108.8	103.4	103.5
15.15				0.77	2:1	108.4	103.0	102.7
15.20		0.472	0.088					
15.30				0.79	2:1	107.1	102.9	103.6
15.35		0.464	0.097					
15.50		0.481	0.107	0.75	2:1	107.4	103.0	103.6

Table 2: Results for an alternative feed position

PCT19BR Industrial PLC controller

PCT20H Industrial PID controller

INSTALLATION REQUIREMENTS

Solvent resistant level floor.

Either a flameproofed room or in an area where a 2 metre clear and uninterrupted space on each and every side and above the unit can be maintained and into which no potentially spark producing equipment should be allowed to enter.

Electrical supply:

UOP3BM-A:	220-240V/1ph/50Hz @ 13A
UOP3BM-B:	120V/1ph/60Hz @ 25A
UOP3BM-G:	220V/1ph/60Hz @ 13A
UOP3CC-A:	220-240V/1ph/50Hz @ 13A
UOP3CC-B:	120V/1ph/60Hz @ 25A
UOP3CC-G:	220V/1ph/60Hz @ 13A

Cold water supply:

15 litres/min at 2.0bar pressure (min.)

Venting:

exhaust line to fume cupboard or to safe discharge area outside of laboratory.

NB: The distillation unit is floor mounted and is supplied already connected to the bench- mounting control console by sufficient armoured cable to allow the 2m clear space to be maintained around the column.

ESSENTIAL ACCESSORIES

Analytical equipment, suitable for composition analyses of any particular liquid mixture selected by the user (e.g. refractometer).

For UOP3CC only:-

Windows PC with USB port. (not supplied by Armfield)

Note: It is not possible to upgrade a UOP3BM unit to a UOP3CC unit, owing to the complexity of the flameproof barriers within the UOP3CC control console.

PCT19BR:

PLC unit incorporating Allen Bradley SLC500 complete with proprietary ladder logic set-up program (requiring user-supplied PC). This program is initially configured by Armfield for two analogue input/output control loops suited to the UOP3 Distillation Column unit (either BM or CC versions), but may be re-configured by users via their PC.

PCT20H:

PID controller, incorporating a Honeywell UDC3300 series unit, with voltage/mA input and output for single loop control and alarm configurations. Suitable for both UOP3BM and CC versions. A software package is supplied on disk to demonstrate the basic principles of SCADA whereby a user-supplied PC can address the PID controller on-line.

DISCOVER WITH armfield

ORDERING SPECIfICATION - UOP3BM

Batch Distillation Column (manual):

- Self-contained sieve plate distillation column unit including reboiler, condenser and reflux tank, suitable for use with flammable solvents and fully instrumented for batch operation
- Eight feed and sample points
- Temperatures throughout the process including those on each and every sieve plate are monitored and displayed on a bench mounted control console, via a selector switch. The console also houses controls for the power supplied to the reboiler heater and for reflux ratio settings between 0 and 100%
- The console front panel connections enable the use of standard laboratory recorders and data loggers and of industry-standard PID and PLC controllers (not supplied)
- A U-tube manometer is incorporated to measure pressure drop over the distillation column
- The 50mm diameter sieve plate column may be readily interchanged with a packed column supplied as an alternative
- A vacuum system enables operation at reduced pressures down to 200mbar(abs)
- The unit is supplied completely assembled including lagging, and a comprehensive instruction manual describes commissioning, maintenance and instructional assignments

OVERALL DIMENSIONS

Process Unit:	Control Console:
Height: 2.25m	Height: 0.30m
Width: 0.85m	Width: 0.52m
Depth: 0.80m	Depth: 0.40m

SHIPPING SPECIfICATION

Packed Volume:	3.4m³
Gross Weight:	425kg

Armsoft 306 - 64/32-bit Windows compatible software

FOR FURTHER INFORMATION ON THE ADVANCED FEATURES OF ARMFIELD SOFTWARE VISIT:
www.armfield.co.uk/data/armsoft

ORDERING SPECIfICATION - UOP3CC

Computer-interfaced Distillation Column:

- Self-contained sieve plate distillation column unit including feed vessels and pump, reboiler, condenser, reflux separator, product collecting tanks, bottoms product cooler/feed pre-heater, suitable for use with flammable solvents and fully instrumented for both batch and continuous operation
- Eight feed and sample points
- Temperatures throughout the process including those on each and every sieve plate are monitored and displayed on a bench mounted control console, via a selector switch. The console also houses controls for the power supplied to the reboiler heater and for reflux ratio settings between 0 and 100%
- The console front panel connections enable the use of standard laboratory recorders and data loggers and of industry-standard PID and PLC controllers (not supplied)
- The console is designed to be connected to a PC (not supplied), and software is provided to enable on-line data logging, real time trend monitoring and PID control loops to be set up, monitored and configured by the user via a mimic diagram
- A U-tube manometer is incorporated to measure pressure drop over the distillation column
- A vacuum system enables operation at reduced pressures down to 200mbar(abs)
- A third feed vessel is supplied such that, with the reflux phase separator, azeotropic distillation may be demonstrated
- The 50mm diameter sieve plate column may be readily interchanged with a packed column supplied as an alternative
- The unit is supplied completely assembled including lagging, and a comprehensive instruction manual describes commissioning, maintenance and instructional assignments

OVERALL DIMENSIONS

Process Unit:	Control Console:
Height: 2.25m	Height: 0.42m
Width: 0.85m	Width: 0.52m
Depth: 0.80m	Depth: 0.40m

SHIPPING SPECIfICATION

Packed Volume:	3.5m³
Gross Weight:	450 kg

*Armfield UOP3CC and UOP3BM are the the only units on the market with this sampling capability, and the column is unique in that it can use flammable solvents.Inaddition,sampleportscanbeutilisedasadditionalfeedpositions on each sieve plate.
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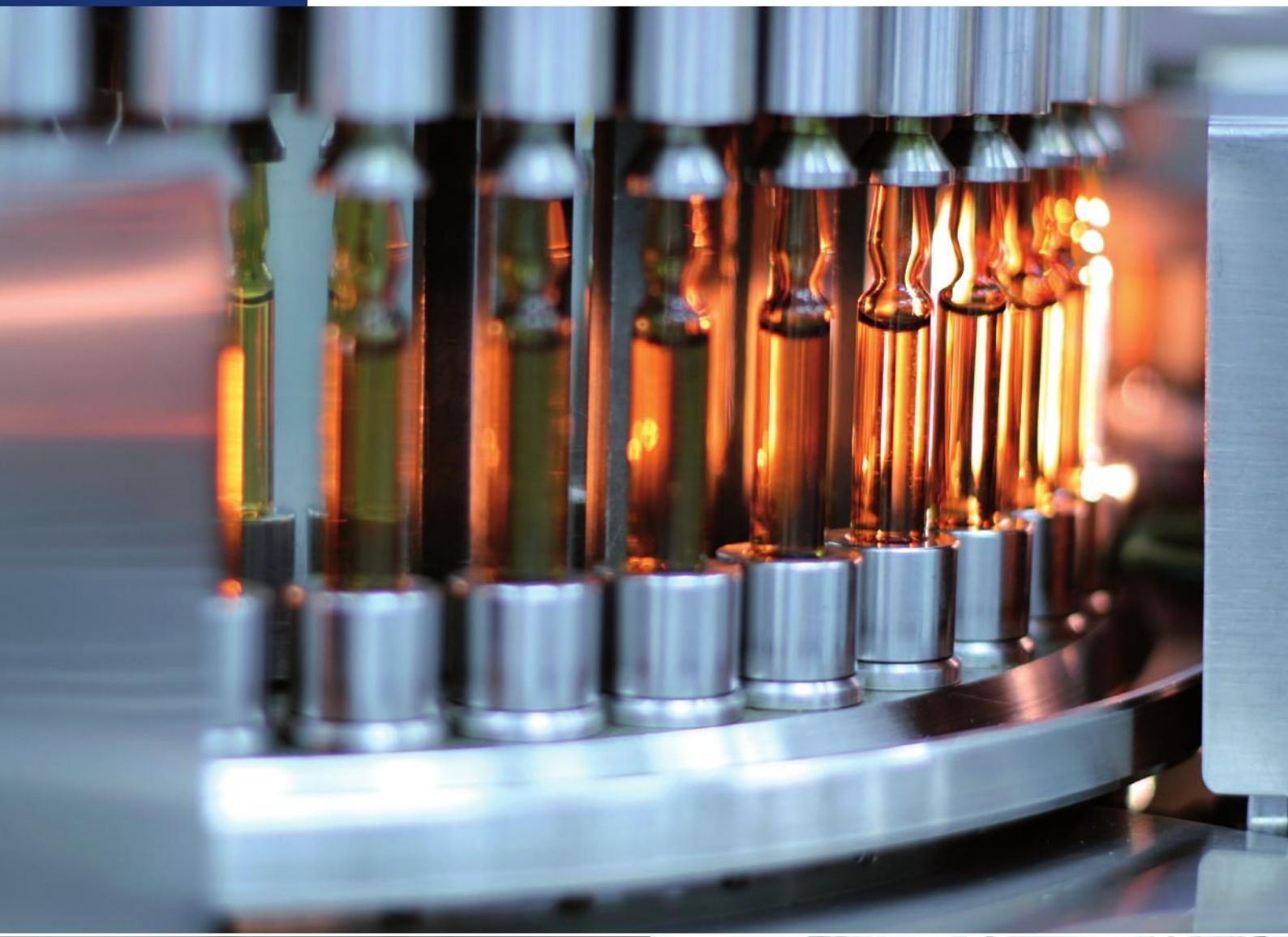
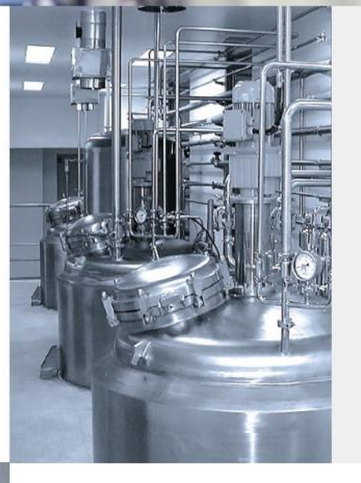


Pharmaceutical industry equipment

biomashin®

The pharmaceutical and cosmetic industry requires complex process tanks and solutions consisting of different aggregated systems with various configurations.

Biomashinostroene AD has a wide product range of tanks and apparatuses for the pharmaceutical industry. We use the latest inventions in terms of engineering and production of such equipment.



Reactor

The processes in the pharmaceutical industry have the highest and most precise requirements in terms of quality. In result, suppliers of pharmaceutical equipment should comply with the highest requirements in accordance with GMP. Biomashin produces and supplies pharmaceutical equipment in accordance with Good manufacturing Practice (GMP) and accompanied by validating documentation IQ, OQ, FAT, SAT inclusively. For reactors with maximum allowable working pressure > 0.5 bar we offer product certification in accordance with PED 97/23/EC.

Reactors are used for heat treatment, stirring, mixing and treatment of liquid and creamy components, living organisms inclusively, as well as active biochemical ingredients. Leading producers in the pharmaceutical industry use our reactors to produce infusion solutions, gels, etc.

Reactor, basic design

- Made of stainless steel AISI 316L/AISI316Ti
- Wide range of volumes
- Surfaces in contact with the product Ra 1.6÷0.4 µm
- Ability to work under pressure and vacuum
- Heat-exchanging device - inner or outer serpentine
- Agitator/Stirring mechanism in accordance with the application of the reactor, viscosity and density of the product
- Insulation with mineral wool or PU-foam, covered with fully welded insulation cladding
- Safety armature and electro-sensors for control of the process

Mixing & Melting Tanks

The application of the mixing & melting tanks is for heat treatment, mixing and treatment of liquid and creamy products.

Melting tanks are used in the cosmetics industry to melt aqueous and oil phase when producing cosmetic products.

Mixing and melting tanks, basic design

- Made of stainless steel AISI 316L/AISI304
- Volumes from 100l to 1000l
- Surfaces in contact with the product Ra 1.6÷0.4 µm
- Ability to work under pressure and vacuum
- Heat-exchanging device - dimple jacket or outer serpentine made of half pipe
- Agitator/Stirring mechanism in accordance with the product
- Insulation with mineral wool or PU-foam, covered with fully welded insulation cladding
- Armature and electro-sensors for control of the process

Tanks - Homogenizer

The term "homogenization" means a process of emulsification of the fluid in another or uniform dispersion of solids in a liquid to increase density, stability, durability, aroma and other qualities of the products.

Biomashin offers tanks for homogenizers for cosmetic emulsions used for production of creams, gels, tooth paste, cleansing milk, etc.

Tanks - Homogenizer, basic design

- Made of stainless steel AISI 316L/AISI316Ti
- Surface in contact with the product Ra 1.6÷0.4 µm
- Volume from 100 to 1000l
- Ability to work under pressure and vacuum
- Heat-exchanging device - outer serpentine
- Insulation with mineral wool or PU-foam, covered with fully welded insulation cladding

Containers

The containers that Biomashin offers and produces have various applications - servicing, storage, stirring/mixing, and transportation of pharmaceutical products. They could be used for powdered products, granules, capsules, or tablets.

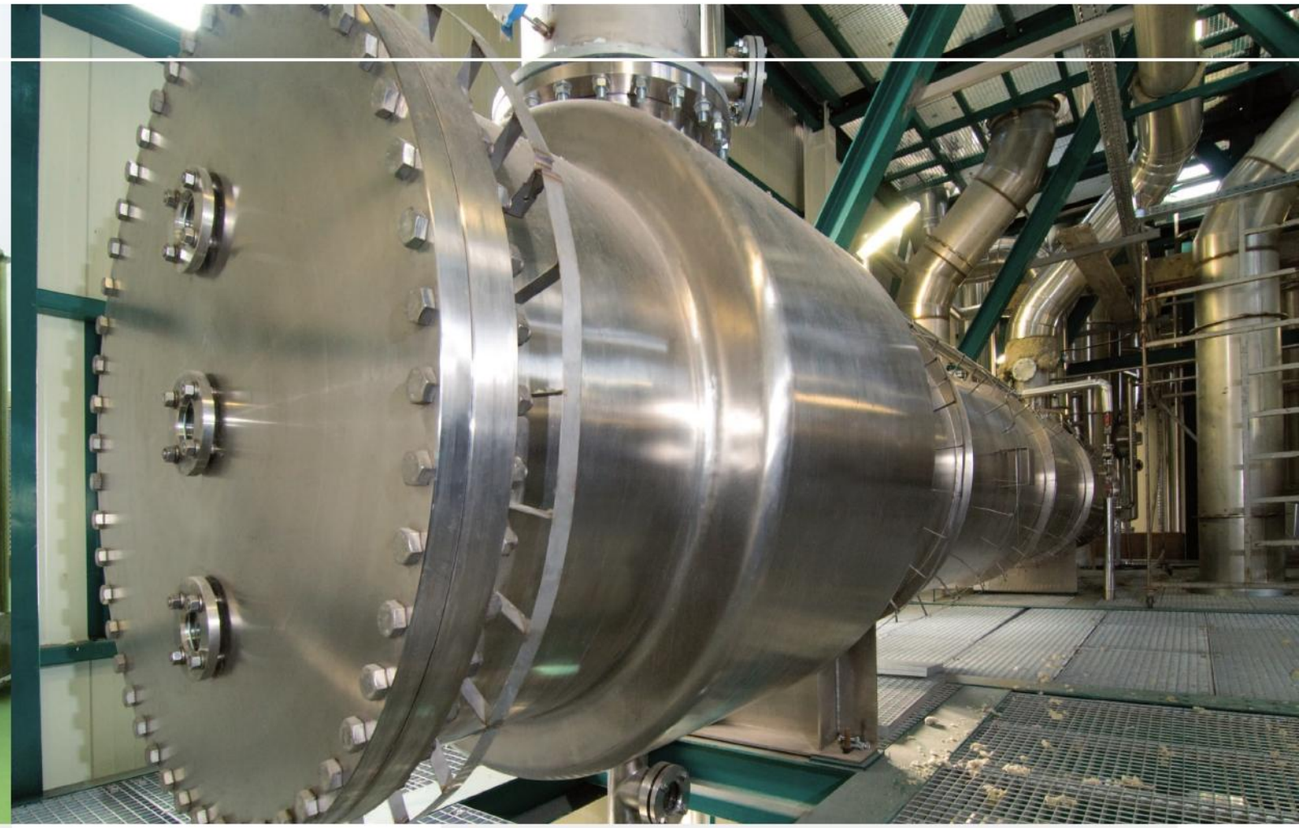
We offer a variety of types and volumes that correspond to the different needs. Our containers are designed in such a way, so that they could be serviced by pallets or forklifts with maximum solidity, precision and durability.

Biomashin produces and supplies pharmaceutical containers in accordance with Good Manufacturing Practice (GMP) and accompanied by validating documentation IQ, OQ, FAT, SAT inclusively.

Containers, basic design

- Made of stainless steel AISI 316L/AISI 304
- Surfaces in contact with the product Ra 1.6÷0.4 µm
- Ability of insulation with mineral wool and fully welded insulation cladding

S&T heat-exchangers



S&T heat-exchangers are widely spread. Their simplified design makes them a perfect solution when it comes to heating or cooling processes for wide application.

Biomashinostroene AD is equipped with up-to-date machines suitable for the production of S&T heat-exchangers made of stainless steel. We have highly efficient equipment for the production of plates. To fix the tubes to the plates, we use specialized instruments as well as automatic orbital welding heads.

Biomashin's equipment and technologies, as well as experience, allow us to cover all hygiene standards for heat-exchangers used in the pharmaceutical and food industries.

For heat-exchangers working under pressure we offer product certification in accordance with PED 97/23/EC. During their construction we apply the European norm for design EN 13445 or AD -2000 Merkblaetter.

Biomashinostroene AD covers the highest levels of quality of welded joints with the support and supervision of our welding control and quality control.

Quality and Environment

The management of Biomashin builds a corporate culture aimed at creating quality products and mentality towards meeting customers' needs and bringing satisfaction. Consequently, the following certificates are implemented in the company:

- System for Quality Control ISO 9001:2008 which is permanently and precisely controlled and upgraded
- Product certification in accordance to the Pressure Equipment Directive EC 97/23/EG - PED
- A system for Occupational Health & Safety Advisory Services: BS OHSAS 18001:2007
- GOST-R - a quality certificate in accordance to the requirements of the Russian Federation
- RTN (Russian Technonadzor) for producing vessels under pressure in accordance to the requirements of the Russian Federation

These certificates allow Biomashin to export and legitimate its products on the territory of the European Union, Switzerland, Russia and the countries from the former Soviet Union, as well as many others.

