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Assessment of wastewater from vegetable oil & soap factories

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EL Tawfig Soap factory staff and works.

DEDICATION

To my **Father**
To my **Mother**
To the memory of my **Sister**
To my **Brothers&Sister**
To my **Friends**
To my **Group**

ABSTRACT

In most developing countries (Sudan is a good example) the vegetable oil and soap industry constitute an important agro-industrial activity that could be the basis for future industrialization and could contribute significantly to the economics of those countries.

However, effluents from vegetable oil and soap factories in general, and in Khartoum North, Omdurman industrial area in particular, create serious problems with regard to the environment within the factories, in the sewerage, finally in the treatment plant at El Haj Yousif and on Land.

The purpose of this study could be summarized in the following: -

(1) To determine the sources of wastes in vegetable oil and soap factories.
(2) To determine the characteristic of wastes (quality and quantity).
(3) To determine pretreatment of wastes from vegetable oil and soap factories to levels acceptable for discharge to municipal works and on land.
(4) To investigate the possibility of recovery of the valuable byproduct from the wastes.

In order to achieve the above objectives two factories have been chosen to represent the majority of vegetable oil and soap factories in Khartoum north and Omdurman industrial area. These factories are: -

(1) Soap, allied industries company in Khartoum North.
(2) EL Tawfig Soap factory in Omdurman.

After comprehensive study and laboratory research, it was found that the effluents discharged from the studied factories, are above allowable limits for discharge to the public sewer and on land.

However it was found that these effluents could be treated by physical process that make them fit for discharge to the public sewer and on land, and also a valuable byproduct (fatty acids) could be recovered from the effluents, which can be used as animal feed.

ملخص

كثـ من البلدان النامية ومن ضمنها السودان تشكل صناعة الزيوت النباتية والصابون نشاطا صناعيا زراعيا كن أن يكون أساسا للتنمية الصناعية كما كن أن يساعد مساعدة فعالة اقتصاديات تلك البلاد.

إلا أن لفات صناعة الزيوت النباتية والصابون السودان عموما و ا نطقة الصناعية با رطوم ري وامدرمان علي وجه ا صوص قد سببت الكثـ من ا شاكل البيئية نطاق ا صانع و شبكة ا اري العامة و طة تنقية ا خلفات السائلة با اج يوسف وكذلك منطقة تفريغ ا خلفات بال كرري.

إن الغرض الأساسي من هذه الدراسة يتلخص الآ : -

(1) ديد مصادر ا خلفات الصناعية مصانع الزيوت النباتية والصابون.

(2) مواصفات هذه ا خلفات نوعاً وكمًا.

(3) ا عا ة ا بدئية ذه ا خلفات حـ تصبح صا ة للتفريغ شبكة ا اري وعلي سطح الأرض حسب القوان ا كم ذلك.

(4) إستخلاص بعض النواتج الثانوية من هذه ا خلفات.

ولتحقيق هذا الغرض فقد اختيار مصنع إحدا ا با نطقة الصناعية ا رطوم ري والآخر با نطقة الصناعية بامدرمان ثلان بقية ا صانع هذه ا نطقة و ا: -

(1) شركة الصابون وا نتجات ا تحدة (بيطار) با رطوم ري.

(2) مصنع التوفيق للصابون بامدرمان.

وبعد الدراسة الشاملة والتجارب ا عملية إتضح أن درجة التلوث هذه ا خلفات تفوق ا د ا سموح لتفريقها ا اري العامة وعلي سطح الأرض حسب القوان ا كم ذلك. إلا إنه كن معا ة هذه ا خلفات بواسطة عمليات فيزيائية تؤدي إ خفض مستوي التلوث للحد ا سموح به وأيضا استخلاص بعض النواتج الثانوية مثل الدهنيات ا كن استعما ا كعلف حيوا .

ABBREVIATIONS

BOD Biochemical oxygen demand.
COD Chemical oxygen demand.
T.S. Total solids.
D.S. Dissolved solids.
S.S. Suspended solids.
pH Concentration of hydrogen ions.
Q Flow rate.
v Surface-loading flow rate.
V Volume.
T Detention time.
L Length.
W Width.
H Depth.

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CHAPTER ONE
INTRODUCTION

1. INTRODUCTION

1.1 General:-

There are over a thousand types of seeds and nuts, which contain significant amount of oil but only about 25 are processed regularly on a commercial scale.

As the particular qualities processed by the wide variety of oil have been determined, the most economic range of plant have been cultivated to yield an oil which fulfils a given local or more general requirement.

There are three principal ways in which oil may be separated from a seed . (1)

(1) By screen pressing.

(2) By solvent extraction.

(3) By hydraulic pressing.

Refining refers to any purifying treatment designed to remove free fatty acids, phosphatids or mucilaginous material or other gross impurities in the oil. It excludes“ bleaching and also deodorization ”.The term bleaching is reserved for treatment designed solely to reduce the color of the oil. Very little material is removed from the oil by bleaching and bleaching treatment is commonly applied to oils after purification has been largely accomplished by refining. Deodorization is the term used for treatment intended primarily for the removal of traces of constituents that give rise to flavours and odors. (2)

Soap has been known for at least 2350 years. Soap can be

produced by:-

(1) The cold process.

(2) The semi-boiled process.

(3) The full-boiled process.

In the cold and semi-boiled processes soap in not separated from glycerin, and any other impurities, which are present in initial materials, will also be present in the final soap. In the cold process the fat charge is placed in " a kettle" and calculated quantity of caustic solution is added carefully. The mass is then left until the exothermic reaction between the two converts it into soap-which is judged by the absence of free caustic alkali. The semi-boiled process is similar to the cold one, except that the mass is heated and agitated-usually by steam.

The full-boiled process is the most widely used one, it produces soaps of high quality as well as glycerin, which is very valuable by product. The process can be carried out in batches or continuously-we are concerned here primarily with batch process but because of the fact that continuous one is evolving vastly for both technical and economic consideration, the basic characteristics of this process shall also be dealt with. (3)

1.2Vegetable oil industry in Sudan: -

In most developing countries the vegetable oil and fats industry constitute an important agro-industrial activity that could be the basis for further industrialization and could contribute significantly to economic of these countries. Sudan is a good example for countries whose development depends strategically on agro-industries. The development of many rural areas, and to a large extent the capital itself, is largely attributed to vegetable oil and textile industries, oil seed extraction was started hundreds of years ago by traditional camel-driven wood presses, then came the mechanical screw presses and very recently solvent extraction. The annual per capita consumption of vegetable oils and fats for the Sudan is 25 g/day.

Table1-1 The annual production of raw materials in the Sudan for the year 2000. In 1000metric tons were: - (4)

Ground nuts in shell	**Cotton seed**	**Sesame seed**
990	157	305

1.3Industrial waste disposal in Sudan: -

In Sudan law states “The environment Health Act 1975” that no person shall drain, throw, attempt to drain or throw any substance, whether solid, liquid or gaseous into any drinking water source, river course, tributary, haffir, well or the sea in a manner harmful l to human or animal health and the uses of water by human beings for other purposes. Without prejudice to the generality of the preceding, no person shall throw: -

(1) Solid, liquid or gaseous industrial waste whether treated or not.

(2) Any chemical substance employed in any industry, whether treated or not.

(3) Any raw sewage waters or treated emanating from kitchen room or latrine.

(4) Any unwanted solid residue whether treated or not, emanating from the human use of dwellings, factories or any other public place.

The health authority allows the discharge of industries liquid waste to the public sewer if certain requirements are met.

1.4Objectives:-

General objective: -

To assess the management of wastewater from vegetable oil and soap factories.

Specfic objectives: -

(1) To determine the sources of wastewater in vegetable oil and soap factories.

(2) To determine the characteristic of wastewater "quantity and quality."

(3) To determine the pre-treatment of wastewater from vegetable oil and soap factories levels acceptable for discharge.

(4) To investigate the possibility of recovery of the valuable by-products from the wastes.

CHAPTER TWO
LITERATURE REVIEW

2.LITERATURE REVIEW

2.1Industrial waste:-

An increased scale of human activity has brought with it pollution, defined as" An undesirable change in the physical, chemical, or biological characteristics of our air, land, and water that may or will harmfully affect human life or that of any desirable species or industrial processes, living condition, or cultural assists, or that may or will waste or deteriorate our raw material resources." Under certain circumstances, the natural processes of self-purification are unable to keep pace with the increase of pollutants and then serious problems arise, which are usually on a local scale. On occasion however, pollution effects may persist long enough so that the atmosphere on the ocean circulation may spread them over the whole earth. (5)

If untreated wastewater is allowed to accumulate, the decomposition of the organic materials it contains mal odorous gases. In addition, untreated wastewater usually contains numerous pathogenic or disease causing microorganisms that dwell in the human intestinal tract or that may be present in certain industrial wastes. It also contains nutrients, which can stimulate the growth of aquatic plants, and it may contain toxic compounds. For reasons of public health and of conservation, the immediate and nuisance. Free removal of wastewater from its sources of generation, followed by treatment and disposal is not only desirable but also necessary in an industrialized society. (6)

Universally industrial wastes can be classified in one or all of the following forms :-

(1) Liquid wastes.

(2) Solid wastes.

(3) Gaseous wastes.

However, industrial wastes can be, fermentable or non-fermentable which are greatly affected by the sources and characteristics of industrial activity.

2.1.1 Industrial liquid waste:-

2.1.1.1 Physical, chemical, and biological characteristics of wastewater and their sources. (6)

Table2-1 Physical, chemical, and biological characteristics of wastewater and their sources. (6)

Physical properties:-

Characteristics	Sources
Color	Domestic and industrial wastes, natural decay of organic materials.
Odor	Decomposing wastewater, industrial waste.
Solids	Domestic and industrial wastes, domestic water supply, soil erosion inflow infiltration.
Temperature	Domestic and industrial wastes.

Chemical constituents:-

Organic: -

Carbohydrates	Domestic, commercial and industrial wastes.
Fats, Oil, and Grease	Domestic, commercial and industrial wastes.
Pesticides	Agricultural wastes.
Phenols	Industrial wastes.
Proteins	Domestic and commercial wastes.
Surfactants	Domestic and industrial wastes.
Others	Natural decay of organic materials.

Inorganic: -

Alkalinity	Domestic and industrial wastes, domestic water supply, ground water infiltration.
Chlorides	Domestic and industrial wastes, domestic water supply, ground water infiltration.
Heavy metals	Industrial wastes.
Nitrogen	Domestic and agricultural wastes.
pH	Industrial wastes.
Phosphorus	Domestic and industrial wastes, natural runoff wastes.
Sulfur	domestic and industrial wastes.
Toxic compounds	Industrial wastes.

Gases:-

Hydrogen Sulfides	Decomposition of domestic wastes.
Methane	Decomposition of domestic wastes.
Oxygen	Domestic water supply, surface water infiltration.

Biological constituents:-

Animals	Open watercourses and treatment plants.
Plants	Open watercourses and treatment plants.
Protista	Domestic wastes treatment plants.
Viruses	Domestic wastes.

2.1.1.2 Undesirable Waste Characteristics:-

Depending on the nature of the industry and the projected uses of the waters of the receiving stream. Various waste constituents may have to be removed before discharge. These may be summarized as follows

(1) Soluble organics causing depletion of dissolved oxygen.

Since most receiving waters require maintenance of minimum dissolved oxygen ,the quantity of soluble organics is corresponding restricted to the capacity of the receiving waters for assimilation.

(2) Suspended solids.

Deposition of solids in quiescent stretches of a stream, will impair the normal aquatic life of the stream, sludge blankets containing organic solids will undergo progressive decomposition resulting in oxygen depletion and the production of noxious gases.

(3) Trace organics.

When receiving water is to be used as a potable water supply, phenol and other organics discharged in industrial wastes will cause tastes and odors in the water. If these contaminants are not removed before discharge, additional water treatment will be required.

(4) Heavy metals and Toxins.

