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Mass Transfer and Hydraulic Testing of the V-05 and V-10 Contactors with the Next Generation Solvent

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EXECUTIVE SUMMARY

The Modular Caustic Side Solvent Extraction (CSSX) Unit (MCU) facility is actively pursuing the transition from the current BOBCalixC6 based solvent to the Next Generation Solvent (NGS)-MCU solvent. To support this integration of NGS into the MCU facilities, Savannah River Remediation (SRR) requested that Savannah River National Laboratory (SRNL) perform testing of a blend of the NGS (MaxCalix based solvent) with the current solvent (BOBCalixC6 based solvent) for the removal of cesium (Cs) from the liquid salt waste stream. This testing differs from prior testing by utilizing a blend of BOBCalixC6 based solvent and the NGS with the full (0.05 M) concentration of the MaxCalix as well as a new suppressor, tris(3,7dimethyloctyl) guanidine.

Single stage tests were conducted using the full size V-05 and V-10 centrifugal contactors installed at SRNL. These tests were designed to determine the mass transfer and hydraulic characteristics with the NGS solvent blended with the projected heel of the BOBCalixC6 based solvent that will exist in MCU at time of transition. The test program evaluated the amount of organic carryover and the droplet size of the organic carryover phases using several analytical methods.

Stage efficiency and mass distribution ratios were determined by measuring Cs concentration in the aqueous and organic phases during single contactor testing. The nominal cesium distribution ratio, D(Cs) measured for extraction ranged from 37-60. The data showed greater than 96% stage efficiency for extraction. No significant differences were noted for operations at 4, 8 or 12 gpm aqueous salt simulant feed flow rates.

The first scrub test (contact with weak caustic solution) yielded average scrub D(Cs) values of 3.3 to 5.2 and the second scrub test produced an average value of 1.8 to 2.3.

For stripping behavior, the “first stage” D(Cs) values ranged from 0.04 to 0.08. The efficiency of the low flow (0.27 gpm aqueous) was calculated to be 82.7%.

The Spreadsheet Algorithm for Stagewise Solvent Extraction (SASSE) predicted equivalent DF for MCU from this testing is greater than 3,500 assuming 95% efficiency during extraction and 80% efficiency during scrub and strip.

Hydraulically, the system performed very well in all tests. Target flows were easily obtained and stable throughout testing. Though some issues were encountered with plugging in the coalescer, they were not related to the solvent. No hydraulic upsets due to the solvent were experienced during any of the tests conducted.

The first extraction coalescer element used in testing developed high pressure drop that made it difficult to maintain the target flow rates. Analysis showed an accumulation of sodium alumino-silicate solids. The coalescer was replaced with one from the same manufacturer’s lot and pressure drop was no longer an issue.

Concentrations of Isopar™ L and Modifier were measured using semi-volatile organic analysis (SVOA) and high performance liquid chromatography (HPLC) to determine the amount of solvent carryover. For low-flow (0.27 gpm aqueous) conditions in stripping, SVOA measured the Isopar™ L post-contactor concentration to be 25 mg/L, HPLC measured 39 mg/L of Modifier. For moderate-flow (0.54 gpm aqueous) conditions, SVOA measured the Isopar™ L post-contactor to be ~69 mg/L, while the HPLC measured 56 mg/L for Modifier. For high-flow (0.8 gpm aqueous) conditions, SVOA measured the Isopar™ L post-contactor to be 39 mg/L. The

post-coalescer (pre-decanter) measurements by SVOA for Isopar™ L were all less than the analysis detection limit of 10 mg/L. The HPLC measured 18, 22 and 20 mg/L Modifier for the low, medium, and high-flow rates respectively.

In extraction, the quantity of pre-coalescer Isopar™ L carryover measured by SVOA was ~280-410 mg/L at low flow (4 gpm aqueous), ~400-450 mg/L at moderate flow (8 gpm aqueous), and ~480 mg/L at high flow (12 gpm aqueous). The amount of post coalescer (pre-decanter) Isopar™ L carryover measured by SVOA was less than 45 mg/L for all flow rates. HPLC results for Modifier were 182, 217 and 222 mg/L for the post-contactor low, medium and high flow rates. The post-coalescer (pre-decanter) samples were measured to contain 12, 10 and 22 mg/L Modifier for the low, medium, and high flow rates.

The carryover results and droplet size measurements were used to determine the decanter performance utilizing the decanter model developed by the ARES Corporation. Results show for the targeted salt flow rate of approximately 8 gpm, that over 93% of the solvent carryover from stripping is predicted to be recovered and over 96% solvent carryover from extraction is predicted to be recovered. This translates to a predicted solvent carryover of <3 ppm from stripping and <20 ppm solvent carryover from extraction. This projected performance at MCU is expected to be well within the operating limits and the historical performance for the baseline BOBCalixC6 based solvent.

Droplet-size data obtained by MicroTrac™ S3400 analyzer consistently shows that the droplet size post-coalescer is significantly greater than the post-contactor or pre-coalescer samples. Increased flow rates did not show a consistent impact to the droplet size results. For the extraction testing, droplet size analysis showed that the post-contactor and pre-coalescer samples were essentially the same. The mean droplet sizes post-coalescer were less than the mean droplet sizes pre-coalescer with a very slight upward trend in the mean droplet size as the flow rate was increased. This result is probably due to the method of sampling. The larger post-coalescer drops immediately rise to the surface after leaving the coalescer element. The downstream sampling point was horizontally in-line with the element and therefore would only capture those organic droplets well mixed in the flowing aqueous stream.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AD	Analytical Development
CF	concentration factor
CRT	contactor residence time
CSSX	Caustic Side Solvent Extraction
CV	Contactor Volume
DAS	data acquisition system
D(Cs)	distribution ratio for cesium= concentration by volume of Cs in organic phase divided by concentration by volume of Cs in aqueous phase
DCiTDG	M N,N'-dicyclohexyl-N"-isotridecylguanidine
DF	decontamination factor
DSS	decontaminated salt solution
DWPF	Defense Waste Processing Facility
ESS	Extraction, scrub and strip
FTIR	Fourier Transform Infrared
HLW	High Level Waste
HPLC	high performance liquid chromatography
ICPES	inductively coupled plasma emission spectroscopy
ICPMS	inductively coupled plasma mass spectroscopy
MCU	Modular CSSX Unit
NGS	Next Generation CSSX Solvent
NTU	Nephelometric turbidity units
O:A	organic-to-aqueous volume ratio
ORNL	Oak Ridge National Laboratory
P&ID	Piping and Instrument Diagram
PSD	Particle Size Distribution
SASSE	Spreadsheet Algorithm for Stagewise Solvent Extraction
SCFM	standard cubic feet per minute
SE	strip effluent
SRNL	Savannah River National Laboratory
SRR	Savannah River Remediation, LLC
SRS	Savannah River Site
SVOA	semi-volatile organic analysis
TiDG	tris(3,7dimethyloctyl) guanidine hydrochloride
TOA	trioctylamine
TTQAP	Task Technical Quality Assurance Plan
TTR	Technical Task Request
VFD	variable frequency drive

1.0 Introduction

A solvent extraction system for removal of cesium (Cs) from alkaline solutions was developed utilizing a novel solvent developed at Oak Ridge National Laboratory (ORNL).[1] This solvent consists of a calix[4]arene-crown-6 (calixarene) extractant dissolved in an inert hydrocarbon matrix. Modifier is added to the solvent to increase the solubility of the calixarene and to prevent the formation of a third phase. An additional additive, the suppressor, is used to improve stripping performance by mitigating, or suppressing, the effects of any surfactants present in the feed stream.[2] The process that deploys this solvent system is known as CSSX. The solvent system has been deployed at the Savannah River Site (SRS) in the MCU since 2008. Figure 1-1 below shows a simplified process diagram for the current MCU process.

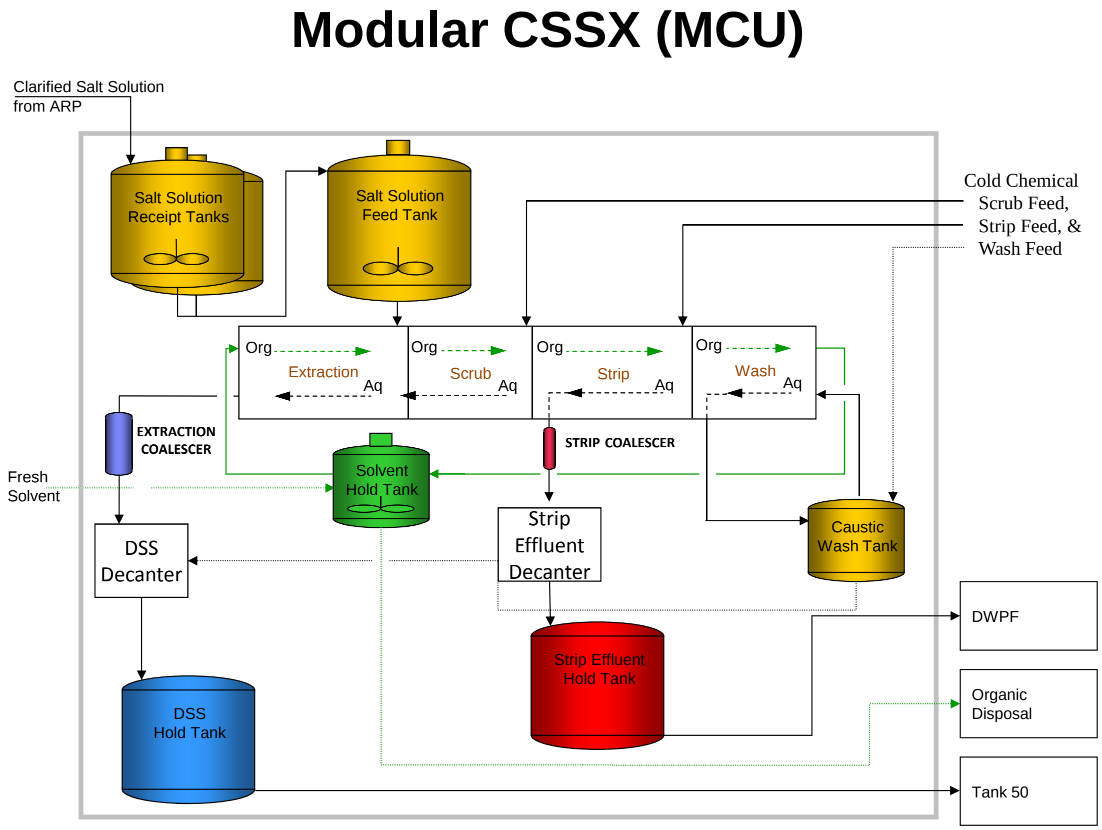

Figure 1-1. Modular CSSX (MCU) Simplified Flow Sheet.

From its radioactive start-up in April 2008 until the end of May 2013, MCU processed approximately 3.6 million gallons of high-level waste (HLW) solution for disposition. The decontaminated salt solution (DSS) is sent to the SRS Saltstone Facility and the concentrated Cs strip effluent (SE) stream is transferred to the Defense Waste Processing Facility (DWPF).

MCU uses centrifugal contactors from CINC® for cesium extraction (10 inch rotor or “V-10”) and for solvent scrub and solvent strip stages (5 inch rotor or “V-05”) to provide mechanical mixing and phase separation between solvent and aqueous waste solutions. The process involves two separations. The first separation extracts Cs from waste solutions into the solvent system; the second separation strips Cs from the solvent into an aqueous phase while providing a nominal Cs concentration factor (CF) of 15. The current strip solution is a dilute nitric acid. NGS will use boric acid for the strip. Between the two cesium transfer processes the solvent is “scrubbed” via contact with dilute nitric acid. The NGS will use a mild caustic solution for the scrub. The purpose is to remove competing cations (K^+, etc.) and to adjust the pH, thereby making the acid strip process more effective. Additionally, the solvent stream is washed to remove impurities and solvent degradation products. Note that the wash was not performed the testing described in this report.

Subsequent development efforts by ORNL have identified an improved solvent system that can raise the expected decontamination factor (DF) in MCU from ~200 to potentially more than 40,000[3]. The improved DF is attributed to an increased distribution ratio for cesium [D(Cs)] in extraction from ~15 to ~50 (at 50 mM extractant concentration), due to an increased solubility of the new extractant (MaxCalix) in the solvent from 0.007 M to ~0.050 M, and the use of boric acid (H_3BO_3) for stripping that yields D(Cs) values less than 0.01. Additionally, the changes incorporated into NGS are intended to reduce solvent entrainment. The NGS solvent contains four components:

- 0.050 M 1,3-alt-2S,27-Bis(3,7-dimethyloctyloxy)-calix[4]arene-benzocrown-6, also known as MaxCalix, is the extractant,
- 0.50 M 1-(2,2,3,3- tetrafluoropropoxy)-3-(4-sec-butylphenoxy)-2-propanol, or Cs-7SB, is the Modifier,
- 0.003 M N,N',N"-Tris(3,7-dimethyloctyl)guanidine, or TiDG, is the suppressor, and
- C_{12}-isoparaffinic hydrocarbon, or Isopar™ L, is the diluent.

Based on ORNL recommendations and testing[4] showing similarly improved DFs, SRR plans to initially blend the NGS with the existing BOBCalixC6 based solvent for use in MCU. Both the existing MCU BOBCalixC6 based solvent and the NGS solvent consist of extractant, modifier and suppressor dissolved in an Isopar™ L diluent. A concentrated NGS solution will be added to the existing solvent heel in MCU at time of transition to prepare blended solvent. This projected blend was used for the testing described in this report. As solvent is depleted, make-up material added will be the NGS components as part of a normal solvent addition cycle at MCU. Over time, all of the BOBCalixC6 and trioctylamine (TOA) will be depleted, leaving only NGS constituents.

The improved solvent extraction system was validated by the Savannah River National Laboratory (SRNL) in a small-scale integrated demonstration using actual SRS high-level waste.[5] In addition, SRNL completed testing with single full scale contactors demonstrating the improved solvent formulation.[6] MCU is actively pursuing the transition from the current BOBCalixC6 based solvent to the NGS solvent. To support this integration of NGS to MCU, SRR MCU-NGS Implementation Project requested that SRNL perform testing of the new solvent for the removal of Cs from the liquid salt waste stream. The new solvent has been shown to improve the decontamination of Cs from the liquid salt waste material; however, understanding of the hydraulic and mass transfer properties of this solvent is required at a larger scale prior to utilization of the material in the MCU process. Additionally, SRNL was tasked with characterizing performance of both a stripping coalescer (20 inch long, 10 micron pore size) and an extraction coalescer (40 inch long, 20 micron pore size). These objectives were achieved through the analysis of droplet size distributions upstream and downstream of the coalescer using standard analytical methods. SRR issued a Task Technical Request (TTR) (HLE-TTR-2012-010) for this study.[7] The key differences between this task and the previous single-contactor full-scale testing include the blend of the BOBCalixC6 based solvent with the NGS, a full strength MaxCalix (previous testing used 0.02 M) and a different suppressor (TiDG versus DCiTDG in the previous testing).

The pilot-scale test facility contains a single full-scale V-10 contactor, a single full-scale V-05 contactor, and full-scale coalescer housing to test two different elements. Due to the limited space and volume of organic solution, the test facility was designed to focus on two aspects of contactor operation in separate tests, mass transfer and hydraulic. The first aspect is the Cs mass transfer, using sequential tests for the extraction, scrub, and strip processes. The second aspect is to quantify the organic carryover during hydraulic operation, using separate tests for the extraction and strip processes. All of these tests were performed with the same test facility by using the appropriate contactor and coalescer for each.

2.0 Task Requirements

Testing goals were established in the Task Technical and Quality Assurance Plan (TTQAP) for the MCU NGS Implementation Coalescer and Contactor Testing[8] and the Savannah River Remediation, LLC, TTR HLE-TTR-2012-010, Revision 1[7]. The requirements are summarized below.

Equipment

- The test facility included the same two contactors installed in SRNL from previous testing.[6] The critical dimensions of the V-05 and V-10 contactors installed for testing at SRNL were verified. The critical dimensions included the vane height, vane diameter, and rotor gap.
- The V-05 contactor utilized a 2.6 inch aqueous weir and the V-10 contactor utilized a 5.1 inch aqueous weir. These weir sizes were used throughout testing.
- SRNL performed coalescer testing using the existing test housing supplied by SRR (originally from testing at Wright Industries), except with a glass center section that was designed and built by SRNL.

Operation

- The contactors were tested sequentially.
- The decant tank was externally heated for operations at 33 ± 3°C as required for strip tests. Temperature control was also provided to operate the extraction tests at 23°C ±3°C.
- SRNL performed cesium mass transfer testing. The mass transfer testing replicated extraction, scrub, and strip operations at three flow rates, i.e. low, medium, and high.
- The initial coalescer feed was dispersed prototypically by the use of a contactor operating at typical design conditions.

Simulants

- SRNL operated a V-05 (Scrub and Strip) and V-10 (Extraction) contactor with a blend of BOBCalixC6 based solvent and improved NGS-MCU utilizing TiDG guanidine. The contactor operations used solvent components supplied by SRR with the solvent blend mixed by SRNL.
- V-10 operations used a nominal 5.6 M sodium salt solution (for extraction) made to a Tank Farm Engineering supplied recipe. V-05 testing used a 0.01 M boric acid solution or a 0.025 M sodium hydroxide solution (for strip and scrub operations, respectively).
- The salt solution was spiked with cesium nitrate (nominally 75 mg/L cesium concentration).

Sampling

- All four streams (solvent, salt solution, dilute caustic and H_3BO_3) to the respective contactor were sampled and analyzed for cesium transport as required. Samples were taken at approximately six (6), seven (7), eight (8), and/or ten (10) contactor residence times (CRT), depending on the flow rate as listed in the test matrix.

- Studies have measured flow dependent organic carryover including pre-coalescence and post-coalescence droplet size measurements through sampling post-contactor, before and after the coalescer.

2.1 <u>Quality Assurance</u>

Requirements for performing reviews of technical reports and the extent of review are established in manual E7 2.60. SRNL documents the extent and type of review using the SRNL Technical Report Design Checklist contained in WSRC-IM-2002-00011, Rev. 2.

3.0 Experimental

3.1 <u>Test Facility</u>

3.1.1 *General Arrangement*

Figure 3-1 shows a simple schematic of the flow loops and locations of sample points. Samples were also collected from the feed and receipt tanks.

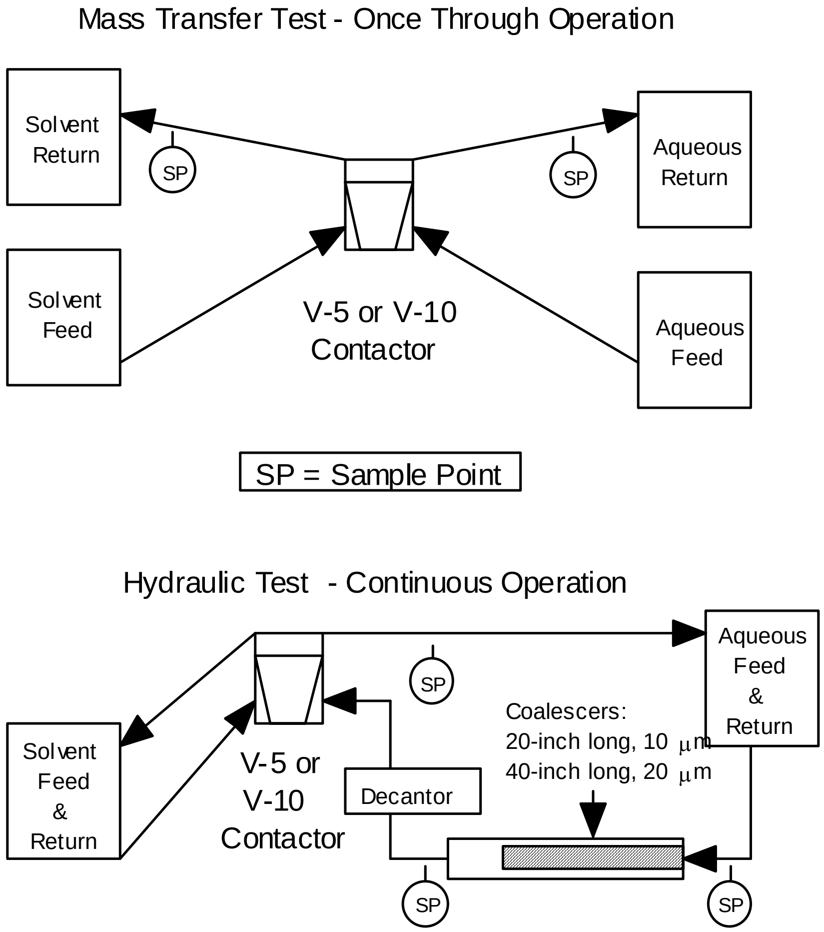

Figure 3-1. Test Facility Arrangement for Each Test Mode

The sample ports for this testing differed from the original test rig used in the 2011 tests. The original locations were on the bottom of the tubing and coalescer housing. It was believed that the location biased the samples from that testing low for organic carryover since the organic would rise as it separates. Collecting samples for the bottom of the flow field would result in the minimum organic in the flow stream. The ports on the contactor outlet and the coalescer inlet were modified by placing an extension in the piping tee to allow the sample to originate from the lower third of the tubing instead of off the bottom. The coalescer outlet sample port was moved to mid-stream of the coalescer. The new coalescer sample location relative to the 40" coalescer is shown in Figure 3-2.