Excellent performance.

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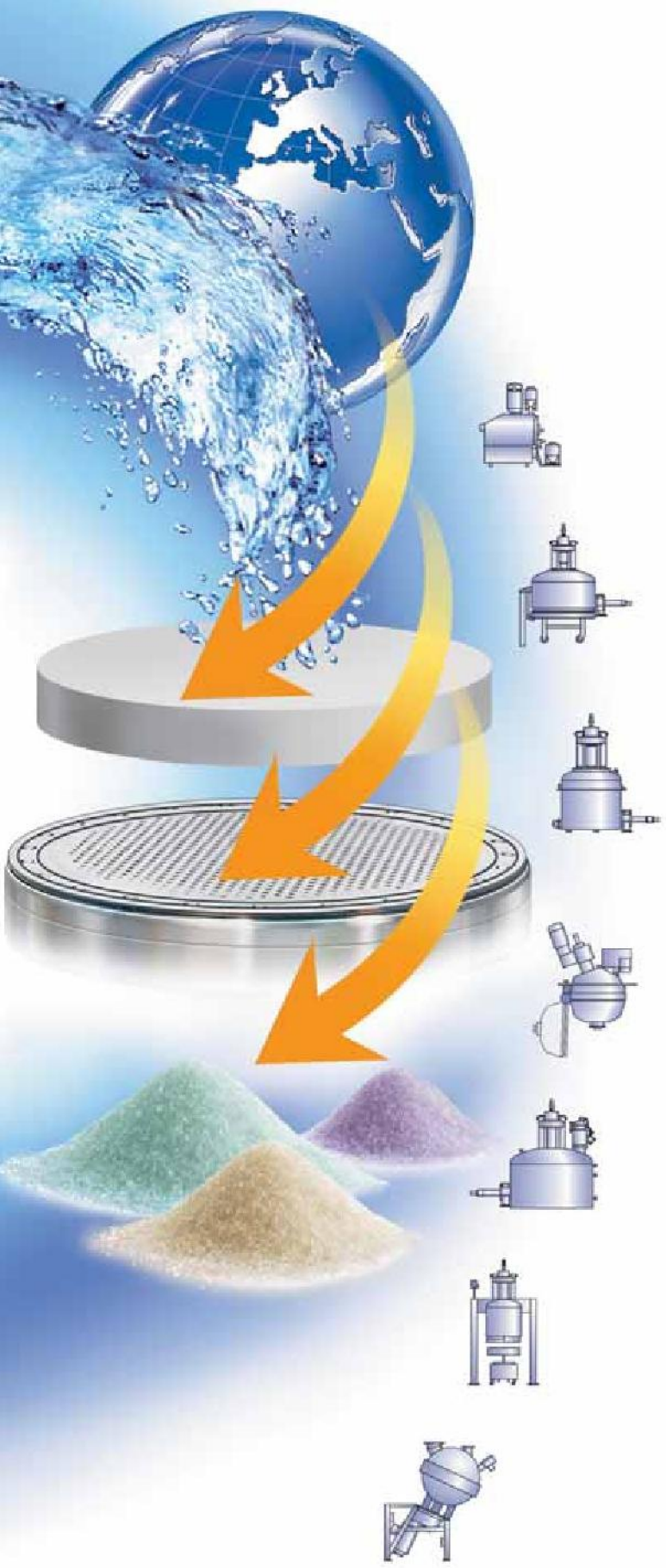
biomashin®

ROSENMUND

MECHANICAL SEPARATION AND DRYING



Only the best technology will lead you to optimum results

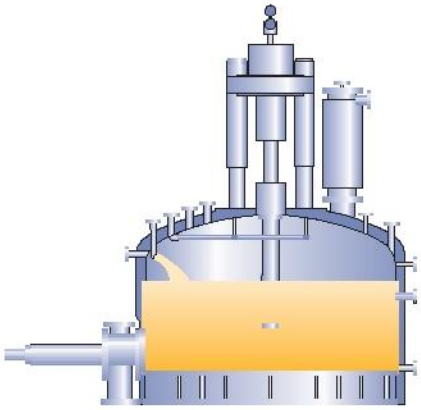
member of De Dietrich PROCESS SYSTEMS

a solution ahead

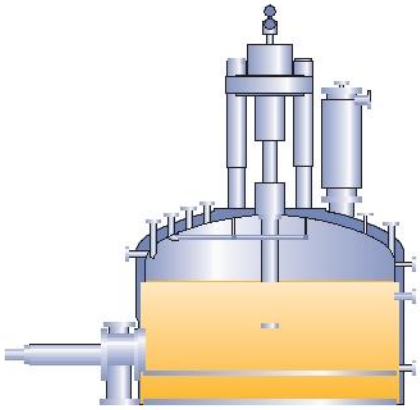
Rosenmund
Spherical dryer

a solution ahead

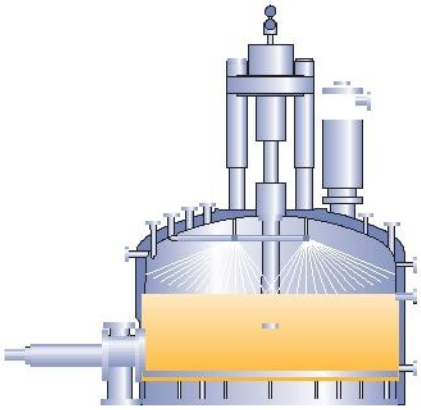
Content



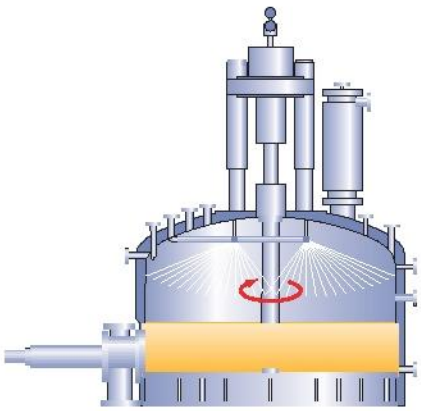
1. Filling



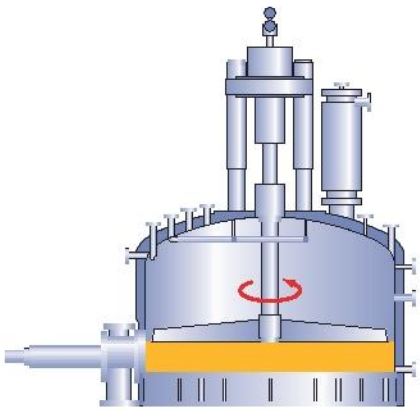
2. Filtering



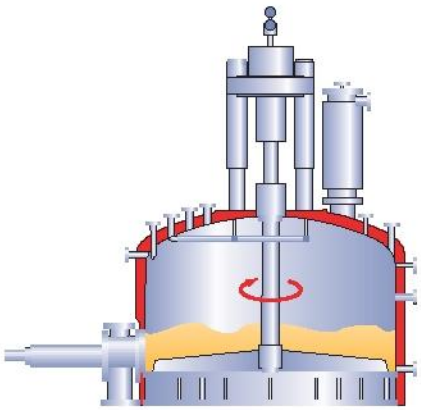
3. Displacement washing



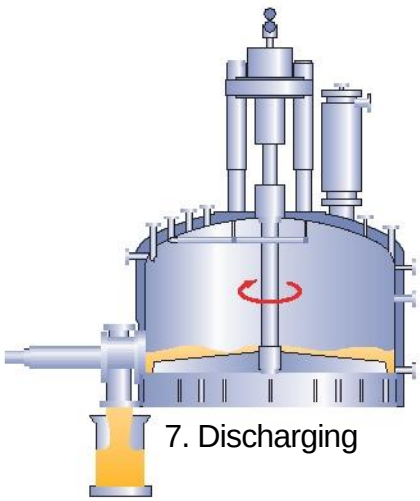
4. Reslurry washing



5. Smoothing



6. Drying/cooling

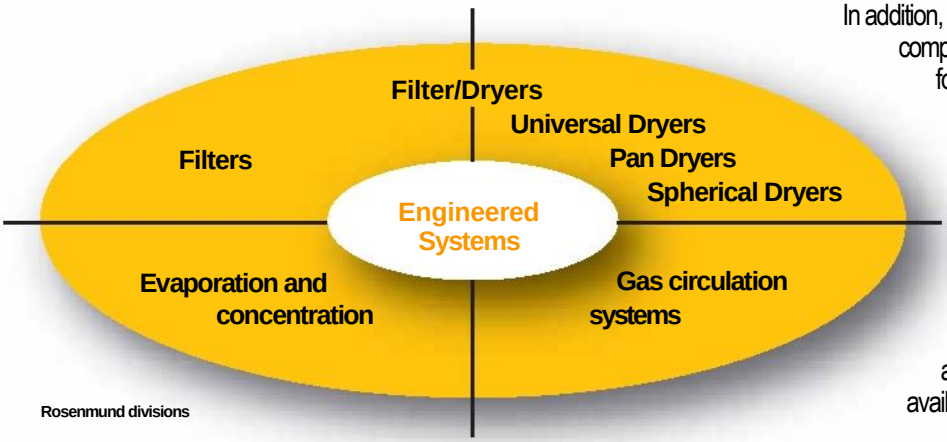


7. Discharging

Products and services

A closely linked system of innovative products and effective services is the guarantee for complete success. For customers as well as for Rosenmund!

Rosenmund offers a comprehensive range of innovative products that meet the highest standards of quality for the pharmaceutical and chemical industry: from separators for solid and liquid materials to high-performance filter systems and dryers to engineered systems.



Rosenmund divisions

In addition, Rosenmund offers a complete range of control systems for all products: manual, semi-automatic or fully automatic systems via PLC/DCS. This wide range of products is perfectly supplemented by a comprehensive range of services, for which highly motivated and qualified specialists are available around the globe.


Rosenmund spherical dryer 1000 l

Range of services:

- Testing
- Process assistance
- Installation
- Commissioning
- Qualification
- Training
- After-sales services

Range of products:

- Engineered systems
- Separation & drying of liquid and solid material:
  Filters · Filter/Dryers · Dryers
- The following materials are available for manufacturing:
  Stainless steel · Hastelloy · Alloy · Glass-Lined
- Heating/Cooling systems
- Vacuum systems
- Gas recirculation systems
- Control systems
- Product discharge and containment systems
- Pilot Plant Facility

All electrical and mechanical Rosenmund devices are in conformance with ATEX 95 (European directive 94/9/EC).

Spare parts and rental program:

- A wide range of rental machines
- Recycling & range of used products
- On-site service & maintenance program
- Spare parts service
- World-wide service centres local to customers

Progress by tradition

Rosenmund VTA AG
Liestal, Switzerland

Advanced technologies have a long tradition at Rosenmund.

For almost 200 years, Rosenmund has been known for innovative products that are accompanied by first-rate performance in service and customer support.
The company was founded in Liestal/Switzerland in 1810, and today it is an extremely successful technology leader in the global market.

Rosenmund has acquired an excellent reputation with pioneering developments such as the very first Filter/Dryer, and it has consistently increased its technological lead since then. Today, Rosenmund is one of the world's best known manufacturers of mechanical separators, filters, dryers, and engineered systems for the pharmaceutical and chemical industry. And this committed company puts all its effort into extending this lead even further in the future!

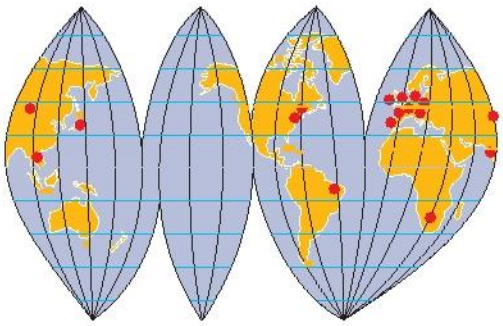
Rosenmund S.A.S.
Semur-en-Auxois, France

Milestones

1810 Foundation of the company
1965 First vacuum filter with mechanical discharge
1969 First automatic pressure filter with mechanical discharge
1970 First pilot plant 1976 First Filter/Dryer
1981 First Nutrex reactor/Filter/Dryer
1981 First sterile Filter/Dryer
1984 First paddle filter, Filter/Dryer with contact drying
1985 Basel innovation prize for Nutrex system
1994 ISO 9001 certification
1994 1,000th machine produced
1995 Acquisition of the Guedu company (France)
1995 First Spherical Dryer 1999 Rosenmund becomes a subsidiary of De Dietrich (France)
2001 Acquisition of Glatt Inox dryer technology

1971

First vacuum filter 1965



Rosenmund is active worldwide

member of De Dietrich PROCESS SYSTEMS

a solution ahead

Filters and Filter/ Dryers

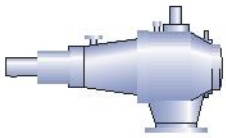
The elementary advantages of the innovative Rosenmund filter and Filter/Dryer technology:
- Optimum efficiency
- Professional high performance
- Total flexibility • Easy cleaning (CIP/WIP and SIP).

Whether in the chemical, pharmaceutical or food industry - Rosenmund filters and Filter/Dryers prove themselves through a very high efficiency in washing and isolating solids, even in the most difficult production processes. The high-performance Rosenmund filters can also be converted to Filter/Dryers simply and quickly, by the addition of upgraded features.

Rosenmund Filter/Dryer 0,4 m²

Side discharge.

The ideal application spectrum for side discharge:
- Multi-purpose production with frequent product changes.
- Processes with stringent requirements for low-particle and sterile production.
- Limited building heights.



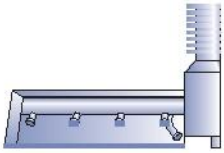
Special design features:
- Side discharge valve with metal-to-metal seal.
- Side discharge valve for pressure-tight closure after each product discharge - without prior cleaning of the sealing areas! Ideal for automatic process control and contamination-free production.
- Rosenmund Easiclean side discharge valve for manual cleaning in the case of difficult products.
- Two- or three-blade agitator for an efficient agitation and discharge process.
- Quick-lock bayonet or C-clamp main flange closure.

Side discharge valve

Rosenmund Filter/Dryer 2 m² sterile version

Total discharge with the Gas Knife system.

The Rosenmund Gas Knife is a unique and innovative solution that enables a total product discharge without manual intervention.



Gas Knife System

Rosenmund Filter/Dryer 0,4 m²

Glass-Lined Filter/Dryer.

The great demand for non-corrosive Filter/Dryers led to this joint development between De Dietrich and Rosenmund. The innovative Glass-Lined/Hastelloy construction guarantees maximum resistance to chemical solutions and aggressive solvents.

Rosenmund Filter/Dryer 0.4 m²

Cleaning and Decontamination (CIP/WIP and SIP).

CIP/WIP and SIP systems are an integral part of Rosenmund's process equipment range, including steam sterilisation and aseptic use. The application of specialised spray systems and sterilisation methods validation of the vessel preparation process.

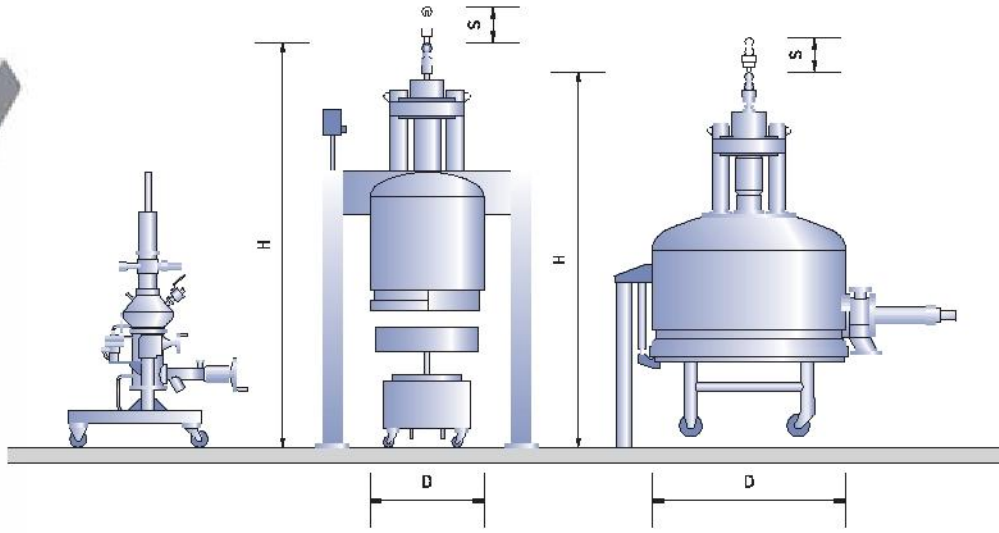
Rosenmund Filter/Dryer 0.4 m²

Special applications: microwave drying.

The use of microwaves for chemical processes provides clear advantages:

- Improved heat transfer to the product.
- Volumetric and selective heating. No harmful substances.
- Gentle and fast drying of difficult products. Low energy consumption.
- Reduced drying times, especially in the case of temperature-sensitive products and when conventional heat transfer methods are difficult to apply.

2-blade agitator



Nominal area m²		Used volume l/m³		Max. cake volume l/m³		Drive power kW		Empty weight approx. kg		Container D mm		H mm		S mm	
F	F/D	F	F/D	F	F/D	F	F/D	F	F/D	F	F/D	F	F/D	F	F/D
0,03		17		6		1,5		320		203		1960		200	
0,06		35		12		3		600		288		2670		200	
0,1	0,1	80	80	30	30	4	4	1000	1000	400	400	1910	2240	250	250
0,2	0,2	145	145	55	55	4	5,5	1500	1500	550	550	2320	2560	250	250
0,3	0,3	185	185	75	75	4	5,5	2000	2000	630	630	2420	2660	250	250
0,4	0,4	350	350	130	130	5,5	7,5	2500	2500	750	750	2420	2660	250	250
0,6	0,6	490	490	185	185	5,5	7,5	3000	3000	900	900	2710	2940	300	300
1	1	1,05	1,05	0,44	0,44	7,5	11	3500	3500	1200	1200	3450	3850	400	400
1,5	1,5	1,4	1,4	0,6	0,6	11	11	4500	4500	1400	1400	3450	3850	400	400
2	2	1,8	1,8	0,8	0,8	11	11	5000	5000	1600	1600	3450	3850	400	400
2,5	2,5	2,3	2,3	1	1	11	15	6000	6000	1800	1800	3450	4150	400	400 3
	3	2,9	2,9	1,2	1,2	15	18,5	8000	8000	2000	2000	3850	4200	400	400 4
	4	3,7	3,7	1,6	1,6	15	18,5	9000	9000	2300	2300	3900	4250	400	400 5
	5	5,2	5,2	2,4	2,4	18,5	22	10000	10000	2500	2500	4250	4750	500	500 6
	6	6,4	6,4	3	3	18,5	22	12000	12000	2800	2800	4250	4750	500	500 8
	8	7,9	9,9	4	4	22	37	14000	14000	3200	3200	4400	5450	500	500
10	10	10,2	12,5	5,3	5,3	22	37	18000	18000	3700	3700	4500	5100	500	500
12	12	13,9	15,4	6,2	6,2	25	37	22000	22000	4000	4000	5100	5250	500	500
16	16	16,8	18,7	7,85	7,85	30	45	26000	26000	4500	4500	5100	5250	500	500

F = Filter F/D = Filter/Dryer

Universal Dryer

The innovation: agitator and chopper in one system.