Cyanide and toxic organics. Those deleterious to aquatic life usually have prescribed limits for discharge.

(5) Color and turbidity.

These present aesthetic problems even though they may not be particularly deleterious for more water uses. In some industries, such as pulp and paper, economic methods are not presently available for color removal.

(6) Nitrogen and phosphorus.

When effluents are discharged to lakes, ponds and other recreational areas, the presence of nitrogen and phosphorus is particularly undesirable alga growth.

(7) Refractory substances resistant to biodegradation.

These may be undesirable for certain water quantity requirements. ABS (alkyl benzene sulfonate) from detergents is substantially non-degradable and frequently leads to a persistence of foam in watercourse.

(8) Oil and floating materials.

These produce unsightly conditions and in most cases restricted by regulations.

(9) Volatile materials.

Hydrogen sulfide and other materials will create air pollution problems under certain chemical. (7)

2.1.1.3 Industrial wastewater treatment methods:-

The processes available for industrial wastewater treatment can be broadly categorized according to the physical and chemical nature of the material to be removed. The final selection of method will depend upon economics, available land , and degree of treatment required. However, treatment may be physical, chemical or biological. (7)

2.1.1.3.1Physical wastewater treatment:-

In separation by physical methods the following units and operation are recognized

(1) Screen separation. Micro strainers, fine and coarse screens.

(2) Sedimentation. Primary and secondary sedimentation.

(3) Rapid sand filter.

(4) Foam separation.

(5) Air stripping e.g. for removal of ammonia.

Table 2-2 Chemical waste treatment (7)

Treatment method	Type of waste	Mode of operation	Degree of treatment	Remarks
Ion exchange	Plating, nuclear	Continuous filtration with resin regeneration	Demineralized water recovery; product recovery	May require neutralization and solids removal from spent regenerant.
Reduction and precipitation	Plating	Batch or continuous treatment	Complete removal of chromium and heavy metals	One day, capacity for batch treatment; 3hrs retention for continuous treatment; sludge disposal or dewatering required.
Coagulation	Paperboard, refinery, rubber, paint	Batch or continuous treatment	Complete removal of suspended and colloidal matter	Flocculation and settling tank or sludge blanks blanket unit; pH control required.

Table 2-3Biological waste treatments (7)

Treatment method	Mode of operation	Degree of treatment	Land requirements	Equipment	Remarks
Lagoons	Intermittent or continuous discharge; facultative or anaerobic	Intermediate	Earth dug; 10-60 days retention		
Aerated lagoons	Completely mixed continuous basin	High in summer; less in winter	Earth basin, 6-12 ft deep; 8-16 acres/mgd	Pier-mounted or floating surface aerators	Solids separation in lagoon; periodic dewatering & sludge removal
Activated sludge	Completely mixed or plug flow; sludge recycle	%90<removal of organics	Earth or concrete basin; 10-15 ft deep 75000-350000 ft3/mgd	Diffused or mechanical aerators ;clarifies for sludge separation &recycle	Excess sludge dewatered and disposed of
Trickling filter	Intermittent or continuous application; may employ effluent recycle	Intermediate or high, depending on loading	1400-225ft2/mgd	Rock filters 3-8 ft deep; plastic packing 20-40 ft deep	
Spray irrigation	Intermittent application of waste	Complete; water percolation into ground water and runoff to stream	300-40gpm/acre	Aluminum irrigation pipe and spray nozzles; movable for relocation	Solids separation required; salt content in waste limited

Fig.2.1 Processes for the removal of industrial waste pollutants. (7)

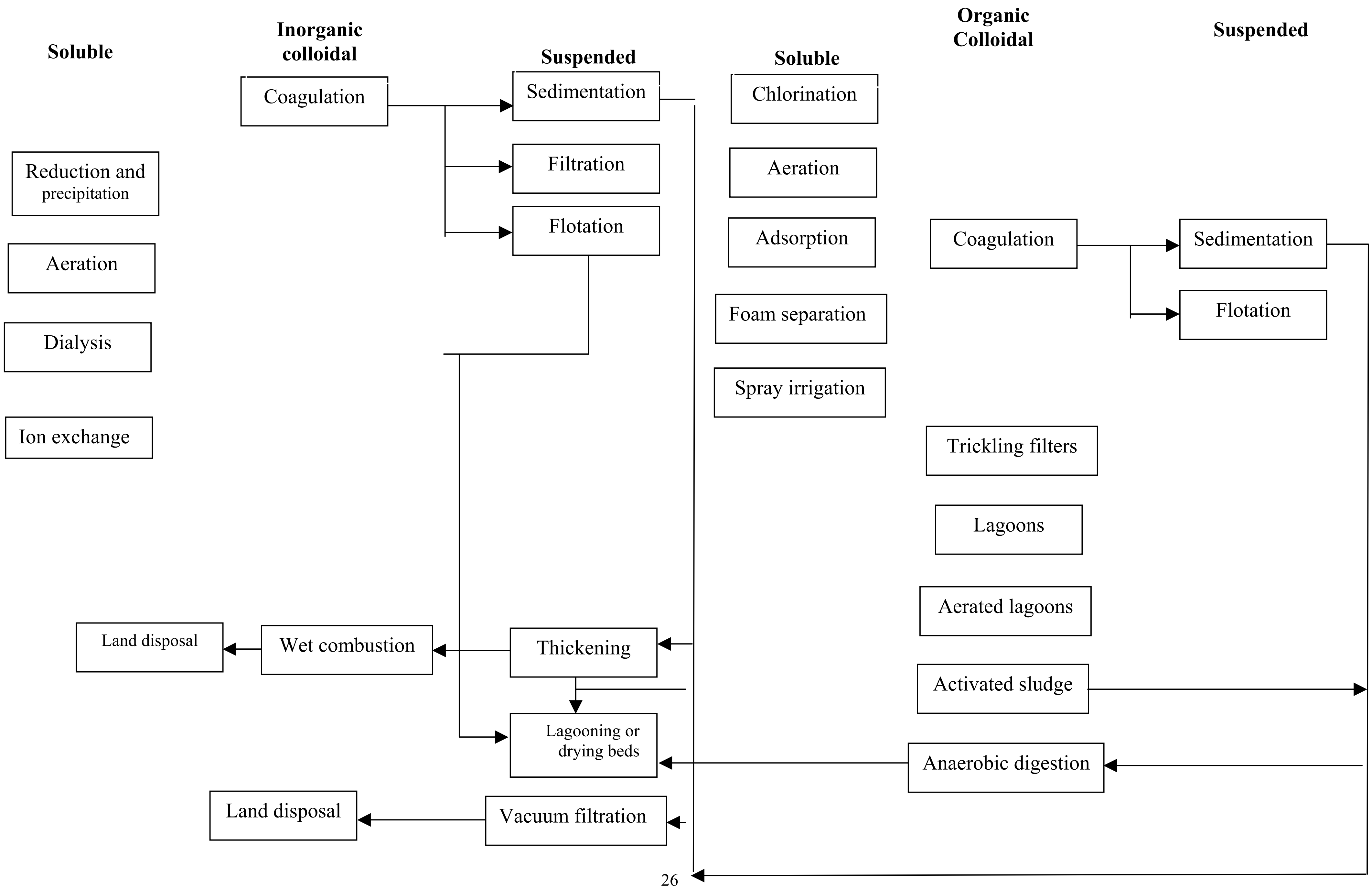
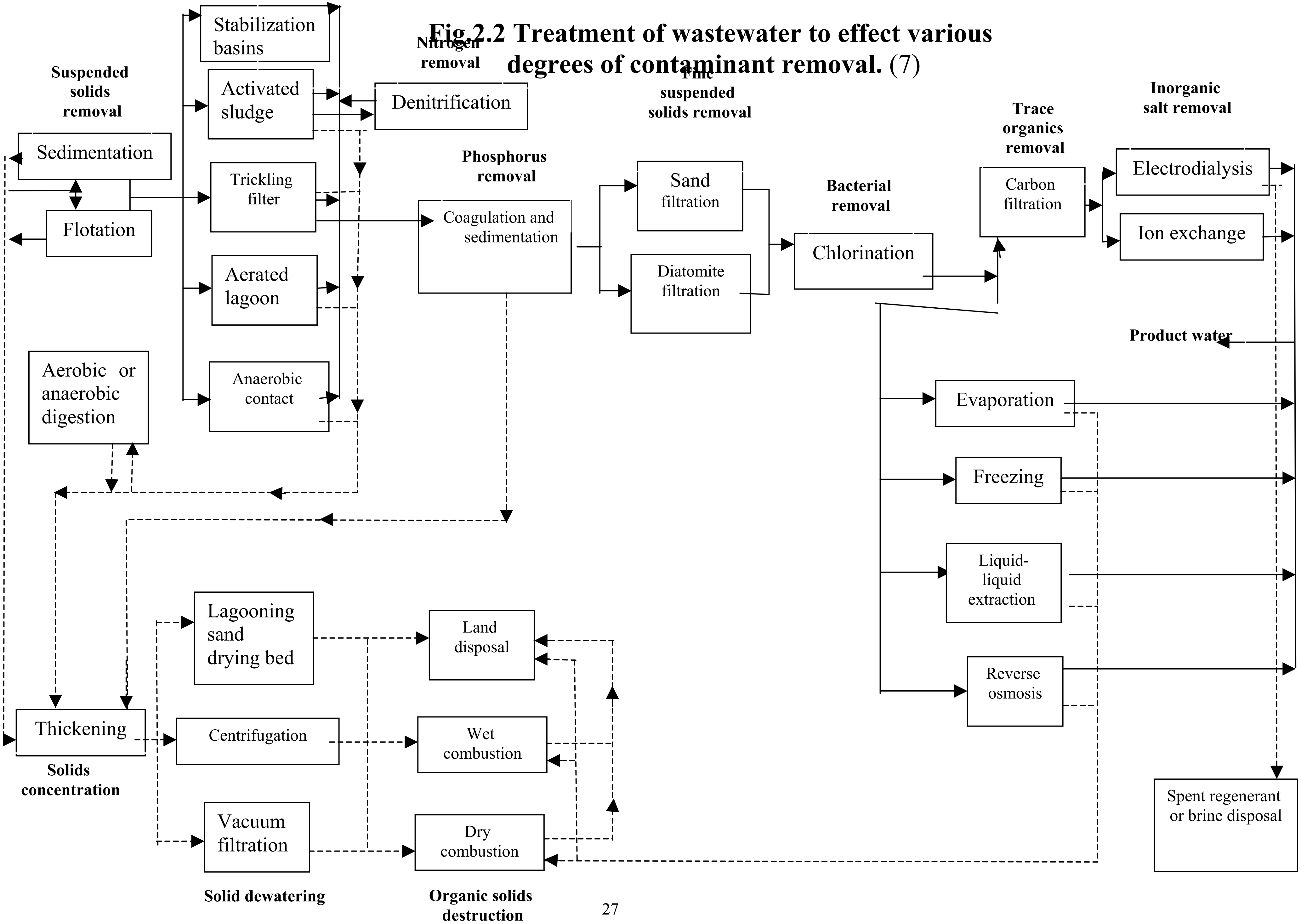


Fig.2.2 Treatment of wastewater to effect various degrees of contaminant removal. (7)



2.1.2 Industrial Solid Waste:-

They include any discard solid materials resulting from an industrial operation or establishment with the exception of dissolved or suspended solids in domestic or industrial wastewater. The composition and quantity of industrial solid waste vary significantly, however a large fraction of the wastes are common to most industries and are listed on the following: -(8)

Table2-4 Industrial solid wastes common

Packing materials	Maintenance material	Generals housekeeping
Fiber	Paints	Waste a per
Metal	Metal	Fires
Paper	Grease	Glass
Plastic	Plastic	Solvents
Wood	Rags	Industrial chemical

2.1.2.1 Effects of solid wastes:-

Solid wastes are heterogeneous in nature and it is very difficult to have a uniform approach to the problems they cause. Generally, in addition to the unsightliness and aethetical effect, improper collection and disposal of solid waste creates a number of problems. These effects which can be summarized in the following (9)

(1) Disease Transmission

Many disease carriers fly, rats, rodents final solid waste an excellent living and reproduction environment. So improper discharge of solid waste which contain food materials permit them to persist in dumping places and migrate to human dwellings in the vicinity, resulting in transmission of many diseases to human like malaria, typhus, ratfever…etc.