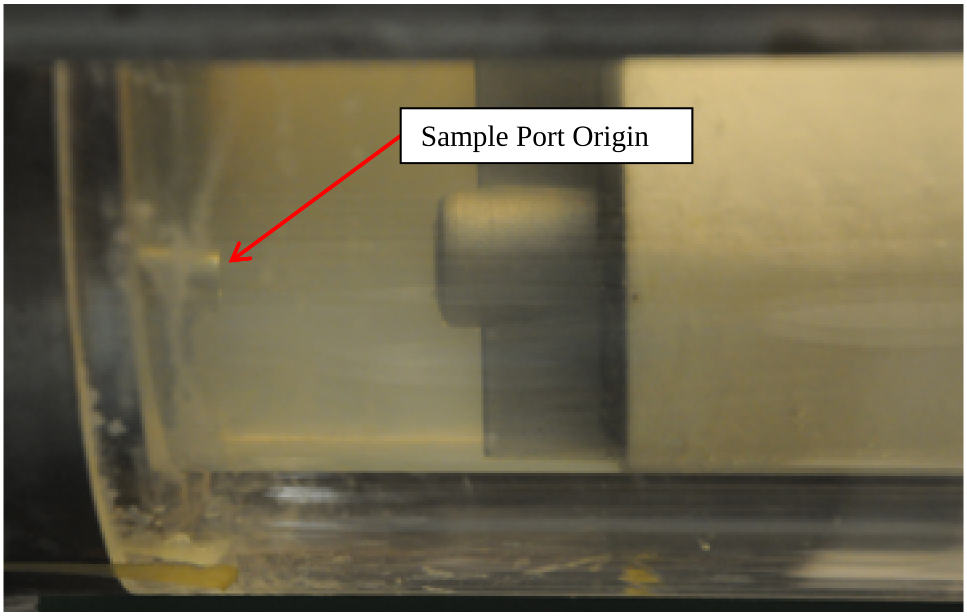

Figure 3-2. Coalescer Outlet Sample Port Location

Details of the test system are shown in the Piping and Instrument Diagram (P&ID), Figure 3-3. A contactor is depicted near the lower center of the P&ID, which is the dividing line between the organic and aqueous flow loops.

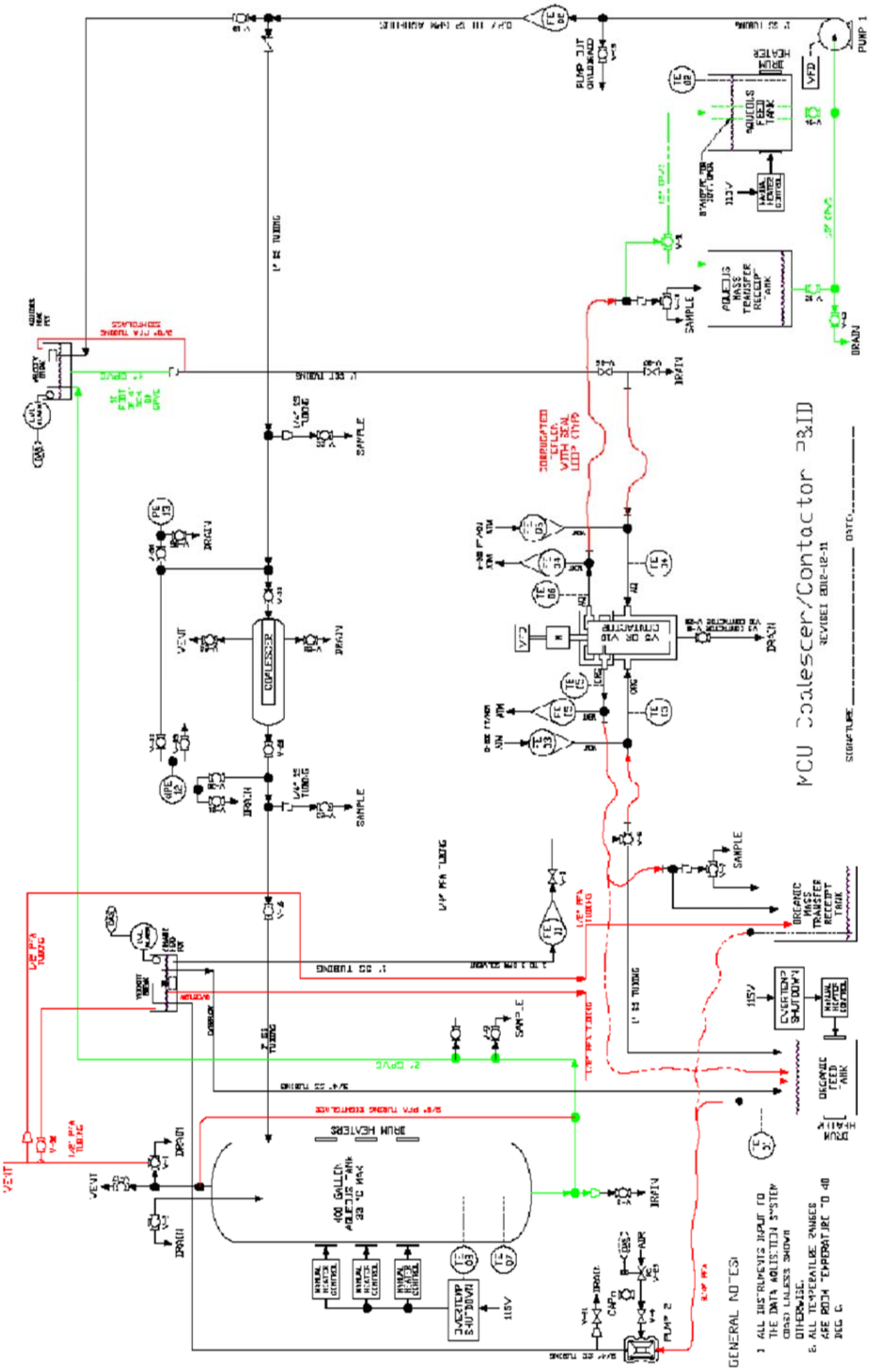

Figure 3-3. Piping and Instrument Diagram for Test System.

The two loops have a common meeting point in one of the two contactors, only one of which is used at a time. The V-10 contactor (10 inch diameter) is used to extract primarily Cs from an aqueous waste stream. The V-05 (5 inch diameter), is used to either scrub the post extraction solvent with a mild caustic or to strip the extracted Cs.

To measure the effectiveness of contactor operation, testing was conducted in two key areas; mass transfer and hydraulic. During mass transfer testing, the test facility is operated in a once-through fashion of both solvent and aqueous during which timed samples are taken to measure the transfer of Cs. For hydraulic operation the organic and aqueous streams are circulated closed loops and are operated in a continuous mode to demonstrate the pressure drop across the coalescer. Samples are collected at the contactor outlet, and the inlet and outlet of the coalescer to understand the organic carryover into the aqueous streams.

The two principal pieces of equipment under study are the contactors and the coalescer. These components are explained in greater detail below.

3.1.2 *Contactors*

The CINC® contactor utilizes the centrifugal force generated by the rotation of an object about a central axis, see Figure 3-4.[9] By spinning two fluids of different densities within a rotating cylinder, or rotor, the denser fluid (aqueous) is forced to the wall at the inside of the rotor while the less dense fluid (solvent) is forced toward the center of the rotor. As additional fluid is introduced to the rotor, the fluid within the rotor is forced upward to the rotor underflows and weirs. The less dense fluid flows toward the center of the rotor where it exits the rotor over the lighter phase weir through the lighter phase outlets. The more dense fluid continues up the rotor through the underflows, then exits over the heavy phase weir. Each fluid is collected in its own collector ring and then leaves the separator through the heavy and light phase outlets.

In Figure 3-4, the mixed fluid is shown in green, the lighter phase fluid in yellow and the heavier phase fluid in blue. The fluids mix in the annulus between the rotor and the inside of the housing in the mixing zone. The fluids are then fed through an inlet or hole at the bottom of the rotor. A diverter plate or disk is used to direct the fluid to the inside of the rotor sleeve (shown in gray).

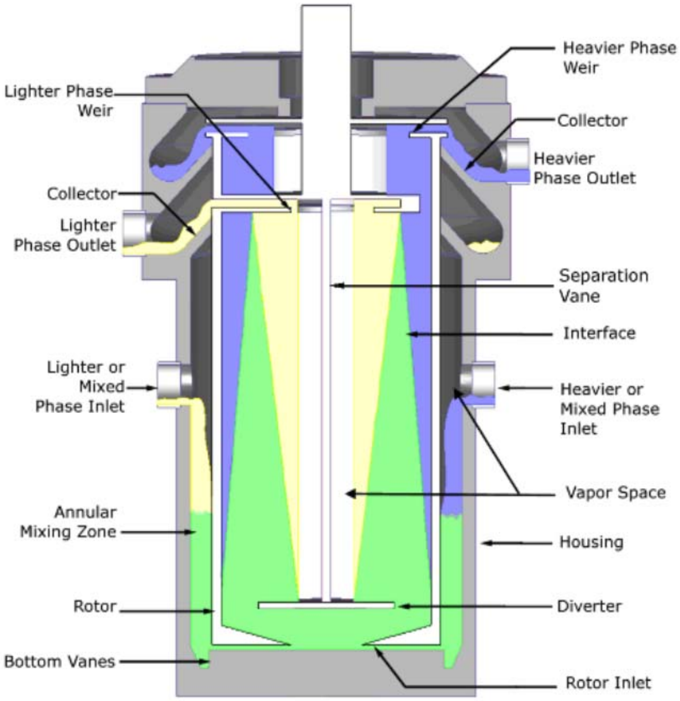

Figure 3-4. Contactor Operation

[CINC® Industries–Theory of Operation (Used with permission obtained on 05-13-2013)]

The V-05 and V-10 contactors are the same as those used at Wright Industries for testing of the CSSX process.[10,11] The contactors are shown in Figure 3-5.

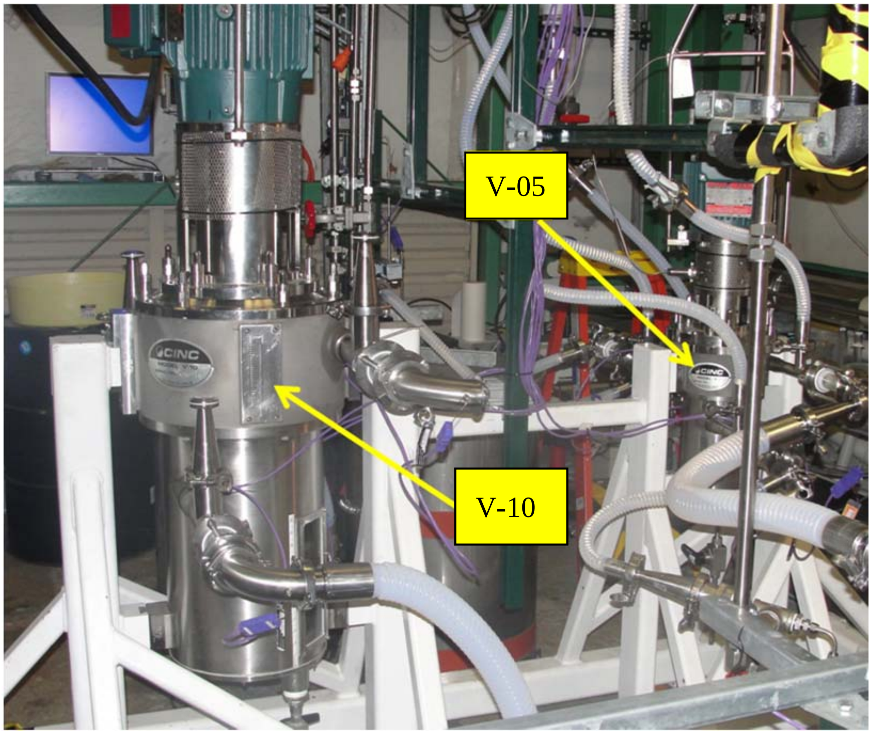

Figure 3-5. Full-Scale V-05 and V-10 Contactors in the Engineering Development Lab

Prior to testing, each contactor was disassembled to verify proper weir sizing and general internal condition (i.e., the heavier phase weirs can be changed to match to flow conditions). The size of the existing V-10 aqueous weir, 5.1 inches (1012320-2), was verified to be the desired size for this testing. The V-05 had a 2.7 inch aqueous weir that was replaced with a 2.6 inch aqueous weir (0512320-2) which was the size desired for this testing.

The gap between the contactor rotor and the vanes of the bottom plate was measured for both contactors. The measurement was performed by removing the bottom plate from the contactor and placing a small amount of epoxy putty between plastic sheets and placing the putty on each vane. The plastic sheet was used to prevent the putty from bonding to either the rotor or vane. The rotor was then carefully re-installed. The bottom plate was allowed to set for one to two minutes and then carefully removed. The putty was allowed to cure for several hours and then measured using a hand micrometer. The appropriate gaps, per the TTR, were 0.039” + 0.010” /- 0.015” for V-05 and 0.049” ± 0.010” for the V-10. The resulting measurements were in the acceptable range and are shown in Figure 3-6 for the V-05 and Figure 3-7 for the V-10.

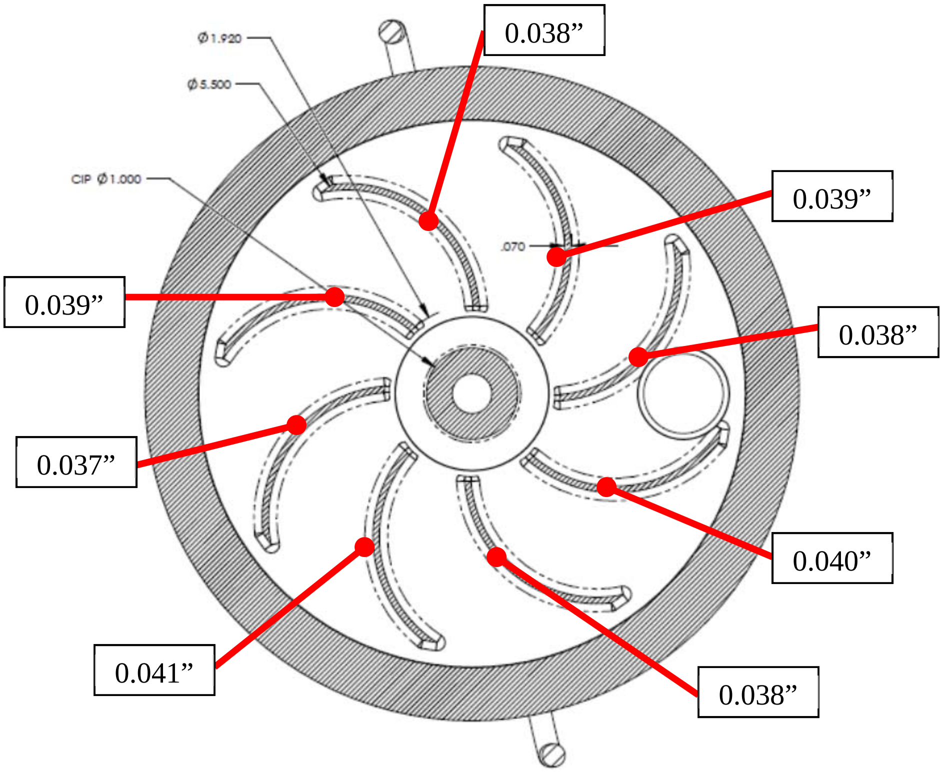

Figure 3-6. Measured Gaps between the V-05 Rotor and Vanes

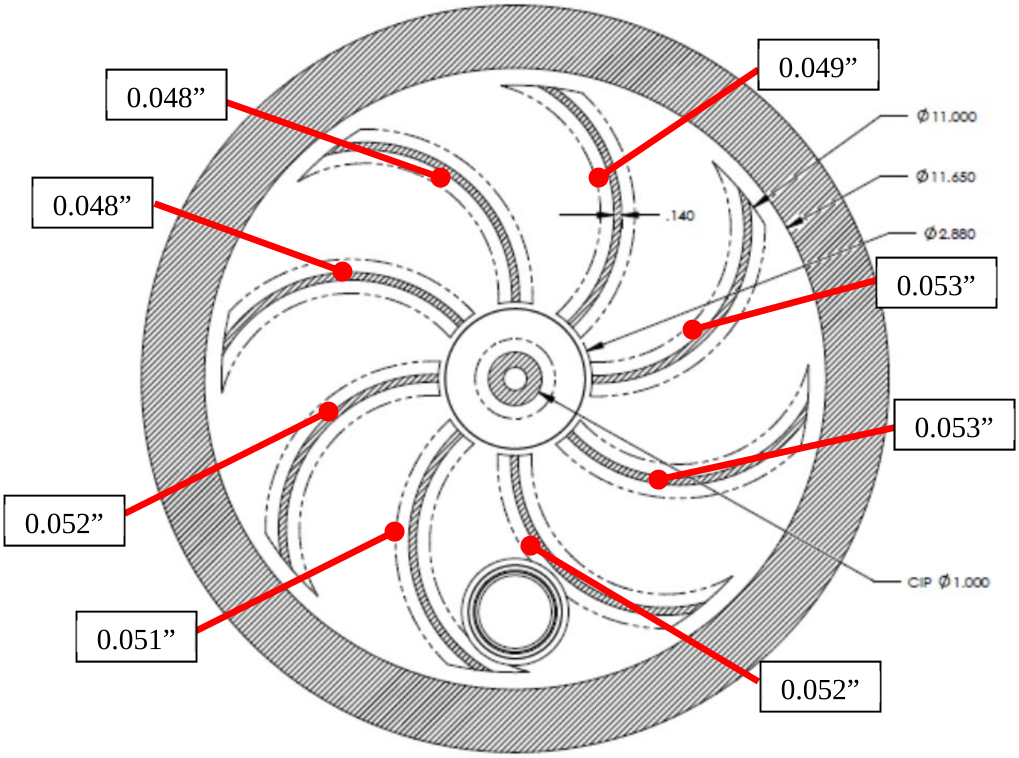

Figure 3-7. Measured Gaps between the V-10 Rotor and Vanes

The bottom vanes enhance mixing of the two liquid streams entering the contactors. Figure 3-8 is a photo of the bottom plates showing the vanes for each contactor. The height of the vanes was measured using a hand micrometer. Vane heights were measured to range between 0.440” and 0.450” for the V-05 and ranged from 0.976” to 0.996” for the V-10. The diameter of the vanes was measured to be 5.165” for the V-05 and 11.030” for the V-10. These measurements matched the anticipated heights found in the manufacturer drawings and Supplier Deviation Disposition Request as referenced in the TTR.[7]

Figure 3-8. Bottom Plate Vanes at the Bottom of the Contactor Housing.