The horizontal construction with an integrated agitator/chopper system and full-area heating allows an unequalled application spectrum and extremely short drying times with the highest possible fill volume.

The better the mixing, the more efficient the drying. To achieve a maximum drying performance, Rosenmund has integrated a high-speed rotating chopper in one of the two agitator arms of the horizontal dryer. This chopper moves through the product with the agitator, efficiently breaking up lumps of agglomerates (wet or dry) but also providing additional mixing capability.

Rosenmund
Universal Dryer 8000 l

Fast drying through full-area heating.

Maximum heat transfer input to the product is achieved by heating the total vessel area and the agitator. A further advantage is the formation of an especially fine product powder in the dryer, which accelerates the heat transfer and thus the drying. The particle size of the product can be decrease further by the addition of a fixed stator to the agitator system.

Assembly:
Rosenmund Standard Dryer 4000 l

Wet or dry chopping.

Wet or dry chopping with the chopper/stator combination can make further milling or sieving steps unnecessary. The wet milling reduces the thermal strain on the product. In addition, a good milling effect is often achieved with an appropriate grain size distribution. For products that are sensitive to high-shear agitation, the chopper can be removed quickly and easily.

Agitator with chopper

Huge flexible degree of filling due to a high torque and a very good mixing effect of the agitator/chopper system.

Hydraulic drives for the agitator and chopper ensure a consistently high torque, even with low rotational speeds. Therefore the dryer can be filled between 20-90% of total capacity whilst retaining optimal agitation, mixing and drying performance. This huge degree of flexibility makes it possible to dry batch sizes that have greatly varying volumes and products that have greatly varying physical characteristics. Regardless of whether you have suspensions, solutions or filter-moist products - lumpy transition phases in which the agitator and chopper require more power can be easily overcome.

Agitator with chopper

Agitator to wall clearance prevents crust formation and product overheating.

The special construction of the agitator (results in a typical wall clearance of 2-5 mm) therefore the entire interior surface of the dryer is evenly coated. Crust formation is therefore absolutely minimised and heat is applied evenly to the product during the entire drying process. Since the agitator is supported at both ends of the shaft, it results smaller wall clearances than those in spherical and pan dryers can be achieved whilst maintaining the very high agitator torque!

Special version.

Standard Dryer with three-arm agitator instead of chopper.

Easy inspection through the front door.

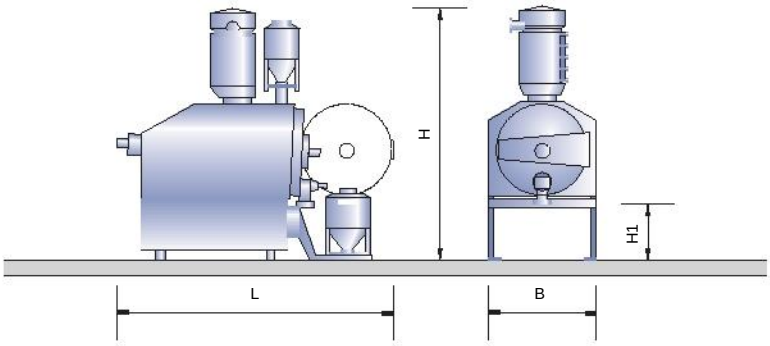
The hinged front door, which can be quickly and easily opened for inspection, provides access to the entire diameter of the cylinder. The agitator is held in place by the main bearing.

Important advantages summarised:

- Chopper integrated in the agitator arm.
- Reliable lumpbreaking.
- Small particle / grain size.
- Wet and dry milling.
- Drying independent of the initial product consistency.
- Small agitator to wall clearance.
- Hinged door for easy inspection.
- Full-surface heating of the agitator and vessel.
- High torque means maximum filling volume.
- Complete encasing of the drive system.
- Single-nozzle device on the agitator for applying nitrogen (N_2) or liquids for granulation.
- Pilot scale trials can be conducted in the Rosenmund technical centre.

Chopper

Rosenmund Universal Dryer 8000 l



Nominal volume l	Used volume l	Drive power kW	Empty weight approx. kg	H mm	L mm	B mm	H1 mm
50	50	11	1400	3450	2000	750	950
100	100	11	2700	3650	2300	950	950
200	200	15	3500	3850	2700	1100	950
400	400	30	4000	4250	2800	1300	950
600	600	37	4800	4600	2900	1450	950
800	800	37	5500	4600	3100	1450	950
1000	1000	45	7200	5500	3400	1700	1400
1500	1500	75	8000	5800	3800	1950	1400
2000	2000	75	8500	5800	4100	1950	1400
3000	3000	75	10000	5900	4100	2400	1400
4000	4000	75	11000	6000	5000	2400	1400
6000	6000	90	12000	7100	5400	2600	1400
8000	8000	110	14000	7300	5700	2800	1400

Spherical Dryers

Cleaned in a flash. Emptied completely.

The trendsetting spherical dryer range with top or bottom drive is the latest development of the proven Rosenmund dryers that achieve the highest performance standards. A versatile solution for drying, mixing and granulating.

The easy cleaning and simple emptying are the most convincing features of the Rosenmund spherical dryer. Its simple structure, the spherical vessel and the slide ring seal above the product area make CIP/WIP cleaning and SIP sterilisation possible with a few spray balls or ARD nozzles. Cleaning fluids and dissolved product residues run out through the drain fittings at the lowest point of the vessel. Along with the slope in the direction of the outlet valve, this enables a complete and fast product discharge. The product outlet is a special ball valve that seals the vessel with minimum volume.

Rosenmund Spherical Dryer with top drive 1000 l

Rosenmund Spherical Dryer with bottom drive 100 l

Maximum mixing with the three-arm agitator.

The spherical dryer achieves a high degree of mixing via a three-arm agitator with a high rational speed. By heating the agitator, the heat-exchange area can be increased further, thus improving heat transfer and preventing wet goods from being baked onto the hub and blades. These are the ideal prerequisites for short drying times and a reproducible drying results.

Rosenmund Spherical Dryer with top drive 1000 l

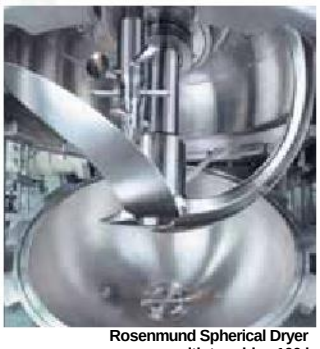
High speed chopper reduces agglomerate formation.

To prevent the formation of agglomerates that avoid moisture from being removed from the product, an additional chopper will improve results in many cases. The vertically arranged chopper brings two decisive advantages: First of all, it helps to achieve consistent results that are practically independent of the filling volume. Secondly, no wet product is sprayed on parts of the walls that the agitator does not reach.

Rosenmund Spherical Dryer with top drive 1000 l

Everything in view during inspection!

To allow quick inspection at any time, the top driven spherical dryer can be opened easily, by swivelling up the lower half of the sphere. This simple operation is achieved by a hydraulic part-turn actuator driving open a bayonet quicklock main flange, all at the touch of button! The dryer can be fixed to the ceiling, ideal for cleaning-room installations for product offloading.



Rosenmund Spherical Dryer with top drive 100 l

Explosion pressure surges? No problem at all!

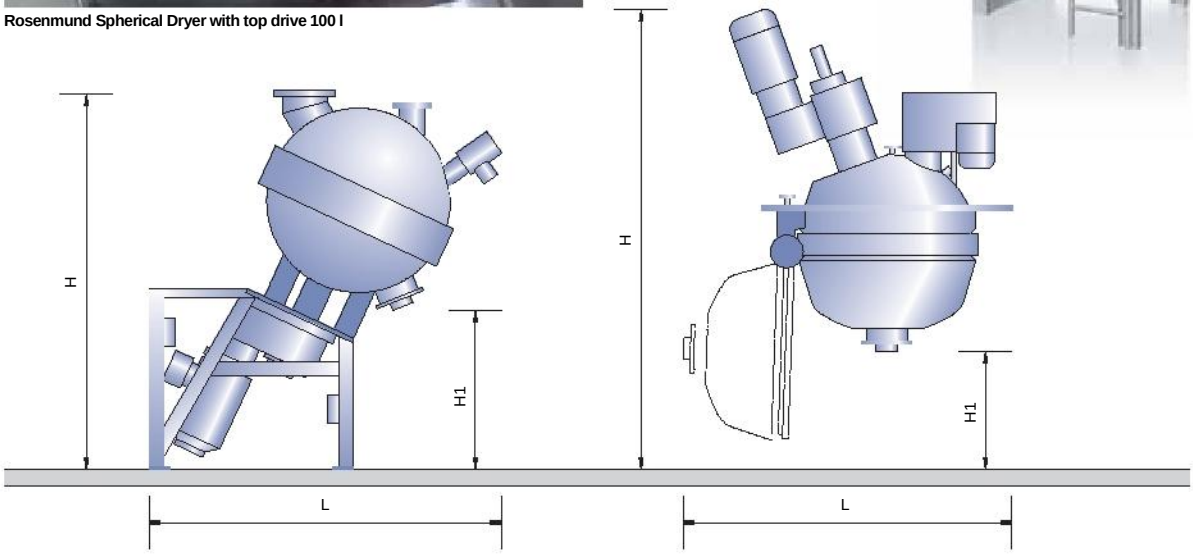
Since dryers are usually designed for vacuum operation, the risk of thermal decomposition or dust explosion requires them to be designed for higher pressures in many cases. The spherical shape with maximum volume and minimum surface is the ideal geometry for an explosion containing vessel. The ball valve will remain in the sealed position even if a power failure occurs, and it is a reliable component in this fail-safe principle. A construction that is resistant to explosion pressure surges is therefore easily accomplished!

Important advantages at a glance:

- Drying, mixing and granulating.
- Fast and easy cleaning (CIP/WIP and SIP).
- Total product discharge.
- Short drying times.
- Reproducible drying result.
- Heatable agitator.
- Vertical chopper/lumpbreaker.
- Easy to inspect.
- Assembly in ceiling.
- Containment of explosion pressure surges.

Rosenmund Spherical Dryer with top drive 100 l

Rosenmund Spherical Dryer with bottom drive 100 l



Nominal volume l t. d.	b. d.	Used volume l t. d.	b. d.	Drive power kW t. d.	b. d.	Empty weight approx. kg t. d.	b. d.	Container D mm t. d.	b. d.	H mm t. d.	b. d.	L mm t. d.	b. d.	H1 mm t. d.	b. d.
25		25		4		500		400		2500		1200		900	
50	50	47	58	10	7,5	1200	800	495	495	2600	2000	1350	1285	900	300
100	100	131	155	15	11	1500	1300	695	695	2700	2455	1500	1700	900	895
200	200	204	230	20	18,5	1800	1600	805	805	2800	3050	1650	1860	900	1115
300	300	283	320	22	22	1800	1800	898	898	2900	3150	1950	2020	900	1225
400	400	427	457	30	37	3000	2800	1030	1030	3450	3610	2000	2115	900	1390
600	600	675	722	33	45	4000	3500	1200	1200	3850	3890	2225	2222	1050	1425
1000	1000	1009	1079	45	55	6000	4400	1372	1372	4900	4165	2700	2330	1400	1460
2000	2000	1804	1929	55	75	8500	7500	1665	1665	5900	4595	3250	2790	1700	1535
	4000		3733		90		9500		2075		5640		3230		1900
	6000		5598		110		12500		2375		6435		3760		2265

t. d. = top drive b. d. = bottom drive

Pan Dryers

Field-proven and reliable: the Filter/Dryer design.

The pan dryer is based on the well established and proven Filter/Dryer technology; here, however, the porous filter bottom is replaced with a heated flat bottom.

Heated agitator with adjustable speed.

The simple change in the design of the heated flat bottom enlarges the heating area considerably. The agitator of the pan dryer is also normally heated and is equipped with speed control. Many elements such as the metallically sealed side discharge valve have been taken from the proven Filter/Dryer range.

Rosenmund Pan Dryer
Final assembly

Rosenmund Pan Dryer
Final assembly

Fast agitator replaces the chopper.

The top driven pan dryer (alternatively with bottom drive as well) relies on rotational velocity. A particularly fast agitator with a circumferential speed of up to 3 m/s (spherical dryer only around 1.5 m/s) ensures optimum mixing. The lifting and lowering agitator also provides mixing on the vertical axis. At the same time, the minimal agitator to wall clearance keeps the wall free from product crust. The rotational high speed of the agitator combined with its vertical translation does not require the use of a chopper.

Slide ring seal without product contact.

As with the spherical dryer, the mechanical seal of the pan dryer is also advantageously located outside of the product area. Depending on the application, it can either be lubricated with gas or liquid. The axial motion of the agitator is sealed by metal bellows, as with the Filter/Dryer.

Rosenmund Pan Dryer

Easy internal inspection.

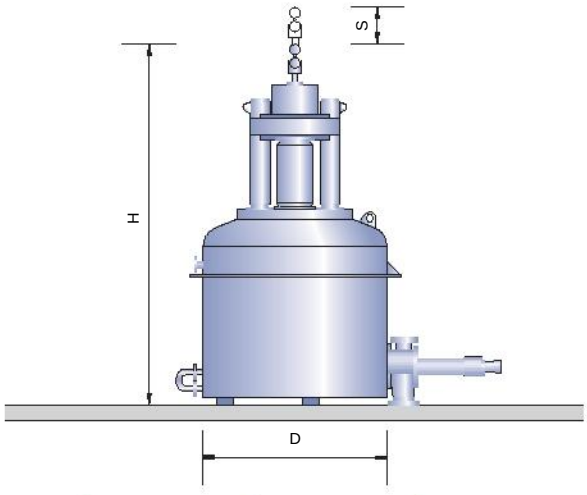
Inspection is easily possible when the pan bottom is lowered, as with the spherical dryer. In the case of frequent cleaning and opening cycles, the pan dryer is also ideally equipped with a time-saving main flange bayonet quick-lock fitting instead of C-clamps.

Important advantages at a glance:

- Proven Filter/Dryer technology.
- Agitator speed-controlled and heated.
- Fast cleaning (CIP/WIP and SIP).
- Simple emptying.
- Short drying times.
- Easy to inspect.

Rosenmund Pan Dryer, Final assembly

Rosenmund Pan Dryer agitator



Nominal volume l	Used volume l	Drive power kW	Empty weight approx. kg	Container D mm	H mm	S mm
100	100	6	1500	550	2350	250
200	200	8,8	2500	750	2500	300
400	400	12	3000	900	2500	300
1000	1000	15	3500	1200	3750	500
1600	1600	16	4500	1400	3750	500
2300	2300	23	5000	1600	4400	600
3000	3000	29	6000	1800	4400	600
3700	3700	35	8000	2000	4400	600
5000	5000	43	9000	2300	4500	600
6000	6000	59	10000	2500	5000	600
7500	7500	70	12000	2800	5000	600

De Dietrich Double conical dryer SR

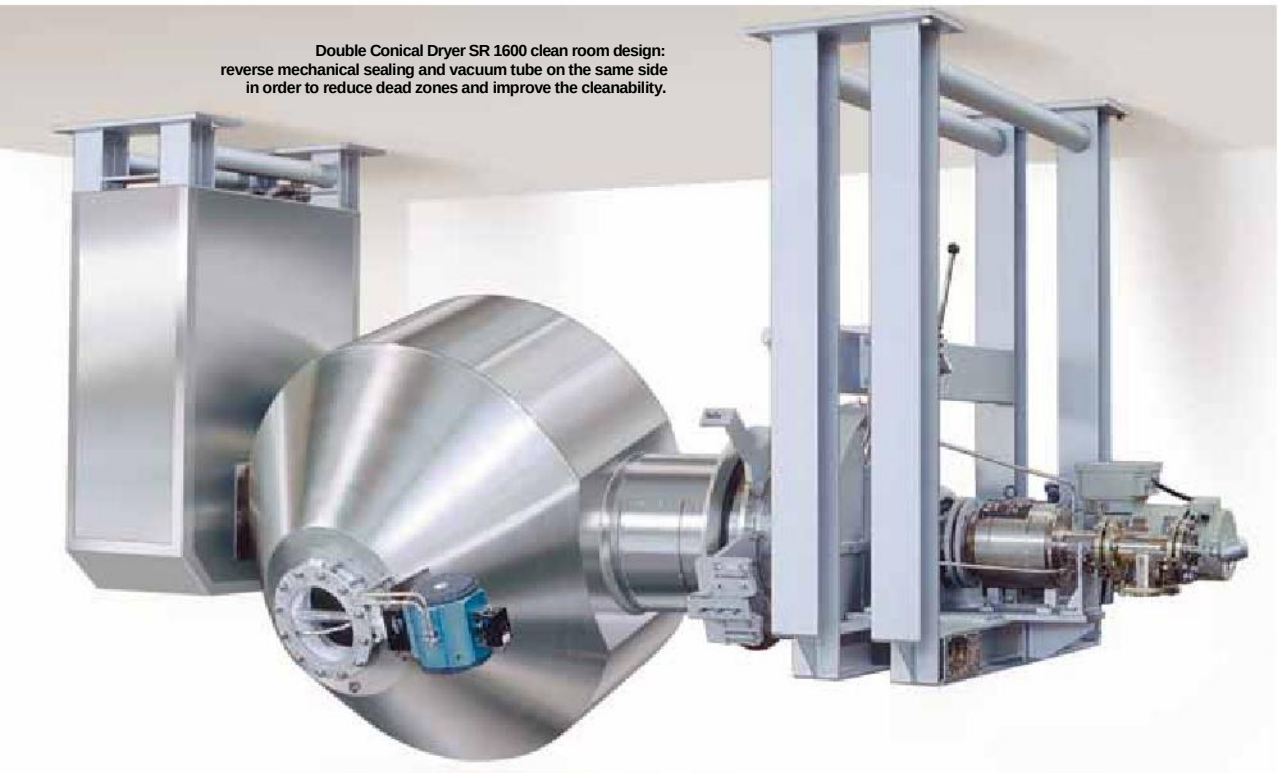
The glass lined double conical dryer SR is a device that was designed for drying easily flowing products.