(2) Contamination of ground and surface water

Improper disposal of industrial solid wastes may bring about water pollution. When a rain passes through the waste the leachate may carry dissolved chemicals and microorganisms to water sources. Also toxic waste, when dumped in sea, may kill aquatic life and may render the water useless for many purposes.

(3) Air pollution

Deliberate, accidental or spontaneous combustion of refuses in open places gives rise to large volumes of smoke soffensie odors and undesirable gases.

(4) Fire hazard

(5)Foul odors

Due to bacterial decomposition of organic constituents.

2.1.2Solid waste processing methods: -

Variety of processing methods is available at handling solid wastes. Most have been in use some modification for at least 50 years. The choice of processing methods will depend of waste, method of collection, public opinion and ultimately economics. (8)

(1)Sanitary landfill. (2) Central incineration (3) Local incineration

(4)Open burning. (5) Compaction high-pressures. (6) Composting.

(7)Carbage grinding. (8) Dumping (9) .Recycling.

2.1.3Industrial gaseous waste:-

Air pollution is the presence of solid, liquid, or gases in amounts that are injurious or detrimental to man, animals, plants, or property, or that unreasonably interfere with the comfortable enjoyment of life and properly. (10)

Sources of Air pollution

The sources of Air pollution may be man-made or natural. The major sources and pollutants are shown in the following: - (10)

Table 2-5Sources and emissions of air pollutants, millions of tons per year 1968

Source	Total	Carbon monoxide	Sulfur oxides	Nitrogen oxides	Hydro Carbons	Particulate
Transportation	(%42) 90.5	63.8	0.8	8.1	16.6	1.2
Fuel combustion in stationary sources	(%21) 45.9	1.9	24.8	10.1	0.7	8.9
Industrial processes	(%14.5) 29.3	9.7	7.3	0.2	4.6	7.5
Solid waste disposal	(%5) 11.2	7.8	0.1	0.6	1.6	1.1
Miscellaneous	(%17) 37.3	16.9	0.6	1.7	8.5	9.6
Totals	214.2	100.1	33.2	20.6	32.0	28.3

Type of air pollutants: -

Could be classified as gaseous or particulate.

(a) Gaseous pollutants

All process involving poisonous gases which escape to the atmosphere are sources of air pollution.

(1) Primary pollutants

Are those emitted directly into the atmosphere.

(a) Oxides of sulfur

Sulfur is an impurity in coal and fuel oil. Through combustion it enters the atmosphere as **SO_2, SO_3, H_2S, H_2SO_4** and various sulfates.

(b) Carbon monoxide (**CO**) and Carbon dioxide (**CO2**)

CO odorless, colorless and lethal gas results from incomplete combustion of hydrocarbons.

CO2 heavy, colorless and odorless gas not considered as an air pollutant. Increased levels of **CO2 produce** the so-called greenhouse effect, which raises the temperature in earth.

(c) Hydrocarbons (**HCS**)

Originate from combustion of gasoline, coal, oil, natural gas and wood-also from evaporation of gasoline and industrial solvents. Hydrocarbons react with **NOx** to produce photochemical smog.

(d) Oxides of nitrogen (**NOx**)

Nitric oxides (**NO**) are a relatively harmless gas but turns to a harmful gas when oxidized to nitrogen dioxide (**N2O**). Originates from fertilizer and explosives industrials also from automobiles, trucks and buses.

(2) Secondary pollutants

Are those formed by reaction in the atmosphere e.g. (a) Billuglum mist. (b) Photochemical smog.

(b) Solid particles or liquid drops e.g. grits, dust, fume, smoke, mist, fog ,…etc

Types of effects associated with air pollution. (11)

1) Visibility reduction

Historically the earliest noted and currently the most easily observed effect of air pollution is the reduction of visibility produced by the scattering of light from the surface of airborne particles, size, aerosol density, thickness of the affected air mass, and certain move subtle physical factors, particulate responsible for the phenomenon may be either primary pollutants e.g. coal smoke, or secondary e.g. photochemical smog.

2) Material damage

Direct damage to structural metals, surface coatings, fabrics and other materials of commerce is a frequent and widespread effect of air pollution. This destruction is related to many types of pollutants, but chiefly attributable to acid mists, oxidants of various kinds ,**H2S** and particulate products of combustion and industrial processing. Secondary pollutants contribute a substantial share for example **O3** is known to cause repaid and extensive damage to many kinds of rubber goods and textiles.

3) Agricultural damage

A large number of food, forage, and or namental crops have been show to be damaged by air pollutants. Curtailed value results from various types of leaf damage, stunting of growth, decreased size and yield of fruits, and destruction of flowers. Some plant species are so sensitive to specific pollutants as to be useful in monitoring air quality. Annual blue grass, the pinto been, spinach, and certain forms have been so employed. Substance thus far identified as responsible for the damage includes ethylene, PAN, SO_2, acid mists, fluorides, O_3 and a number of organic oxidants.

4) Physiological effects on man domestic animals

Fluorosis in cattle exposed to fluoride containing ducts has been proved to be related to emission from certain industrial operations.

5) Psychological effects

Since fear is recognizable element in public reaction to air pollution, the psychological aspects of the phenomenon cannot be ignored. Psychosomatic illnesses are possibly related to in adequate knowledge of publicized threat. Little effort has been directed to ward evaluation of such impacts in relation to general mental health of affected group or determination of their role in individual neuroses.

Air pollution control technology: -

Control can be applied at one or more points between the source and the receptor, starting preferably at the sources. The application of control procedures and devices is more effective when supported by public information, production and process revision, installation of proper air cleaning equipment regulatory persuasion, and if necessary, legal action. (10)

Methods of gases cleaning: -

The method adopted of course on the nature of the material to be removed. If this is a gas two alternatives are possible. The gas can either be passed or brought into contact with a medium, which will absorbs the required gas in a preferred way, or it can be chemically changed. Gas absorption in liquids is widely used on such gases as hydrochloric acid vapor, ammonia, sulfur dioxide and carbon dioxide, which form an appreciable part of the gas stream. While adsorption on a solid is more common with small quantities or traces of gases such as water vapor on slicagel, carbon dioxide on time or organic vapor on activated carbon. Changing the chemical nature of the gases usually implies combustion or catalytic processing, particularly catalytic oxidation of organic materials, but of course also applies to such technique as gas retention in a holding chamber to allow a process to go to completion. (12)

The processes of removing gases are therefore chemical reaction absorption or adsorption. The basic mechanisms that can be employed are: - (12)

(1) Gravity separation.

(2) Inertial impaction.

(3) Brownian diffusion.

(4) Thermal precipitation.

(5) Brownian agglomeration.

(6) Turbulent deposition.

(7) Centrifugal separation.

(8) Direct interception.

(9) Eddy diffusion.

(10) Magnetic precipitation.

(11) Sonic agglomeration.

Removal of particulate depends on nature and properties of particulate material. The mechanism of particle collection can be summarized as follows: -

Table 2-6 The mechanism of particle collection

Mechanism	**Origin of force field**
Interial deposition.	Velocity gradient.
Diffusional deposition.	Concentration gradient.
Gravity deposition.	Elevation gradient.
Electrostatic precipitation.	Voltage gradient.
Thermal precipitation.	Temperature gradient.

2.2 Vegetable oils

2.2.1 Historical:-

Since ancient times man has known how to remove oils and fats from their natural sources and make them fit for his own uses. The animal fats were first consumed as food, but it was not long before the burning of the oils for light and heat was leaned. Obtaining oils from vegetable sources is of ancient origin, for the natives in the tropical regions of the globle have long been removing these oils from various nuts after drying them in the sun. The utilization of mrine oils began with the whaling industry, which was started by the Bay of Biscay in the fifteenth Century. (13)

The first chemical reaction applied to fats and oils give soap. The early raw materials were mainly of animal origin, the rendering of animal flesh being an old art. Industrialization of oils and fats began with the erection of a cottonseed mill in South Carolina, about 1826. This crude industry did not expand very rapidly until after 1865. In

1850, the use of caustic soda to remove free acids from the oils was introduced from France. About this time, the millers became aware of the value of linters that clung to the hulls, and also of the hulls themselves, for cattle feed. The beginning of the oleomargarine (margarine) industry in Chicago in 1885 gave a large impetus to the cottonseed oil industry. The higher quality demanded by this new market produced several processing improvements. Fuller's earth was used to deodorize the oil. In 1893, it was learned that the oil be deodorized by blowing steam through it at high temperature later it was found that deodorization under reduced pressure bettered both flavor and odor. In 1900 the discovery that oils could be up graded by hydrogenation to produce fats revolutionized the entire oil and fat industry and led to our modern hydrogenated shortening. This discovery also made marketable many of the lesser-known oils. (13)

From different raw materials table contains selected seeds, nuts and fruits from which oil can be extracted and restricted to those materials that are processed traditionally on a wide scale.

Table2-7Raw materials from which oil can be extracted (14)

Raw material	Oil content	Use
(1)Oil seed		
Caster	%55-35	Paints and lubricants.
Cotton	%25-15	Cooking oil, soap making.
Linseed	%44-35	Paint and varnishes.
Niger	%50-38	Cooking oil, soap, paint.
Neen	45of kernel	Soap making.
Rape/Mustard	%45-40	Cooking oil.
Sesame	%45-35	Cooking oil.
Sunflower	%50-35	Cooking oil.
(2)Nuts		
Coconuts	%64dried copra %35fresh nut	Cooking oil, body, hair Cream, soap making.
Ground nuts	%50 -38	Cooking oil, soap making.
Palm kernel nut	%57-46	Cooking oil, body, hair. Cream, soap making.
Shea-nut	%44-34	Cooking oil, soap making.
Mesocarps	%56	Cooking oil, soap making.

2.2.2Processing of fats and oils: -

The removal of oil and fats from their natural sources is the first step on the overall process. Each type of oil source requires special techniques, which are usually not applicable to other sources. Rendering, pressing and solvent extraction are the most common method for the recovery of fats and oils. (15)

2.2.2.1 Refining

The crude fats and oils produced by rendering expression impurities. In the case of high-grade animal fats and certain vegetable oils, such as coconut and palm kernel oil, these impurities consist principally of free fatty acids. There are significant amounts of other substance, however, in most vegetable oils, as well as in animal fats, which have been rendered from low-grade materials.

Some oils and fats are seldom given any of purity treatment, Butterfat, oleo oil, and oliveoil are neither refined nor bleached in the ordinary course of manufacture although in rare instance the refining process may be applied for the reclamation of off grade or badly deteriorated materials. (16)

In addition to the gums removed by water washing, the caustic materials, usually sodium hydroxide or sodium carbonate, also remove acidic compounds such as free fatty acids. The phospholipid residual in degummed oils is readily removed by caustic in water solution sufficiently high, in the order of 10-15% sodium hydroxide.

The physical process is to intimately mix crude oil and caustic solution and to separate the clear oil from the semi solid mass impurities. The amount of caustic soda used is based on the free acid content. These acids are neutralized to form soaps, which are insoluble in the free oil. Excessive caustic can saponify the neutral oil, increasing the amount of fatty acid removed and reducing the yield of refined oil.

All refining was once done in jacketed tank or kettle. The crude oil-caustic mix was agitated in an open kettle, heated and allowed to stand so that the soap could settle; the settled material was called the “Foots” or “Soap stock”. The bulk of this residue consisted of crude soap maker for further processing. Much of this material is now neutralized with sulfuric acid to form a mixture of crude fatty acids and phospholipids. It is sold to animal feed manufactures as "acidulated foots." (16)

2.2.2.2 Bleaching

The bleaching of fats and oils is almost invariably by refining treatment, which are relatively unaffected by refining. Such substances are almost without exception unobjectionable except in so far as they affect the appearance of the oil. In some cases the preference of the consumer for light-colored oil is entirely rational.