Other information on the contactors is given in Table 3-1.

Table 3-1. Contactor Salient Features

Contactor	Heavy Phase Weir Size (Diameter), inches	Bottom Vane Design	Variable Frequency Drive (VFD)
CINC® V-05	2.60” Weir, PN 0512320-2	High Mix	Leeson PN 174919
CINC® V-10	5.10” Weir, PN 1012320-2/5.10	High Mix	Leeson PN 174552

For previous testing[6], both contactors were given a thorough cleaning consisting of rinses with acid and Isopar™ L. After this cleaning, samples were collected and analyzed by Fourier Transform Infrared (FTIR) for impurities. The level of cleanliness was found acceptable for pilot-scale testing.[6] For the current test program, the contactors, and the associated flow system, were given a thorough cleaning with 1 M nitric acid, rinsed with water (aqueous loop) and rinsed with water followed by solvent (for the solvent loop). No further testing for impurities was deemed necessary.

3.1.3 *Coalescer*

A coalescer housing originally installed allows the use of a 20 inch or a 40 inch coalescer element as required per the test matrix. The coalescer housing with a 20 inch element is shown in Figure 3-9.

Figure 3-9. Coalescer in Acrylic Housing with 20 inch Coalescer Element.

The main housing was fabricated of glass (with an acrylic outer pipe to meet ASME B31.3 piping requirements). This design allowed real-time visual observations of solvent coalescence. This design feature proved invaluable in understanding some of the droplet size data and carryover data. The coalescers were supplied by Pall®, and are constructed of polyphenylene sulfide. The coalescers used in testing met the MCU purchase specifications. Testing sizes included a 20 inch with 10 micron pores (Part Number T5512, Item RLS2FPS100) and 40 inch with 20 micron pores (Part Number T5524, Item RLS4FPS200). Note that there is no pre-filter to the coalescer as there is in MCU.

3.1.4 *Tankage*

Shown in the P&ID, Figure 3-3, the aqueous side of the test rig consisted of three tanks: For the mass transfer tests only, the feed and receipt tanks were used. Both of these tanks have 26 inch inside diameters and are 37 inches tall, or a volume of 85 gallons (see Figure 3-10 and Figure 3-11). The hydraulic tests used the Feed tank and the Decanter tank (~400 gallons, see Figure 3-12).

The solvent side required only two tanks. For the mass transfer test both feed and receipt tanks (both have a 22.5 inch inside diameter and are 34 inches tall, or a volume of 58 gallons) were employed (see Figure 3-13). The continuous loop hydraulic tests recirculated the solvent back to the solvent feed tank, which is shown on the left side of Figure 3-13.

Figure 3-10. Side view of the Aqueous Feed (left) and Receipt (right) Tanks

Figure 3-11. Top view of the Aqueous Feed (left) and Receipt (right) Tanks

Figure 3-12. Coalescer, Lower Foreground, with 400-gallon Decanter in Rear

Figure 3-13. Side View of the Organic Feed (left) and Receipt (right) Tanks

3.1.5 *Pumps*

Two pumps were required for the system, one for the aqueous side and one for the solvent side. The information for the two pumps is shown in Table 3-2.

Table 3-2. Pumps

PUMP	Manufacturer	Model	Controller (2)
1	Teel (Grainger)	2P392 (1)	VFD-Leeson PN 174919
2	Wilden	T2/SSPPB/TNU/TF/STF	Controlled by manual (3) air valve

(1) One of several models used due to seal failures, but all utilized a 3 hp motor
(2) A system upset, e.g., simulant overflow, automatically shut off the pumps
(3) Upstream of valve was a computer-controlled valve for emergency shutdown

Pump 1 was a 3 hp centrifugal pump and controlled through by a variable frequency drive (VFD) and calibrated from 0 to 14.75 gpm. The VFD was controlled by the Data Acquisition System (DAS). If an alarm (e.g., head pot overflow) occurred during testing, the computer would automatically cut power to the pump. Pump 2 was an air-driven double diaphragm positive displacement pump, and all wetted parts were either stainless steel or Teflon™ to be compatible with the organic solvent. This pump was controlled through V-4, a manual valve which metered air. Additionally, air was sent to V-4 via an electrically controlled valve, V-29. This valve was controlled by the DAS to provide safety shutdown upon head pot overflow.

3.1.6 *Head Pots*

Head pots were used on both the aqueous and solvent sides, Figure 3-14 and Figure 3-15. Both the aqueous and organic streams were pumped up to their respective pots and then by keeping the liquid level steady in each pot the flow rate was controlled by the liquid head and the pressure drop within the contactor as it was fed through gravity. Furthermore, by allowing the simulant to first travel to the pots open to the atmosphere, any air in the system would separate at this location. The simulant would then drain from the pots to the contactor. Each pot had a camera to provide visual feedback and monitor the height of the liquid-air interface and thereby the flow rate.

While the concept of the head pot operation was the same for both, the control of flow was slightly different. For the organic pot, the liquid level was kept just above the ½-inch Teflon™ PFA overflow tube, seen in the middle of Figure 3-14, and just below the stainless steel overflow tube, seen in the rear. For the aqueous pot, the simulant level was always maintained below the pot in the 4 inch air separation tube, seen at the bottom of Figure 3-15. The aqueous stream flow rate was much higher than the organic simulant during extraction, totaling up to 12 gpm. By having a 4 inch stand pipe with a parallel liquid level site gauge, the liquid level could be easily monitored so the pot would not overfill. Both pots were equipped with float type liquid level sensor to indicate the overflow level. If the predetermined overflow level was reached, an alarm was sent by the computer and the test facility would be automatically shut down by tripping the pumps and contactor.

Figure 3-14. Organic Head Pot

Figure 3-15. Aqueous Head Pot

3.1.7 *Air De-entrainment Column*

The test system included a 4 inch CPVC de-entrainment column that was 10 feet long as shown in Figure 3-16. During operation the liquid level was monitored with the transparent tube that ran the height of the tube to maintain it constant.

Figure 3-16. De-entrainment Column and Liquid-level Gauge into the Aqueous Head Pot

3.1.8 *Decanter*

To provide solvent/aqueous phase disengagement, a decanter was used (labeled 400 gallon Aqueous Tank) that was designed in a previous test.[6] The intent of the decanter was to be of sufficient diameter to minimize the superficial flow velocity of the bulk fluid, and consequently the flow velocity of buoyant solvent during hydraulic testing. As simulant enters the decanter, heavier aqueous solution moves to the bottom of the vertical vessel, shown in Figure 3-12, to be recirculated while most of the lighter solvent floats to the top where it is trapped to be recovered after testing. Any solvent that manages to leave the decanter through the bottom drain must be very small droplet size to be carried by the flow streamlines. Note that no effort was made in these tests to replicate MCU Strip Effluent or Decontaminated Salt Solution decanters design and operation.

3.1.9 *Heaters*

Heaters were required to maintain the 33°C ±3°C for strip test conditions. All heaters used were 1000-Watt (external) band heaters, and were installed on the Aqueous Feed Tank, the Solvent Feed Tank, and the 400 Gallon Aqueous Tank. They can be seen as the orange bands visible nearer to the lower portions of the tanks in Figure 3-10, Figure 3-13 and Figure 3-12, respectively. The power inputs to the heaters were controlled manually by monitoring the temperatures and adjusting the power to each heater to maintain required temperature. For the extraction and scrub tests the target temperature was 23°C ±3°C; therefore, heating was not necessary except on very cold mornings. After a test began, the ambient temperature and pump heat was sufficient to maintain the temperature. Cooling was not available for any of the tanks.

3.1.10 *Instrumentation*

All of the installed instrumentation used is listed in Appendix A. Test facility measurements are categorized in Table 3-3. Some key details are given below and the locations are show in Figure 3-3.

Table 3-3. Measurement Available on Test Facility

Organic Flow Loop	
Liquid Flow	To contactors
Air Flow	To and from contactors
Temperature	Feed Tank, Inlet and Outlet of the contactors
Aqueous Flow Loop	
Air Flow	To and from contactors
Temperature	Feed Tank, Inlet and Outlet of the contactors, Decanter
Pressure	Gauge of Coalescer Feed, Differential across Coalescer
Turbidity	Inlet and outlet of Coalescer
Speed	Rotors

Liquid Flow

A magnetic flow meter was used to measure the aqueous flow and was located in the vertical section of the discharge line from Pump 1. The organic flow rate was measured with a turbine flow meter located just upstream of valve V-6 and was gravity feed from the head pot.

Air Flow

Hot wire anemometers were installed to measure the influent and effluent of air from the vents on the contactors, and provided readings in standard cubic feet per minute (SCFM). Figure 3-17 shows the four meters that were installed between, and above, the two contactors. These meters were used for both contactors; therefore, they were only connected to the appropriate contactor for testing. For example, Figure 3-17 shows them connected to the V-05 contactor. It was important that the lines not to be restrictive so that the movement of air in and out of the contactors was as free as possible. The U-tube shown at the top of Figure 3-17 was installed to give the air movements a parallel path to flow to help reduce the air pressure drop. The tubing sizes were evaluated prior to testing. Based on data from the 2011 tests[6] and anticipating similar flow rates, it was determined that the tubing size was sufficient.

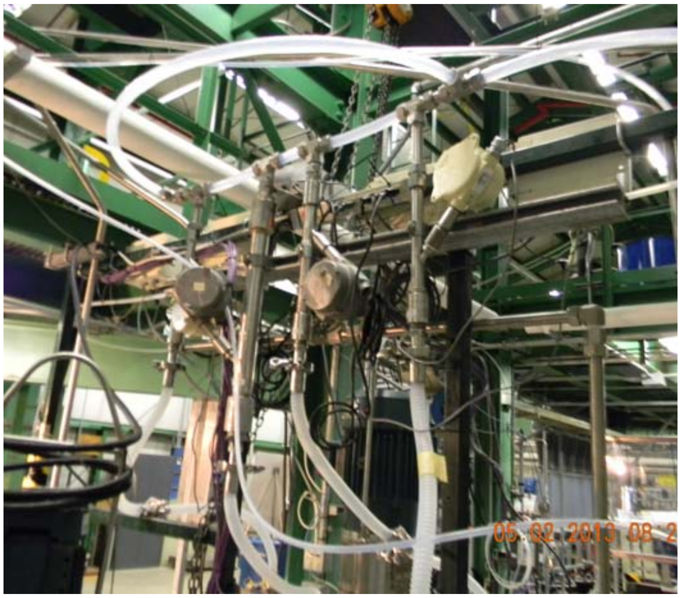

Figure 3-17. Four Hot-wire Anemometers to Measure Air Flow

These devices were calibrated for a previous test[6], and they were checked against a rotameter to verify readings in the expected test range. Readings obtained during the evaluation check were within 5% of the DAS readings, indicating that the anemometers were operating correctly.

Temperature

Twelve Type E thermocouples were utilized throughout the test facility because the requirement for testing had two target temperatures (i.e., 23°C and 33°C) to match operating conditions in the plant. The tolerance for these targets was ±3°C. Before starting any experiment it was important for the feed tanks (i.e., organic and aqueous) to be mixing, to avoid reading a stratified temperature.

Pressure

Two measurements of pressure were made; the gauge pressure of the aqueous feed to the coalescer and the differential pressure across the coalescer. As seen in Figure 3-3, three pressure ports (i.e., one gauge pressure transducer and two for differential pressure transducers) all had drain valves. Each time a simulant was changed on the aqueous side of the test facility the pressure transducer lines were purged to ensure there was no solids accumulation that could create plugs (e.g., from precipitation) when changing from an acid to a caustic. The purge also ensured the lines were free of gas bubbles. Since the lines were at different elevation, a different density fluid would also affect the measurements; therefore, a line purge maintained the pressure transducer line filled with the same fluid already in that section of the test facility.

Turbidity

During testing, whenever a SVOA sample sequence was taken from the three sample points shown in Figure 3-3, two additional samples were taken from the two sample points on either side of the coalescer. Those samples were allowed to sit for about five minutes to permit any air to escape and then the turbidity was measured in each sample. This method differed from the previous testing where turbidity was measured at the inlet of the aqueous head pot. This was done to reduce the impact of entrained air on the measurement.

Contactor Speed

The rotational speed of the contactors was set by the DAS per the test matrix but was verified with a calibrated hand-held tachometer. After starting a contactor, allowing it time to build speed and come to steady state, the speed was measured before testing began. Periodically, the speed would be rechecked to see if it changed. These measurements were not included in the DAS, but were documented in the task notebook.

All the instrumentation was in calibration per SRNL procedures prior to testing. All instruments were calibrated to within manufacturer's stated tolerances.

3.1.11 *Data Acquisition System*

Signal processing and control was accomplished using an IBM compatible PC running National Instruments Labview® software. The signal hardware used included the following components:

SCXI-1000 4 slot chassis, with SCXI 1600 USB Control Module,
SCXI-1102B, 32 Channel T/C and Voltage Input Module, with SCXI-1303 Terminal Block,
SCXI-1124, 6 Channel D to A converter for signal output, with SCXI-1325 Terminal Block, and
SCXI-1161 General Purpose Relay Module, with SCXI-1324 Terminal Block.

Note that the measurement uncertainty introduced through the use of the 32-bit data acquisition system was insignificant (< 0.1% reading).

The Labview® program had a dual function of reading all the instruments at a frequency set by the work instruction and controlled several pieces of equipment, including:

- VFDs to the Contactors motors,
- VFD to the Aqueous Pump motor,
- Organic pump air valve (V-29) and
- Alarms: Liquid level in the Head Pots, System Temperatures, power to the VFDs.

3.2 Test Operation

3.2.1 *Test Matrix*

The test matrix illustrated in Table 3-4 is a subset of that which was used for previous testing.[6] The major difference in testing being the limited number of hydraulic tests because only two coalescer sizes, those currently used in MCU, needed evaluation.

The matrix is divided into two major sections; Mass Transfer (Tests 1, 2, and 3) and Hydraulic (Tests 3 and 4). The remaining tests (i.e., 0.9A & B) were performed to shakedown the overall operation of the test facility after it was cleaned with 1 M nitric acid and de-ionized (DI) water. These shakedown tests employed a previously used but filtered Isopar™ L solvent in the organic flow loop and the listed aqueous solution in the aqueous flow loop to prepare the test facility and evaluate the operation of all the test and measurement equipment.

To mimic plant operation each of the test sessions were subdivided into the extraction, scrub and strip. During extraction, the organic solvent separates cesium from the caustic 5.6 M Na salt solution simulant, which is a surrogate waste stream. The scrub uses a dilute caustic solution to remove competing extraction ions and reducing the aqueous flow loop's high pH to prepare for the next process. Stripping is where a dilute acid solution removes the cesium from the organic solvent.

Each of the flow processes were further subdivided into low, medium, and high flows to evaluate the effect of flow rate on the decontamination efficiency. However, in all cases the Organic to Aqueous ratio (O:A), was maintained at 1:4 for the extraction process and 3.75:1 for the scrub and strip processes. The contactor rotor speeds were varied based on the total flow through the contactor. The tests were conducted at the normal MCU operation temperatures.

Two operational differences between the 2011 tests[6] and current tests is the separation of the extraction tests and the repeat scrub tests, which are explained in the next two sub-sections.

Table 3-4. Test Matrix for Testing from 02-27-2013 to 04-18-2013

		Test Duration	Contactor*	Contactor	Aqueous Simulant	Organic Flowrate	Aqueous Flowrate	Contactor Speed	Solution Temp.	Contactor Residence Times, m:s			
Test #	Description	minutes	Turnover Volumes	Name	Concen-tration	GPM	GPM	RPM	°C	6 CRT	7 CRT	8 CRT	10 CRT
0.9A	Shakedown/Strip Hydraulic Testing w/Isopar-L (V-05)	cont.	N/A	V-05	0.01 M H_3BO_3	various	various	various	33	N/A	N/A	N/A	N/A
0.9B	Shakedown/Extraction Hydraulic Testing w/Isopar-L (V-10)	cont.	N/A	V-10	5.6 M Salt	various	various	various	23	N/A	N/A	N/A	N/A
1A	Extraction (low flow)	9.6	8	V-10	5.6 M Salt	1	4	1200	23	0:07:12	0:08:24	0:09:36	N/A
1B	Extraction (medium flow)	4.8	8	V-10	5.6 M Salt	2	8	1700	23	0:03:36	0:04:12	0:04:48	N/A
1C	Extraction (high flow)	3.2	8	V-10	5.6 M Salt	3	12	1700	23	0:02:24	0:02:48	0:03:12	N/A
2A-1	Scrub Solvent (low flow)	50	N/A	V-05	0.025 M NaOH	1	0.27	1800	23	0:02:51	0:03:19	0:03:47	0:04:44
2A-2	Scrub Solvent (low flow)	50	N/A	V-05	0.025 M NaOH	1	0.27	1800	23	0:02:51	0:03:19	0:03:47	0:04:44
2B-1	Scrub Solvent (medium flow)	25	N/A	V-05	0.025 M NaOH	2	0.53	2100	23	0:01:25	0:01:39	0:01:54	0:02:22
2B-2	Scrub Solvent (medium flow)	25	N/A	V-05	0.025 M NaOH	2	0.53	2100	23	0:01:25	0:01:39	0:01:54	0:02:22
2C-1	Scrub Solvent (high flow)	17	N/A	V-05	0.025 M NaOH	3	0.80	2100	23	0:00:57	0:01:06	0:01:16	0:01:35
2C-2	Scrub Solvent (high flow)	17	N/A	V-05	0.025 M NaOH	3	0.80	2100	23	0:00:57	0:01:06	0:01:16	0:01:35
3A	Strip (low flow)	3.8	8	V-05	0.01 M H_3BO_3	1	0.27	1800	33	0:02:51	N/A	0:03:47	0:04:44
3B	Strip (medium flow)	1.9	8	V-05	0.01 M H_3BO_3	2	0.53	2100	33	0:01:25	N/A	0:01:54	0:02:22
3C	Strip (high flow)	1.3	8	V-05	0.01 M H_3BO_3	3	0.80	2100	33	0:00:57	N/A	0:01:16	0:01:35
4A	Strip Hydraulics w/Coalescer (low flow) [20", 10 micron rating]	cont.	N/A	V-5	0.01 M H_3BO_3	1	0.27	1800	33				
4B	Strip Hydraulics w/Coalescer (medium flow) [20", 10 micron rating]	cont.	N/A	V-05	0.01 M H_3BO_3	2	0.53	2100	33				
4C	Strip Hydraulics w/Coalescer (high flow) [20", 10 micron rating]	cont.	N/A	V-05	0.01 M H_3BO_3	3	0.80	2100	33				
5A	Extraction Hydraulics w/ Coalescer (low flow) [40", 20 micron rating]	cont.	N/A	V-10	5.6 M Salt	1	4	1200	23				
5B	Extraction Hydraulics w/ Coalescer (medium flow) [40", 20 micron rating]	cont.	N/A	V-10	5.6 M Salt	2	8	1700	23				
5C	Extraction Hydraulics w/ Coalescer (high flow) [40", 20 micron rating]	cont.	N/A	V-10	5.6 M Salt	3	12	1700	23				

*Note: V-10 Internal Volume ~ 6 gallons and V-05 Internal Volume ~ 0.6 gallon

3.2.1.1 Extraction Test Matrix Change

After testing started but before extraction Test 1B was complete, the scope was changed after discussions with the customer (see a test update in Appendix B). Test 1A, 1B, and 1C use about one-third of the available 50 gallons of solvent for these once-through tests. That is, as seen in Table 3-4 each test processed 9.6 gallons of solvent at steady state operation. Combined with the solvent spent during the system shut down and the volume held up in contactor and associated piping the total volume was closer to 15 gallons for each test. In the past[6] the one-third of the solvent for Test 1A would end up in the organic receipt tank. For Test 1B another one-third was processed out of the organic feed tank, which ended up on top of the processed Test 1A solvent in the organic feed tank. This process would also be repeated for Test 1C to end up with Cs loaded solvent in the organic receipt tank ready to begin the scrub tests. However, with this method, the receipt tank after Tests 1B and 1C would add the current test's solvent to that of the previous tests. Therefore, in order to not mix the processed solvent, the test protocol was changed so at the end of each extraction test the organic receipt tank was completely emptied of its contents. In this way, the grab sample taken from the receipt tank at the end of each extraction tank would only show the Cs concentration related to each specific flow rate and not a mixture.