The rotation of the double cone allows the product to be mixed - without an internal agitator.

Field-proven and reliable: the Dryer principle.

A proven concept.

The design of the double conical dryer combines the drying and mixing function in one simple and stable device. The operation and maintenance costs are very low. The drying times are reduced to an acceptable level. As a result, this concept provides a simple solution for many drying requirements.



Double Conical Dryer SR 1600 clean room design: reverse mechanical sealing and vacuum tube on the same side in order to reduce dead zones and improve the cleanability.

The advantages of a glass lined coating.

The characteristics of the glass lined coating provide special solutions for numerous processes:

- Anti-corrosion, when the dry solution is not chemically neutral.
- Fire polishing and anti-sticking, the dry mass does not stick.
- Anti-contamination for products that require a 100% metal-free contact. Easy
- cleaning for API.

Various options:

- Adjustable lump breakers (choppers) for materials that tend to become lumpy.
- Insulation and special coating.
- Heated cover to prevent condensation.
- "Clean room" version with minimised dead zones and remote control for filling, emptying and cleaning functions.
- Stainless steel design available.

Important advantages at a glance:

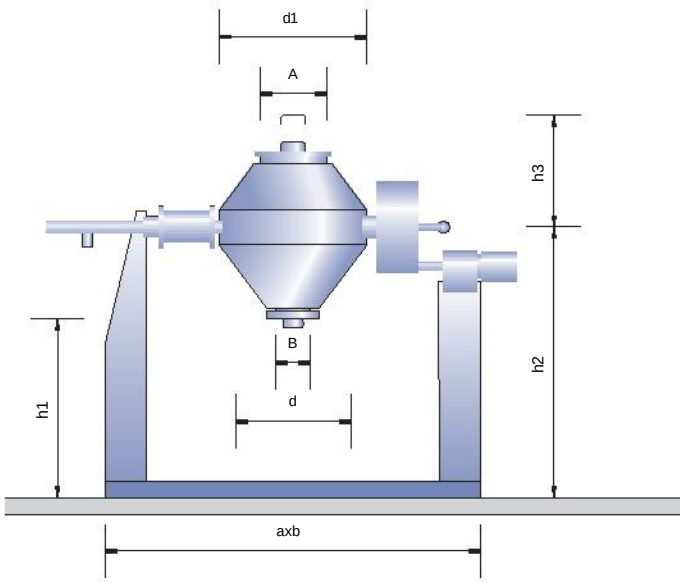
- Functional design.
- Simple operation.
- Problem-free cleaning.
- Low operating costs.
- Wide range of options.

A De Dietrich product.

The double conical dryer is part of the De Dietrich product range. Like Rosenmund, this company is a member of the French group De Dietrich Process Systems with its long tradition, innovation and expertise.

Double Conical Dryer SR

Double Conical Dryer SR 1000:
Stainless steel design with ruffled cover



Type SR	Container volume l	Heating area m²	Drive power kW	Empty weight appr. kg	Dimensions in mm a x b mm	h1 mm	h2 mm	h3 mm	A mm	B mm	d mm	d1 mm
100	120	1.15	1.5	1900	1795 x 900	676	1300	520	300	150	600	700
400	475	2.8	2.2	2100	2355 x 1200	1288	1950	785	450	160	1000	1100
1000	1040	4.0	34	3300	2705 x 1500	1327	2150	935	450	200	1300	1400
1600	1625	6.7	5.5	4300	3084 x 1700	1494	2450	1070	450	200	1500	1600
2500	2550	9.5	11	5800	3384 x 2000	1490	2600	1225	450	200	1800	1900
4000	4300	13.1	15	8300	3937 x 2300	1502	2850	1465	500	250	2100	2250
6300	6500	17.9		11000	4301 x 2600	1581	3100	1640	500	250	2400	2550

Pilot Plant Facility

Experiments and process optimisation in the new pilot plant in Liestal/Switzerland.

The decisive step from theory to practice. In the recently built technical centre pilot plant, customers can perform practical experiments and test process optimisation steps with experienced experts from Rosenmund.

Made-to-measure solutions for all customers.

No two customers are alike. No two problems are the same. From years of experience, we know that every equipment is unique. Every customer has his own products, which are manufactured on different premises by individual employees - based on different ideas. For this reason, we offer comprehensive services to individually optimise our product range of delivery - at our new technical centre.

Rosenmund technical centre, Universal Dryer 100 l

A completely new technical centre.

The fully equipped Rosenmund technical centre opened in November 2002. This international test centre provides Rosenmund customers from the pharmaceutical and chemical industry with a complete range of services. The technical centre is designed for carrying out industrial experiments with products from the chemical and pharmaceutical industry. The recognised core competence lies in the area of the concentration and drying of API (Active Pharmaceutical Ingredients) that contain solvents.

Rosenmund technical centre, Universal Dryer 100 l

Plant and know-how from one supplier.

The Liestal technical centre provides Rosenmund customers with comprehensive competence that significantly simplify the decision-making involved in selecting plants and machines. Do you want to change or optimise your process? For this purpose, you will want to compare systems - for example, between a horizontal, vertical or spherical dryer. No problem at the new technical centre; our experimental units are at your disposal. Since we provide all the systems, we can guarantee you objective advice.

Rosenmund technical centre, Evapor CEP-1

Direct advantages for Rosenmund customers:

- Shorter equipment commissioning times through determination of product suitability correct system selection and process sequence specification.
- Optimisation of processing times through precise scale-up and / or estimation of vessel residence times throughout the process route.
- Determination of effective cleaning processes (CIP/WIP and SIP).
- Determination of the selection criteria according to customer evaluation, e.g. drying time, quality (crystal shape, activity etc.), emptying, CIP-capability, price.

Dr. Rainer Laible, manager of the Rosenmund technical centre

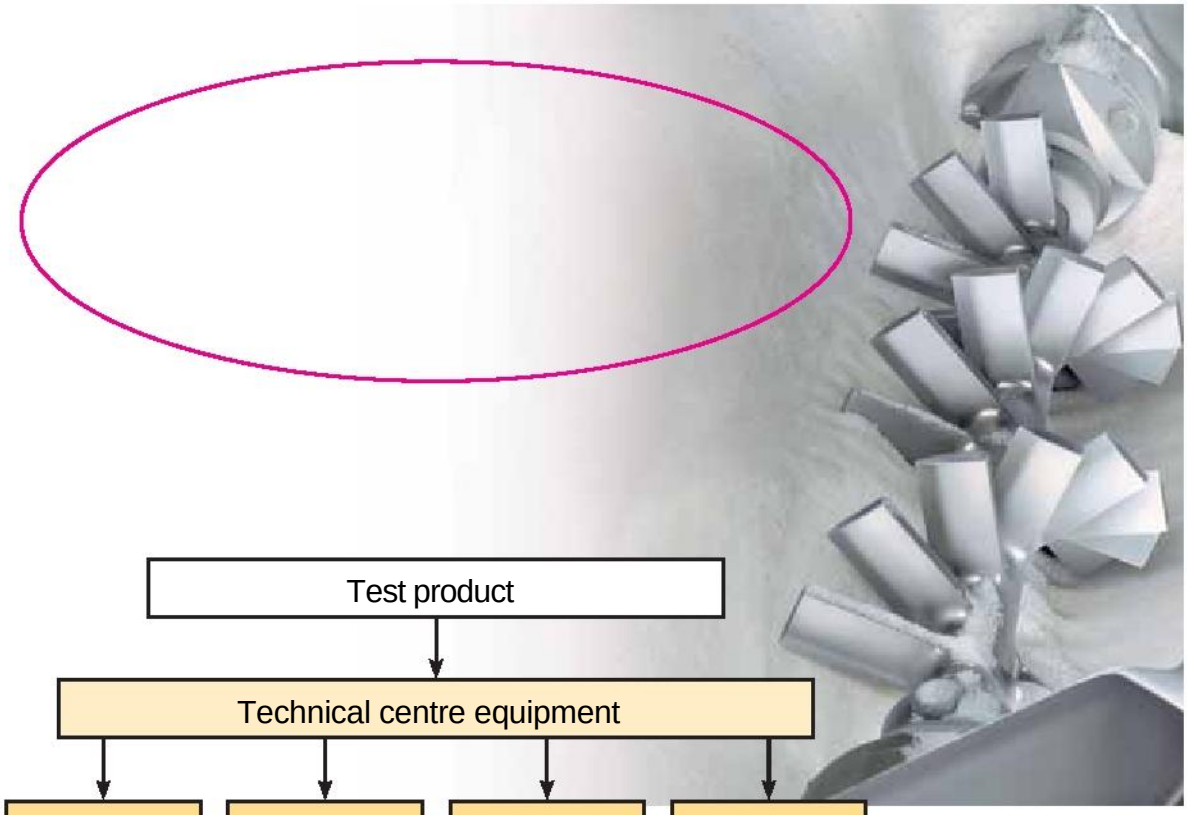
Due to their special design, which fulfils all GMP standards, Rosenmund equipment allows complete GMP and FDA validation.

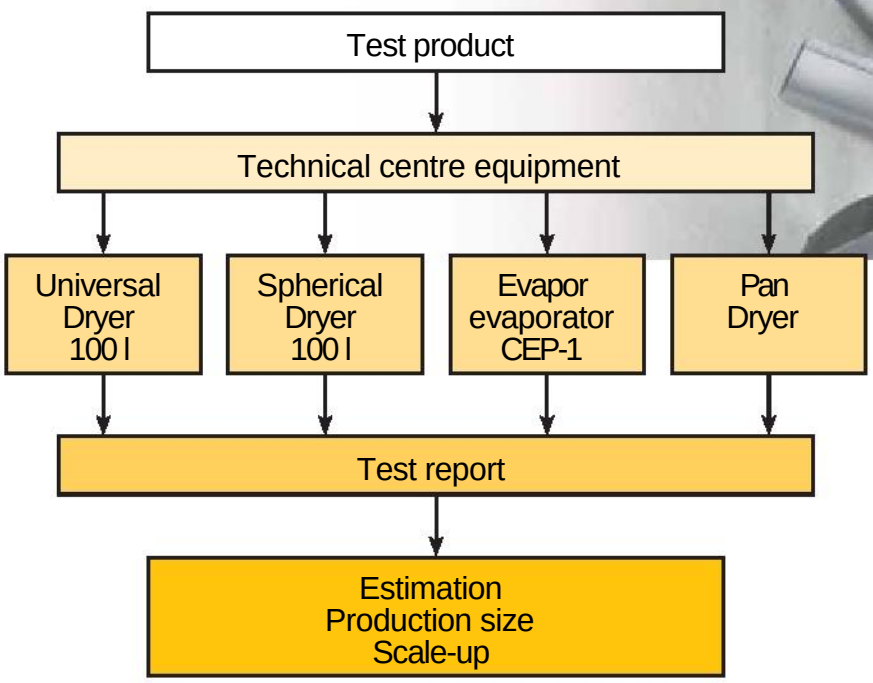
Summary of Rosenmund Tech Centre Pilot Plant Capability:

- Data acquisition and analysis.
- Scale-up experiments as a basis for projection to production sizes in respect to filtration and drying time, fill volume, recrystallisation and particle size distribution.
- Optimisation of the process sequence. Machine optimisation.
- Product trials for equipment selection and to establish suitability.

Rosenmund technical centre, Spherical Dryer with top drive 100 l

Spherical Dryer 100 l





ROSENMUND

High-Tech Solution

Engineering.

Profit from the superior competence of high-tech solutions!

We not only perform the planning and integration of our product in your buildings, we also partner with our customers to provide fully engineered solutions from concept stage to performance qualification.

Product handling.

We provide almost everything to do with the filter and vacuum dryer: screens/sieves, lifting columns, containers, container mixers, insulation valves, weighing systems and many other pieces of equipment.

Training and courses.

Should your personnel already be trained on the new control system when the plant is delivered? Or does your process first have to be optimised on the new plant?

We will be happy to support you with help and advice.

member of De Dietrich PROCESS SYSTEMS

a solution ahead

ROSENMUND

Addresses

Rosenmund is a subsidiary of the French De Dietrich technology group. Rosenmund customers therefore have quick access to the technology, the know-how and the global service of an international company at all times. You benefit from this!

Service without limitation or borders. Whether you need advice or troubleshooting, information or services - we provide you with a quick and direct connection worldwide through our global sales and service network. This guarantees short reaction times and excellent service. The addresses of our factories and sales representatives are found here.

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WATSON MARLOW

Watson-Marlow Pumps Group

The pump of choice for industry

Recognised expertise

Watson-Marlow Pumps Group is acknowledged as the world's leading manufacturer of positive displacement pumps.

Founded on over 50 years of supplying trusted engineering and process expertise across a wide range of industries and with over one million pumps installed worldwide, our products and solutions are tried, tested and proven to deliver.

Our vision

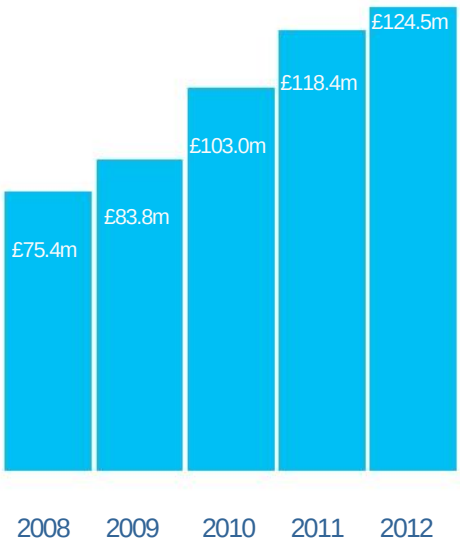
At Watson-Marlow our vision is to deliver products, services and knowledge of such excellence that Watson-Marlow Pumps Group will be the first choice for pump technology and process solutions in the market.

The revolutionary Qdos 30 no-valve metering pump

More than one million pumps installed worldwide

Unparalleled experience

Watson-Marlow Pumps Group consistent, year-on-year growth, revenue over the last 5 years



No other company shares our level of experience and knowledge of positive displacement pump technology.

Watson-Marlow is committed to continuous investment in innovation, technology leadership and advanced manufacturing techniques.

We have grown significantly in recent years through selective acquisitions and strategic investment.

Watson-Marlow is now comprised of six distinct businesses and six world-class manufacturing facilities. This has strengthened our portfolio, expanded our accessible markets and significantly increased our market share.

As a wholly-owned subsidiary of Spirax Sarco Engineering Group plc, (LSE:SPX) we are part of a global organisation which employs over 4,500 people worldwide, enjoys consistent and profitable growth, and has been quoted on the London Stock Exchange for more than 40 years.

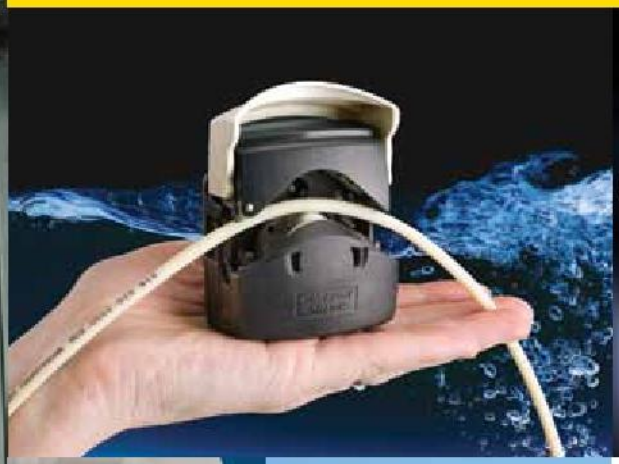
Our business

Our roots lie in positive displacement pump technology. As the acknowledged leader in our field, Watson-Marlow products are the pumps of choice for applications requiring accuracy, hygiene and reliability.

Watson-Marlow Pumps Group is comprised of six established brands, each with their own areas of expertise:

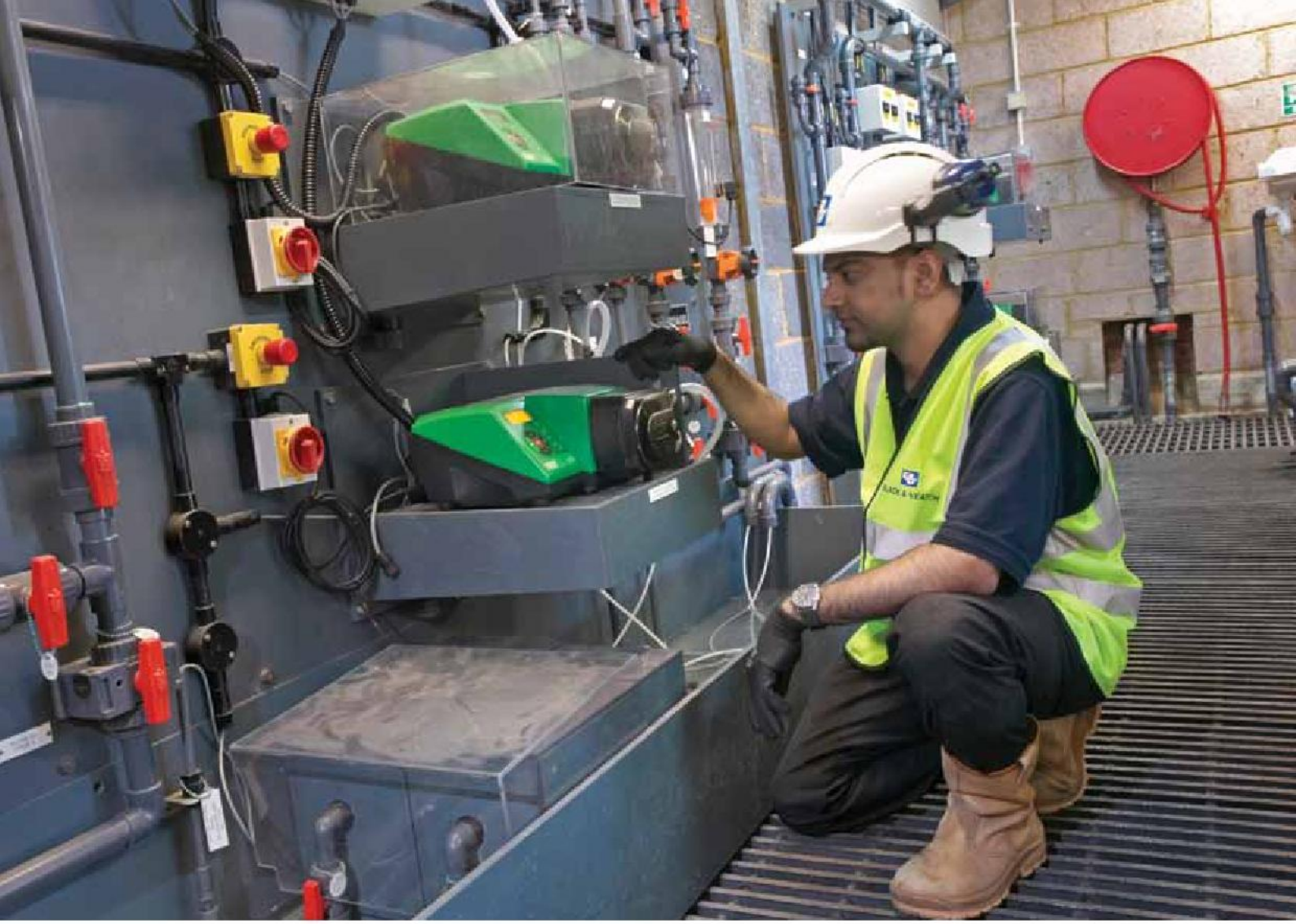
Watson Marlow Pumps	peristaltic tube pumps
Watson Marlow Tubing	precision tubing
Flexicon Liquid Filling	aseptic filling and capping systems
Bredel Hose Pumps	heavy-duty hose pumps
masosine Process Pumps	sinusoidal pumps
Alitea OEM Pumps	solutions for OEM customers equipment and machinery manufacturers

No other company shares the same experience and knowledge of positive displacement pump technology as Watson-Marlow Pumps Group



Watson-Marlow is also the only pump company in the world to manufacture and supply its own precision tubing.