In some cases, however, thus preference rests simply upon the somewhat mistaken impression that color is general index of purity and general high quality. At any rate, the preference of consumer can't be ignored, and at the present time the production of light colored oils and fats is one of the primary concerns of manufactures of both soaps and edible products.

The processing treatments of refining, hydrogenation and deodorization all have some incidental effect upon the color of oils, but most fats and oils at some stage of processing are subjected to a treatment usually consists of brining the oil into contact with a solid adsorbents having an affinity for the coloring materials. In practice, the adsorbents used consist of bleaching clay "fuller's" earth and "activated carbon" chemical methods are also used to some extent for bleaching. They usually involve treatment of the oil with an oxidizing a gent capable of oxidize and destroys an toxicants in the oil, it is of limited applicability, and is practically never used in connection with the manufacture of edible products. Bleaching by means of an oxidizing current of air is in the same category with chemical bleaching methods.

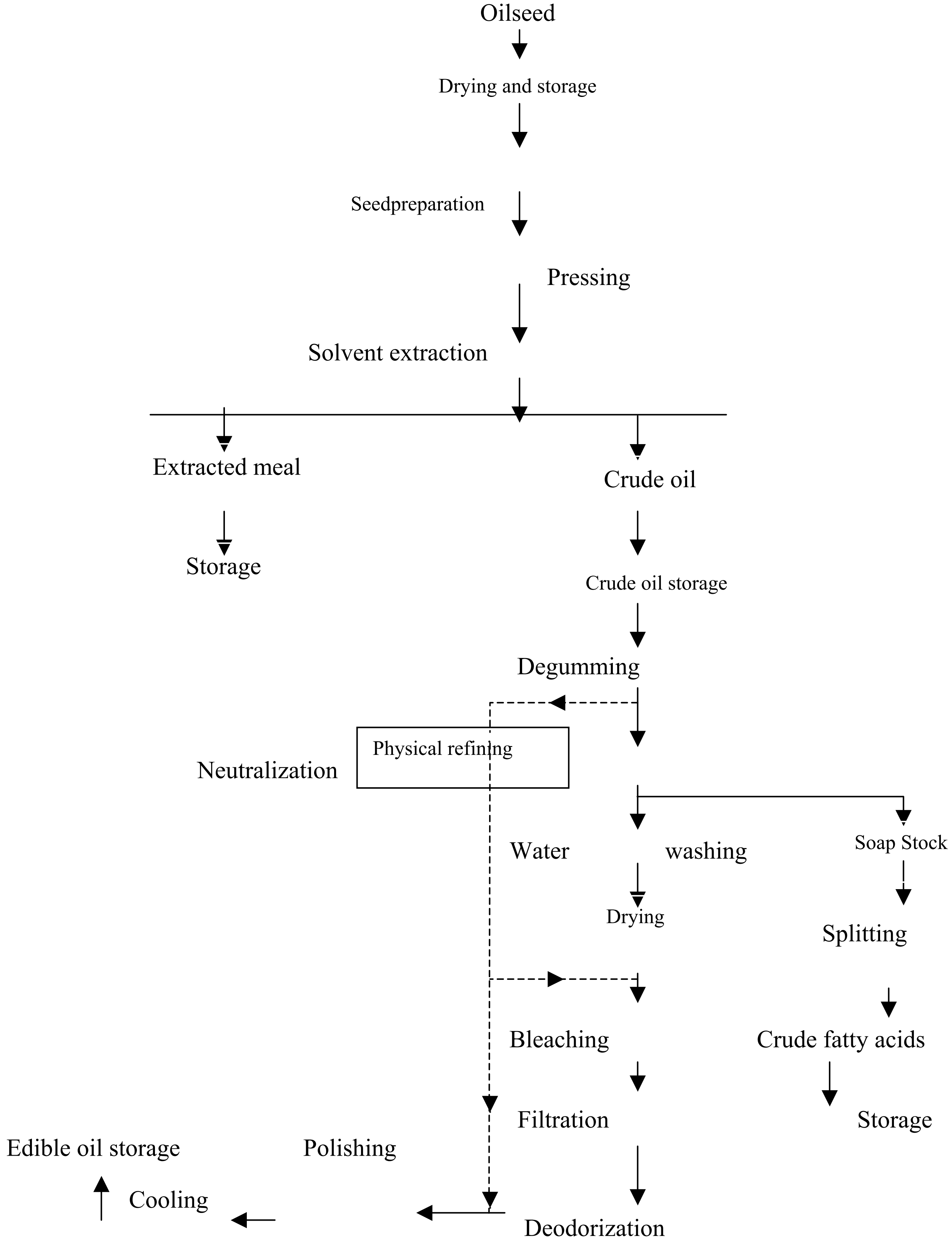
Bleaching is normally carried out after refining and prior to hydrogenation or deodorization, as the lightest colored products are obtained by following this sequence of operation. Some oils bleached only with great difficulty after exposure to high temperature such as those employed in hydrogenation or deodorization. Bleaching before hydrogenation is also desirable because bleaching materials tend to adsorb traces of soaps and other catalyst poisons, which may be led in the oil after refining. (16)

2.2.2.3 Deodorization

The natural flavors of vegetable fats, are relatively strong, and in addition are utterly foreign to that of butter. In comparison with other vegetable oils, cottonseed oil is distinguished by an unusually high content of strongly flavored non-oil substances. Even after alkali refining it is still so unpleasantly flavored as to be virtually in edible without deodorization consequently in order to make the production of cottonseed available for edible purposes it was necessary from the beginning for the oils to be deodorized.

Steam deodorization is feasible because of the great deference in volatility between the triglycerides and the substance, which give oils and fats their natural flavors and odors. It is essentially a process of steam distillation, where in relatively volatile odoriferous and flavored substances are stripped from the relatively non-volatile oil. The operation carried out at a high temperature to increase the volatility of the odoriferous components. The application of reduced pressure during the operation protects the hot oil from atmospheric oxidation, prevents undue hydrolysis of the oil by the steam, and greatly reduces the quantity of steam required. Certain ketoses, notably methylnonyl ketone have been identified in coconut oil, palm kernel oil and coco butter. Other common odors, ferrous components probably include aldehydes, hydrocarbons, and essential oil. Flavor and odor removed is observed to generally parallel free fatty acid in oils. (16)

Fig.2-3 Oilseed processing and crude oils refining (17)



2.2.3 Methods for the treatment of vegetable oil wastewater: -

Food processing plants have in general, been designed to include one or more effective methods for removing gross amounts of such pollutants as biological oxygen demand, solid, fats, oils and grease, acids and alkalis. In reference to the plant wastewater stream, however, the main technological emphasis has been given to the recovery of valuable by-products, the pollution-control achievements have been a desirable, but non-essential.

2.2.3.1 Skimming

Gravity separation is employed as a by-product recovery and pollution control method almost universally by industries, which have significant amounts of fats and oils in their wastewater streams. The method usually involves the combining of the various plant wastewater streams and dumping into a common separation station. The separation station consists of a large pit equipped with bottom sludge removal equipment and a mechanical skimmer for removing the floating oils and fats. There is also a drain for taking off excess water. This recovery method is subject to over loading during peak production periods is quite frequently a sources of offensive odors, and produces neither high quality reusable products nor acceptably clean water. Operating costs for this type of equipment and relatively low, but the effluent water is far outside current limits for concentration of pollutants.

2.2.3.2 Dissolved Air Flotation

A much move recent improvement in the treatment of food processing wastes is a method known commonly as dissolved air flotation. This method is more effective than skimming but less effective than some other known methods. Basically, the treatment consists of releasing pressurized air into a non pressurized tank containing the wastewater. The tiny air bubbles formed by this action will attach themselves to dispersed grease and oil droplets and to the suspended solids. This will tend to rise to the surface more rapidly and completely than in simple skimming tank. Heavier solids will still fall to the bottom. The efficiency of the dissolved air flotation method of fat, oil, grease, BOD and suspended by the use of chemical flocculent and coagulants e.g. alum and synthetic polymer. (18)

2.2.3.3 Biological oxidation

Biological oxidation method some times used by food processes as secondary method for removing pollutants prior to discharging to a stream or sewer. Aerated lagoons, anaerobic lagoons, trickling filters and activated sludge are commonly used methods and all are familiar to vegetable oil processes. These types of biological treatment systems can be efficient, but variable-operating conditions, such as pH, temperature and bacterial activity, can be difficult to control lagoons, of course must be located out of doors and require considerable amounts of land area due to retention time requirements. All of the biological oxidation methods are subject to over loading during peak production periods, and any upset in operating conditions for the systems will require hours or days for correction. (18)

CHAPTER THREE
MATERIALS AND METHODS

3.MATERIALS AND METHODS

3.1Materials: -

The objective of this study is to determine the source, quantity, quality of wastes from vegetable oil and soap factories and to propose pretreatment system for this wastewater to levels acceptable for disposal to municipal sewage “Khartoum North Industrial Area” and on land “Omdurman Industrial Area”.

In order to achieve the above objectives two factories have been chosen to represent the majority of vegetable oil and soap factories in Khartoum North and Omdurman Industrial Area.

These factories are: -

Soap, Allied Industries Company In Khartoum North Industrial Area.

El Tawfig Soap Factory in Omdurman Industrial Area.

3.2 The Study Area: -

3.2.1 Soap, Allied Industries Company (Bittar): -

It is taken as study area in Khartoum North Industrial Area. The factory uses cottonseed; ground nuts and sunflower seed as oil seeds and uses palm stearin and palm oil for the production of laundry soap .The factory consist of the following departments. Fig.3.1

(1) Delinter.

(2) Preparation department.

(3) Extraction department.

(4) Neutralization or refining section, which consist of: -

(a) Neutralization of frees fatty acid.

(b) Washing of the impurities.

(c) Bleaching.

(d) Deodorization.

(e) Filtration.

(5) And another parts of soap manufacture “laundry, toilet and glycerin”

(a) The first step in the neutralization of free fatty acid present in the crude oil was by adding caustic soda of concentration of 22 Baume in excess. It was added at a temperature of 50 ˚C to yield a soap-stock as by product. This soap-stock was transferred to laundry soap division to complete the Saponification with soap.

(b) The oil washed with solution of caustic soda in water at 70 ˚C to assure complete neutralization to remove unwanted materials “pigment, phosphatides, gum…etc.” It may be washed once, twice or three times depending on the dirtiness and the type of crude oil, it was let to rest for 4 hours and then the washing water separated by discharging to the sedimentation “gravity settling tank.” The treatment used called skimming of the oil, and then the water was discharged to the final effluent. The washed oil was then dried and transferred to the bleaching vessel.

(c) In bleaching process a bleaching earth was added to the oil at 120 ˚C to achieve the standard color.

50 kg for cotton seed oil.

25 kg for groundnut oil.

(d) Deodorization of the oil

The vessel was operated at 150 ˚C under vacuum, in the deodorizer actually steam distillation was maintained, the light volatile organic materials were evaporated cording to their boiling point and then condensed, this was continued for 4 hours to assure that every impurities were separated.

Two types of wastes were formed and were treated by: -

Either transferred with soap-stock to the soap section to be saponified "if the concentration of oil was high" or to separate the oil with addition of sodium chloride solution. The white soap, which was formed from the washing of oil "semi soap or an emulsion of oil+NaoH" was combined with the deodorizer waste and treated together with the salt solution. All refining operation was done in batch processes.

3.2.1.1 Sources of wastes in vegetable oil processing.

3.2.1.1.1 Liquid Waste: - Fig.4.1.1

3.2.1.1.1.1 Wastewater from oil neutralization: -

The neutralizing process used practically exclusively is the extraction of oil with a solution of caustic soda. The alkaline materials convert the free fatty acids to sodium soap and dissolve other materials from the raw oil. Immediately following the extraction of the oil, the oil stream is washed with to remove any fatty acids soap remaining with oil stream or remove any fatty acids soap including any traces of caustic.