3.2.1.2 Scrub Test Matrix Change

Starting with the batch of organic solvent fully with Cs from the extraction test, the original test matrix was to perform Scrub Tests 2A, 2B, and 2C as they were done in the past (i.e., one after another in sequence). This was done by transferring the scrub solvent from the organic receipt tank to the feed tank to repeat each test. However, plant operation scrubs loaded solvent twice before stripping begins. Therefore, the each scrub test was broken up into two subtests so that each could scrub the solvent twice at each of the flow settings. Test 2A-1 was performed as the original Test 2A; however, at the end of that test the contents of the organic receipt tank were transferred to the organic feed tank again and then Test 2A-2 was performed at exactly the same conditions as 2A-1 to determine if the repeated tests did a better job of scrubbing the solvent. Likewise, Scrub Tests 2B and 2C were each performed twice.

3.2.1.3 Mass Transfer Sample Times

The sample times in the test matrix for the mass transfer tests were established using the CRT, which is defined as:

CRT = Contactor Rotor Hold-Up Volume / (Aqueous + Organic) Flow Rate Through Contactor

The number of CRT used for each test (i.e., 6, 7, 8, or 10) was the same as the previous testing[6] as well as the hold-up volumes (i.e., 6 gallons for the V-10 and 0.6 gallons for the V-05). The times associated with each number of CRT are listed in the test matrix, Table 3-4. These are also the times aqueous and organic samples were taken from each solution prior to entering the respective receipt tank.

3.2.2 *Test Methodology*

Prior to testing, the equipment was cleaned per SRNL's work instruction, Appendix C, which included flushing the test facility with water, 1 M nitric acid, and a final water rinse. The protocol for testing was determined by the amount of NGS available, which was approximately 50 gallons. SRNL determined that the most judicious use of the limited solvent was to perform mass transfer tests first and then follow with hydraulic testing. The medium flow rates in the test matrix, Table 3-4, were chosen using the current MCU flow rates for the respective stream (extraction, scrub, or strip). The low-flow rate was chosen to be 50% of the medium-flow value, and the high-flow rate was selected at 150% of the medium-flow value. The flow rates also matched the previous testing.[6] Per the test matrix, SRNL performed four extraction tests (three mass transfer and one hydraulic). A summary of the O:A ratios for all tests is shown in Table 3-5.

Table 3-5. Organic:Aqueous Volume Ratios for Testing

Test	Volume Ratio (O:A)
Extraction: 1A-1C (Mass Transfer)	1:4
Scrub: 2A-2C (Mass Transfer)	3.75:1
Strip: 3A-3C (Mass Transfer)	3.75:1
Strip: 4A-4C (Hydraulic)	3.75:1
Extraction: 5A-5C (Hydraulic)	1:4

The mass-transfer tests processed the organic solvent and aqueous streams in an open-loop once-through operation. That is, a solution left a feed tank, fed through a contactor, and ended up in a receipt tank. This approach was necessary to analytically measure the effectiveness of each process. Because the aqueous solutions were sampled for both cesium and organic carryover at the end of each test the coalescer and the decanter were not used in the mass transfer tests. Furthermore, between each process the aqueous flow loop had to be thoroughly rinsed with first water and then the next aqueous solution (i.e., Salt Simulant (with 75 mg/L Cs), sodium hydroxide [NaOH], or H_3BO_3), to ensure it was not contaminated with the previous solution. The aqueous feed tank was only filled with just enough solution to complete the low, medium, and high flow rate tests.

The mass-transfer tests were follow by hydraulic testing, which included:

- three strip tests at low, medium, and high flow rates using a 20 inch long, 10 micron polyphenylene sulfide coalescer from Pall® (Part Number T5512, Item RLS2FPS100), and
- three extraction tests at low, medium, and high flow rates using a 40 inch, 20 micron polyphenylene sulfide coalescer from Pall® (Part Number T5524, Item RLS4FPS200).

The hydraulic tests were conducted as closed-loop continuous operation; the feed tanks of the aqueous and organic solutions were also the receipt tanks. For these tests, the coalescer and the 400-gallon decanter tank were employed. Here the effectiveness of the coalescer was evaluated and the decanter was to help separate the organic from the aqueous solutions. After the strip hydraulic tests, which used boric acid, were completed, the aqueous flow loop was thoroughly flushed with water and then with the salt simulant to help minimize the formation of precipitated solids that would affect the overall results. Due to pressure drop issues during testing, the coalescer element was changed in the course of the extraction testing.

3.3 Next Generation Solvent

The solvent used in this testing was comprised of the six components that make up the blend that will be employed at MCU. It is comprised of: 0.0465 M MaxCalix, 0.500 M Cs-7SB (Modifier), 0.0035 M BOBCalixC6, 0.003 M TiDG, and 0.0015 M TOA with the balance being Isopar™ L (~74 wt %). The solvent used for this testing was blended by SRNL. The makeup of the all three solvents is shown in Table 3-6.

Table 3-6. Development of the Next Generation Solvent

Solvent	Constituent Concentrations
BOBCalixC6 Based Solvent	BOBCalixC6 = 0.007 M Cs-7SB = 0.750 M TOA = 0.003 M Isopar-L balance (69 wt %)
(As Implemented) Blended solvent	MaxCalix = 0.0465 M Cs-7SB = 0.500 M BOBCalixC6 = 0.0035 M TiDG = 0.003 M TOA = 0.0015 M Isopar-L balance (~74 wt %)
(NGS-MCU) NGS_{TiDG}	MaxCalix = 0.050 M Cs-7SB = 0.500 M TiDG = 0.003 M Isopar-L balance (~74 wt %)

3.4 Aqueous Streams

3.4.1 *Strip: Boric Acid*

The strip solution was 0.010 M H_3BO_3 in DI water prepared in SRNL. Specifically, 300 gallons of DI water were added to a new clean tote. To the tote were added 702.12 g of H_3BO_3 which dissolved with DI water to produce a target 108 mg/L B concentration. A sample of the solution, Lab-ID: 13-0776, was analyzed by ICP-ES and found to contain 106.5 mg/L of B (an average of two measurements). This result gives an average H_3BO_3 concentration of 0.0099 M.

3.4.2 *Scrub: Sodium Hydroxide*

The scrub solution was 0.025 M NaOH in DI water prepared in SRNL. Specifically, 188.9 kg (~50 gallons) of DI water were added to a clean plastic drum. To this drum were added 379 g of 50 wt% NaOH solution. No confirmatory analyses were made of the final solution except a check pH which measured 12, which confirmed the concentration.

3.4.3 *Extraction: Salt Simulant*

To support the MCU contactor and coalescer testing, SRNL, with SRR approval, developed a 5.6 M Na Simulant Salt Solution recipe (Table 3-7).

Table 3-7. 5.6 M Na Simulant Salt Solution, Made by Harrell Industries

Name	Formula	MW	Weight, lb
Potassium Nitrate	KNO_3	101.09	8.0
Sodium Hydroxide (50% Solution)	$NaOH$	40.00	1360.0
Sodium Nitrate	$NaNO_3$	84.98	585.1
Sodium Nitrite	$NaNO_2$	68.98	222.5
Aluminum Nitrate Hydrated	$Al(NO_3)_3*9H_2O$	375.04	679.6
Sodium Carbonate Hydrate	$Na_2CO_3*H_2O$	123.98	120.2
Sodium Sulfate	Na_2SO_4	142.02	127.9
Sodium Chloride	$NaCl$	58.44	9.0
Sodium Flouride	NaF	41.99	7.8
Sodium Phsphate Dibasic	$Na_2HPO_4*7H_2O$	268.01	6.4
Sodium Oxalate	$Na_2C_2O_4$	133.98	6.9
Sodium Metasilicate Hydrate	$Na_2SiO_3*9H_2O$	284.14	13.0
Sodium Molybdate Dihydrate	$Na_2MoO_4*2H_2O$	241.92	0.1
Deionized Water	H_2O	18.02	4089.2
		Total Mass =	7235.7
		Approximate Volume (gal.) =	690

A purchase requisition (3U2709) was initiated to order the Simulant Salt Solution for MCU testing from a vendor. Harrell Industries, Inc. was awarded (PO #81814) to provide 700 gal of this solution. The 700 gallons (lot #69750111130) was shipped from the vendor (on April 17, 2013) in three 275-gallon containers with a certificate of analysis and batch sheet. The SRNL Process Science Analytical Laboratory and Analytical Development (AD) analyzed samples and confirmed that analyte concentrations were in accordance with recipe requirements except for low variances in carbonate and oxalate content. The analyses are provided in Table 3-8.

Table 3-8. Analyses of Vendor-Provided 5.6 M Na Simulant Salt Solution

Analyte	Specification (1)	(2)	(3)	(4)
NaOH	1.854 - 2.266 M	2.2 M	N/A (5)	N/A
Al	0.252 - 0.308 M	0.275 M	0.305 M	0.290 M
Na	4.98 - 6.09 M	5.5 M	5.02 M	5.33 M
K	0.013 - 0.016 M	0.015 M	0.015 M	<0.0003 M
Si	0.0063 - 0.0077 M	0.0063 M	0.0066 M	0.0065 M
Mo	6.48E-05 - 7.92E-05 M	6.8E-05 M	7.16E-05 M	<1.04E-05 M
PO_4	0.0063 - 0.0077 M	0.0068 M	N/A	N/A
SO_4	0.126 - 0.154 M	0.13 M	0.146 M	0.041 M
NO_2	N/A	N/A	0.570 M	0.488 M
NO_3	N/A	N/A	1.97 M	2.00 M
Cl	N/A	N/A	0.0086 M	0.0244 M
C_2O_4	N/A	N/A	0.0031 M	0.0083 M
Cs (6)	0 M	N/A	78.6 mg/L	N/A
Specific Gravity	1.24 - 1.27	1.257	1.254	1.254
Clarity	< 5 NTU	0.8 NTU	< 1.0 NTU	< 1.0 NTU
pH	N/A	N/A	13.7	13.8
	Total Solids =		29.1 mg/L	29.1 mg/L
	Soluble Solids =		29.1 mg/L	29.1 mg/L

Notes:
1. From the Certificate of Analysis - Harrell Industries
2. Results from Harrell Industries
3. Process Systems Analytical Lab. - SRNL: ± 20%: on 2/14/2013 Test Start
4. Process Systems Analytical Lab. - SRNL: ± 20%: on 4/25/2013 Test End
5. N/A = Not Available
6. Simulant was spiked with cesium just before testing in
three batches that were subsequently mixed together.
ICP-MS Analytical results were: 78.8, 78.0, and 79.0 mg/L

Non-radioactive Cs was added to ~150 gallons of the salt solution after receipt from Harrell Industries, Inc. The Cs was added as cesium nitrate ($CsNO_3$), >95% purity. The total volume (150 gallons) was made in three different batches of approximately 50 gallons each. In all cases, the $CsNO_3$ was dissolved in approximately one liter of salt solution. That concentrate was then added to the final volume of simulant salt solution and mixed. The batches were then combined and mixed to assure all tests started with the same cesium concentration. A minimum of 75 mg/L cesium was selected to match test conditions from the 2-cm contactor NGS tests.[5] A sample of the simulant salt solution containing Cs was analyzed by inductively coupled plasma mass spectroscopy (ICPMS) and found to contain 79 mg/L of Cs (mass 133). This result for Cs is well within the SRNL analytical uncertainty of 20%.

3.5 Analytical Methods

Many measurements were made of organic and aqueous samples during active testing to determine how effectively the contactor process operated. The principal measurement was the concentration of Cs to calculate the effectiveness of the organic solvent to extract that element from an aqueous waste stream and then to measure the effectiveness of stripping the cesium from the solvent. Also important is determining if the organic Isopar™ L (solvent) is being lost through entrainment into the aqueous solution. Modifier concentrations were also measured to determine if it is being separated from the solvent. Finally, to judge how well the coalescer operated, the organic droplet sizes were measured in the aqueous stream as it left the aqueous discharge of the contactor, as it entered the coalescer, and as it exited the coalescer. For each of these measurements an appropriate analytical method was employed the methods are explained in the following sections.

3.5.1 *ICP-MS*

Inductively Coupled Plasma Mass Spectrometry (ICPMS) was used to determine the concentrations of mass-133 in samples from the mass-transfer tests. Mass-133 is solely attributed to ^{133}Cs, so this method can be used reliably to determine the concentration of cesium. Aqueous samples were sent directly to ICPMS for analysis with no adjustment or dilution. Organic samples were sent first for digestion via a Parr Bomb, and then sent for an ICP-MS analysis. Any dilutions due to the digestion are already accounted for in the reported results. Note that the digestion process also adds uncertainty to the analysis. This is evident in the greater scatter in the organic sample results.

The Plasma Quad II Radiological ICPMS manufactured by Fisons provides multi-element analyses of aqueous solutions based on the measurement of atomic species from their ions created in the plasma. Liquid samples are nebulized and the aerosol transported to an argon plasma. In the high temperature plasma, metallic species are ionized. The ions generated by the plasma enter the mass spectrometer through a sampling cone set near the end of the plasma. The ions are separated by a quadrapole mass filter and focused on an electron multiplier that measures pulse counts. The signal from the detector is amplified, measured, and processed by the detection electronics. These measurements are used to calibrate the instrument, perform sample analyses, and display spectra.

It should be noted that in actual waste samples, cesium is measured directly by gamma counting.

3.5.2 *SVOA*

The SVOA method was used to determine the concentrations of Isopar™ L and Modifier in aqueous samples. The typical sample size of ~100 mL was sent to SVOA, and the entire sample was extracted with hexane. This protocol recovered analytes into hexane. The hexane solution was then distilled into a smaller volume and directly analyzed. One milliliter of hexane extract was spiked with phenyloctane internal standard, and then analyzed by Gas Chromatography with Flame Ionization Detector to identify organic compounds in the extracts. Analytical separations were carried out with a Hewlett Packard 6890 gas chromatograph equipped with a 25 m DB-5ms column that had a 0.20 mm diameter and a 0.33 µm film thickness. The measurement was then performed using a flame ionization detector.

3.5.3 *HPLC*

Another, and presumably more accurate, method to measure Modifier is through a normal-phase chromatograph. An Agilent 1100 HPLC equipped with a photodiode array detector was used. The controlling computer was equipped with Agilent Chemstation 9.01 software. Samples were extracted with hexane (O/A = 0.25/1) by mixing in a vortex mixer. Of the two methods to measure Modifier, SVOA and HPLC, the latter has less uncertainty in the measurement. When using laboratory matrix spike extracted standards a low recovery of <76% was obtained using gas chromatography, but for HPLC the recovery was >85%; therefore, it seems to produce more reliable results for the Modifier. However, SVOA was found to be accurate for diluent Isopar™ L.

3.5.4 *MicroTrac™ Droplet Size Distribution Measurements*

During the hydraulic testing phase, samples were taken in three locations; see the Hydraulic Test setup sample points (SP) in Figure 3-1 (i.e., two locations upstream and one location downstream of the coalescer to measure the particle (droplet) size distribution (PSD)). These samples were submitted for a droplet-size analysis in an attempt to demonstrate the efficiency of coalescer operation. The analysis was accomplished with a MicroTrac™ S3500 particle size analyzer. This is the same equipment used in measuring droplet sizes during the 2004-2005 testing of the BOBCalixC6 based solvent at Wright Industries[11] and in previous SRNL tests[6]. A summary of the measurement technique follows.

1. The instrument (S3500 with separate circulating control unit) is charged with approximately 300 mL of matrix-matched aqueous liquid after routine flushing of the machine.
2. The S3500 provides a baseline reading of particles in the liquid. The count rate must be less than a given limit to determine that the instrument and fluid are clean and free of air bubbles.
3. Normally a few milliliters of sample are introduced into the circulating stream. Particles, droplets, or bubbles in the sample will immediately boost the count rate. Further sample is added to adjust the count rate to a new level specified by S3500 operating procedure. [Note, liquid bubbles in a liquid suspension change with time; therefore, it is important to have a standard time to make measurements. The instant a sample began to be pulled a timer was started and then that sample was rushed to the analyzer to begin the measurement at exactly 5 minutes. That is, all PSD measurements are of samples processed beginning at exactly 5 minutes from being pulled.]
4. Number-weighted count scans are recorded and averaged.
5. The S3500 calculates volume-weighted particle distribution from the number-weighted data.
6. Results for the sample are printed in the form of tabulated percentages of particles less than machine-defined bin sizes, along with a bar graph of the levels in each bin.

The data are displayed both by number and volume analyses to determine the amount and size of entrained solvent droplets as they leave the contactor in the aqueous stream.

3.6 Sampling Protocols

The entire set of samples pulled for both the mass transfer and hydraulic tests is shown in the sample matrix, Appendix D.

3.6.1 *Mass Transfer Protocol*

During the mass transfer tests, samples were pulled from two distinct sets of sample points. Refer to Figure 3-3 for valve locations. Organic samples were pulled from valve V-7, while aqueous samples were pulled from valve V-10. Portions of these samples were removed and sent for ICPMS analysis. Before each test a sample was taken from the organic and aqueous feed tanks and this organic sample was also used to measure its density. At the end of each test, samples were taken from the organic and aqueous receipt tanks.

3.6.2 *Droplet Size Analysis Protocol*

As already mentioned in Section 3.5.4, the sample age was considered a critical factor in droplet size analysis. Organic material entrained in the aqueous phase will quickly coalesce and rise to the top. To minimize data skew associated with this behavior, a sample time protocol was developed for all droplet size analysis. The time from the taking of a sample to the time the sample was placed into the MicroTrac™ S3500 was controlled to 5 minutes; prior Wright Industries and SRNL testing of contactors used this duration.[11] When a sample was taken, a stop watch was started, and the sample was placed into the MicroTrac™ S3500 at exactly 5 minutes after the sample draw.

3.6.3 *Solvent Concentration Analysis Protocol*

For the hydraulic tests, samples were collected downstream of the contactor aqueous effluent at valve V-10, and upstream of the coalescer from valve V-22, and finally, downstream of the coalescer at valve V-25. Samples were collected in clean glass jars with Teflon™ lids. The samples were sent to AD without delay and stored in a refrigerator until analyzed.

4.0 Results and Discussion

4.1 Mass Transfer

4.1.1 *Contactor Test Results*

The extraction and strip steps were operated individually with one stage; the exception was the scrub step, which was repeated once for each test to mimic two-stage operation that is prototypic of plant operation, as explained in section 3.2.1.2. SRNL examined the effects of the contactor speed and flow rate on the Cs distribution ratio in primarily three extraction, six scrub, and three strip tests. The subset of the mass transfer tests from the test matrix (Table 3-4) is shown in Table 4-1. Along with demonstrating the efficiency of each of the three contactor operations (i.e., Cs extraction from a simulated waste by NGS, scrubbing the NGS to prepare for the removal of Cs, and stripping the solvent of Cs), the mass transfer tests would also demonstrate the effect of solution flow rates, contactor speed, and the contact time within the contactor. The first two effects were studied by changing the flow rates and speeds, respectively, but the last effect was measured by taking samples at different contactor residence times, see 3.2.1.3. The complete set of data is shown in Table 4-2, Table 4-3 and Table 4-4.

Table 4-1. List of Cesium Mass-Transfer Tests

Test	Flow Stream	Contactor	Contactor Rotor Speed	Organic: Aqueous Flow Rates	Aqueous Solution	Organic/ Aqueous Temp. (1)
No.	**Type**	**Type**	**RPM**	**GPM**	**Type**	**°C**
1A	Extraction	V-10	1200	1:4	5.6 M Salt	23
1B	Extraction	V-10	1700	2:8	5.6 M Salt	23
1C	Extraction	V-10	1700	3:12	5.6 M Salt	23
2A-1	Scrub	V-05	1800	1:0.27	0.025 M NaOH	23
2A-2	Scrub	V-05	1800	1:0.27	0.025 M NaOH	23
2B-1	Scrub	V-05	2100	2:0.53	0.025 M NaOH	23
2B-2	Scrub	V-05	2100	2:0.53	0.025 M NaOH	23
2C-1	Scrub	V-05	2100	3:0.8	0.025 M NaOH	23
2C-2	Scrub	V-05	2100	3:0.8	0.025 M NaOH	23
3A	Strip	V-05	1800	1:0.27	0.01 M H_3BO_3	33
3B	Strip	V-05	2100	2:0.53	0.01 M H_3BO_3	33
3C	Strip	V-05	2100	3:0.8	0.01 M H_3BO_3	33
(1) All temperatures were held to ±3°C						

For each of the extraction tests the following protocol was used.