Watson-Marlow Tubing offers accurate, long-term performance. Our tubing complements our peristaltic pumps and enables our customers to deploy end-to-end solutions for their pumping requirements from a single reliable and innovative source.



WATSON MARLOW Pumps

Peristaltic pumps have become the first choice of pump for chemical and industrial metering applications.

Watson-Marlow peristaltic pumps are simple to install, operate and maintain.

As nothing but the tube touches the fluid, the risk of contamination in the pump is eliminated. Pump action is created by compressing the tube between rotating rollers and a track. Between each roller pass, the tube recovers to create a vacuum and draws in fluid. Complete tube closure provides the pump with its action, preventing backflow and siphoning, and eliminating the need for check-valves when the pump is not running.

Widely accepted as the world's fastest growing pump type, peristaltic pumps have no valves, seals or glands. Peristaltic pumps have a number of advantages over other pump types: they provide superior flow rate stability and metering accuracy; have extensive chemical compatibility; and are inherently hygienic.

Flexicon
Liquid Filling

Flexicon Liquid Filling equipment facilitates high accuracy aseptic filling (±0.5%) and easy product changeover without issues of cross-contamination or cleaning validation.

asepticsu
Filling

The liquid being filled only contacts the FDA approved pump tubing and the filling nozzle. Modular bottle handling including conveying, filling, capping and sealing, with users able to choose from simple manual filling to semi-automatic filling or fully automated systems designed to deliver volumes ranging from 0.1ml to 100ml with a filling accuracy of ±0.5% which is check-weighed throughout the filling batch, with adjustments made automatically if required. Accusil™ tubing fulfils biopharmaceutical requirements and is ideal for single-use filling.

masosine
Process Pumps

MasoSine sinusoidal process pumps offer a highly reliable, economic method of fluid transfer ideally suited to high pressure, hygienic operations in sectors such as food manufacture.

The pump's exclusive sinusoidal rotor overcomes the limitations of conventional rotary lobe pumps to produce powerful suction with low shear, low pulsation and gentle handling.

MasoSine pumps can be dismantled, cleaned, and running again in 20 minutes. No special skills or tools are required and the task can be completed by production line operatives rather than maintenance engineers. They offer a flow capacity up to 91.2 m³/hr and pressures up to 15 bar. They can safely pump high viscosity products, while their innovative yet simple design allows economical in-line maintenance.

Bredel
Hose Pumps

Bredel is the world's largest manufacturer of hose pumps and hose element materials. Our positive displacement pumps are working non-stop around the world.

With operating pressures to 16 bar and flow rates to 80 m³/hr, our pumps save time and money by successfully handling the toughest applications.

Bredel hose pumps are the ideal pump for a vast range of industry applications, including chemical, ceramics, water and waste treatment, food and beverage, print and packaging. Our positive displacement pumps have no valves, seals or glands, and the fluid contacts only the bore of the hose. They are simple to install and operate, and easy to maintain.

High quality tubing is precisely why increasing numbers of customers are turning to Watson-Marlow, a major global player in tubing design, manufacture and supply, specifically for the biopharmaceutical industry.

The company's tubing product range has been developed in-line with key market drivers such as derivative-free, low leachable materials, high reliability, security of supply and - where required - single-use technology. The product range on offer is vast - 10 different materials and 50 different sizes, from 0.13 to 40mm.

In Watson-Marlow's state-of-the-art cleanrooms the company manufactures Pumpsil premium quality platinum-cured (and post cured) silicone tube, Bioprene, a unique thermoplastic elastomer (TPE) tube, and, most recently PureWeld XL, which is a thermoplastic elastomer tubing designed to deliver purity and performance in single-use bio-processing applications.

Alitea
OEM Pumps

Zero contamination and virtually maintenance-free pumping are just two of the reasons Alitea OEM pumps are specified for medical devices and environmental analysers.

Peristaltic pumps have clear advantages when handling fluids containing small particles such as those in endoscopy or dental surgery equipment. Compact in size, the pumps function as their own check valve so avoiding the need for further expense or system complication in equipment often severely restricted by space.

With over 300 drive speeds and voltages, 130 pumphead variants and 60 tubing sizes, we are confident we can offer medical and diagnostic equipment designers and manufacturers the best solution to their pumping needs.

All pumps have a long and predictable service life, with minimal downtime and spares inventory, providing the lowest whole life cost of any OEM pump type.

Product innovation

At Watson-Marlow, we have always been one step ahead of the competition.

Product innovation is the foundation of our growth strategy.

Our smallest pump, operating at its lowest speed, would take nearly 13,000 years to pump what our largest pump, at its highest speed, can pump in just one minute.

Our strong connections with the market means we understand customer needs, and we continuously research to identify new product opportunities.

Our current products aim to be best-in-class, and our new products are winning market share from other positive displacement pump types, such as diaphragm, lobe and progressive cavity.

We are committed to investing in technology to fully integrate our products and systems with customers' processes. This allows them to increase plant efficiency and reduce their maintenance costs.

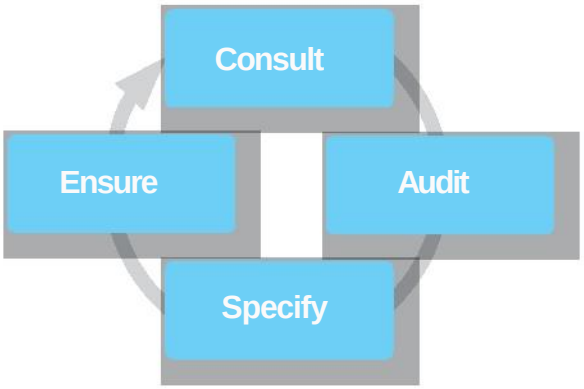
Optimised performance

Our goal is to help our customers maximise their throughput and achieve cost reductions.

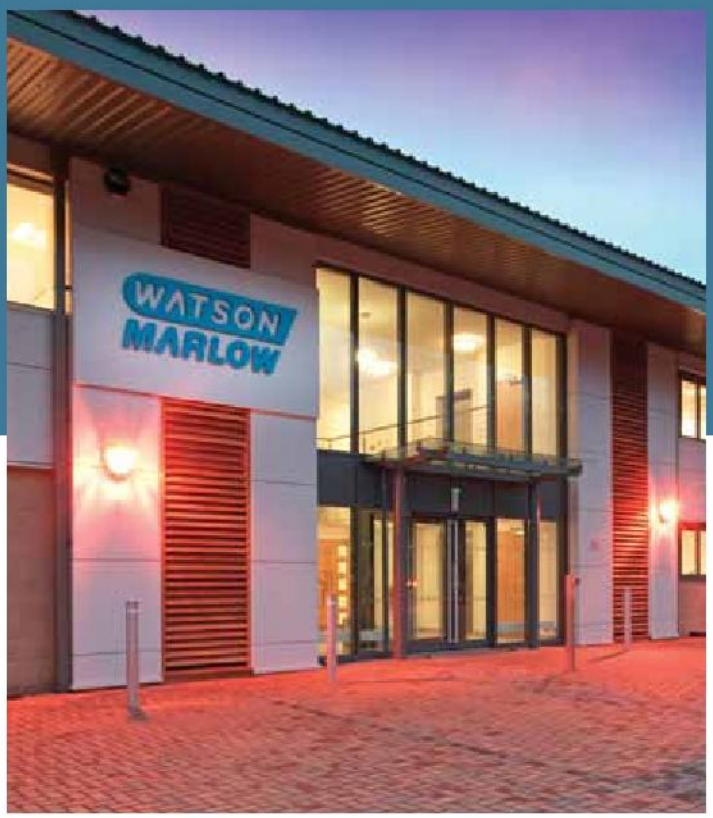
As part of our commitment to continual improvement, our design teams encourage customer feedback throughout the product development process. This enables us to ensure we are designing products that meet our customers needs, now and in the future.

Our approach concept, **CASE** (Consult, Audit, Specify and Ensure) means we work closely with our customers to identify the potential for even better product performance and then specify the exact solution to deliver that improvement.

- **Minimising downtime**
- **Improving end-product quality**
- **Minimising wastage**
- **Implementing process efficiencies**



Global presence - local expertise



Watson-Marlow is a global business, but we deliver local solutions.

With direct sales operations in 24 countries and distributors in a further 50, we are better placed than any other pump manufacturer to respond to the needs of our customers.

Customer support is provided through a network of industry specialists and technical support teams. This ensures our customers always benefit from local knowledge and sector expertise.

No matter where your business operates, Watson-Marlow is never far away.

Knowledge and development

Direct sales operations in 24 countries and distributors in 50 other countries.

We recognise that our people are equally important as our technology. Ongoing investment in training and development for all our staff lies at the core of Watson-Marlow's corporate philosophy.

Our people understand the importance of providing the highest standard of service to our customers, at every level. We work with them to develop their understanding of our customers, their applications and the pressures which affect their business.

At every level, our team is committed to helping customers:

- **increase productivity**
- **improve their processes**
- **deliver cost reductions**

Safeguarding our environment

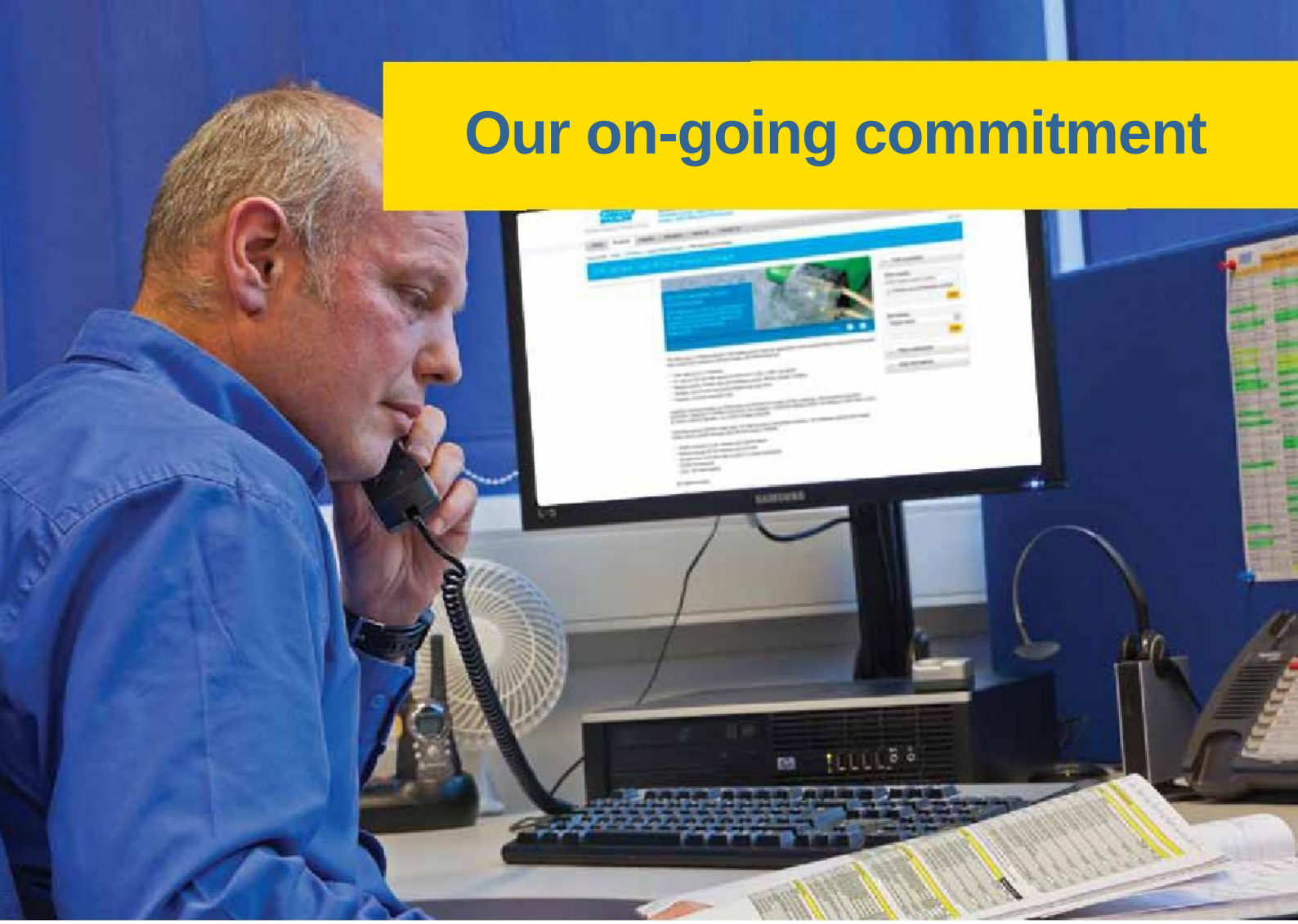
At Watson-Marlow, we continually work to improve our environmental performance in the design, development and manufacture of our products.

As an ISO14001 certified company, we have implemented a range of measures to safeguard and minimise our impact on the environment. These include eliminating use of chemical substances, using recyclable materials where possible and reducing energy consumption during manufacture.

We have incorporated specific design features into our products to reduce energy consumption when in use and always keep product 'end of life' in mind.

A key requirement for customers selecting our products is environmental improvement. Waste water treatment, for example, where our pumps are ideally suited to chemical dosing.

Our technical expertise and knowledge regarding the application of our products is a key factor in maximising the production and process benefits that can be achieved; all of which have a significant and positive effect on the environment.



Our on-going commitment

Our "Value for Life" promise means that everything we design is built to last.

Watson-Marlow equipment has an unrivalled reputation for quality and dependability. We combine this with our "Value for Life" promise, meaning that everything we design and manufacture is built to last.

We apply our technical expertise to the application of our products, services and engineered solutions. This maximises the benefits of the products we supply, ensuring customers always get the right solution for their application.

In selecting Watson-Marlow, you can be confident that you will also receive the reliability, quality and performance that sets Watson-Marlow apart as the world's leading manufacturer of positive displacement pumps and tubing.

5 YEARS WARRANTY

Serving a host of industries

Where our one million pumps keep industry productive.

Watson-Marlow pumps save time and money worldwide by successfully handling the toughest applications in a broad range of industries including:

Biopharmaceutical:
fully automatic aseptic filling, plugging and capping systems.

Food and beverage:
clean-in-place applications, dairy, bakery, flavourings and additives.

Mining:
reagents, polymers and floccullants.

Water and waste:
sodium hypochlorite, hydrofluorosilic acid and ferric chloride.

OEM applications:
medical devices and environmental analysis.

Chemical:
safe containment of acids, alkalis and bases.

Engineering:
spray coating and waste recovery.

Ceramics:
eliminating pinholes, contamination and pulsing.

Paint and pigments:
dispersion mill feed, pigment and latex transfer.

Print and packaging:
varnishes, inks, coatings and adhesives, with no colour cross-contamination or aeration.

Pulp and paper:
dyes, brighteners, sizing agents, retention aids and titanium dioxide.

WATSON MARLOW

Watson-Marlow Pumps Group

A Spirax-Sarco Engineering Company

Watson-Marlow Pumps Group has six world-class factories supported by direct sales operations in 24 countries and distributors in more than 50 countries. For contact details visit our website:

www.wmpg.com

Watson-Marlow *Bredel* *Flexicon* *MasoSine*

Watson-Marlow online

Our engineers around the world can help you choose the perfect pump and tubing for your needs.

More information? Our brochures are on our website - www.wmpg.com

Watson-Marlow… Innovation in Full Flow

Tel: +44 (0) 1326 370370

Watson-Marlow Pumps Group
Falmouth,Cornwall TR114RU,UK

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Pumps Group accepts no liability for any errors it contains, and reserves the right to alter specifications without notice. WARNING: These products are not designed for use in, and should not be used for, patient-connected applications. Watson-Marlow,

info@wmpg.com

www.wmpg.com

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HB0410/2

BIO-PHARM

ULTRAFLOW

An Efficient CIP in Compact, Portable Design

ULTRAFLOW 110

ULTRAFLOW 45

The patented Sani-Matic ULTRAFLOW is a self-contained, compact, and portable system programmed to accommodate a variety of single-use, recirculated CIP applications. Designed for critical cleaning, the ULTRAFLOW meets cGMP and ASME-BPE standards.

Advantages

- **Small Footprint.** Space-saving design for installations with limited floor space. Fits through standard doorways with ease.
- **Wide Operating Range.** The systems range from 2-45 GPM and 5-110 GPM and are able to clean small and large applications.
- **Self-Cleaning.** Self-cleans without extra step, and eliminates cross-contamination.
- **Portable.** Positioned on low-friction casters for easy movement between process suites. No expensive supply and return line installation required.
- **Water & Chemical Savings.** The high-turbulence flow rate and low water requirements for operation reduce the amount of water and chemicals needed for a complete clean.
- **Low Outlets? No Problem.** Returns solutions with entrained air to accommodate vessels with low and restricted outlets.