3.2.1.1.1.2 Wastewater from bleaching: -

This process produces insignificant wastewater quantities.

3.2.1.1.1.3 Wastewater from deodorization: -

Volatile organic not removed by previous processes is removed by steam stripping. The quantity of steam used requires tremendous quantities of cooling water for its condensation. The water is recalculated over cooling towers. The organic carrying over to the condensing water builds up to high concentration consequently a significant blow-down stream is typically discarded to the sewer.

3.2.1.1.1.4 Wastewater from hydrogenation: -

The addition of hydrogen is accomplished by reacting the oil with hydrogen in the presence of nickel catalyst. Any wastewater that result consist of water overflow from the hydrogen tanks, seals and house keeping wastes. At times of repairs of pumps, tanks and pipes system, small losses of the oil and nickel slurry to floor may occur. Also the cleaning of filters and filter clothes where used results in wastewater. Care is to be taken since nickel is categorized as a toxic material.

3.2.1.1.1.5 Wastewater from drying: -

For some products it is desirable to remove all traces of water from oil so that the shelf life is not affected by traces amounts of water. This is done by drying under vacuum. Direct condensation of the vaporized water or other volatile material by water sprays is practiced. Ordinarily the quantity of entrained oil or other volatile material is insufficient to produce a significant concentration in the condensing water.

3.2.1.1.1.6 Other sources: -

These include filter cloth, washing, filling packing and warehouses. Numerous sources of wastewater originate in the unloading and storing operations through leaks, spills and washout of tank. However these sources do not involve the release of routine process wastewater.

3.2.1.1.2 El Haj Yousif treatment plant: - Fig.3.2

Liquid effluents from the different factories in the study area are collected through the municipality sewerage network, which carry the combined waste to a wastewater treatment plant at El Haj Yousif, in the north eastern of study area.

The treatment plant was implemented in 1969 and the industrial wastes were conveyed to it, the plant consists of: -(19)

(1) Pretreatment: -

(a) Screening, numbers of screens are two.

(b) Grit removal, number of grit chambers is one.

(c) Primary sedimentation, numbers of clarifies are two.

(d) Sludge digestion and disposal, primary digesters are two.

(e) Waste stabilization, primary, anaerobic ponds are four.

(2) Secondary treatment: -

(1) Secondary clarifies are two.

(2) Secondary digesters are two.

(3) Secondary aerobic ponds are four.

(3) Tertiary polishing and disinfecting ponds: -

Numbers of ponds are two.

The station has not been working efficiently since 1975 and was completely stopped at 1998 due to: -

(a) The main problem was the lack of residential waste, which carries the microorganisms needed for the biological degradation.

(b) Technical and mechanical problems.

Table3.2.1.1.2 Characteristic of wastewater from El Haj Yousif treatment plant

Parameter	BOD	COD	T.S.S.	pH	Oil& Grease
Inffluent	412	842	1290	6.0	725
Effluent	250	501	350	6.5	356
Removal %	39.3	40.5	72.9		50.9

3.2.1.1.2 Solid waste: -

(1) Spent bleaching materials.

(2) Oil-seed residues.

(3) Spent metal catalyst.

(4) Packing bags, tins, barrels…etc.

(5) Sludge from storage tanks and gravity settling tanks.

The solids of the study area is generally about 1.6 ton/day collected manually and taken by trucks to dumping area located in the northern east at El Silat.

3.2.1.1.3 Gaseous waste: -

From fuel combustion and industrial operations Gaseous waste are emitted into the atmosphere by the chimney.

3.2.1.3 Quantity of waste waters from Soap, Allied Industries Company: - Fig.3.6

(1) Wastewater produced from vegetable oil refining. Fig.3.3 (a,b)

Waste waters produced from oil washing per batch (10 tons)=2 tons

(2) Wastewater produced from Soap stock washing.

(a) Soap stock treatment.Fig.3.4

Waste water produced from Soapstock per batch (10 tons)=26 tons

(b) Fatty waters treatment. Fig.3.5

Waste water produced from fatty waters per batch (17 tons)=2.5 tons

3.2.1.3 Characteristic of wastewater: -

Standard methods for the examenationation of wastewater: -

(1) **Biochemical oxygen demand (BOD): -** (20)

Is usually defined as the amount of oxygen required by bacteria while stabilizing decomposable organic matter under aerobic conditions. The BOD test is widely used to determine the pollutional strength of domestic and industrial wastes in terms of oxygen that they will require if discharged into natural watercourses in which aerobic conditions exist.

(2)**Chemical oxygen demand (COD): -** (20)

Is widely used as a means of measuring the polltional strength of domestic and industrial wastes.

(3)**Acidity or Alkalinity (pH): -** (20)

Is a term used rather universally to express the intensity of the acid or alkaline condition of a solution pH scale is usually represented as ranging from 0 to 14, with pH=7 representing absolute neutrality, under 7 Acid and above 7 Alkaline.

(4)**Solids:** -(20)

The usual definition of solids, however, refers to the matter that remains as residue upon evaporation and drying at 103 to 105 ˚C.

(5)**Oil and Grease: -** (20)

The oil and grease content of domestic and certain industrial waste, and of sludge, is an important consideration in the handling and treatment of these materials for ultimate disposal.

2.1.4 In Factory treatment: - Fig.3.7

The methods and facilities to be used for industrial wastewater treatment depend on the composition, properties and concentration of contaminant and the desired degree of purification.

3.2.1.4.1 Treatment of the wastewater from vegetable oil (Factory own pretreatment units): -

Design of sedimentation tanks: -

Basis of design: (6)

If all solids in wastewater were discrete particles of uniform size, uniform density, reasonably uniform specific gravity, and fairly uniform shape, the removal efficiency of these solids would be dependent on the surface area of tank and time of detention.

3.2.1.4.1.1 Primary sedimentation tank: -

Primary sedimentation tank may provide the principal degree of wastewater treatment, or they may be used as a preliminary step in the further processing in the wastewater. When used as the only means of treatment this tank provide for the removal of: -

(1) Settable solid capable of forming sludge tank in the receiving wastewater.

(2) Much of the floating materials.

Efficiently design and operated primary sedimentation tank should remove from 50-65 % of the suspended solids and from 25-40 % of the BOD. (6)

The present design (in Bittar): -

T=1.2 hour v=0.75 m/hour Q=1.06875 m^3/hour

Length=1.9m Width=0.75m Depth=0.9m

3.2.1.4.1.2 Skimming tanks: -

Skimming tank is a chamber so arranged that floating material rises and remains on the sewerage until removal, while the liquid flows out continuously through deep out lets or under partitions, curtain walls, or deep seam boards. This may be accomplished in a separated tank or combined with primary sedimentation depending on the process and nature of the wastewater. The object of skimming tank is the separation from the sewerage of the lighter, floating substances. The material collected on the surface of skimming tanks, when it can be removed, in cloud oil, grease and soap. Most skimming are rectangular or circular in shape and provide for a detention period of 1 to 15 min. the outlet, which is submerged, is situated opposite to the inlet and to remove any solid that may settle.(6)

3.2.1.4.1.3 Secondary sedimentation tanks: -

The sedimentation system of the factory consists of two gravity-settling tanks connected together with a channel. The first one is divided with two partitions to give three parts the first two parts are similar in depth 1.9 m and sloped, 1.8 m of the third partition, each with the same width 1.95m and length of 4.1, 1.2, .5 m respectively and the surface level of (water+oil) is 1.58 m.

The second tank is divided into two parts, the first one is 1.9 m high and sloped to 1.8 m for the second and with width of 1.95 m and length of 2.5 and 2.0 m respectively and the surface level of (water+oil) is 1.57 m. The wastewater is segregated from one partition to the other either flow from above or below the partition wall keeping the oil floating up and the sludge settled down.

3.2.1.4.2 Treatment of the wastewater from soap processes: -

3.2.1.4.2.1 Primary sedimentation tank: -

The present design (in Bittar): -

T=2 hour v=1.0 m/hour Q=4.35 m^3/hour

Length=3.0 m, Width=1.45 m, Depth=2.0 m

3.2.1.4.2 Secondary sedimentation tanks

Secondary treatment consist of the two lines, each line consist of the three sedimentation tanks. They are work alternately.

No. of line	Basis of design	First tank	Second tank	Third tank
Line One	Length (m)	4.0	6.0	4.25
	Width (m)	2.0	2.45	2.25
	Depth (m)	2.0	2.0	2.0
Line Two				
	Length (m)	3.45	4.85	4.75
	Width (m)	1.75	1.8	1.5
	Depth (m)	2.0	2.0	2.0

Fig.3.1 Process Flow Sheet For Soap, Allied Industries Company (Bittar)

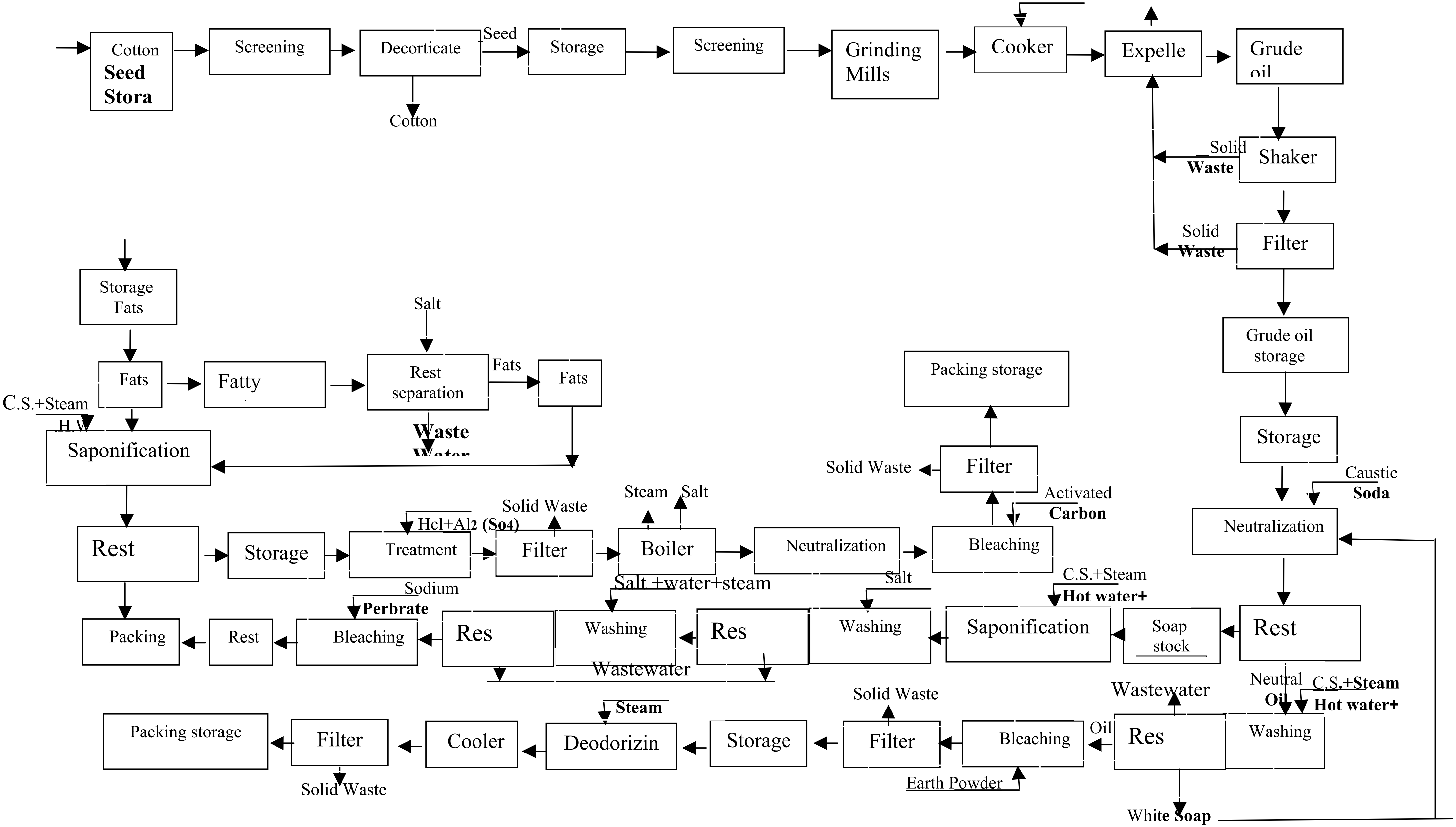
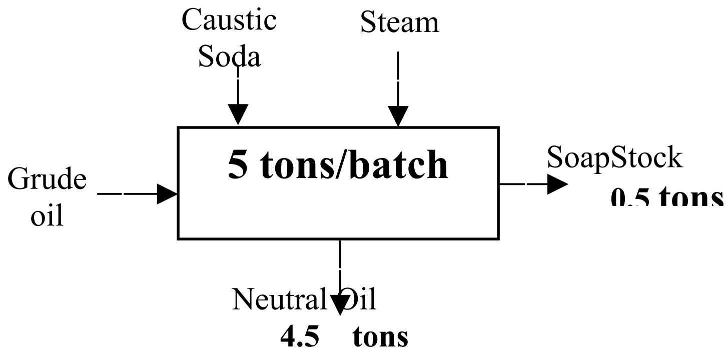
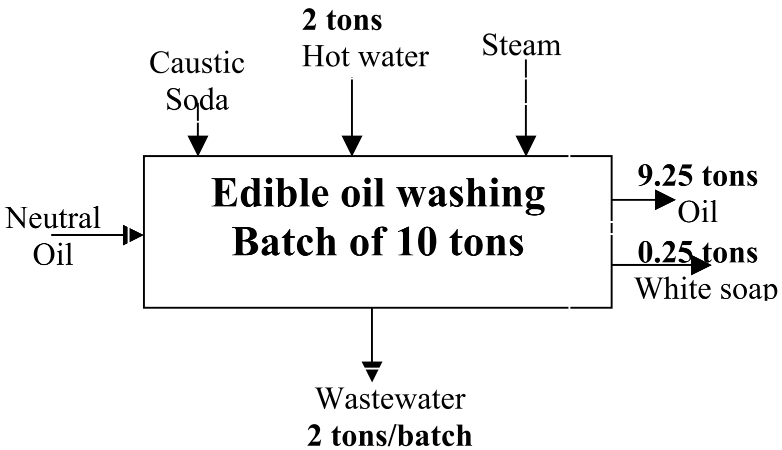