1. Grab samples were obtained from each of the feed tanks.
2. The contactor was turned on and set to the test speed.
3. The aqueous flow loop was circulated (through the contactor).
4. The organic flow loop was circulated (bypassing the contactor).
5. Then the organic stream was directed towards the appropriate contactor.
6. Once the organic stream was discharged from the contactor the sample timer was started.
7. Samples were pulled from the organic and aqueous streams from the respective receipt tanks at the sample times listed in the test matrix, Table 3-4.
8. After all timed samples were drawn, archive samples were drawn from each of the receipt tanks.
9. The test was terminated and the DAS stopped.

For the mass transfer tests, the target and actual flow rates are shown in
Table 4-2 with the standard deviation of the measurement during each test.

Table 4-2. Flowrates Measured during the Mass Transfer Tests

Test	Target ORG Flowrate	Target AQ Flowrate	Actual ORG Flowrate	Std. Dev.	Actual AQ Flowrate	Std. Dev.
No.	gpm	gpm	gpm	gpm	gpm	gpm
1A	1	4	1.01	0.05	3.92	0.08
1B	2	8	2.04	0.16	7.94	0.04
1C	3	12	3.02	0.40	11.93	0.06
2A-1	1	0.27	0.98	0.01	0.29	0.08
2A-2	1	0.27	1.00	0.05	0.17	0.11
2B-1	2	0.53	2.07	0.05	0.45	0.08
2B-2	2	0.53	2.05	0.03	0.47	0.08
2C-1	3	0.80	2.97	0.05	0.75	0.10
2C-2	3	0.80	2.89	0.12	0.76	0.09
3A	1	0.27	1.03	0.10	0.32	0.09
3B	2	0.53	2.07	0.05	0.50	0.09
3C	3	0.80	2.85	0.13	0.80	0.08

To better understand reaching steady state and the fluctuations for the flow rates, two tests (Tests 1A and 2B-2) are illustrated in Figure 4-1, which show relatively stable flows[1]. Of course, for the very low aqueous flow rates (i.e., 0.27, 0.53 and 0.80 gpm) the fluctuations become a large percentage of the flow rate so that standard deviation of 0.1 gpm becomes about 30% of a target flow of 0.27 gpm.

The flow rates of the solutions generally did not take long to stabilize and therefore the flow circulations operated only as long as was necessary to obtain mass transfer samples. However, for the test facility temperatures to stabilize, it sometimes took considerable time, especially for the strip tests where it was necessary to have 33°C ±3°C as shown in Figure 4-2. Because of the volumes of feed materials (i.e., around 50 gallons), the target temperature was sometimes surpassed, so then it would take a while to bring the temperature down because active cooling was not planned. The feed tanks would be cooled with fans until the target temperature was reached. Figure 4-2 shows the temperature history of the strip Test 3A when the organic feed tank temperature reached 38°C; therefore, it had to be cooled until 36°C was reached to begin taking the mass transfer samples. For this example, after about 20 minutes of cooling the feed tank temperature dropped to 36°C allowing the test to begin. The contactors were not actively heated or cooled and remained at a fairly constant temperature throughout the process.

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[1] Those two tests are highlighted because they had the longest time periods of monitoring. As can be seen in the test matix, Table 3-4, the sampling time for Test 1A was just over 9 minutes and for Test 2B-2 just over three minutes. For these two tests shown the data were logged a little longer then the sampling time.

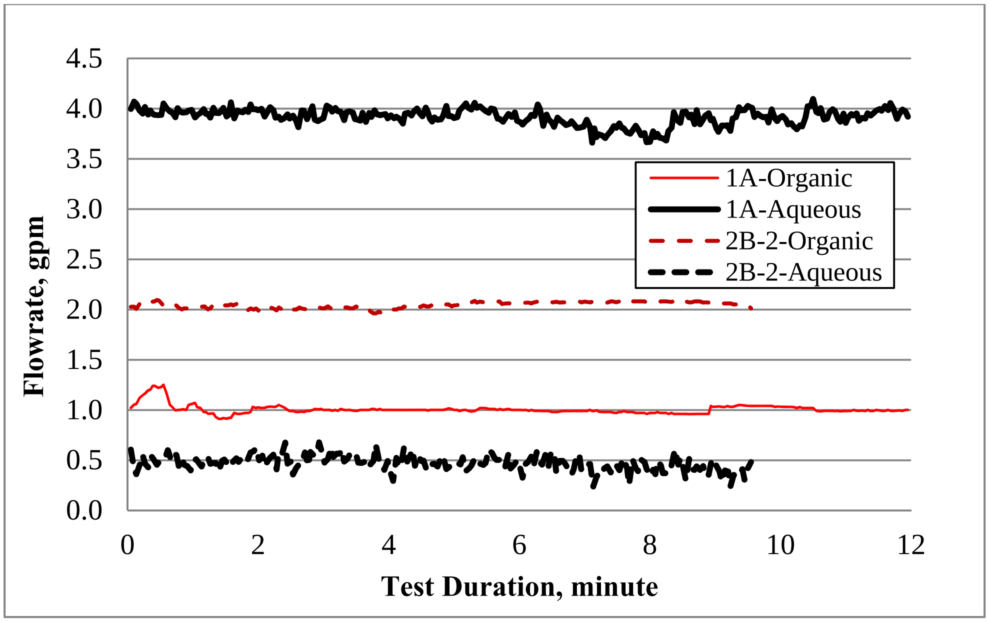

Figure 4-1. Flow Rate Histories of Two Tests during Mass Transfer Tests

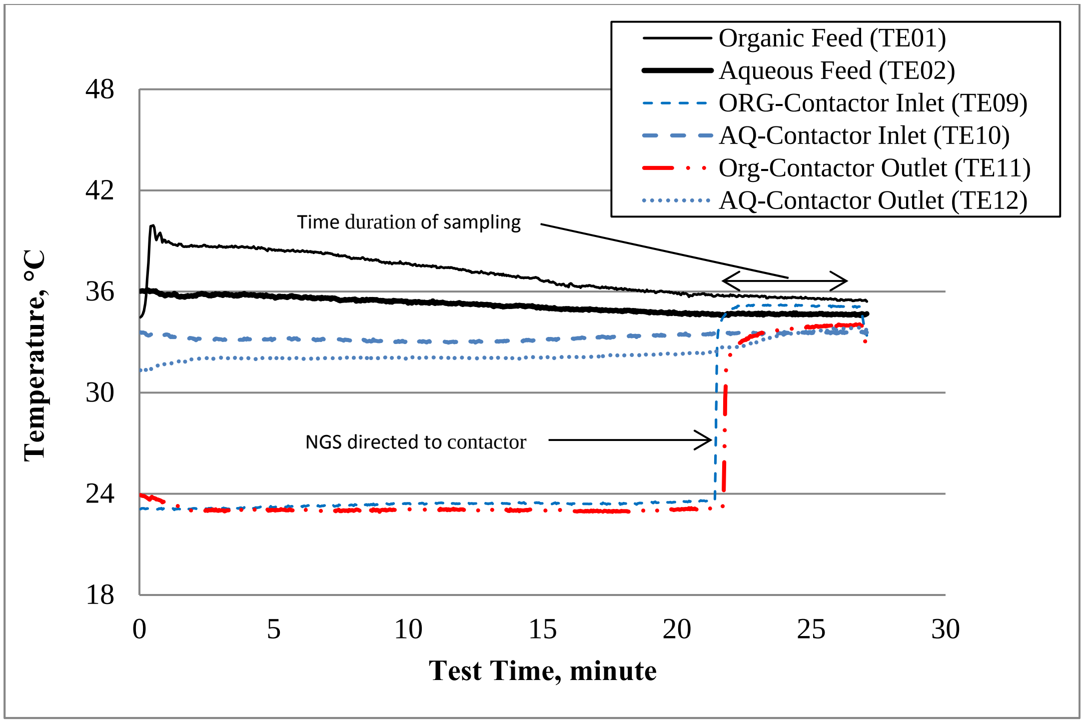

Figure 4-2. Temperature History of Mass Transfer Test 3A

With respect to temperature, Table 4-3 shows the feed and contactor inlet average temperatures measured during the sampling period of each mass transfer test. All test temperatures met the required targets (i.e., 23°C ± 3°C for extraction and scrubbing and 33°C ± 3°C) for stripping except Test 1C when the feed and discharge stream temperatures ranged from 17.5°C to 20.1°C. Initially, no heating was expected for tests with the target temperature of 23°C. However, for Test 1C, the ambient and laboratory temperature was cold; therefore, after Test 1A, it was decided to heat the feed materials for the room-temperature tests to better meet the target.

Table 4-3. Temperatures Measured during the Mass Transfer Tests

	Target	Averaged Measured Temperatures					
	Temp.	*** Organic ***			*** Aqueous ***		
Test	(±3°C)	Feed	Contactor		Feed	Contactor	
			Inlet	Outlet		Inlet	Outlet
No.	°C	°C	°C	°C	°C	°C	°C
1A	23	17.8	22.8	23.1	17.1	22.7	23.0
1B	23	21.4	21.4	21.7	21.6	21.7	21.9
1C	23	20.0	19.8	20.1	17.1	17.5	18.7
2A-1	23	21.1	21.3	21.5	21.2	21.4	22.2
2A-2	23	21.3	21.0	21.2	21.2	21.2	21.8
2B-1	23	20.9	22.0	22.3	21.3	22.0	22.6
2B-2	23	22.2	22.5	22.8	21.5	22.5	23.3
2C-1	23	21.7	22.6	23.1	22.2	23.3	23.1
2C-2	23	22.3	23.9	24.1	22.4	23.6	23.8
3A	33	35.6	34.2	32.2	34.7	33.5	33.3
3B	33	33.9	33.6	32.8	33.8	32.2	32.8
3C	33	32.5	29.0	29.7	32.9	32.3	32.0

The mass transfer results were obtained from the aqueous and organic samples that were analyzed by ICPMS for Cs (mass 133). Those results are shown in the following three tables: Table 4-4, Table 4-5, and Table 4-6. For each row that contains a "0" for the contactor volume indicates the feed solution concentration. In those same second columns, the timed results are shown in the rows that indicate 6, 7, 8, or 10 contactor volumes. The tables list the results in Cs concentration by volume as well as the Cs concentration ratio [D(Cs)] by dividing the Cs concentration for the organic phase by the Cs concentration in the aqueous phase. Finally, to compare the current data to the data obtained in the 2011 test[6], the last column of each table shows the ratio of the cesium concentrations in the aqueous solutions for each of the tests.

The extraction results in Table 4-4 show that the NGS effectively extracted cesium from simulated waste stream, the 5.6 M Na solution. The initial Cs concentration in the simulated wasted dropped from between a high of 84 mg/L pre-extraction to a final low concentration of 3.3 mg/L post-extraction. Another way to look at this is the cesium distribution ratio ranged from 37.4 to 60.1 indicating good extraction. The 2011 test show slightly different results with less extraction, but at that time the NGS had only 40% of the MaxCalix component. However, the D(Cs) values increased more than 2.5 times the D(Cs) calculated in the 2011 tests, so the full MaxCalix mixture of NGS did a better job at separation, to the extent that it shows an approximately linear dependence on the extractant concentration.

Table 4-4. Extraction Mass-Transfer Test Results

Extraction	# of Contactor	2013 Test			2011 Test(1)			Comparison 2013/2011
V-10	Volumes	Org.	Aq.	D(Cs)	Org.	Aq.	D(Cs)	
Contactor	Processed	Cs	Cs	Org/Aq	Cs	Cs	Org/Aq	$D(Cs)_{2013}$/ $D(Cs)_{2011}$
Test No.	When Sampled	mg/L	mg/L	-	mg/L	mg/L	-	
1A	0	1.4	83.7	-	-	75.3	-	-
1A	6	245.5	4.5	53.4	254	14.3	17.8	3.00
1A	7	260.5	4.3	61.0	268	14.9	18.0	3.39
1A	8	270.6	4.1	66.0	249	14.9	16.7	3.95
1B	0	0.6	72.1	-	-	75.8	-	-
1B	6	188.2[i]	5.2	31.3	248	15.6	15.9	1.97
1B	7	213.4[i]	4.8	38.6	256	15.7	16.3	2.37
1B	8	311.6[i]	5.0	46.5	246	15.7	15.7	2.97
1C	0	3.9	69.0	-	-	76.1	-	-
1C	6	210.4	3.3	38.5	230	19.3	11.9	2.92
1C	7	260.5	3.6	43.6	232	19.7	11.8	3.14
1C	8	166.3	3.3	30.1	224	19.9	11.3	2.19

(1) The 2011 test had only 40% of the MaxCalix in the organic solvent

[i] **Note:** The Cs analysis for the 1B organic samples were resubmitted for analysis. The initial values were 519, 192 and 350 mg/L respectively for the 6, 7 and 8 CRT samples. These values were inconsistent with the previous tests and expected values. The same samples were reanalyzed with the re-analysis returning similar values of 495, 170 and 312 mg/L indicating there was an issue with the sample. An archive sample was submitted and returned results consistent with other test results and the next sample in the test series. The analysis from the second sample is presented in the table.

The D(Cs) values shown are temperature corrected to reflect deviations from the desired (23 or 33 °C) temperatures. The temperature correction coefficients are the same ones used for pure NGS.[12] At this time there are no experimentally determined temperature correction coefficients for the blend solvent.

After the NGS extracts Cs from the waste stream, the Cs needs to be stripped back into the aqueous solution for ultimate disposition. To prepare the NGS to strip the captured Cs it is first “scrubbed” to remove the competing ions. Furthermore, it is also important to buffer the organic NGS with a mild caustic solution in preparation for contacting with the acidic stripping solution that will remove the captured Cs. The results of the two scrub tests are listed in Table 4-5.

The distribution ratio for the scrubbing is an order of magnitude smaller than for the extraction process. The D(Cs) is consistent with the recent NGS Extraction, Scrub, and Strip (ESS) tests.[13] With respect to the 2011 test, the current scrubbing D(Cs) is approximately two to four times larger. This was expected considering the previous testing used only 40% of the MaxCalix.

Table 4-5. Scrub Mass-Transfer Test Results

Scrub	# of Contactor	2013 Test			2011 Test(1)			Comparison 2013/2011
V-05 Contactor	Volumes Processed	Org. Cs	Aq. Cs	D(Cs) Org/Aq	Org. Cs	Aq. Cs	D(Cs) Org/Aq	$D(Cs)_{2013}$/ $D(Cs)_{2011}$
Test No.	When Sampled	mg/L	mg/L	-	mg/L	mg/L	-	
2A-1	0	337.7	0.09	-	252	0.10	-	-
2A-1	6	199.0	47.5	3.38	187	135	1.4	2.44
2A-1	7	173.8	44.7	313	186	158	1.2	2.66
2A-1	8	189.1	45.5	3.35	200	168	1.2	2.81
2A-1	10	201.5	47.1	3.45	192	174	1.1	3.13
2A-2	0	161.3	0.02	-	[redacted]	[redacted]	[redacted]	[redacted]
2A-2	6	159.5	49.1	2.63	[redacted]	[redacted]	[redacted]	[redacted]
2A-2	7	150.4	55.9	2.18	[redacted]	[redacted]	[redacted]	[redacted]
2A-2	8	158.4	61.6	2.08	[redacted]	[redacted]	[redacted]	[redacted]
2A-2	10	153.0	64.5	1.92	[redacted]	[redacted]	[redacted]	[redacted]
2B-1	0	43.8	0.17	-	[redacted]	[redacted]	[redacted]	[redacted]
2B-1	6	237.6	41.6	5.16	[redacted]	[redacted]	[redacted]	[redacted]
2B-1	7	243.3	44.8	4.91	[redacted]	[redacted]	[redacted]	[redacted]
2B-1	8	246.4	45.6	4.88	[redacted]	[redacted]	[redacted]	[redacted]
2B-1	10	208.3	48.5	3.88	[redacted]	[redacted]	[redacted]	[redacted]
2B-2	0	181.4	0.38	-	[redacted]	[redacted]	[redacted]	[redacted]
2B-2	6	157.8	64.9	2.40	[redacted]	[redacted]	[redacted]	[redacted]
2B-2	7	166.7	71.1	2.32	[redacted]	[redacted]	[redacted]	[redacted]
2B-2	8	170.2	74.8	2.25	[redacted]	[redacted]	[redacted]	[redacted]
2B-2	10	160.5	77.9	2.04	[redacted]	[redacted]	[redacted]	[redacted]
2C-1	0	191.5	0.88	-	183	0.10	-	-
2C-1	6	231.0	43.2	5.44	192	146	1.3	4.14
2C-1	7	262.3	46.9	5.68	107	165	0.6	8.76
2C-1	8	244.7	50.1	4.97	123	191	0.6	7.71
2C-1	10	242.2	52.1	4.73	104	205	0.5	9.31
2C-2	0	186.5	(2)	-	[redacted]	[redacted]	[redacted]	[redacted]
2C-2	6	152.5	85.1	2.01	[redacted]	[redacted]	[redacted]	[redacted]
2C-2	7	149.2	89.9	1.79	[redacted]	[redacted]	[redacted]	[redacted]
2C-2	8	152.0	95.9	1.81	[redacted]	[redacted]	[redacted]	[redacted]
2C-2	10	153.4	102.0	1.67	[redacted]	[redacted]	[redacted]	[redacted]

(1) The 2011 test had only 40% of the MaxCalix in the organic solvent

(2) Sample not taken

With the NGS scrubbed, it was then ready to release its captured Cs by using a dilute acid, 0.01 M H_3BO_3, in the stripping process. The results of the strip tests are listed in Table 4-6. In both the current test and the 2011 test, the acid did an equally effective job of removing the Cs from the organic solvent. This was the expected result as the strip solution was the same in both tests (0.01 M boric acid). The D(Cs) for both tests are the same within measurement error. The current test generally showed a better D(Cs) as it had a higher concentration in the organic as stripping started with the exception of the last two samples in the 12 gpm test (Test 3C).

Table 4-6. Strip Mass Transfer Test Results

Strip	# of Contactor	2013 Test			2011 Test(1)			Comparison 2013/2011
V-05 Contactor	Volumes Processed	Org. Cs	Aq. Cs	D(Cs) Org/Aq	Org. Cs	Aq. Cs	D(Cs) Org/Aq	$D(Cs)_{2013}$/ $D(Cs)_{2011}$
Test No.	When Sampled	mg/L	mg/L	-	mg/L	mg/L	-	
3A	0	333.5	0.003	-	122	0.0175	-	-
3A	6	33.2	358.6	0.0833	32.6	286	0.11	0.73
3A	8	30.9	361.6	0.0770	23.1	338	0.07	1.13
3A	10	31.4	405.2	0.0698	22.8	358	0.06	1.10
3B	0	152(2)	0.013	-	107	0.0217	-	-
3B	6	32.5	338.4	0.0926	17.1	283	0.06	1.53
3B	8	24.7	368.7	0.0646	16.6	324	0.05	1.26
3B	10	24.8	389.5	0.0613	15.5	352	0.04	1.39
3C	0	137.8	1.460	-	128	1.85	-	-
3C	6	24.4	309.1	0.0467	16.9	279	0.06	0.77
3C	8	19.1	331.2	0.0341	14.8	341	0.04	0.79
3C	10	20.1	338.8	0.0351	19.7	369	0.05	0.66

(1) The 2011 test had only 40% of the MaxCalix in the organic solvent
(2) Sample was reanalyzed. Original analysis reported 46.3 mg/L

All three processes had some similar results with respect to contactor volumes and contactor flow rates. Plotting the D(Cs) against the contactor volumes (Figure 4-3, Figure 4-4 and Figure 4-5) showed an improvement (with one exception in the 12 gpm extraction test). There is a general trend of increased performance with increased contactor residence time, though the increase was small and is within the margin for uncertainty of the data.