ULTRAFLOW 110

- 74"L x 33"W x 80"H
- Operating range of 5-110 GPM @ 60 psig
- Electric or steam heat available
- For process tank diameters up to 10'
- For process line diameters up to 3"

OPERATING REQUIREMENTS	
Instrument Air	1/4" NPT, 10 scfm @ 90 psig [2]
Water Supply	Two 1" tri-clamps, WFI, DI, potable ≤ 2 GPM @ 25 psig, 20˚- 80˚C
Drain	2" tri-clamp (programmable to meet app)
Dry Weight	1,000 lbs (approximate)
Electrical Power (electric heater)	• 15 kW, 50 amps @ 460 VAC, 3 Ph, 60 Hz • 30 kW, 68 amps @ 460 VAC, 3 Ph, 60 Hz
Electrical Power (steam heat)	27 amps @ 460 VAC, 3 Ph, 60 Hz
Plant Steam	1 1/2" flange, 540 lbs/hr @ 50 psig [1]
Plant Condensate	1" flange
CIP Supply	2" tri-clamp, 5-110 GPM @ 60 psig
CIP Return	2" or 3 tri-clamp, 5-110 GPM @ 11' of head @ 80˚C

ULTRAFLOW 45

- 62"L x 24"W x 73"H
- Operating range of 2-45 GPM @ 55 psig
- Electric or steam heat available
- For process tank diameters up to 4.5'
- For process line diameters up to 2"

OPERATING REQUIREMENTS	
Instrument Air	1/4" NPT, 10 scfm @ 90 psig [2]
Water Supply	Two 1" tri-clamps, WFI, DI, potable ≤ 2 GPM @ 25 psig, 20˚- 80˚C
Drain	2" tri-clamp (programmable to meet app)
Dry Weight	900 lbs (approximate)
Electrical Power (electric heater)	• 12kW, 27 amps @ 460 VAC, 3 Ph, 60 Hz • 24kW, 43 amps @ 460 VAC, 3 Ph, 60 Hz
Electrical Power (steam heat)	11 amps @ 460 VAC, 3 Ph, 60 Hz
Plant Steam	1/4" flange, 195 lbs/hr @ 50 psig [2]
Plant Condensate	1/4" flange [2]
CIP Supply	1 1/2" tri-clamp, 2-45 GPM @ 55 psig
CIP Return	2" tri-clamp, 2-45 GPM @ 8.5' of head @ 80° C

SANI-MATIC

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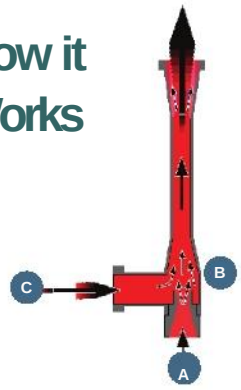
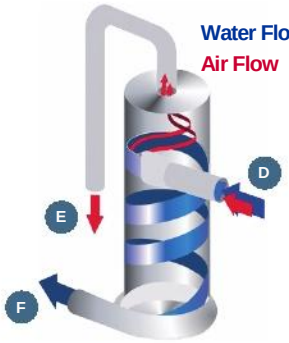
USA

BIO-PHARM

How it Works



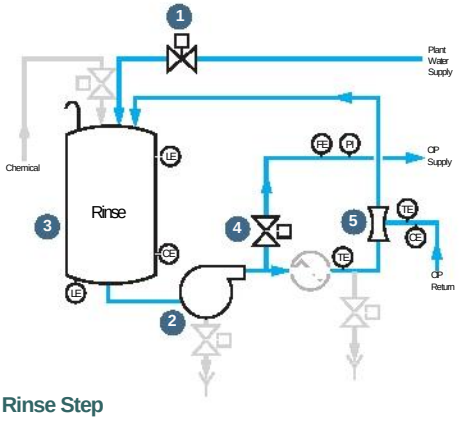
Eductor



Air Separation Chamber

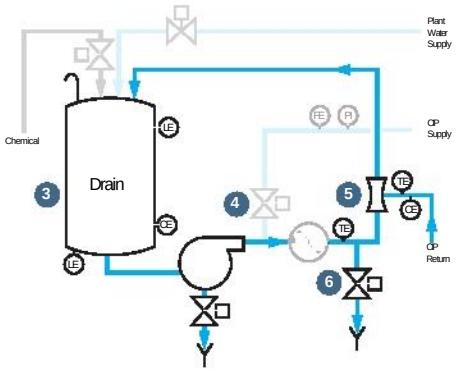
Eductor Return System

- **A** Motive solution is pumped to the eductor through this nozzle.
- **B** Vacuum is created within the eductor through a series of velocity changes. The velocity of the solution exiting the nozzle is reduced in the wide body and then increased again as solution exits the top of the eductor.
- **C** A mixture of air and solution (in the return line) rushes in to satisfy the vacuum within the eductor. The volume of both air and liquid is greater than that being supplied to the vessel.
- **D** Returned air and solution enter the chamber through the top port.
- **E** Centrifugal action spins the solution around the walls of the chamber, forcing air through the center of the vortex and out of the vent.
- **F** Solution exits back to the pump from the bottom port.



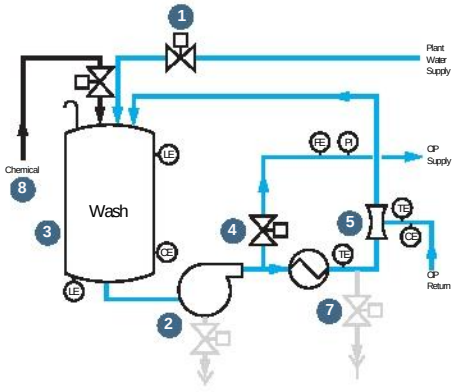
Rinse Step

The separator tank (3) is filled through one of the two separator tank water fill valves (1). The supply pump (2) draws the water from the separator tank (3) and delivers the solution to the process through the discharge control valve (4) at a programmed flow rate. At the same time, solution is pumped through the eductor (5) and back into the separator tank (3) inlet, thereby creating a vacuum at the CIP return connection. The high turbulence created within the ULTRAFLOW prevents the settling of any solids and self-cleans the system. The rinse step is followed by a drain step. Typically, a series of 3 to 4 rinse/drain steps are utilized for the final rinse.



Drain Step

The discharge control valve (4) is closed and solution from the separator tank (3) is pumped through the eductor (5) and back into the separator tank (3) inlet, which creates a vacuum at the CIP return connection. Returning solutions create a high-level condition in the separator tank (3) causing the drain control valve (6) to bleed solution to drain at a set flow rate until the process and separator tank (3) are empty.



Wash Step

The separator tank (3) is filled through one of the two separator tank water fill valves (1) The supply pump (2) draws the water from the separator tank (3) and delivers the solution to the process through the discharge control valve (4) at a programmed flow rate. At the same time, solution is pumped through the eductor (5) and back into the separator tank (3) inlet, thereby creating a vacuum at the CIP return connection. The high turbulence created within the ULTRAFLOW prevents the settling of any solids and self-cleans the system. CIP solution temperatures are elevated utilizing a heater (7) in the recirculation loop. Chemical solutions (8) are injected into the highly turbulent separator tank (3) and controlled through conductivity.

Optional Documentation

- Functional Specifications (FS)
- Configuration Specification (CS)
- Factory Acceptance Test (FAT)
- Site Acceptance Test (SAT)
- Installation and Operation Qualification (IQ/OQ)
- Traceability matrix
- ISA Data Sheets
- Cleaning and passivation report
- Digital weld video record (Borescope)

Controls/Programming

- Allen-Bradley CompactLogix (standard)
- Allen-Bradley PanelView HMI
- Ethernet communication
- 40 customizable cleaning cycle programs
- Report ticket printer available
- UL listed, 304SS, NEMA 4X enc

SANI-MATIC

USA

QVF® ist eine Marke der
De Dietrich Process Systems

(p) 800-356-3300 (f) 608-222-5348 www.sanimatic.com 1915 S. Stoughton Rd.,
Madison, WI 53716 BP-UF 0414

QVF® PHARMA REACTOR

Series

Reaction units are of considerable importance to the chemical and pharmaceutical industry in production and development. Particularly where small volumes are concerned batchwise reaction and distillation processes are

- ¾ 16 to 63 litre compact version
- ¾ Innovative vessel design
- ¾ Matching GMP requirements

economic solutions.
Pharmaceutical applications provided the user requirements for the design of the QVF® PHARMA REACTOR. The development goals were maximum purity and optimized heat and mass transfer combined with suitability for GMP use.
To suit the availability of space in the majority of laboratories the QVF® PHARMA REACTOR is designed in a compact layout with reduced headroom requirements for reaction vessel capacities from 16 to 63 liters.

vessel	heating area m²	W1 m²	W2 m²	B1 l	B2/B3 l
16	0,25	1,0	0,2	5	5
25	0,37	1,0	0,2	10	10
40	0,53	2x0,7	0,3	20	20
63	0,75	2x1	0,3	20	20

Tab. 1: Technical daten - QVF® Pharma Reactor

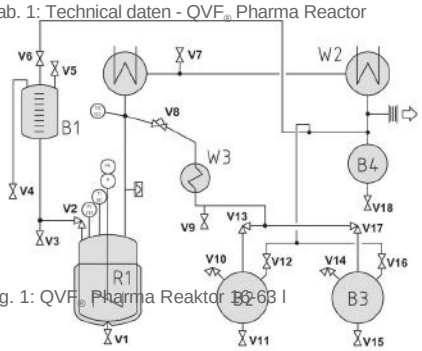


Fig. 1: QVF® Pharma Reaktor 16-63 l

Function

The QVF® PHARMA REACTOR is specially designed for the two process stages of reaction and distillation. The reaction stage operates under total reflux, whereupon the solvent can be distilled off as effectively as possible in the concentration phase. Both stages can be carried out under either positive pressure (+0.6 barg) or vacuum. The materials of construction used are borosilicate glass 3.3, glass-lined steel and PTFE.

Distillation overhead ASSEMBLY Reaction vessel

The distillation overhead assembly is made of components from the QVF® SUPRA-Line meeting the requirements of the Pressure Equipment Directive and the equipment safety regulations. The components made of borosilicate glass 3.3 larger than DN25 are accordingly CE-marked. With its buttress glass flanges the QVF® SUPRA-Line not only provides a GMP-compliant connection but also a wide variety of well thought-out individual solutions.
To ensure that the equipment drains completely the horizontal product piping is largely installed at an angle of 5°. The inclined condenser has a rinsing neck and the receiver vessel can be emptied and rinsed during the process by means of valve V3.
The integral sampling valve V9 is used to take samples from the actual distillate flow, even when operating under vacuum. In the basic version of the QVF® PHARMA REACTOR the instrumentation is equipped with all basic functions.

Fig. 2: QVF® Pharma Reactor

addition to the temperature of the vessel content and the distillate, the pressure is indicated by a tantalum membrane manometer. A bursting disk provides protection against excess pressure. The rotation speed of the glass lined impeller stirrer can be adjusted by means of the handwheel on the drive.
All the valves are located close to the vessel involved, thus enabling direct and correct operation. Valve V8 controls the adjustment of the integral reflux separator.

The enamelled reaction vessel developed by De Dietrich Process Systems for the QVF® PHARMA REACTOR has the following special features:

- Block flange for connection to the glass cover (1)
- Heating jacket up to the flange (2)
- Support brackets without thermal bridge (3)
- Block flange with minimal dead space bottom outlet valve (4)
- Polished insulating jacket with foam glass, stainless steel, tightly welded (5)
- White enamel to improve visual control (6)

Flat buttress ends with GMP gasket

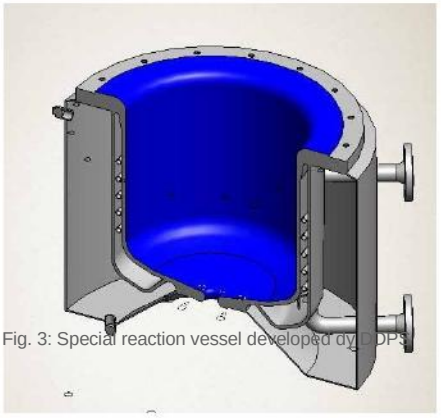


Fig. 3: Special reaction vessel developed by DDPS

In addition to the basic benefits of the flat glass buttress end the QVF® SUPRA- flange has two special features which make it the obvious choice for GMP- compliant plant. All nominal bores up to DN 300 have fire-polished sealing faces and a groove. The groove stabilises and ensures positive location of the PTFE gasket seated on the extremely smooth sealing face. Together with the GMP compliant gasket, which, via centering in the groove and on the outer edge, effects a seal on the inside diameter of the flange, the flat buttress end provides a coupling with minimal dead space fully draining in pipeline laid out at an angle of at least 5°.

Modular construction

Because of its modular construction the basic version of the QVF® PHARMA REACTOR can be expanded to handle various special functions. The following options are, therefore, available:

- Hydraulic lifting device for the reaction vessel
- Phase separator
- Electronic speed indicator
- Version for increased pressure
- Coated glass components
- Weighing cells for reactor, feed and distillate vessel
- Double-acting mechanical seal
- Anchor, turbine and propeller type stirrers
- Process control systems

PP138e.4, Technical data are subject to change. Copyright © De Dietrich Process Systems GmbH

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De Dietrich PROCESS SYSTEMS

ErtelAlsop

The First Name in Liquid Filtration

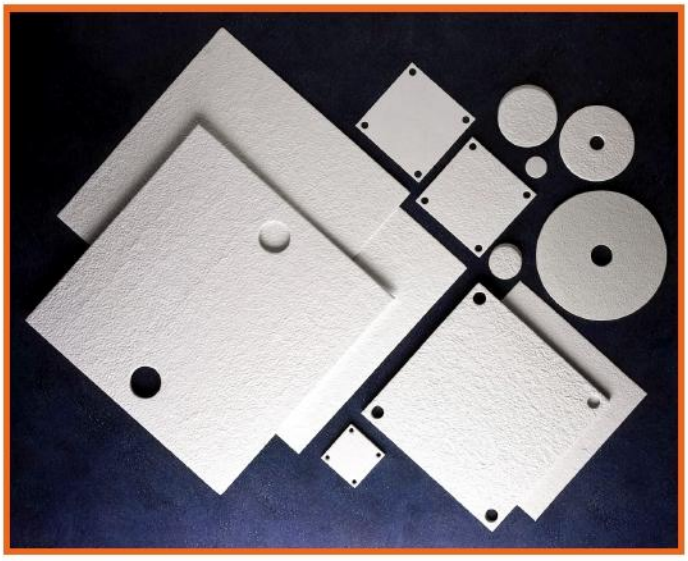
Filter Media

Micro-Media®

FielRtgerCMieedoaCritical Processing i

Th i ht ho c f r

PharmaceuticalGradeMicro-Media®SeriesDepthFilterMedia,formulatedwithcellulose,wetstrengthresinand diatomite and/or perlite is specifically designed for use in critical pharmaceutical and biotech applications. All componentsarelistedintheCFRasgenerallyrecognized as safe for contact with food as dictated by 21CFR 176.170. PharmaceuticalGradeMicro-Media®SeriesDepthFilter MediaismanufacturedinaccordancewithErtelAlsopDrug Master File located at the United States Food and Drug AdministrationCenterforDrugEvaluationandResearch.



Composition

ErtelAlsop Micro-Media® filter sheets are composed of cellulose pulp, Diatomaceous Earth and/or Perlite, or CelPure®fortheXLSeries™,andawetstrengthresin, which charge modifies the media to exhibit a net positive charge referred to as Zeta Potential. This allows for the highly efficient removal of particles smaller than the filter's nominal rating.

Applications:

- Blood Fractions
- Sera
- CellCultureMedia
- ActivePharmaceuticalIngredient
- s
- Large Volume Parenterals
  Small Volume Parenterals

Product Testing

Product testing is always available either at your facility, throughournetworkofdistributors,oratourin-house laboratory.

Pilot Testing - Rentals

Forin-planttestingandscale-upprocedures,ErtelAlsop offers a variety of lab filters for rent. A portion of rental fees can be applied to the purchase of your full production filter.

The Format to Fit Your Needs

AllErtelAlsopmediaformulationscanbemanufacturedinformats

to fit your application. Filter sheets, discs and Pak® Lenticular Cartridgesareallavailabletoprovideyouwithproducttooptimizeyourapplication.ErtelAlsopalsomanufacturesacompletelineof filter machinery, from Small Batch and Pilot Scale Lab Filters to Plate and Frame Filters, Sealed Disc Filters and Pak® Lenticular Cartridge Housings.

Forover80years,ErtelAlsophasbeenproactivelysolvingthedepth filtration problems of industry. We originated and patented the Pak® Lenticular Cartridge concept. We created the BioClean™ Sanitary Filter Plate Assembly to accommodate the stringent cleaning standards of the pharmaceutical industry.