Fig.3.3 Wastewater produced at oil refining



(a) Wastewater produced at oil neutralization



(b) Wastewater produced at oil washing

Fig. 3.4 SoapStock treatment

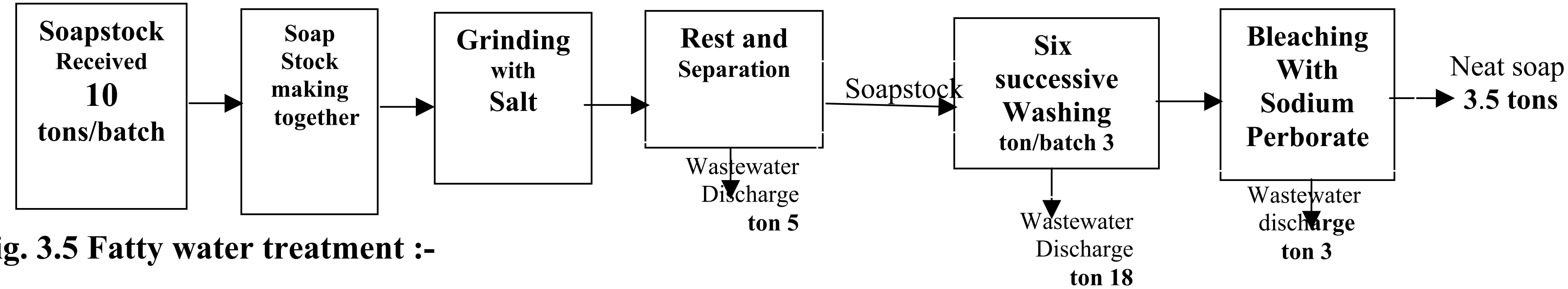
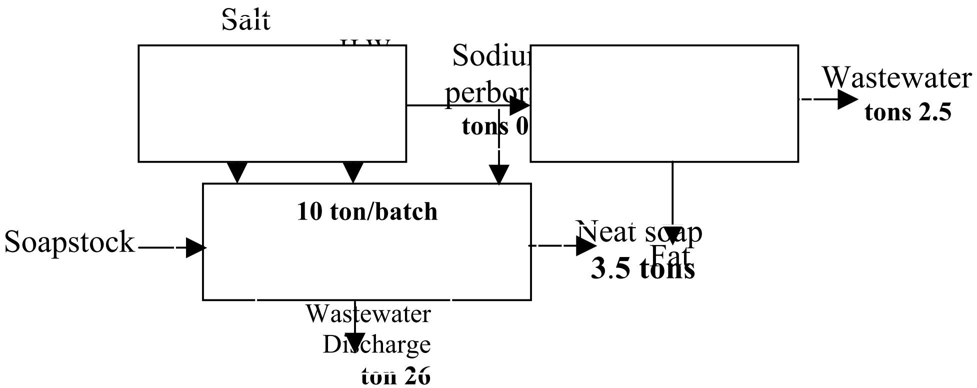


Fig. 3.5 Fatty water treatment :-

This process can be summarized as follows:



This process can be summarized as follows:

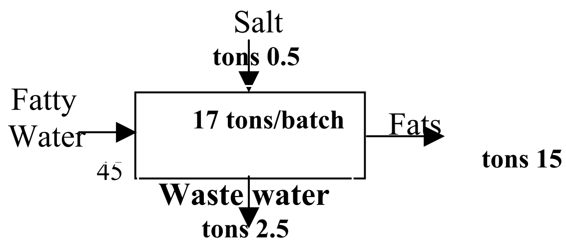


Fig. 3.6Wastewater flow sheet processing from (Bittar) :-

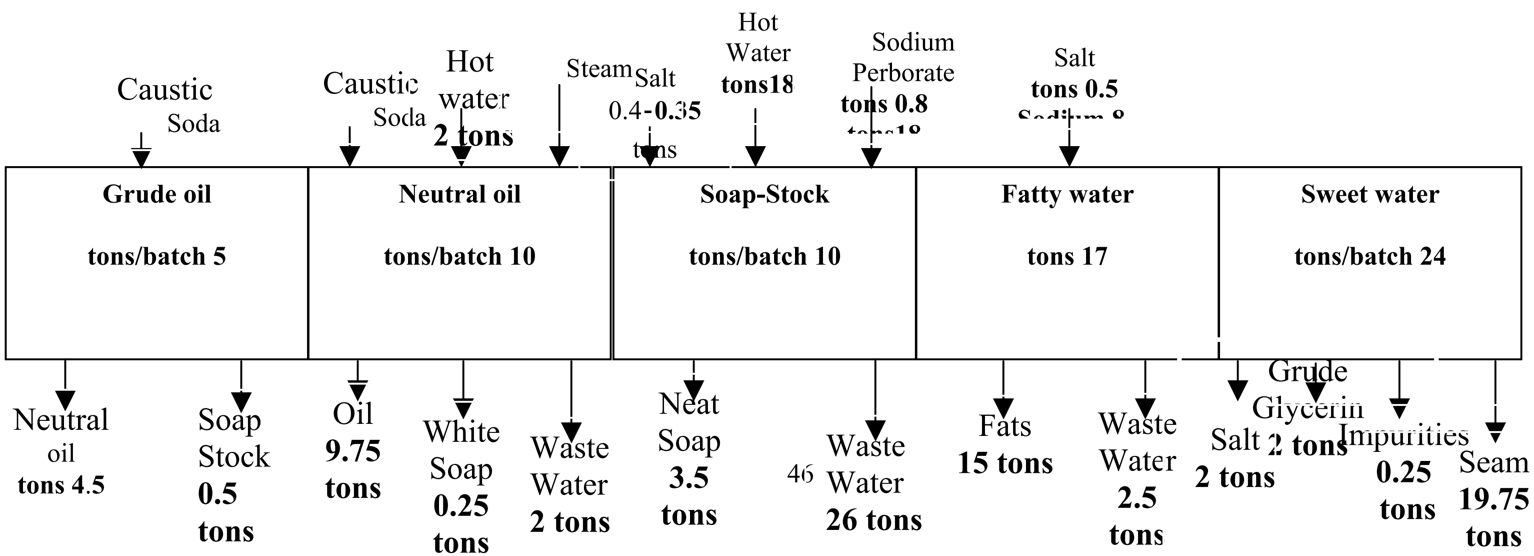
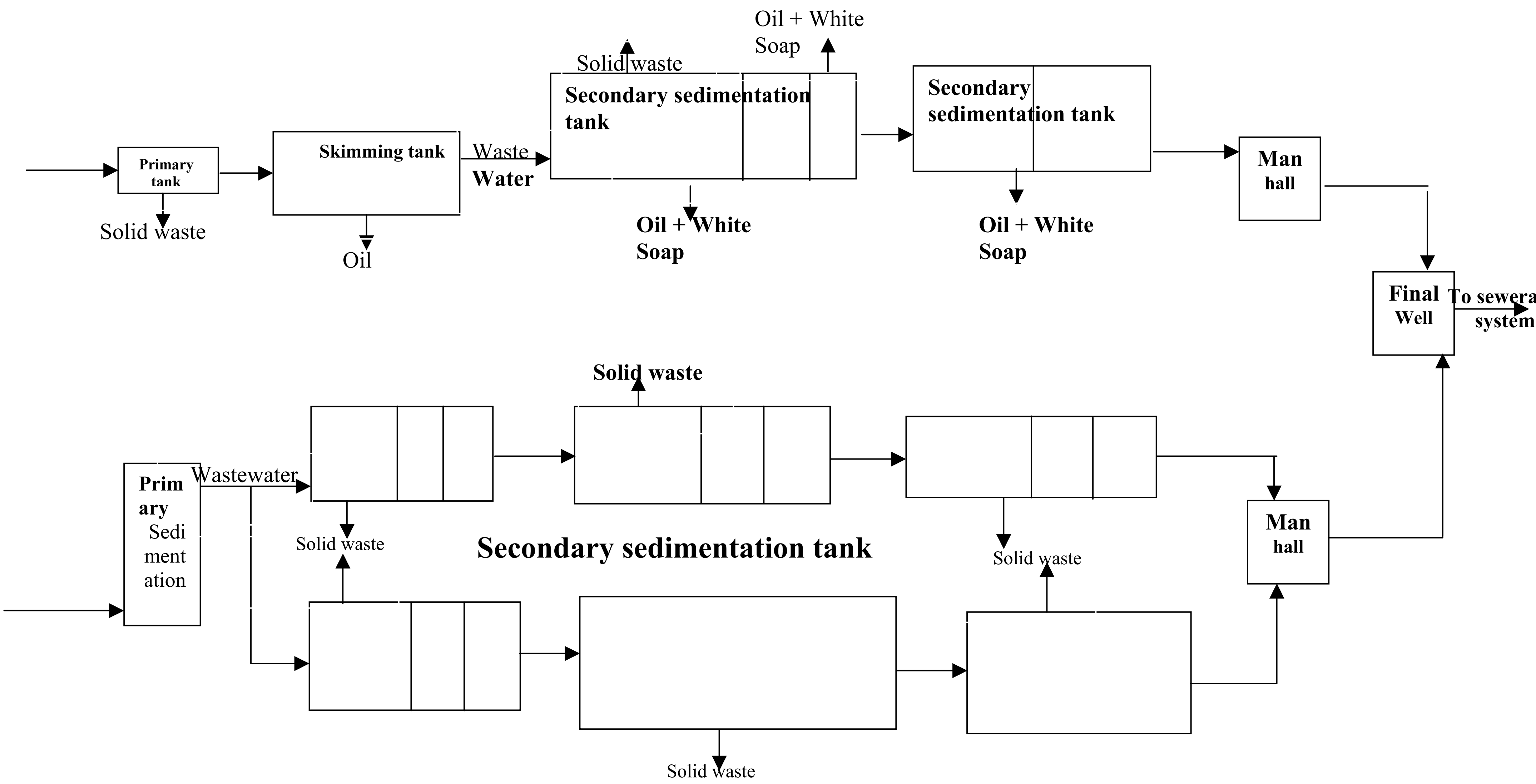