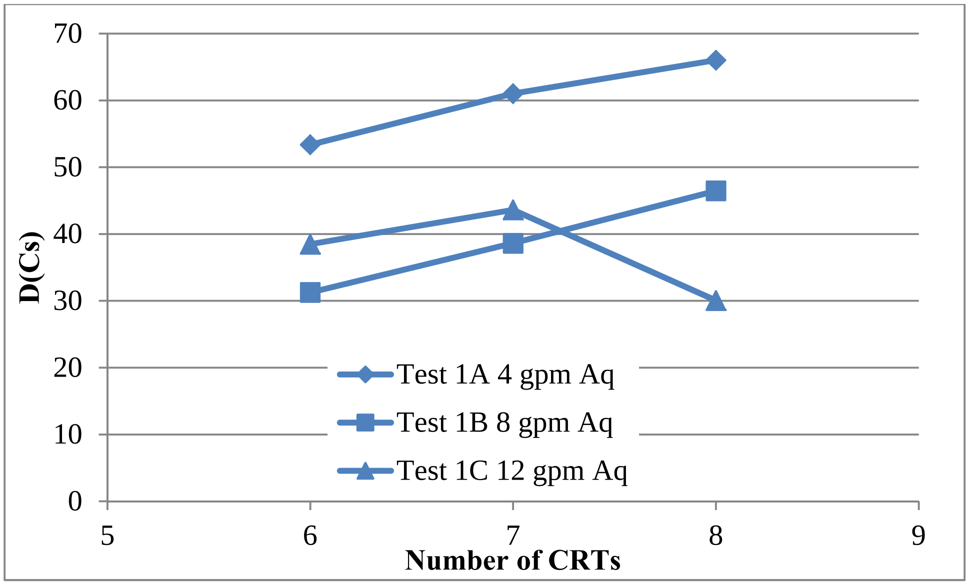

Figure 4-3. Comparison of Contactor Residence Time on Extraction D(Cs)

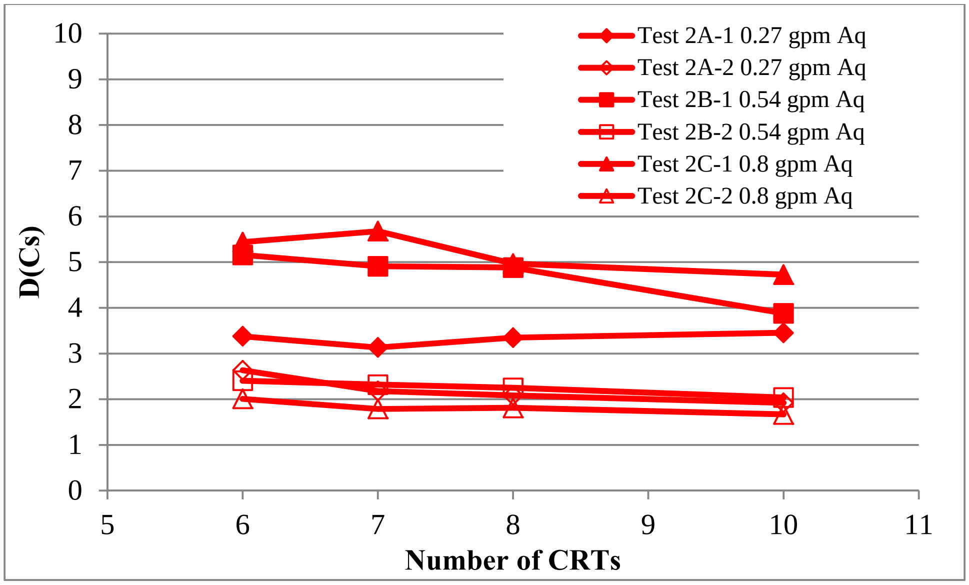

Figure 4-4. Comparison of Contactor Residence Time on Scrub D(Cs)

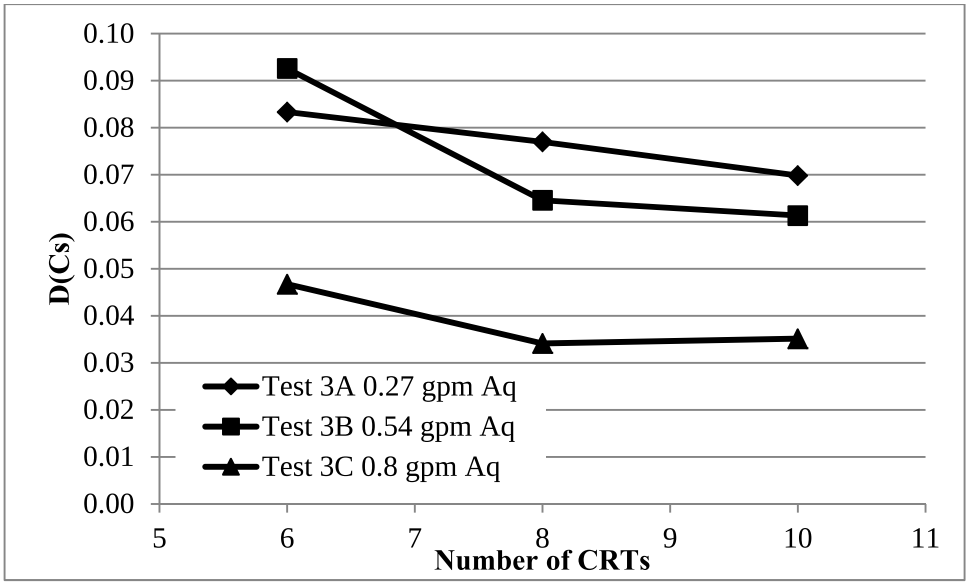

Figure 4-5. Comparison of Contactor Residence Time on Strip D(Cs)

The effect of flow rate of solutions through the contactor does not seem to be significant. Figure 4-6 and Figure 4-7 show that from Tests A to C with increasing flow rates, both the organic and aqueous Cs concentration trends are inconclusive. In general, the process shows good performance under the tested range of conditions.

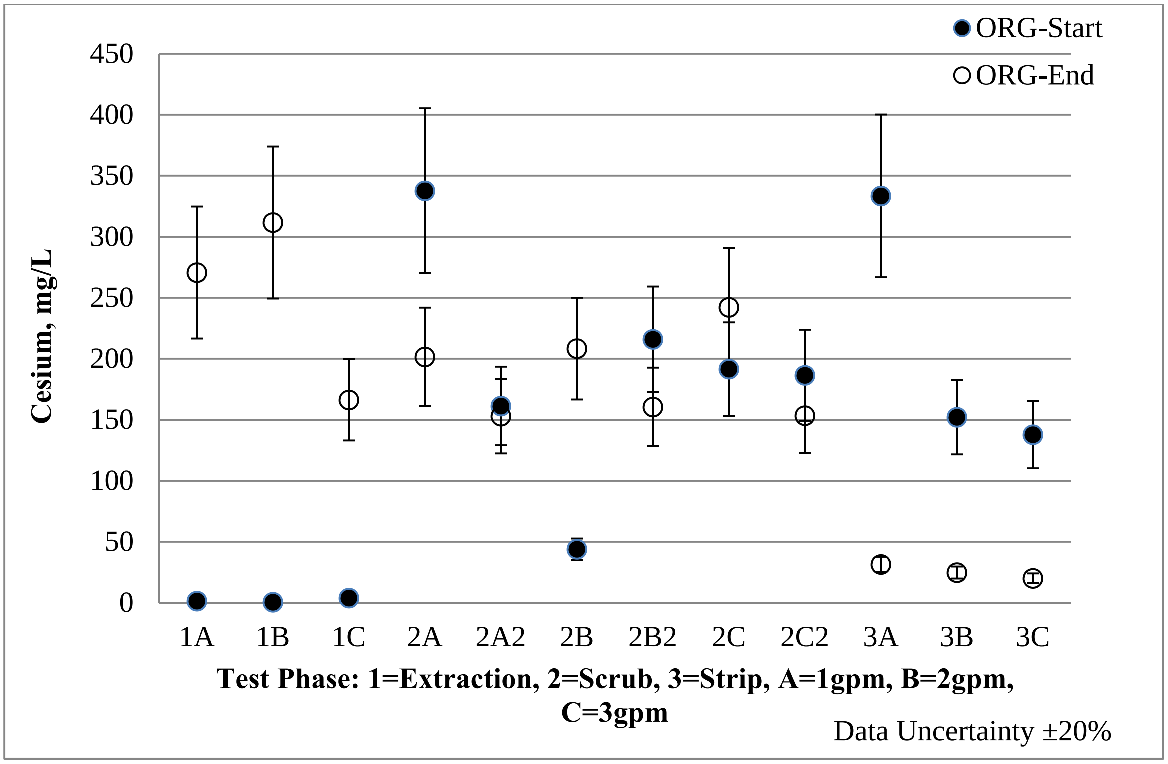

Figure 4-6. Start and End Cs Concentration in NGS during Mass Transfer Test

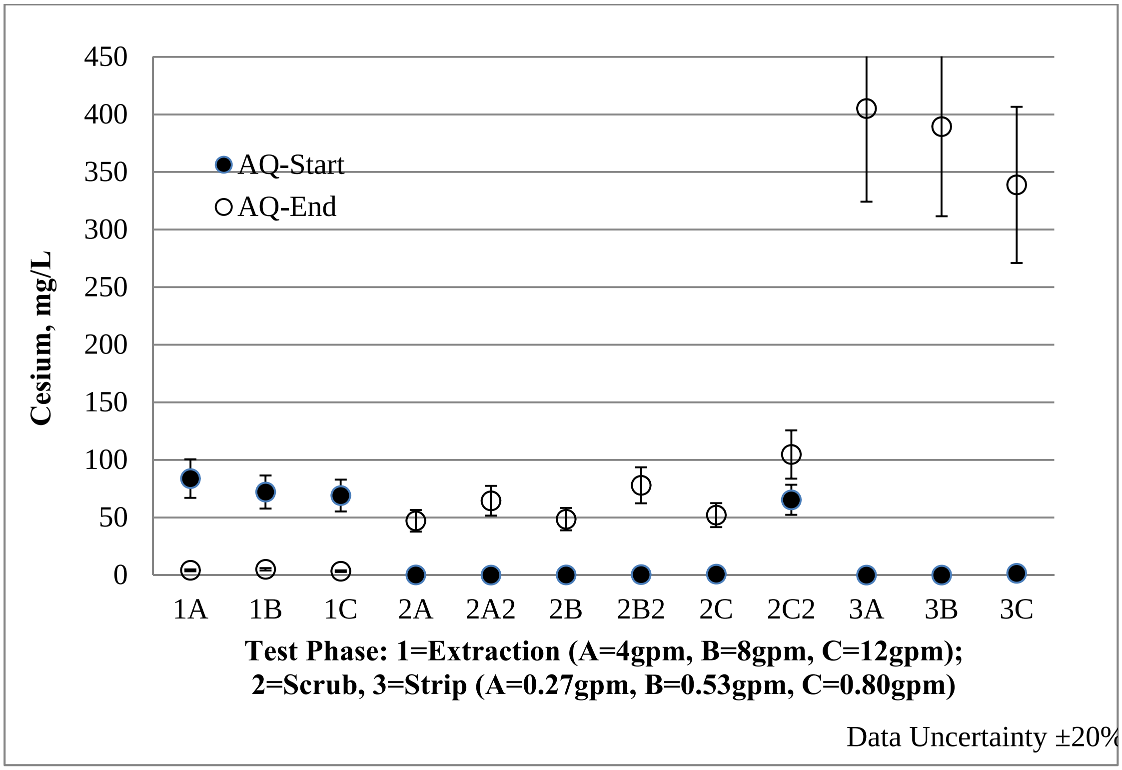

Figure 4-7. Start and End Cs Concentration in Aqueous Stream during Mass Transfer Test

4.1.2 *Equilibrium Sample Results*

The samples that were regularly pulled from the organic and aqueous streams at the end of Tests 1A (extraction), 2A (scrub), and 3A (strip) were used to both measure the cesium concentration at the time pulled and to measure equilibrium concentrations. These samples were obtained from the aqueous and organic sample ports at the end of the individual tests. That is, each sample split so one part was used to measure the cesium concentration and one was later contacted with the appropriate volume of the aqueous sample that was taken at exactly the same time. This method of obtaining sample to perform the equilibrium measurements differed from the previous testing[6] where the samples were obtained by draining the contents of the contactor and sampling the aqueous and organic phases after they had separated. Contactor drain samples were obtained for most of the current tests but were compromised; therefore the final contactor discharge samples were used.

From the samples, eleven contact tests were performed, each in a single glass vial. For the extraction tests, portions from the archived organic and aqueous phases from Test 1A, 1B and 1C were added to individual vials in a 1:4 O:A volume ratio. For the scrub and strip tests only the low flow test samples were used (2A-8CV and 3A-8CV, respectively). These utilized organic and aqueous phases from Test 2A and 3A in a 3.75:1 O:A volume ratio. The vials were agitated by vigorous hand shaking for 30 seconds and then allowed to sit for several days. By allowing the samples to contact for an extended period of time, the final equilibrium point for the phases were determined. At the end of that time, samples from each phase from each vial were sent for ICPMS for Cs analysis. The organic samples required digestion before analysis. The results are reported in Table 4-7.

Table 4-7. Mass Transfer Equilibrium Concentrations

Test ID	Temperature (°C)	Process Stream	Aqueous Cs-133 (mg/L)	Organic Cs-133 (mg/L)	D(Cs)	D(Cs) Temp Corrected	Instantaneous D(Cs)
1A-6CV	17.5	Extract	1.8	161	79.6	58.3	53.4
1A-7CV	17.5	Extract	1.8	249	136.6	68.3	61.0
1A-8CV	17.5	Extract	1.8	229	127.4	63.7	66.0
1B-6CV	17.5	Extract	2.0	280	142.0	71.0	31.3
1B-7CV	17.5	Extract	2.0	199	100.5	50.3	38.6
1B-8CV	17.5	Extract	1.9	152	79.2	39.6	46.5
1C-6CV	17.5	Extract	1.7	191	115.6	57.8	38.5
1C-7CV	17.5	Extract	1.6	223	137.9	69.0	43.6
1C-8CV	17.5	Extract	0.8	123	152.5	76.3	30.1
2A-8CV	21	Scrub	39	165	4.2	2.63	3.35
3A-8CV	21	Strip	327	37	0.12	0.01	0.08
Analytical measurement uncertainty = 20%							

While the aqueous results show a high degree of consistency between the 6, 7, and 8 CV results, the organic results vary to a much higher degree. This is the same trend noted in the mass transfer samples (Table 4-5 and Table 4-6). Given the variation in the organic results, we cannot discern a trend in the 6-7-8 CV series in each test.

For extraction, the greater the D(Cs), the more efficient the process. The equilibrium sample D(Cs) values are always higher than the equivalent instantaneous values for the extraction samples. This is an indication that the instantaneous extraction samples were not fully at equilibrium.

The D(Cs) for the 2A-8CV (scrub) instantaneous and equilibrium results were essentially the same.

For the strip samples (3A-8CV), the lower the D(Cs) values the more efficient the process. For this testing, the D(Cs) equaled 0.077 and the equilibrium value D(Cs) was 0.0112, indicating equilibrium was not reached. The 10CV for test 3A did see a slight drop in the instantaneous D(Cs) to 0.0698. However, when considering measurement uncertainty, the difference is only slightly significant.

4.1.3 *Stage Efficiencies*

Stage efficiency was calculated using the Murphree stage efficiency calculation.[14] The results are presented in Table 4-8. The Murphree stage efficiency is calculated by dividing the difference between the initial and test Cs concentrations for the test by the difference between the initial and temperature-corrected equilibrium Cs concentrations. Calculations are based on the stage being depleted of Cs, which is the aqueous stream for extraction and the organic stream for stripping.

Table 4-8. Stage Efficiency

Test ID	Rotor Speed (rpm)	Aqueous Flow (gpm)	Organic Flow (gpm)	Contactor Volumes When Sampled	Stage Efficiency (%)
1A	1200	4.0	1.0	6	98.7
				7	99.2
				8	99.3
				average	99.1
1B	1700	8.0	2.0	6	97.0
				7	97.7
				8	97.1
				average	97.3
1C	1700	12.0	3.0	6	96.9
				7	96.1
				8	96.1
				average	96.4
3A	2100	0.27	1.0	8	82.7
values shown are temperature corrected					

The data show good efficiencies for the extraction, ranging from 96.1% to 99.3%. The efficiency for one strip test was calculated. The Test 3A, 1 gpm organic and 0.27 gpm aqueous, strip efficiency was calculated to be 82.7%. These results compare well with the 2011 tests which had efficiencies of 95-98% for extraction and 82 -90% for strip.[5]

The calculated efficiencies were used as the basis for input into SASSE to predict the total DF of a multistage system, in this case, 7 extraction, 2 scrub and 7 strip contactors. All three cases used as input, the operating conditions and results of the tests performed in this study. Three different sets of stage efficiencies were assumed, 90% and 80% for each all stages, as well as a final case assuming 95% extraction efficiency and 80% scrub and strip efficiency. The DF values are shown in Table 4-9. The concentration factor (CF) is also given in Table 4-9.

Table 4-9. SASSE Calculated DF Values for MCU Stages

Case #	Organic Flow Rate (gpm)	Extraction		Strip		Stage Efficiency	DF	CF
		Flow Rate (gpm)	D(Cs)*	Flow Rate (gpm)	D(Cs)*	%		
1	1	4	60.1	0.27	0.077	80	3359	14.8
2	2	8	38.8	0.54	0.073	80	2021	15.1
3	3	12	37.4	0.8	0.039	80	3637	15.0
4	1	4	60.1	0.27	0.077	90	18,822	14.8
5	2	8	38.8	0.54	0.073	90	12,466	15.1
6	3	12	37.4	0.8	0.039	90	45,939	15.0
7	1	4	60.1	0.27	0.077	95 extraction 80 scrub/strip	4870	14.8
8	2	8	38.8	0.54	0.073	95 extraction 80 scrub/strip	3503	15.1
9	3	12	37.4	0.8	0.039	95 extraction 80 scrub/strip	21,089	15.0
* Average from the 6, 7 and 8 CV samples								

The 95% extraction with the 80% scrub and strip assumed efficiencies more closely represents the efficiencies from testing. Therefore, the results of the tests performed would predict DF in excess of 3500. The inputs used in SASSE are given in Appendix E. At lower flow rates, the organic phase becomes limiting and excessive air can enter the contactor chamber causing deteriorating performance. MCU operates near the lower hydraulic capacity for the contactors. The high flow rate of this test (e.g., 12 gpm aqueous) is well within the normal hydraulic capacity of the equipment and far from the maximum operating flow rate. Hence, one anticipates slightly poorer performance for the low flow rates.

4.2 Hydraulic Performance

After the completion of the mass transfer tests, the system was adapted for hydraulic testing. This included setting the valves to recirculate both the aqueous and organic streams. On the aqueous side, the coalescer and decanter were plumbed into the system. Thus, as described in previous sections, the discharge of the aqueous feed pump now went to the coalescer and from the coalescer to the decanter prior to the head pot. Since the system already contained strip solution, the stripping hydraulic tests were conducted prior to the extraction hydraulic tests. By doing the tests in this order, an additional contactor cleaning was avoided.

The hydraulics tests were conducted by starting the system and holding at constant flow rates given in the test matrix. The O:A ratio was maintained throughout testing at 3.75:1 for the strip hydraulics test and 1:4 for the extraction hydraulics test. Samples were taken from three sample ports on the aqueous side in sequence. The first sample port was on the contactor aqueous outlet. The second sample port was on the coalescer inlet. The third sample port was on the coalescer outlet.