Micro-Media®		XL Series	
Cellulose/Perlite	Cellulose/DE	Cellulose/DE**	Retention
M-05P	M-054P	M-053P	15 µm
M-10P	M-104P	M-103P	10 µm
M-40P	M-404P	M-403P	5.0 µm
M-45P	M-454P	M-453P	2.5 µm
M-50P	M-504P	M-503P	1.0 µm
M-50TP	M-504TP	M-503TP	0.8 µm
M-70P	M-704P	M-703P	0.45 µm
M-85P*	M-854P	M-853P	0.3 µm
	M-954P	M-953P	0.25 µm

P-Grade Micro-Media®

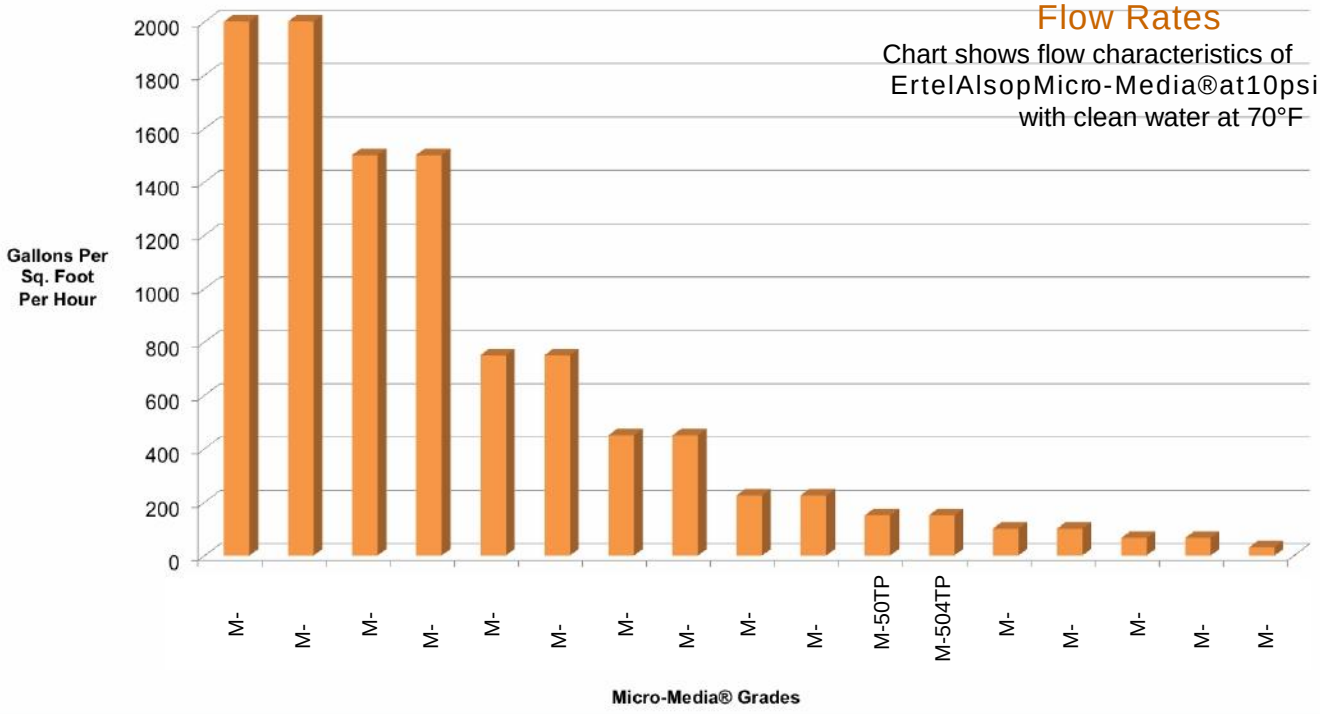
Themostaccuratewaytooptimizeyourprocessisthroughlaboratoryscaletesting.SamplesofP-GradeMicro-Media®,Micro-Media®XLSeries™,orMicro-Clear™ Media are available at no charge. Authorized ErtelAlsoprepresentativesareequippedtoruntrialson-site,orproductsamplesmaybesentdirectlytoErtelAlsopfortestingwithpriorapproval.

Table to the left is for reference only.

* Contains Cellulose, Perlite, and DE ** Contains Cellulose, High Purity DE

Flow Rates

Chart shows flow characteristics of ErtelAlsopMicro-Media®at10psi with clean water at 70°F

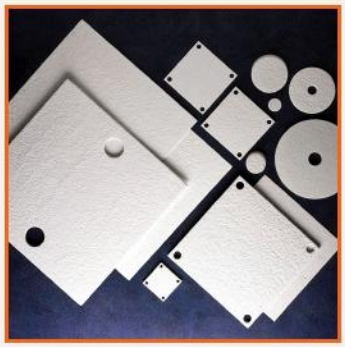


Filter Media

ErtelAlsop filter media is available for any application and/or operating condition, and is chosen based on your specific operating conditions, the performance required by the filtering media, and criteria given to us by you and/or by sample proces singwedoinourlab.

ErtelAlsop offers the widest varieties of filter media including 100% cellulose pads, cellulose and diatomaceous earth pads, celluloseandCelpure®diatomaceousearthpads,celluloseandperlitepads,andcelluloseandactivatedcarbonpads.

All filter pads are manufactured to very high standards for a wide range of applications in the pharmaceutical, chemical, cosmetic, electric utility and food and beverage markets. ErtelAlsop also offers a Validation Guide to assist in the validation of its filter pads in your process. The Validation Guide contains information regarding raw materials, extractables, and general information about the product. The combination of ErtelAlsop "P" grade filter pads and ErtelAlsop's BioClean™ plate and frame filter press design, can help to simplify your depth filtration validation now more than ever.



For additional product information visit **ErtelAlsop.com**

Technical Bulletin MMP-11

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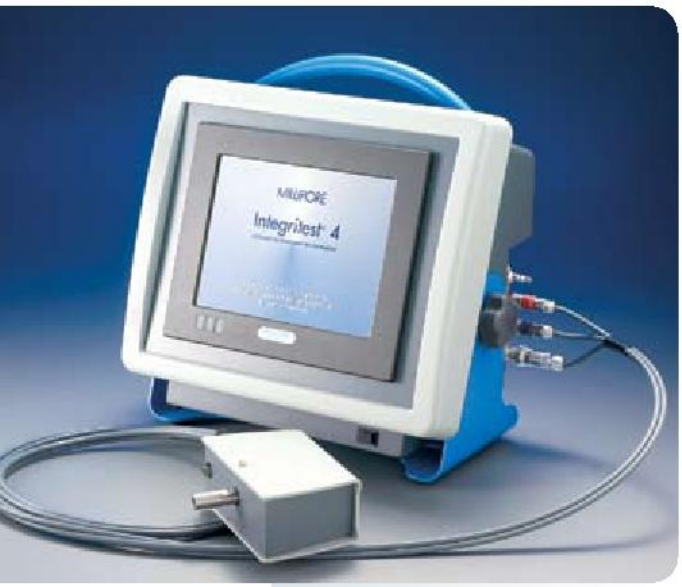
Your Local Distributor

MILLIPORE



Integritest 4® Series

Automated Filter Integrity Test Instruments and Central Instrument Management Tool Software

- Portable, easy to use
- Reliable, accurate measurements
- Fast testing improves productivity
- Network model is 21 CFR Part 11 compliance ready
- Centralized administration with IMT software
- Available in multiple languages

Easy-to-use, portable, networkable,* and fully-automated integrity test systems that offer reliable, repeatable measurements fast

The Integritest 4 instrument is an easy-to-use, portable, fully-automated integrity test system. Available in either a standalone or networkable configuration, the Integritest 4 instrument offers reliable and repeatable integrity test data. The intuitive touch screen user interface streamlines the test while the accelerated testing capability provides users with more time for processing. On-site calibration support and diagnostic capability minimizes downtime, saving time and money. Leveraging a proven test algorithm, the Integritest 4 instrument performs bubble point, diffusion, enhanced bubble point, and HydroCorr℠ (Millipore water-based test for hydrophobic filters) tests on a wide range of filters including disks, cartridges and TFF filters, virus, and asymmetric membrane filters.

The rugged, ergonomic design of the system enables users to easily carry the Integritest 4 instrument to any site. The standalone configuration enables users to print the results on the onboard printer.

The networked configuration enables users to quickly perform an integrity test, print the results on a shared network printer and automatically store test reports on a network data repository.

*Integritest 4N only

The Integritest 4N networkable configuration enables users to print results directly to any networked printer via Ethernet connection. The Integritest 4N instrument is 21 CFR Part 11 compliance ready for electronic records and electronic signatures, improving productivity and facilitating record keeping.

Easy to Use

The Integritest 4 instrument features a graphical user interface with touch-screen menus and intuitive icons for faster testing, enabling more effective use of production equipment and resources. Millipore and customer specific filter testing information can be easily entered on-site. Test results can be printed using the built-in printer. Printed test results can be customized to include operator, batch, or other desired data.

- Intuitive, multilingual graphical user interface
- 10-inch touch-screen color SVGA display with active matrix
- Pivoting base for easy adjustment of display angle
- Bar code input for easy filter identification and data entry*
- Utilizes market-leading Windows XP® embedded operating system
- Customized interface based on operational roles
- Context-based online help

Accurate, Reliable Results

The instrument has been designed and qualified to achieve high test accuracy. To ensure correct performance, the software automatically checks the functionality of the computer and pneumatic manifold components prior to each test. User programmable test parameters allow for more case specific testing when needed for analysis.

Rugged Industrial Design

The exterior surfaces can be easily wiped clean with alcohol or bleach. Instrument-grade inlet and outlet connections on the pneumatic manifold assembly minimize leaks, providing accurate results.

- Compact industrial design with quick-connect ports for easy set up
- External valve array prevents back flow of fluids into the instrument
- Modular hardware design allows for easy servicing on location
- Durable, onboard printer produces a printout that does not fade, even when wet
- Easily field calibrated for routine maintenance and record keeping

Sound Algorithm

The Integritest 4 instrument uses a software algorithm to determine the bubble point of a filter. The accuracy of this algorithm is key to proving that your filter is integral. Our algorithm is based on a mathematically proven tangent method. Unlike other solutions on the market today, it extrapolates the accurate portion of a flow curve while avoiding dependencies on the volatile portions. This, in combination with an event-based capture of the flow curve, gives you the most reliable, sustainable method of bubble point testing.

- Supports all traditional tests such as bubble point and diffusion
- Optional accelerated test allows you to quickly obtain accurate, repeatable results
- Accurate, reliable testing for asymmetric bubble point
- Programmable prepressurization for properly testing multilayer virus removal filters
- New pressure hold test to test vessels, valves, equipment and pipework

*Requires external bar code reader

Networkable Configuration

Leveraging the built-in networking capability of the Integritest 4N instrument together with the Windows XP® tool kit, users can share a networked printer for central printout of test reports. The software also enables electronic signatures for sign-off of test reports, which can be transferred to a central data repository for the backup of all Integritest 4N instrument test reports. The Integritest 4N instrument can also support wireless Ethernet communication eliminating the need to physically plug the unit into the network.

21 CFR Part 11 Compliance Ready

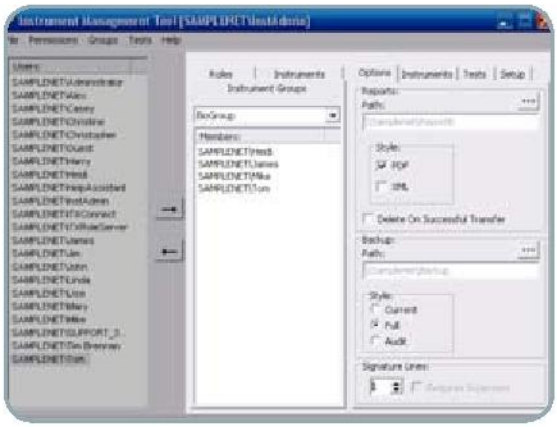
The Integritest 4N software meets the technical requirements of FDA regulation 21 CFR Part 11 for electronic records and electronic signatures.

Increase Process Speed

When integrated into a network, final filter integrity test results are uploaded into the main control system enabling an immediate stop/go decision, improving the pharmaceutical production process without compromising quality control.

Central Instrument Management Tool Software

Centralized instrument management and automated electronic recordkeeping



The ability to manage remote instruments via a networked PC, streamlines operations as well as optimizing integrity testing consistency and reliability throughout manufacturing.

The Integritest 4N Central Instrument Management Tool (Central IMT) software allows centralized management of all Integritest 4N instruments integrated to a network domain, improving manufacturing and system administrator productivity .

The Integritest 4N Central IMT software enables system administrators to:

- Manage Users
  - Assign users to instruments
  - Define user roles
  - No need to create user IDs or assign passwords*
  - Track password* changes
- Manage Integritest 4N Instruments
  - Add or change test definitions
  - Define report formats
  - Track the addition and deletion of users*
- Manage Filter Test Reports
  - Define data repository location
- Automatically download setups when Integritest 4N instruments are logged onto the network
- Organize instrument groups
- Automatically generate remote backups
  - Periodically
  - Information for instrument recovery and event logs
- Security
  - Domain controller assigned user names

Assign Instruments and Users to Logical Groups

- Users are selected from the domain of users provided by the domain controller
- Tests are assigned to defined instruments in the group
- An instrument tab lists all the instruments added to the Central IMT software. All checked instruments are part of the group.
- Report transfer, remote backup and electronic signature parameters are assigned to a group of instruments

*The central IMT software uses the same ID and password used to log onto a company's network domain.

Consistent, Effective and Reliable Integrity Tester Instrument Management

Centralized user and instrument management of all Integritest 4N test systems enhances testing consistency and repeatability. Central IMT allows a user in one location to access and configure multiple instruments in several locations. A test can be entered on one PC and added to a group of Integritest 4N instruments without having to access each instrument individually. A password change on one instrument automatically propagates to all instruments on the same network when a domain controller is used.

Figure 1. The Integritest 4N systems can be connected to a network printer and a central data repository.

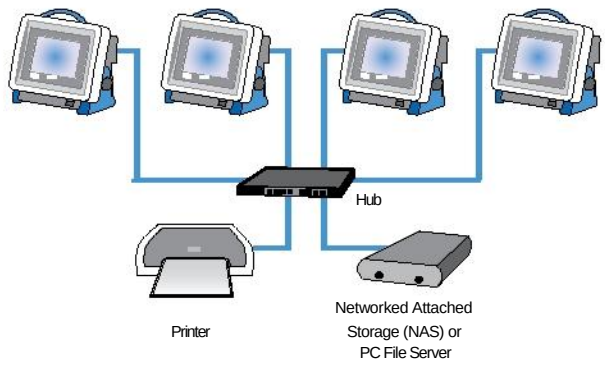
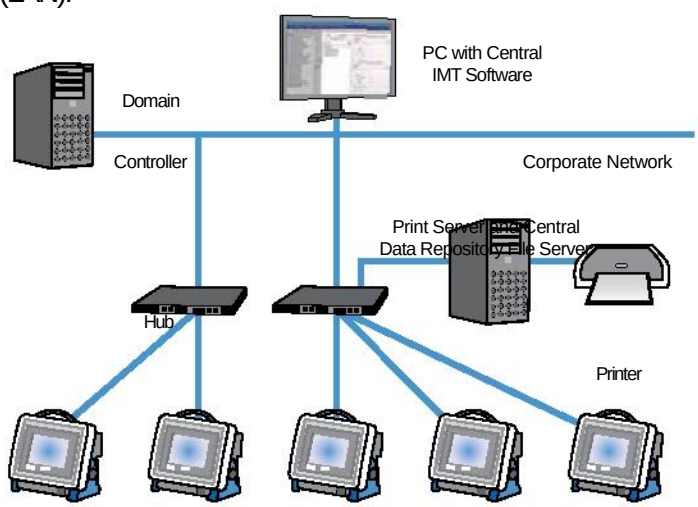


Figure 2. The Integritest 4N systems can also be networked to a domain-controlled Local Area Network (LAN).



Available Expedited Instrument Validation Service

The Integritest 4 instrument was developed and validated according to the GAMP Guide for Validation of Automated Systems. Validation reports are available for review during an on-site audit. The Integritest 4 instrument can be validated on-site using a validation protocol customized for you and executed by a Millipore Access® Services team.

Comprehensive Services and Support

Access Services is available to conduct installation, calibration and validation on-site. Millipore offers a proven validation protocol that tests the range of filters and tests used in a facility. Millipore Service Representatives offer factory or on-site maintenance and repair services.

The Requirement of Integrity Testing

Regulatory agencies require integrity testing of sterilizing grade filters as well as the integrity of process critical filters, such as bioburden reduction filters, which directly affect product quality. For production operators, supervisors, and validation managers who need to perform on-site filter integrity tests, the Integritest 4 instrument is a solution that is easy to learn and gives you the confidence and assurance you need for your test results. Users can conduct bubble point, diffusion, enhanced bubble point, HydroCorr and pressure hold tests on disk, cartridge and TFF filters, virus, and asymmetric membrane filters.

Specifications

Test Accuracy (at standard, stable conditions)

Test Type	Range	Accuracy
Diffusion (Standard and Accelerated)	Flow rates < 20 mL/min	≤ 1mL/min
	Flow rates ≥ 20 mL/min (water)	≤ 5%
	Flow rates ≥ 20 mL/min (alcohol)	≤ 10%
30 Second Diffusion*	Flow rates < 20 mL/min	≤ 2 mL/min
	Flow rates ≥ 20 mL/min	≤ 15% /-10%
Bubble Point (BP) Standard	345-6205 mbar (5-90 psig)	≤ 68.9 mbar (1 psig) <
Bubble Point Asymmetric	345-6205 mbar (5-90 psig)	344.7 mbar (5 psig)
Accelerated BP Hydrophilic PVDF	345-6205 mbar (5-90 psig)	≤ 137.9 mbar (2 psig)
Accelerated BP Hydrophobic PTFE	345-6205 mbar (5-90 psig)	≤ 206.8 mbar (3 psig)
HydroCorr	Flow rates < 0.4 mL/min	≤ 0.02 mL/min
	Flow rates ≥ 0.4 mL/min	≤ 5%
Virus Diffusion	Flow rates < 20 mL/min	≤ 2 mL/mi
	Flow rates ≥ 20 mL/min	≤ 10%
Pressure Hold	Pressure drops < 68.9 mbar (1 psig)	≤ 3.5 mbar (0.05 psi)
	Pressure drops ≥ 68.9 mbar (1 psig)	≤ 5%

*Used in accelerated enhanced bubble point and asymmetric enhanced bubble point tests.

Test Reproducibility (at standard, stable conditions)

Coefficient of variation (CV) or standard deviation (sn-1)

Test Type	Range	Reproducibility
Diffusion*	Flow rates < 20 mL/min	sn-1 ≤ 2 mL/min
	Flow rates ≥ 20 mL/min	CV ≤ 10%
All Bubble Point Tests	345-6205 mbar (5-90 psig)	CV ≤ 10%
HydroCorr	Flow rates < 0.4 mL/min	sn-1 ≤ 0.04 mL/min
	Flow rates ≥ 0.4 mL/min	CV ≤ 10%
Virus Diffusion	Flow rates < 20 mL/min	sn-1 ≤ 2 mL/min
	Flow rates ≥ 20 mL/min	CV ≤ 10%
Pressure Hold	Pressure drops < 68.9 mbar (1 psi)	sn-1 ≤ 6.9 mbar
	Pressure drops ≥ 68.9 mbar (1 psi)	(0.1 psi) CV ≤ 10%

*Diffusion reproducibility is not specified for the 30 second diffusion test.