Fig. 4.7Pretreatment of wastewater from (Bittar) :-



3.2.2 El Tawfig Soap Factory: -

Is taken as study area in Omdurman industrial area. The factory uses palm stearin, oleic, palm oil and palm kernel oil for the production of both toilet and laundry soaps. Fig.3.8

Soap can be produced by: - (3)

3.2.2.1 The cold process.

3.2.2.2 The semi-boiled process.

3.2.2.3 The full-boiled process.

The reaction between the fatty materials and the caustic soda solution to produce soap is carried out in cylindrical vessels usually of conical bottoms known as "kettles". For efficient heat utilization they are usually insulated. They are provided with closed steam coils or jackets for heating as well as with open direct steam for stirring. "Killing" is first stage of the process; its objective is to saponify the greater part of the fresh fat charge. Neutral fat "like tallow, stearin, cottonseed oil…etc" and caustic soda solution are immiscible the reaction between them would there fore be slow at first. Since this reaction is autocatlitic, the presence of soap will help speed up the reaction. It is, there fore, usual to boil the lye from the previous batch "known as Niger" first, and slowly add the fresh fat and the caustic soda solution "37 – 40 Be" to the boiling "Niger". One must note here that the reaction can be very fast and a lot of heat is generated and the contents of the kettle may rise. The rate at which the reactants are added to each other is very important within around three hours of boiling 85 – 90 % of the mass is saponified. Towards the end of the "Killing" stage the kettle begins to take up additions of fresh caustic lye more and more slowly. This is an indication that Saponification has gone as for as is practical. But before going to the next stage the content of the kettle should be boiled thoroughly until there is practically no free caustic soda left. Following the Killing stage is “graining out” or“ Salting out” stage. Here the resulting soap is “grained out” of the liquid mass by the addition of a solution chloride “ordinary salt” solution to the boiling mass. Great care must be exercised in obtaining the right concentration of the salt solution. Insufficient salt results in a spent lye-containing al a large amount of dissolved soap. Too much salt in the lye results in “a hard grain” soap holding a greater percentage of water and the excess salt is likely to settle at the bottom of the kettle and create problems in the subsequent operation. On cooling and “standing” the mass will separates into two layers, the soap layer “known as crud” or “grain” at the top and the “spent lye” or “sweet water” at the bottom. This bottom layer is the source of glycerin, which is quite an important by product. To complete the soap recovery the separated soap layer is subjected to a number of wastes by salt solution. In addition to helping soap recovery brine washing also cleans the soap from impurities. The small quantities of neutral fat, which are saponified in the “killing” stage, are saponified in the subsequent “strong” stage. This is carried out in a manner similar to that described in the “graining” stage except that caustic soda is used instead of the salt solution, and the batch is boiled for a longer time. The quantity of glycerin in the resulting lye is very small and it is not economical to try to recover it, but the lye can be used to saponify the next fresh batch of the fats. The final stage in boiling is the “finishing” or “fitting” stage. On settling, the batch will separate into an upper layer of “neat” soap and a bottom layer called “Niger” as mentioned before. The main objective of this stage is the purification of the soap, the bottom layer contains most of the dirt, coloring materials, metallic salt, dissolved salts and alkali. Four to six days are needed for the completion of the full-boiled process, the "neat" soap which about 32 % moisture, is now ready for the cooling and drying. **3.2.2.4 Quantity of wastewater from soap factory: -**

Soap treatment Fig.3.9

Wastewater produced from soap washing (34 tons)

=16 – 18 tons/ batch

3.2.2.5 Solid waste: -

The solid of the study area is generally about 0.5 ton/day collected manually and taken by trucks to dumping area located in the north near the Karry Hill.

3.2.2.6 Gaseous waste: -

From fuel combustion and industrial operations are emitted into the atmosphere by the chimney.

In Factory Pretreatment: - Fig.3.10

(1) Primary sedimentation tank:

Basis of design: - (6)

(1) $T=1.5\text{-}2.5$ hours

(2) $v=0.625\text{-}1.5$ m/hour

(3) $L/W \leq 5$

(4) $H \geq 3$ m

Assume: -

$T=2$ hour & $v=1$ m/hour

$V=20\ m^3/batch$

$Q=V/T=20/2=10\ m^3/hour$

$A=Q/v=10/1=10\ m^2$

$d=V/A=20/10=2$ m

$H=1+2=3$ m

L*W*H

4*2.5*3 m

(2) Skimming tank:

Basis of design: - (6)

(1) T=1-15 min

Assume: -

T=0.25 hour & v=10 m/hour

V=20 m^3/batch

Q=V/T 20/0.25=80 m^3/hour

A=Q/v=80/10=8 m^2

d=V/A=20/8=2.5 m

H=2.5+0.5=3 m

L*W*H

4*2*3 m

(3) Secondary Sedimentation tank:

Basis of design: -

(1) T≥3 hours

(2) v≤1.3333 m/hour

Assume: -

T=4 hour & v=0.5 m/hour

V=20 m^3/batch

Q=V/T=20/4=5 m^3/hour

A=Q/v=5/0.5=10 m^2

d=V/A=2 m

H=1+2=3 m

L*W*H

5*2*3 m

Table 4.3.2 characteristics of the final effluent from (EL Twafig)

Parameter mg/l	BOD	COD	T.S.S	Oil & grease
Inffluent	**131**	**250**	**1180**	**1257**
Effluent	**4**	**10**	**23.5**	**10**
Removal %	**97**	**96**	**98**	**99**

3.3 Experimental Work: -

3.3.1 Sampling: -

Characteristics of wastewater from vegetable oil and soap factories: - Totals of 17 grab samples were collected from two studied factories of different occasion. Of these samples 14 were collected from the soap, Allied Industries Company. Since refining process is batch and it was necessary to collected samples from individual process, and 3 samples were collected from El Tawfig Soap Factory.

3.3.2 Testing: -

3.3.2.1 Characteristic of wastewater from Soap, Allied industries Company: -

(a) Wastewater from oil washing and floor washing (No. of samples=4) were collected and analyzed in terms of **BOD, COD, pH, Temp., Solids and Oil and Grease.**

(b) Wastewater from soapstock washing (No. of samples=4) were collected and analyzed in terms of **BOD, COD, pH, Temp., Solids and Oil and Grease.**

(c) Wastewater from combined final effluent (No. of samples=4) were collected and analyzed in terms of **BOD, COD, pH, Temp., Solids and Oil & Grease.**

(d) Wastewater from treatment plant (No. of samples=2) were collected and analyzed in terms of **BOD, COD, pH, Temp., Solids and Oil & Grease.**

3.3.2.2 Characteristic of wastewater from El Tawfig Soap Factory: -

Wastewater from final effluent (No. of samples=3) were collected and analyzed in terms of **BOD, COD, pH, Temp., Solids and Oil and Grease.**

Fig.3.8 Process flow sheet for El Tawfig Soap Factory

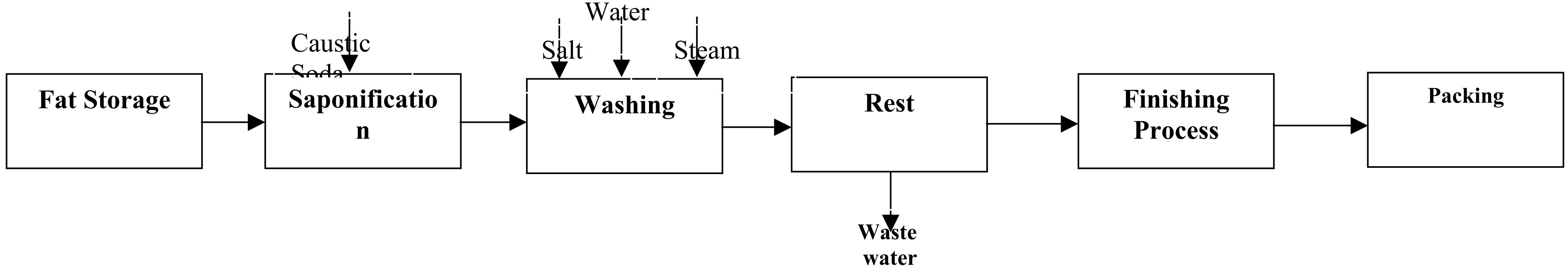


Fig.3.9 Soap Treatment

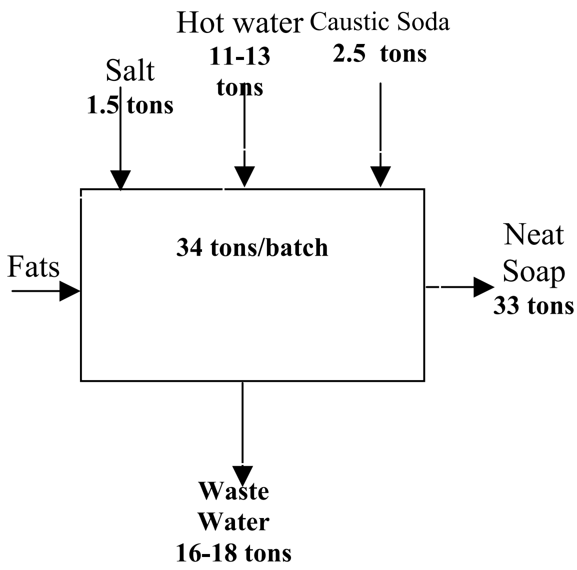
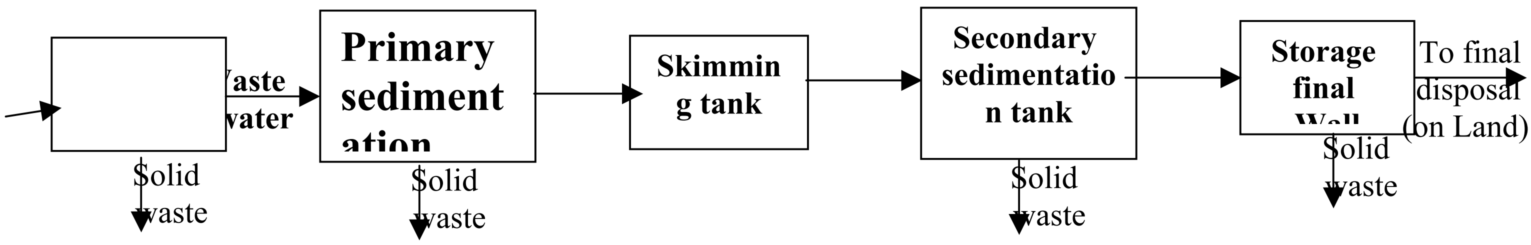


Fig.4-10Pretreatment of wastewater from EL Tawfig Soap Factory



CHAPTER FOUR
RESULTS AND DISCUSSION

4.RESULTS AND DISCUSSION

4.1 Characteristics of wastewater from vegetable oil and soap factories: -

In this investigation, priority was given to the study of the most trouble-some constituents of the wastewater.