The sampling sequence started after the system obtained relatively steady flows. The first sample was taken at the contactor outlet. A time count was initiated with a stop watch once the sample was pulled. The sample was sent for MicroTrac™ analysis that was to be started exactly 5 minutes after the sample was pulled. The next sample was pulled from the coalescer inlet sample port 30 minutes after the previous sample. The time between samples was dictated by the time required to run the initial sample and prepare for the next sample. Therefore, the time interval was set by the amount of time required for the MicroTrac™ to perform the analysis and set up for the next analysis.

The third sample was pulled from the coalescer outlet 30 minutes after the coalescer inlet sample. After the third sample was pulled, three samples were pulled simultaneously from the three sample ports. These samples were for potential SVOA and HPLC analyses. Once the coalescer outlet sample was obtained, the next sample would start the sample sequence all over again. Hence, 30 minutes later a sample was pulled from the contactor outlet for MicroTrac™ analysis.

4.2.1 *Strip Hydraulics*

Overall, the operation of the strip hydraulic testing, Tests 4A, 4B and 4C, proceeded without incident. The system behaved well and showed no signs of instability. A view of typical flows through the site glasses of the inlet and outlet lines are shown in Figure 4-8 for the organic flows and Figure 4-9 for the aqueous flows.

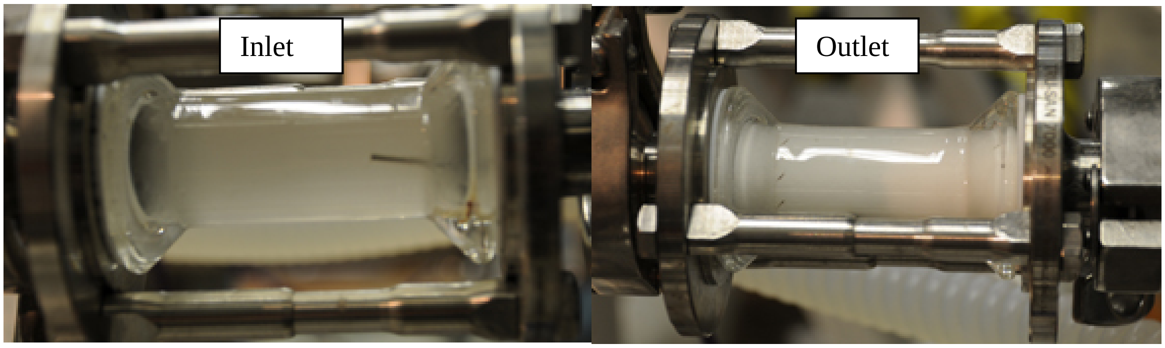

Figure 4-8. Organic Inlet and Outlet Flows of the V-05 Contactor during Test 4B (2 gpm Organic Flow Rate)

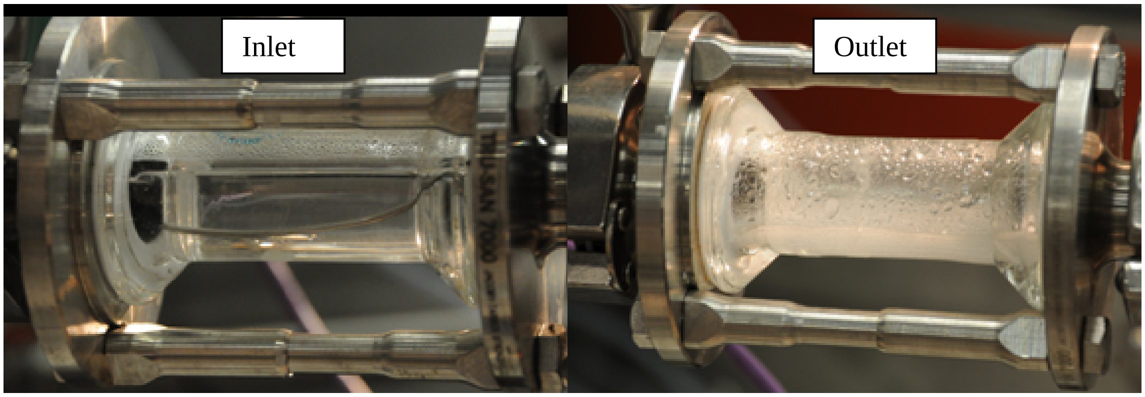

Figure 4-9. Aqueous Inlet and Outlet Flows of the V-05 Contactor during Test 4B (0.54 gpm Aqueous Flow Rate)

Very little solvent was observed in the coalescer chamber. The only observed material was a very thin sheen and one to two small droplets of solvent were observed. No significant amount of solvent was observed on the coalescer surface throughout all three strip hydraulics tests. Figure 4-10 is a photo of the coalescer during operation in Test 4B.

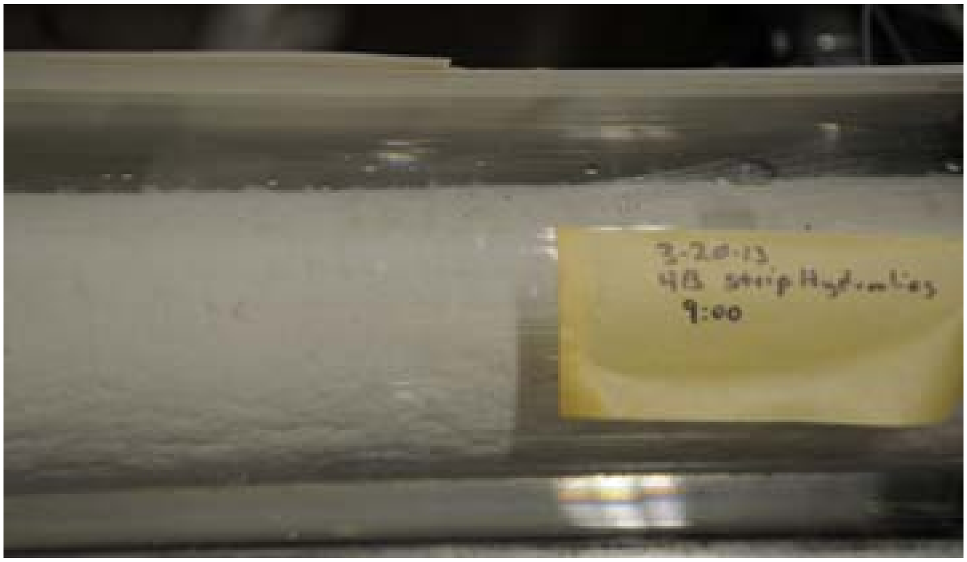

Figure 4-10. Coalescer Operation during Strip Hydraulics Testing (Test 4B, 2 gpm Organic Flow Rate, 0.54 gpm Aqueous Flow Rate)

During testing, graduated cylinder samples were obtained at random times to observe the clarity of the aqueous and organic streams. Figure 4-11 is an example of these samples.

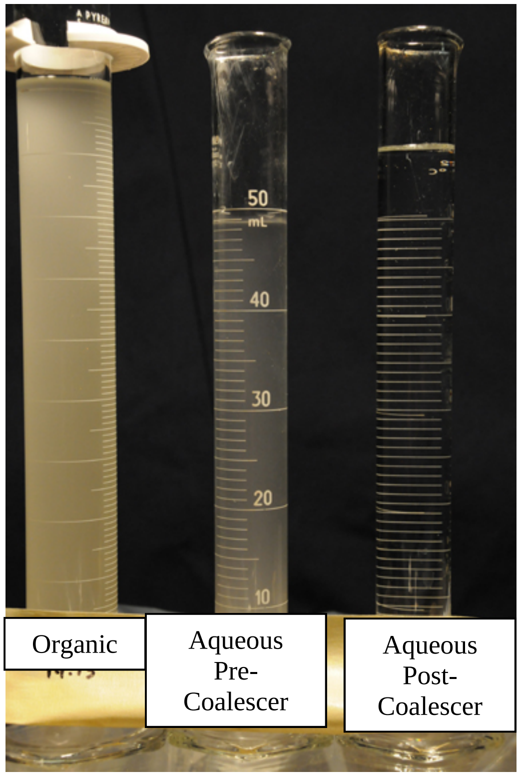

Figure 4-11. Test 4B (Strip, 2 gpm Organic Flow, 0.54 gpm Aqueous Flow) Organic and Aqueous (pre- and post- coalescer) Samples

The photo shows that the organic stream was visually cloudy but did not have significant aqueous carryover observed as a separate layer in the sample. The pre-coalescer aqueous sample was also cloudy and did not have a distinct organic layer indicating significant carryover. The post-coalescer sample was clearer than the pre-coalescer sample, as was expected. The organic sample and pre-coalescer sample clarified over the next couple of days as can be seen in Figure 4-12.

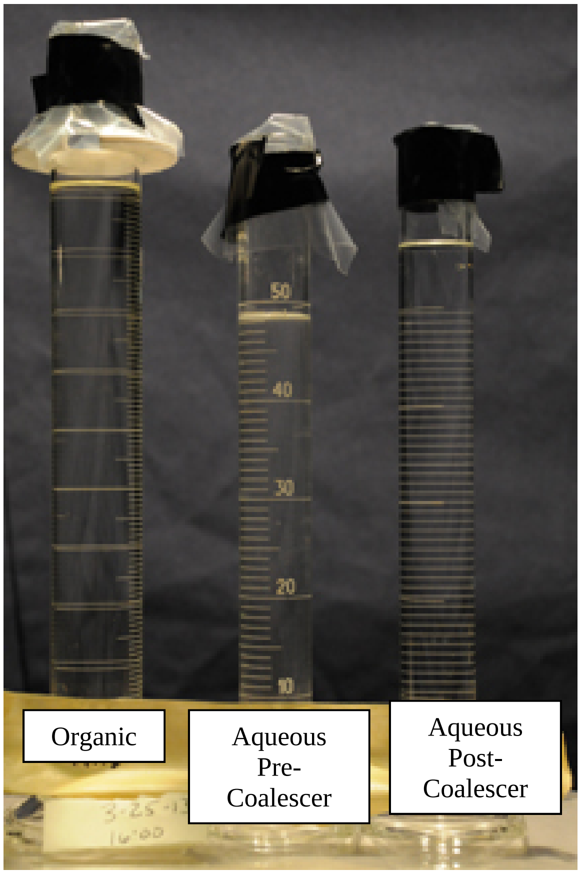

Figure 4-12. Test 4B (Strip, 2 gpm Organic Flow, 0.54 gpm Aqueous Flow) Organic and Aqueous (pre- and post-coalescer) Samples after 5 Days

As described earlier, samples for analysis were taken throughout the testing. The last set of simultaneous samples was submitted for SVOA and HPLC analyses to quantify the amount of organic carryover. The results are shown as Table 4-10.

Table 4-10. SVOA and HPLC Analysis of Aqueous Samples during Strip Hydraulic Testing

Flow Rates O:A (gpm)	Test Identifier	SVOA	SVOA	HPLC
		Isopar (mg/L)	Modifier (mg/L)	Modifier (mg/L)
1/0.27	4A_AQ_POST_CONT	25	25	39
	4A_AQ_PRE_COAL	12	34	39
	4A_AQ_POST_COAL	<10	14	18
2/0.53	4B_AQ_POST_CONT	67	45	56
	4B_AQ_PRE_COAL	69	52	58
	4B_AQ_POST_COAL	<10	17	22
3/0.8	4C_AQ_POST_CONT	39	47	39
	4C_AQ_PRE_COAL	29	32	49
	4C_AQ_POST_COAL	<10	15	20

The aqueous sample results agree with the visual observation concerning the effectiveness of the coalescer, where the post-contactor or pre-coalescer samples had higher levels of entrained organic than the post-coalescer sample. In general, there is not much difference between the post-contactor and pre-coalescer samples.

In theory, the coalescer should remove virtually all of the insoluble (suspended) organic material. Results from the post-coalescer samples should therefore be due only to soluble material. The highly water-insoluble Isopar™ L (all results <10 mg/L) can be assumed to be soluble at 0 mg/L (all measured Isopar™ L is suspended). The soluble concentration of Modifier is calculated to be equal to be the average of all the measurements; 17.7 mg/L (17.0% RSD).

Table 4-11 shows the calculated soluble Modifier can be subtracted from the average of the measured Modifier values ("Average Modifier" column), leaving a residual that corresponds to the insoluble material suspended in solution ("Ave. Mod. – sol. Mod." column). This residual suspended Modifier can then be compared to the suspended Isopar to derive an Isopar/Modifier ratio. In comparison, the blended solvent has an Isopar™ L /Modifier ratio of ~3.

Table 4-11. Analysis of Carryover Components

mg/L					Isopar™ L/Modifier Ratio
Isopar™ L SVOA	Modifier SVOA	Modifier HPLC	Average Modifier	Ave. Mod. -sol. Mod.	
Post-Contactor Samples					
25	25	39	32	14.3	1.74
67	45	56	50.5	32.8	2.04
39	47	39	43	25.3	1.54
Pre-Coalescer Samples					
12	34	39	36.5	18.8	0.637
69	52	58	55	37.3	1.85
29	32	49	40.5	22.8	1.27

The Isopar™ L/Modifier ratio for the post-contactor samples averages 1.77 (14.2% RSD). The Isopar™ L/Modifier ratio for the pre-coalescer samples averages 1.25 (48.4% RSD). Even though the Isopar™ L /Modifier ratio deviates from the nominal; this is not inconsistent with MCU strip effluent samples.

A trend for the impact of increasing the strip flow rates on carryover is not evident from the available data (see Figure 4-13). Though the lowest flow rate has the lowest carryover number, the middle flow rate has the highest carryover and the highest flow rate carryover number is between the two. Carryover may be low enough at these flows to be essentially the same.

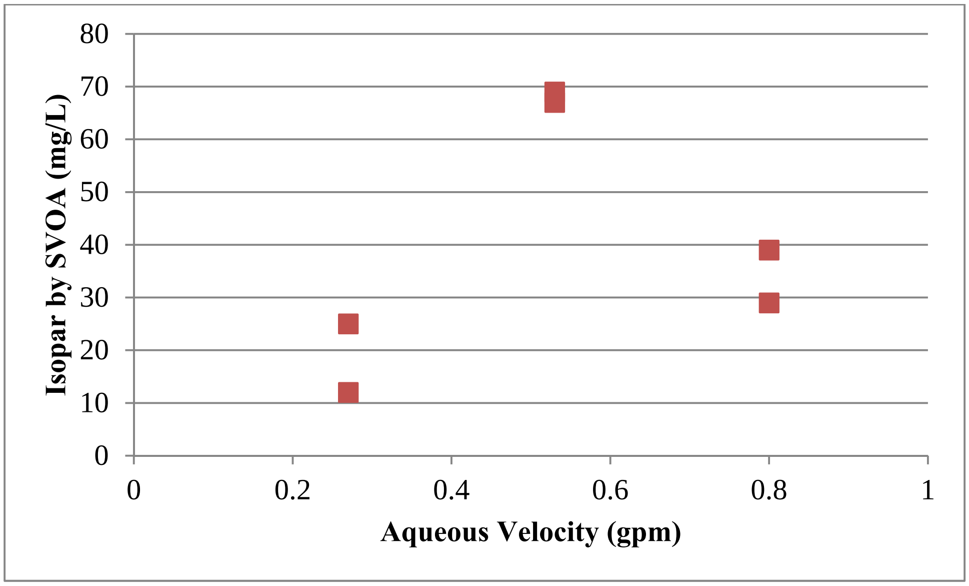

Figure 4-13. Strip Hydraulics - Isopar™ L Carryover as a Function of Aqueous Flow Rate

As described in the methodology section, samples were obtained for particle (droplet) size analysis. Each sample was analyzed in triplicate to provide mean diameters as a function of volume as well as a numbers distribution. The mean values for volume distribution are presented in Figure 4-14, Figure 4-15, and Figure 4-16 for Test 4A, Test 4B, and Test 4C, respectively. The results show that the post-contactor and pre-coalescer droplet means are very similar. The post-coalescer samples have significantly higher mean values. The Test 4A data illustrates a greater spread in the data results than either Test 4B or Test 4C. This is probably due to the lower flow rate and the sampling location.

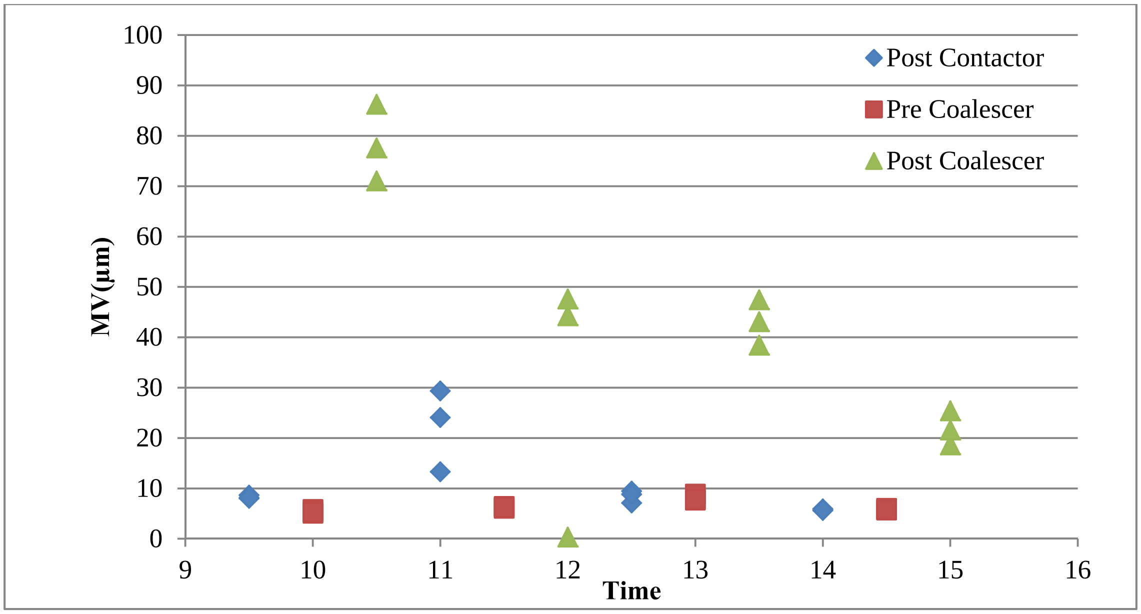

Figure 4-14. Mean Particle Size Date for Test 4A (1 gpm Organic, 0.27 gpm Aqueous Flow Rates)

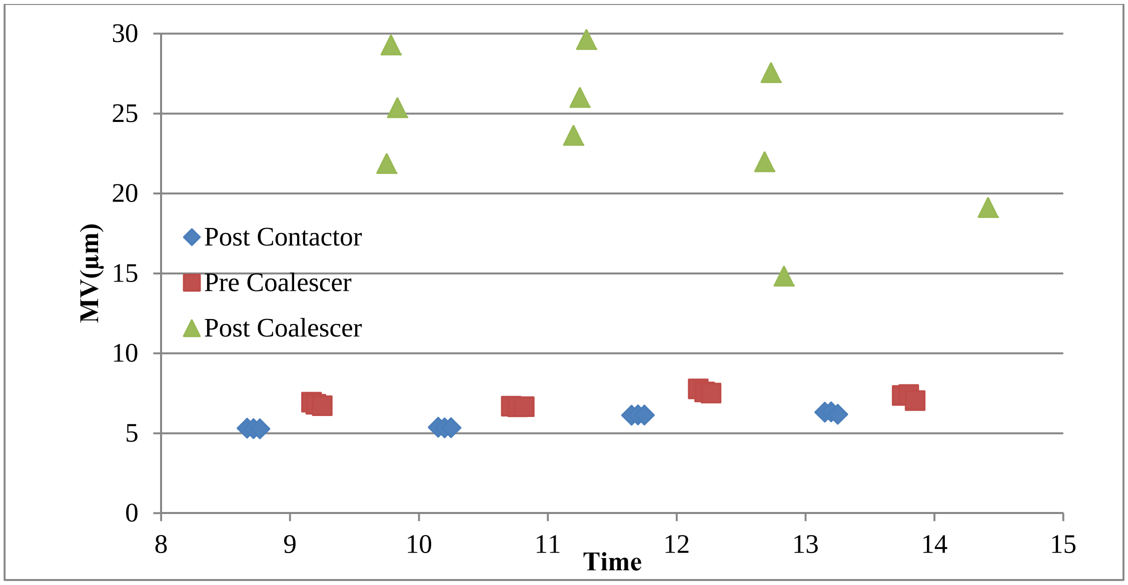

Figure 4-15. Mean Particle Size Date for Test 4B (2 gpm Organic, 0.54 gpm Aqueous Flow Rates)

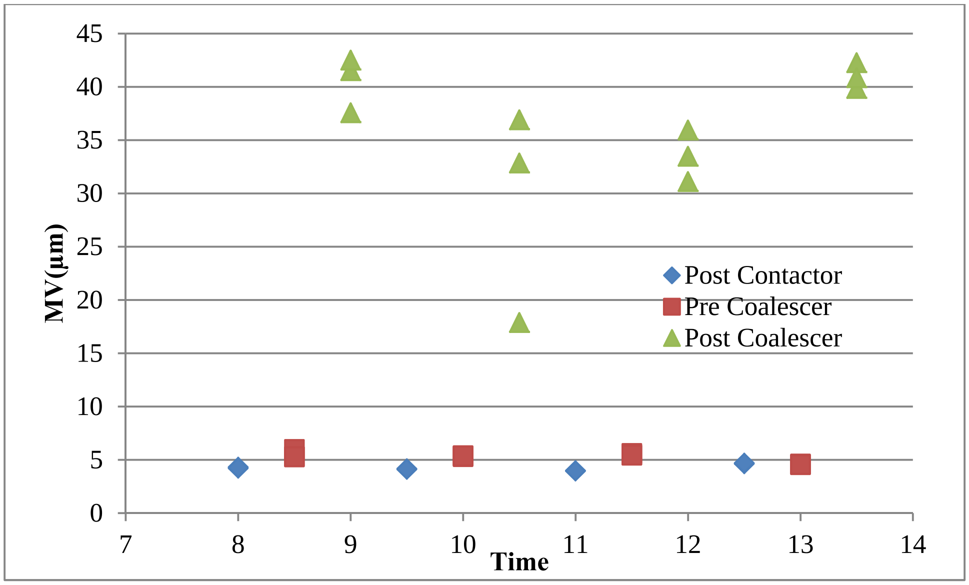

Figure 4-16. Mean Particle Size Date for Test 4C (3 gpm Organic, 0.8 gpm Aqueous Flow Rates)

For all three tests, the post-contactor samples have significantly higher mean diameters. This trend indicates that the coalescer is performing well. This observation is consistent with the carryover analysis presented in Table 4-10.