Test Specifications

Test Type	Configuration Range	Operating Range
Diffusion*	47 mm disks - 12 round x 30 in. systems Capsules to TFF systems	Diffusion rate: 1 - 750 mL/min Test pressure: 345-6550 mbar (5-95 psig)
Bubble Point (All Except Accelerated Hydrophobic)	47 mm disks - 3 round x 30 in. systems	Test pressure: 345-6205 mbar (5-90 psig)
Accelerated Hydrophobic Bubble Point	47 mm disks - 1 round x 30 in. systems	Test pressure: 345-6205 mbar (5-90 psig)
HydroCorr	47 mm disks (Aervent-50) - 3 round x 30 in. systems	Test pressure: 345-6205 mbar (5-90 psig) Flow rate: 0.01 - 10 mL/min
Virus Diffusion	25 mm disks - 3 round x 30 in. systems	Diffusion rate: 1 - 600 mL/min Test pressure: 345-6550 mbar (5-95 psig)
Pressure Hold	Up to 12 round x 30 in. systems	Test pressure: 345-6550 mbar (5-95 psig)

* Pneumatic flow rate is at least 2500 mL/min at 5516 mbar (80 psi). The operating range claim of 750 mL/min is based upon the qualification testing of a 12 x 30-inch filter configuration. However, the maximum physical capacity of the pneumatic module is 2500 mL/min, which enables integrity testing of large TFF systems.

Specifications (continued)

Power Requirements

Voltage	90 -264 volts AC, 50/60 Hz
Current rating	3.5 amps

Compressed Gas

Inlet pressure	Clean, dry air or nitrogen source of 2.4 - 8.2 bar (35 -120 psi) at least 1.03 bar (15 psi) greater than the highest test pressure
Operating pressure range	0.34 - 7.03 bar (5 -102 psig)

Environmental

Storage temperature	-20 to 80 °C
Operating temperature	1 to 40 °C
Humidity	5 to 95%, non-condensing

Nominal Dimensions

Height	37.2 cm (14.6 in.)
Width	41.6 cm (16.4 in.)
Depth	25.4 cm (10.0 in.)
Weight	< 15 kg (32 lb)

Computer

Software operating system	Windows XP embedded
Port 1	5-pin DIN connector for service access
Port 2	PS/2 Bar code reader input
Port 3*	RJ45 for Ethernet connection

*Integritest 4N only

System Attributes

	Integritest 4* Instrument	Integritest 4N Instrument	Integritest 4N Used with PC Central IMT Software
Comprehensive library of integrity testing modes that include diffusion (standard, accelerated/virus); bubble point (standard/asymmetric/accelerated; enhanced BP; HydroCorr test; pressure hold	●	●	●
Intuitive, multilingual, easy to use 10.4 in. SVGA touch user interface	●	●	●
Rugged, por table industrial design	●	●	●
Developed according to GAMP 4 Guidelines	●	●	●
Network Ready		●	●●
Ethernet printer support		●	●
Remote Integritest 4N database backup with Networked Attached Storage (NAS) or networked server PC		●	●
Automatic filter test report transfer and storage on a central repository with a NAS or networked PC when electronic signature requirements are met		●	●
Meets the technical requirements of 21 CFR Part 11		●	●
From a networked PC: - Add or change network definitions - Define users and user permissions - Track additiom and deletions of users - Track changing of passwords - Organize instruments into groups			●● ●●

* The Integritest 4 can be upgraded to an Integritest 4N instrument. Contact Millipore for details.

Ordering Information

Description	Catalogue No.
Integritest 4 Standalone Instrument**	XIT4 S00 01
Integritest 4N Instrument**	XIT4 N00 01
Integritest 4 External Valve Array	XIT4S PEVA 01
Integritest 4 Field Calibration Kit	XIT4SP FCA 01
Integritest 4 Printer Paper (3 pack)	P83071
Integritest 4 Printer Ribbon Cartridge (3 pack)	P83075
Integritest 4N Central IMT Software	XIT4N CIMT 01
Integritest 4 Inlet Tubing with Dessicant Air Filter	P83076

** Includes power cord, external valve array and operators manual

To Place an Order or Receive Technical Assistance

In the U.S. and Canada, call toll-free
1-800-MILLIPORE (1-800-645-5476)
In the U.S., Canada and Puerto Rico, fax orders
to 1-800-MILLIFX (1-800-645-5439)
Outside of North America contact your local office.
To find the office nearest you visit www.millipore.com/offices
Internet: www.millipore.com
Technical Service: www.millipore.com/techservice

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BIOLOGICAL SAFETY CABINETS
Class II, Type A2 Biological Safety Cabinet

PART 1 - GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)
NAAMM MFM (1988) Metal Finishes Manual
NSF INTERNATIONAL (NSF)
NSF 49 (2007) Class II (Laminar Flow) Biosafety Cabinetry
UNDERWRITER'S LABORATORY (UL)
UL Standard 61010-1

1.2 DESIGN AND PERFORMANCE CRITERIA

A. Provide biological safety cabinets with workspace for testing and experimentation of low to moderate risk agents in the Classes and Types indicated, as defined by *NSF International* NSF/ANSI 49. Class II cabinets shall provide protection of experiment from ambient environment and protection of ambient environment from experiment.

B. Biological safety cabinets shall operate in an efficient and sustainable manner. Electrical consumption of new units shall be no greater than: 170 watts for nominal width 3 foot unit; 200 watts nominal width 4 ft unit; 310 watts for nominal width 5 foot unit; and 400 watts for nominal width 6 foot unit.

1.3 SUBMITTALS

Product Data - Biological safety cabinets
Biological safety cabinets - Compliance with NSF/ANSI 49
Biological safety cabinets - Operating and Service Manuals
Biological safety cabinets - Demonstration
Factory Test Reports

1.4 QUALITY ASSURANCE

A. Each cabinet will be certified by UL for electrical safety and integrity.
B. Each cabinet will be NSF listed and approved for design, construction and performance.
C. A factory test for each cabinet validating proper performance including:
1. Cabinet integrity test with pressure decay or soap bubble leak
2. HEPA Filter leak test of downflow and exhaust filters
3. Downflow air velocity and uniformity
4. Inflow air velocity
5. Airflow smoke patterns

1.5 QUALIFICATIONS

A. Manufacturer
Company with minimum ten years documented experience in the construction of NSF Listed and Approved Class II biological safety cabinets.
B. Cabinet

Cabinet shall be an NSF Listed and Approved Class II biological safety cabinet.

1.6 WARRANTY

a. Manufacturer's warranty against defects in material or workmanship covering parts and labor must be available for a period of five years. Standard exceptions for filters, lamps and glass shall apply.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Thermo Scientific

2.2 CLASS II TYPE A2 BIOLOGICAL SAFETY CABINETS

1. Exterior dimensions
   a. Nominal 3 ft width - 61.8"H x 39.4"W x 31.5"D (1568mm H x 1000mm W x 800mm D)
   b. Nominal 4 ft width - 61.8"H x 51.2"W x 31.5"D (1568mm H x 1300mm W x 800mm D)
   c. Nominal 5 ft width - 61.8"H x 63"W x 31.5"D (1568mm H x 1600mm W x 800mm D)
   d. Nominal 6 ft width - 61.8"H x 74.8"W x 31.5"D (1568mm H x 1900mm W x 800mm D)
2. Additional Height Range with Stand
   a. Adjustable Height Stand - Work surface heights from 30 to 38" (750 to 950 mm) adjustable in 2" increments, overall cabinet height from 88.5" to 95.4" (2248 to 2448 mm) [stand is 26.8" to 34.7", 680 to 880 mm]
   b. Motorized Stand - Work surface heights from 30 to 38" (750 to 950 mm), overall cabinet height from 88.6" to 96.5" (2249 to 2449 mm) [stand is 26.8" to 34.6", 680 to 880 mm]
   c. Castor Stand - Work surface heights at 30" (760 mm), overall cabinet height is 88.6" (2350 mm) [stand is 680 mm]
3. Interior dimensions
   a. Nominal 3 ft width - 30.7"H x 35.4"W x 24.8"D (780mm H x 900mm W x 630mm D)
   b. Nominal 4 ft width - 30.7"H x 47.2"W x 24.8"D (780mm H x 1200mm W x 630mm D)
   c. Nominal 5 ft width - 30.7"H x 59.1"W x 24.8"D (780mm H x 1500mm W x 630mm D)
   d. Nominal 6 ft width - 30.7"H x 70.9"W x 24.8"D (780mm H x 1800mm W x 630mm D)

2.3 CONSTRUCTION

A. Cabinet shell shall use steel no less than 19 gauge (0.0394" thick) and validated to meet the NSF performance specification where top front edge shall not move forward more than 0.063 inches (1.6 mm) from the static position when a 250 lb (110 kg) lateral force is applied to the top rear edge and the top of the sides shall not move forward more than the same amount when the same force is applied to the top of the opposite side.

B. Unit shall have all metal plenums designed for easy removal at filter change. (Non-metal, fabric type plenums are not acceptable.)

C. To facilitate cleaning, the interior sides and rear wall of the work area shall be of one piece no less than 19 gauge (0.0394" thick) Type 304 stainless steel construction with No. 4 finish. The joins between the side and rear interior walls shall have coved corners of no smaller than 0.406" radii.
D. An efficient means of adjusting the downflow and inflow separately shall be provided. Additional penetrations of the shell of the cabinet should be avoided.
E. Corrosion resistant ball valve for drain from trough beneath the work surface. F. Externally mounted fluorescent lighting fixture.
G. One supply and one exhaust, scan-tested, zero-probe HEPA filter, 99.995% percent efficient on most penetrating particle size (H14 per EN 1822), serviceable and removable from front of unit.
H. Two duplex receptacles, GFI protected with total load capacity of at least 5 amps. I. Single power cord 12 ft in length with a NEMA plug 5-15P. J. Corrosion resistant diffuser below the downflow filter.
K. Protective screen to prevent foreign objects from being drawn into fans.
L. A minimum of six media valves (at least three on each side, for vacuum or other) available on the cabinet.
M. A minimum of two replaceable 3 inch cable/tubing ports (at least one on each side)

2.4 PERFORMANCE REQUIREMENTS

A. Work access opening inflow velocity: Acceptable operating range 100 - 110 fpm.
B. Inflow compensation controlling inflow velocity with 3% of set value with 100% increase in filter loading.
C. Visual indicator on the front panel for the following features:
1. Compensation reserve capability.
2. Hours of operation
3. Inflow velocity display (feet per minute)
4. Downflow velocity display (feet per minute)
5. Night Set-Back mode
6. UV on
7. Receptacles on
8. Operating speed airflow
9. Front window position
D. No HEPA filter leakage $\geq$0.01% of upstream concentration.
E. Downflow velocity ± 5 fpm of NSF/ANSI validated nominal value.
F. All downflow measurements within 20% of average.
G. Separate downflow and inflow velocity flow alarms to signal overall variation greater than 20% from set values.
H. Airflow smoke patterns test acceptable
1. Downflow is smooth with no dead spots or upward flow.
2. Smoke released behind view screen moves smoothly down and does not escape from the cabinet.
3. Smoke released outside the cabinet will not escape from the cabinet once drawn in or billow over the work surface or penetrate onto it.
4. No smoke released in the work area 2 inches from the window side or top edges will escape from the cabinet.
I. Power consumption: Not to exceed 170 watts for nominal 3 ft width, 200 watts for nominal 4 ft width or 400 watts for nominal 6 ft width.
J. Reduced flow or Night Set-Back mode allowing reduction in airflow and energy consumption while maintaining cleanliness and containment when not in operation. Power consumption during reduced flow or Night Set-Back not to exceed 70 watts for nominal 3 ft or 4 ft widths, and 120 watts for nominal 5 ft and 6 ft widths.

2.5 ERGONOMIC OPERATION REQUIREMENTS

A. 10° sloped front (the top of the cabinet is slanted away from the operator) to provide operator the space to change position forward and back while working.

B. Work area illumination: No less than 120 footcandles at the worksurface
C. Noise: No greater than 65 dB(A)
D. Front and back of window easily cleanable without special tools.
E. Armrests must sit above front air intake grill and be easily removable
F. Available UV disinfection cycle
   1. adjustable UV exposure time saved in memory to facilitate consistent operation
   2. safety interlock to prevent UV illumination when window is open

2.6 ACCESSORIES

A. Thimble connections for external exhaust allowing external exhaust variation of 30%:
   Nominal 3 ft width with 8 inch opening - 269 cfm
   Nominal 3 ft width with 10 inch opening - 336 cfm
   Nominal 4 ft width with 8 inch opening - 360 cfm
   Nominal 4 ft width with 10 inch opening - 450 cfm
   Nominal 5 ft width with 8 inch opening -448 cfm
   Nominal 5 ft width with 10 inch opening - 560 cfm
   Nominal 6 ft width with 8 inch opening - 540 cfm
   Nominal 6 ft width with 10 inch opening - 670 cfm

B. External exhaust alarm (as required by NSF 2012)
C. Universal Piping to top, side and bottom, up to two pre-plumbed penetrations per side
D. Floor anchoring brackets
E. Service valve taps
F. Adjustable footrest
G. Ergolign saddle stool
H. IV bag holder
I. Hanging shelf for base stand

Recycling Services

Solvents for Recycling Fact Sheet

Clean Harbors Recycling Services offer a full range of solvent recycling options from traditional recycling to tolling, or a combination of the two. Recovered products, which are not returned to customers, are available for sale.

Our flexible operations, combined with chemical knowledge and engineering expertise, bring advanced solutions to the challenges of separation and purification. During the recovery process, components of the solvent/chemical streams are isolated and purified to high-quality product specifications.

Clean Harbors Recycling Services employees are experts in recycling and tolling. All processing meets strict local, state, federal regulations, and customer requirements.

Recycling - We provide recycling services, where the product is recycled to our high quality specifications and sold on the secondary market.

Customized Solutions - Customized solutions that utilize traditional recycling with tolling to meet customers' unique requirements are also available.

Typical Solvents Recycled

Chemical Name	CAS #
Methylene Chloride	75-09-2
Tetrachloroethylene	127-18-4
1,1,1 Trichloroethane	71-55-6
Trichloroethylene	79-01-6
Trichlorotrifluoroethane	76-13-1
Perchloroethylene (Dry Cleaning Filters)	127-18-4
N-Methyl-2-Pyrrolidone	872-50-4
N-Propyl Bromide	106-94-5
Ethanol Solutions*	64-17-5
*Excluding Specially Denatured Alcohols	
Methanol	67-56-1
Isopropyl Alcohol	67-63-0
Isopropyl Alcohol (High Water)	67-63-0
Toluene	108-88-3
Xylenes (ortho-, meta-, para-)	1330-20-7
Tetrahydrofuran	109-99-0
Acetone	67-64-1
Methyl Ethyl Ketone	78-93-3
Ethyl Acetate	141-78-6
Petroleum Distillates	8052-41-3
Petroleum Distillates (Dry Cleaning Filters)	8052-41-3
Naptha	8032-32-4
Naptha (Dry Cleaning Filters)	8032-32-4

Tolling - Our tolling programs provide a closed loop cycle in which the customer's spent solvents are recycled to their precise specifications and returned directly to them.

Examples of Solvents for Tolling

- Decalin (Decahydronaphthalene)
- N,N-Dimethyl Acetamide
- Dimethyl Sulfoxide
- 1-Ethyl-2-Pyrrolidone
- Isoamyl Alcohol

Recycled Materials for Sale - High quality recycled materials are sold through Service Chemical, LLC a full service distributor of specialty and commodity chemicals.

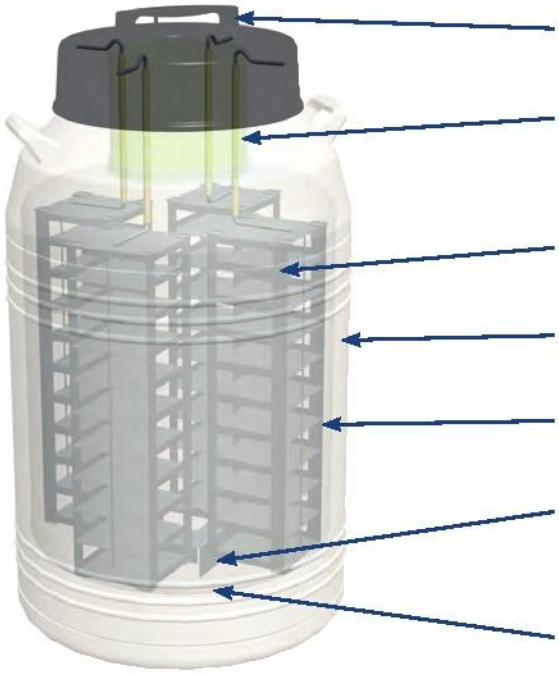
MVE CryoSystem Series

The MVE CryoSystem Series combines the benefits of low nitrogen consumption with mid-range vial capacity to meet the diverse needs of today's professionals worldwide. The lightweight and low-space demands of these containers make them the most economi- cal units in their class.

Features Include:

- Designed for large capacity storage
- Low liquid nitrogen consumption
- Convenient lightweight package

Tank Features



A Durable, tamper-proof lid design

B High strength neck tube reduces liquid nitrogen loss

C Canisters

D Strong, lightweight aluminum construction

E Advanced chemical vacuum retention system

F Spider design on platform for easy retrieval and insertion of product canisters

G Liquid Nitrogen Reservoir

	CryoSystem 750	CryoSystem 2000	CryoSystem 4000	CryoSystem 6000
Maximum Storage Capacity				
Number of Canisters	6	4	4	6
Number of 1.2 & 2.0 ml vials 100/box	-	2,000	4,000	6,000
Number of 1.2 & 2.0ml via 25/box	750	-	--Boxes per Rack	5
	5	10	10	
Performance				
LN2 Capacity L	47.4	61.0	121.0	175.0
Static Evaporation Rate* L/day	0.39	0.85	0.99	0.99
Working Volume L	47	51	111	165
Normal Working Duration, Full Days**	76	38	70	104
Unit Dimensions				
Neck Opening in. (mm)	5.0 (127)	8.5 (216)	8.5 (216)	8.5 (216)
Overall Height in. (mm)	26.50 (673)	27.25 (692)	38.00 (965)	37.75 (959)
Outer Diameter in. (mm)	20 (508)	22 (559)	22 (559)	26 (665)
Weight Empty lb. (kg)	42 (19.0)	58 (26.3)	81 (36.7)	103 (46.7)
Weight Full lb. (kg)	126 (57)	182 (82.5)	300 (136)	425 (193)

* Static evaporation rate and static holding time are nominal. Actual rate and holding time will be affected by the nature of container use, atmospheric conditions, and manufacturing tolerances.

** Normal Working Duration is an arbitrary reference, to estimate container performance under normal operating conditions. Actual working time may vary due to current atmospheric conditions, container history, manufacturing tolerances and any individual patterns of use.

TWO Year Standard Warranty • THREE Year Vacuum Warranty

Conforms to MDD 93/42/EEC, the Medical Device Directive for the EU