4.1.1Soap, Allied Industries Company (Before Pretreatment)

4.1.1.1Wastewater samples from oil washing and floor washing

Table4.1.1.1 Characteristics of wastewater from oil and floor washing

Parameter	Sample
BOD mg/l	610
COD mg/l	1314
pH	10
Temp. ˚C	78
T.D.S. mg/l	24790
T.S.S. mg/l	4225
T.S. mg/l	29015
Oil and Grease mg/l	1212

4.1.1.2Wastewater samples from Soap Stock washing: -

Table4.1.1.2 Characteristics of wastewater from Soap Stock washing

Parameter	Sample
BOD mg/l	662
COD mg/l	1312
pH	7.7
Temp. (°C)	84
T.D.S. mg/l	57747
T.S.S. mg/l	18365
T.S. mg/l	76112
Oil and Grease mg/l	4862

4.1.1.3Wastewater samples from combined final effluent:

Table4.1.1.3 Characteristics of wastewater from combined final effluent

Parameter	Sample
BOD mg/l	480
COD mg/l	905
pH	9
Temp. °C	80
T.D.S. mg/l	61782
T.S.S. mg/l	8280
T.S. mg/l	70062
Oil and Grease mg/l	2499

4.1.1 Soap, Allied Industries Company (After pretreatment)

4.1.1.4 Wastewater samples from oil washing and floor washing

Table4.1.1.4 Characteristics of wastewater from oil washing and floor washing

Parameter	Max.	Min.	Mean	Standard Deviation	Pollutant Kg/batch	Pollutant Kg/ton product
BOD	371	309	340	25.4	0.7	3.3
COD	712	648	680	26.3	1.4	6.6
PH	9.58	7.89				
Temp	46	44	45	0.8		
T.D.S	27687	155176	19423.7	5843.8	40.9	189.4
T.S.S	3400	874	2351.3	1074.9	4.9	22.9
T.S	28561	18188	21775	4801	45.4	212.3
Oil & Grease	848.4	529	647.6	142.8	1.4	6.3

No. of samples=3

Production of oil refining per batch (10tons)=9.75 tons

Flow per batch=2 tons

4.1.1.5 Wastewater samples from Soap Stock washing

Table4.1.1.5 Characteristics of wastewater from Soap Stock washing

Parameter	Max.	Min.	Mean	Standard Deviation	Pollutant Kg/batch	Pollutant Kg/ton product
BOD	369	343	355.7	10.6	9.2	1.2
COD	712	698	698.4	10.9	18.2	2.4
PH	8.15	8.05				
Temp	50	48	49	0.8		
T.D.S	85636	12232	37590	33990.4	977.3	131.6
T.S.S	9430	8300	8963.3	481.8	233	31.4
T.S	94795	20532	46553.3	34147.3	1210.4	162.9
Oil Grease	1928	1419	1678.7	207.9	43.6	5.9

No. of samples=3

Production of Soapstock per batch (10tons)=3.5 tons

Flow per batch=26 tons

4.1.1.6 Wastewater samples from combined final effluent

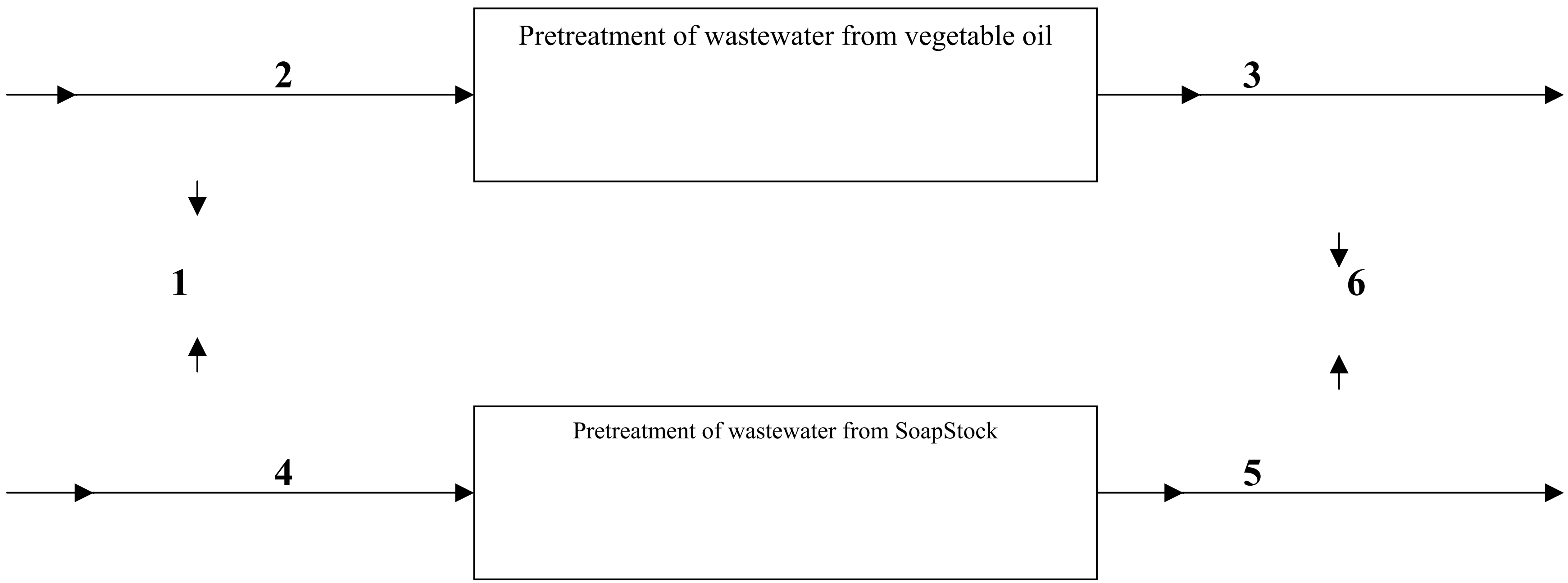
Table4.1.1.6 Characteristics of wastewater from combined final effluent

Parameter	Max.	Min.	Mean	Standard Deviation	Pollutant Kg/batch
BOD	255	223	241.3	13.5	6.8
COD	504	424	470.7	34.0	13.2
pH	8.2	8.06			
Temp	43	40	41.7	1.2	
T.D.S	33858	14914	25433	7874.3	712.1
T.S.S	910	420	723.3	216.4	20.3
T.S	34768	15334	26156.3	8086.4	732.4
Oil & Grease	265	218	248.3	21.5	7.0

No. of samples=3

Flow per batch=28 tons

Fig.4.1.1 Sampling points from Soap,Allied Industries Company



4.1.2El Tawfig Soap factory (Before Pretreatment)

4.1.2Wastewater samples from final effluent:-

Table4.1.2 Characteristics of wastewater from final effluent

meter	Max.	Min.	Mean	Standard Deviation	Pollutant kg/ton product	Pollutant Kg/batch
	131	94	112	15.1	3.7	3.7
	250	185	216	26.6	7.1	7.3
	8.8	7.2				
).	42	40	41	0.8		
;	8020	4071	5398	1854.1	178.1	183.5
	1180	770	1030	184.6	34	35.0
	9160	4841	6428	1940.2	212.1	218.6
& se	1257	927	1116.3	139	36.8	38.0

No. of samples=3

Production of Soap per batch (34tons)=33 tons

Flow per batch=16-18 tons

4.2Liquid waste analysis: -

Table4.2.1Soap, Allied Industries Company in Khartoum North industrial area [After pre-treatment]

Parameter	Max. reads of three samples	Max. limits for discharge in network	Remaks
BOD mg/l	371,369,255	400	Within the limit
COD mg/l	712,712,504	700	Above the limit
pH	9.58,8.15,8.2 7.89,8.05,8.06	9 (max.) 6 (min.)	Witin the limit
Temp. C°	46,50 ,43	40	Above the limit
T.S.S mg/l	3400,9430,910	500	Above the limit
T.D.S mg/l	27687,85636, 33858	2000	Above the limit
Oil&Grease	848.4,1928,265	100	Above the limit

Table4.2.2EL Tawfig Soap Factory in Omdurman industrial area

Parameter	Max. read of one sample	Max. limits for discharge on land	Remaks
BOD mg/l	131	20	Above the limit
COD mg/l	250	30	Above the limit
pH	8.8 (max.) 7.2 (min.)	9 6	Within the limit
Temp. C°	42	40	Above the limit
T.S.S. mg/l	1180	30	Above the limit
T.D.S. mg/l	8020	800	Above the limit
Oil&Grease	1257	10	Above the limit

4.4Discussion

Human activities in the filed of manufacturing industries have been precipitating huge quantities of industrial waste with a wide range in quality and form. They may be in the form of solids, liquids, gases, heat, noise, vibrations, and etc. However the emphasis in the present work are confined to solid, liquid and gaseous wastes.

Unless properly handled, industrial wastes may have serious impact on the biosphere in general and on the immediate environment in particular. This may jeopardize man's health or may render man existence in the biosphere impossible. For reasons of public health and of conservation, the immediate and nuisance-free removal of waste water from its source of generation, followed by treatment and disposal is not only desirable but is vitally important, not only to a limited few individuals or interests, but to many people whose lives and welfare are directly or indirectly affected.

Effluents from vegetable oil and soap factories in Khartoum north industrial area are believed to be the most polluting to the environment. Most of these factories have no pre-treatment units that render the effluents fit for discharge to sewerage system. This situation leads to serious problems, which could be summarized in the following: -

(1)Deterioration of the environment within factories

(a) Blockage in sewer lines inside the factories due to excessive amounts of Oil&Grease, which lead to frequent stoppage of these factories necessitating cleaning of sewer lines.

(b) Creation of bad odors.

CHAPTER FIVE
CONCLUSION AND RECOMMENDATION

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

With reference to table4.1.1.6 it can be concluded that the quantity of the effluents discharged from the studied factory (Bittar) is above the characteristics allowable limits for discharge of industrial waste to the public sewer. Effluents characteristics could be summarized in the following: -

(a) Large quantities of flow.

(b) High pollutants concentration (COD, Temp.,Oil & Grease And S.S.)

With reference to table4.1.2 it can be concluded that the effluents discharged from the studied factory (EL Tawfig) is above the characteristics allowable limits for discharge on land. Effluents characteristics could be summarized in the following: -

(1) Large quantities of flow.

(2) High pollutants concentration (BOD, COD, Temp.,Oil & Grease And S.S)

Consequently, pre-treatment of these effluents is a must, in order to avoid their negative effects on the environment & human health.

Primariy sedimentation tank, skimming tank and secondary sedimentation tanks as pre-treatment processes are capable of a achieving the objective set for it, and has the following advantages: -

(1) 97-96 % reduction in BOD & COD.

(2) 98**%** reduction in oil & grease.

(3) 98.5-98 % reduction in S.S.

5.2Recommendations

In order to avoid the negative impacts of industrial waste in general and the studied factories in particular on the environment, the following recommendations might be taken in consideration for improvement and for further studies: -

(1) Improvement in house keeping in vegetable oil & soap factories to minimize waste resulting from spills, tanks over flow, leaks, etc.

(2) Vegetable oil & soap factories owners must provide at their own expense preliminary treatment comprising skimming and sedimentation before discharging their effluents into the public sewer and on land.

(3) Using central treatment to share the cost of treatment.

(4) The environmental health and the industrial building Communities to follow up the environmental regulation and laws.

(5) Changing the productive processes to continuous instead of batch because it showed minimum oil losses.

(6) By-product recovery in vegetable oil factories e.g. recovery of the fatty material from the soap stock, which can be used as an animal feed, result in a saving to the industry and reduce waste and environmental pollution .

(7) Rehabitation of EL haj Yousif treatment plant as it is now completely inoperational. In order to safey accommodate waste from the Khartoum North Industrial Area.

(8) Change the sewage line from oil washing water sedimentation tank to meet the line entering the segregation basins from the soap making, to recover any oil or semi saponified oil .

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APPENDIX
MAXIMUM LIMITS FOR DISCHARGE OF INDUSTRIAL POLLUTANTS IN THE WATER ENVIROMENT