At the end of the strip hydraulic testing, the aqueous feed tank was decanted to remove the solvent. During this process, a small amount of brown material was found between the strip and solvent layers. The total collected was approximately 25 mL. A photo of the collected material is shown in Figure 4-17.

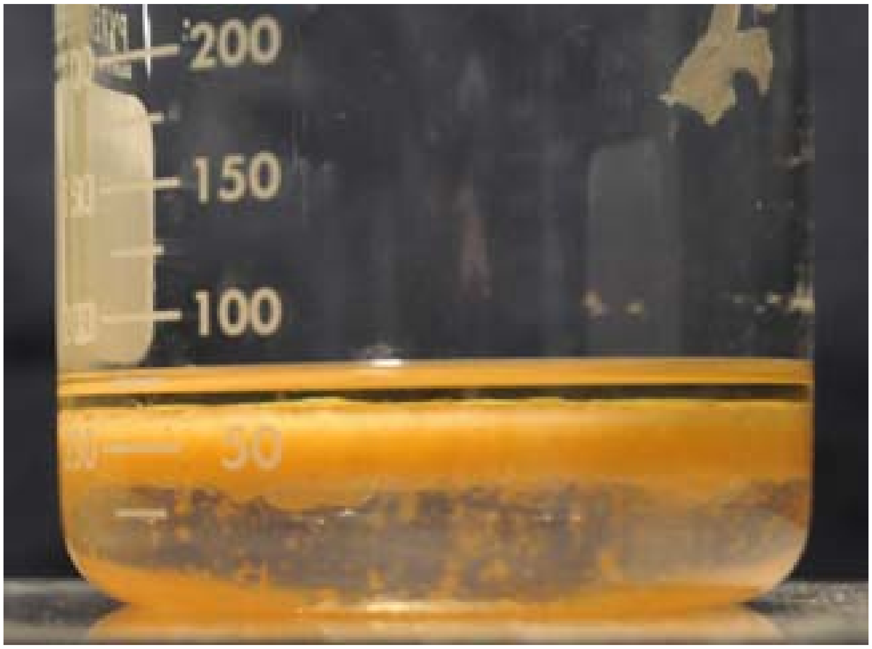

Figure 4-17. Brown Material from Feed Tank, after Strip Hydraulics Test 4C (3 gpm Organic, 0.8 gpm Aqueous Flow Rates)

A sample of the material was analyzed by FTIR. The results showed that the layer is an emulsion of Modifier and water containing sec-butyl phenol (a degradation product of the Modifier) and particles of bayerite. The relevant spectra are shown in Figure 4-18. None of the material was found in the organic tanks. Therefore, none is expected to accumulate in the solvent and this material should be carried out in the aqueous stream.

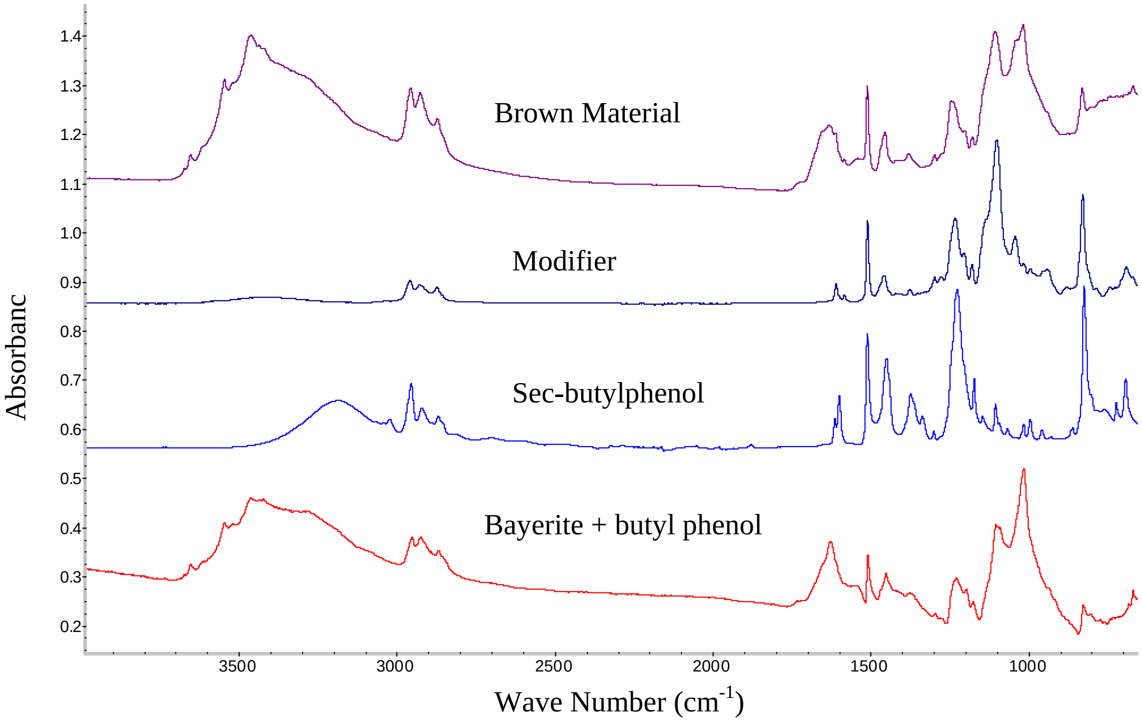

Figure 4-18. Spectrum of Brown Layer between Strip and Solvent

4.2.2 *Extraction Hydraulics*

The system was then charged with the balance of the new salt solution fabricated for this testing. The coalescer was changed to the 40 inch 20 micron element number T5524 manufactured by Pall corporation lot #TEL900. The coalescer was prepared by operating at various aqueous (salt solution) flow rates for over two hours. Flow rates ranged between 4 and 12 gpm on the aqueous side; no solvent was circulated during the coalescer preparation.

During the extraction hydraulic testing, the solvent behavior was very stable. Flows were easily set and maintained for both the aqueous and organic. While there were some issues due to alumino-silicates in the coalescer (discussed in Section 4.4), they were not a result of the solvent. Typical flows as seen through the inlet and outlet site glasses are shown in Figure 4-19 for the organic flows and Figure 4-20 for the aqueous flows.

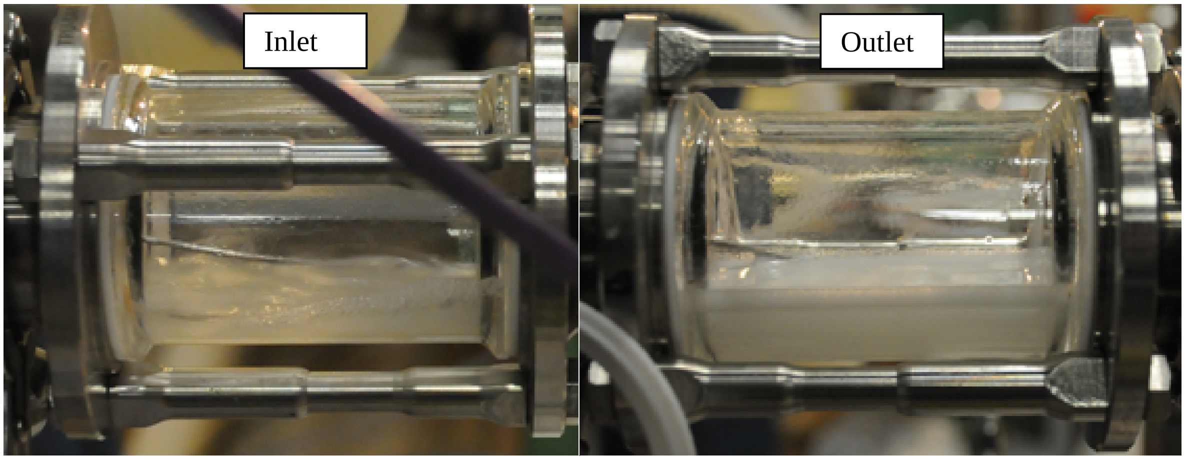

Figure 4-19. Organic Inlet and Outlet Flows of the V-10 Contactor during Test 5A (1 gpm Organic Flow Rates

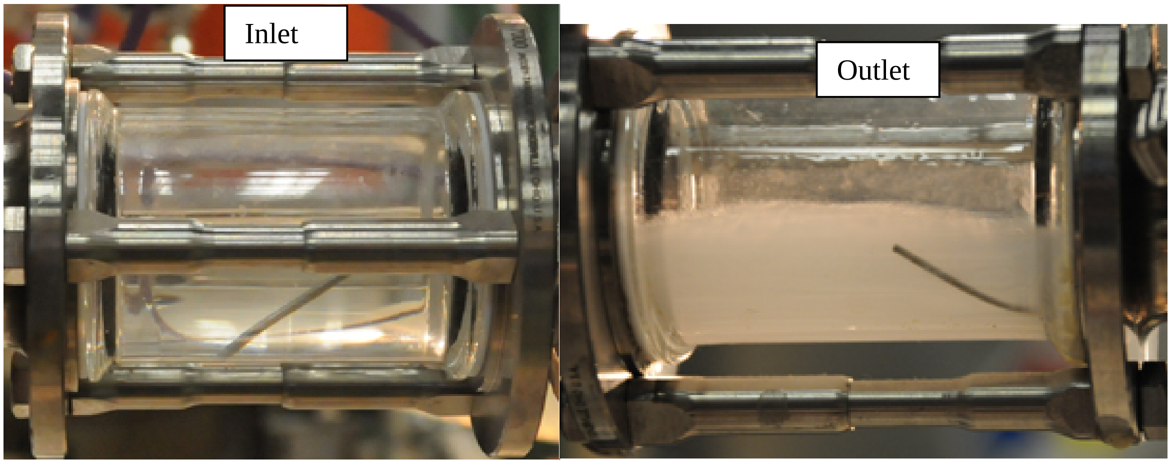

Figure 4-20. Aqueous Inlet and Outlet Organic Flows of the V-10 Contactor during Test 5A (4 gpm Aqueous Flow Rates)

A photo of the V-10 contactor in operation during Test 5B is shown in Figure 4-21.

Figure 4-21. The V-10 Contactor Operating during Test 5B (2 gpm Organic, 8 gpm Aqueous Flow Rates)

As with the Strip Hydraulic testing, Extraction Hydraulics samples of the aqueous loop were taken at intervals and sent for particle (droplet) size analysis. However, additional time was required to purge and de-aerate the MicroTrac™ for the salt solution. Therefore, the sample collection interval was increased to 45 minutes. This was consistent with the previous SRNL testing.[6] As with the Strip Hydraulic testing, the first sample was obtained at the contactor outlet. Forty-five minutes later, the second sample was obtained at the coalescer inlet. The third sample was obtained at the coalescer outlet 45 minutes after the second sample. After the samples for PSD analysis were obtained, a set of samples were taken simultaneously at the three sample points. Starting at the next 45 minute interval, the sequence was repeated. The trio samples were archived with the exception of the last set of samples taken for the test. Those samples were submitted to AD for SVOA and HPLC in order to quantify the amount of solvent carryover.

During the first half of Test 5A, the coalescer (coalescer #1) experienced a very large pressure drop (>30 psid, where previous test[6] experienced ~1 psid). The coalescer inlet pressure increased throughout the day to >40 psig at which point the aqueous flow could not be maintained and began to drop from 4 gpm to less than 2 gpm. Because of this pressure issue, Test 5A was repeated after Test 5C. A decision was made to start up on the second day of hydraulic testing with the same coalescer filter to see the effect of a shutdown with no flow for a period of 14 hours overnight. The starting pressures were considerably lower on the second day (starting at ~4 psid at 4 gpm aqueous flow), which allowed the Test 5A to continue, but in a short time the pressure began to build again. Also, the aqueous pump was making noise consistent with the seal being compromised, but it continued to operate. Starting on this second day, the coalescer flow was periodically stopped for a second, or "pulsed", which always resulted in a reduction of the pressure drop, allowing the testing to continue. This "pulsing" was accomplished by cycling the coalescer inlet isolation valve (V-19).

As stated, Test 5A was repeated after Tests 5B and 5C were completed and designated Test 5AR. Test 5AR utilized a new coalescer medium. (The coalescer was changed after the start of Test 5C) A comparison of the feed flows between Test 5A and Test 5AR is shown as Figure 4-22.

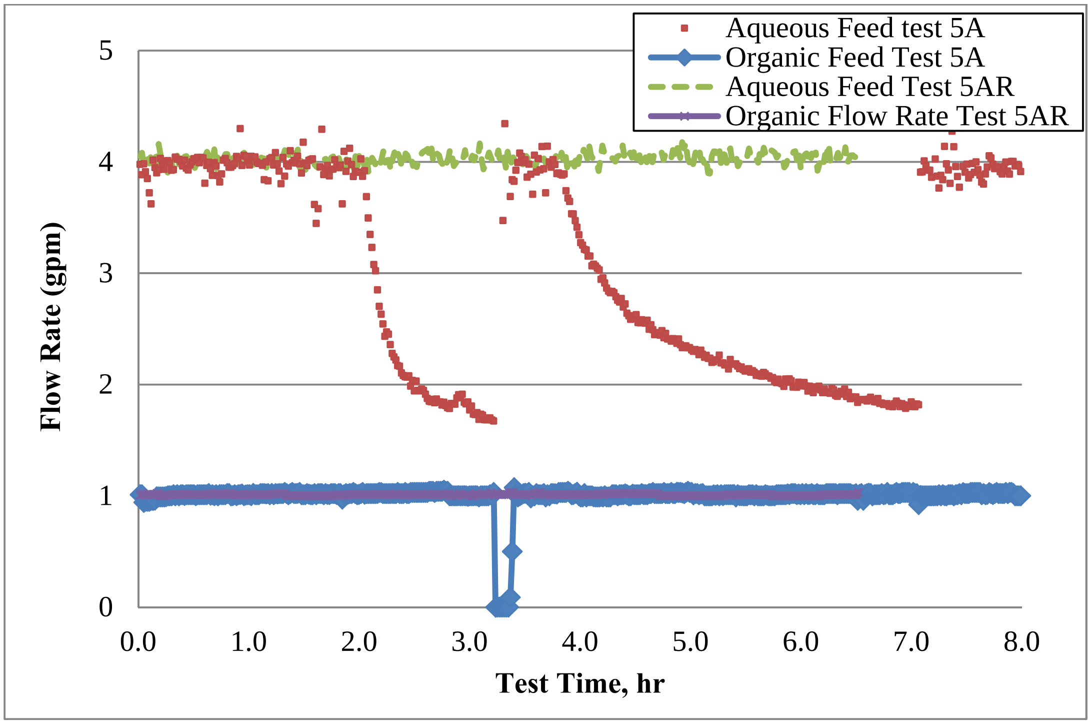

Figure 4-22. Feed Flow Rates for Tests 5A and Test 5AR

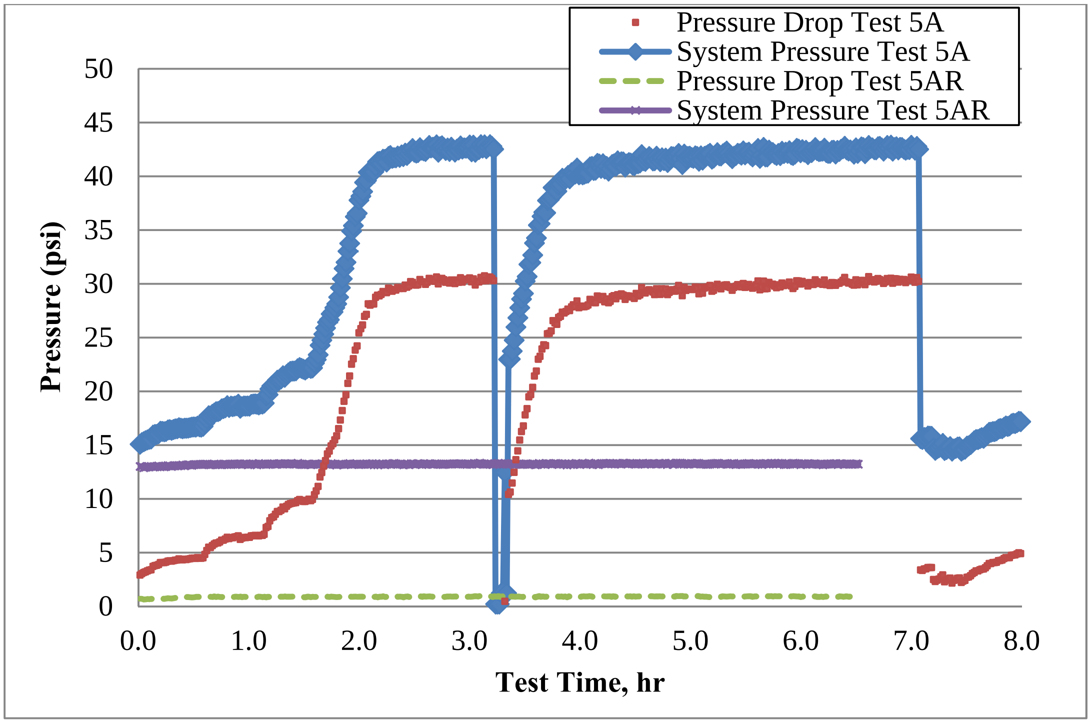

Figure 4-23. System Pressure and Coalescer Pressure Drop for Test 5 and Test 5AR (1 gpm Organic, 4 gpm Aqueous Flow Rates)

During Test 5A, solvent was observed passing through the filter and coalescing. A photo of the coalescer in operation at 4 gpm aqueous and 1 gpm organic is shown as Figure 4-24. Solvent and air were observed passing through the coalescer material and clinging to the coalescer. The solvent and air would form peaks at the top of the coalescer element. Once sufficient material had collected, large droplets would disengage from the coalescer and be swept out by the flow.

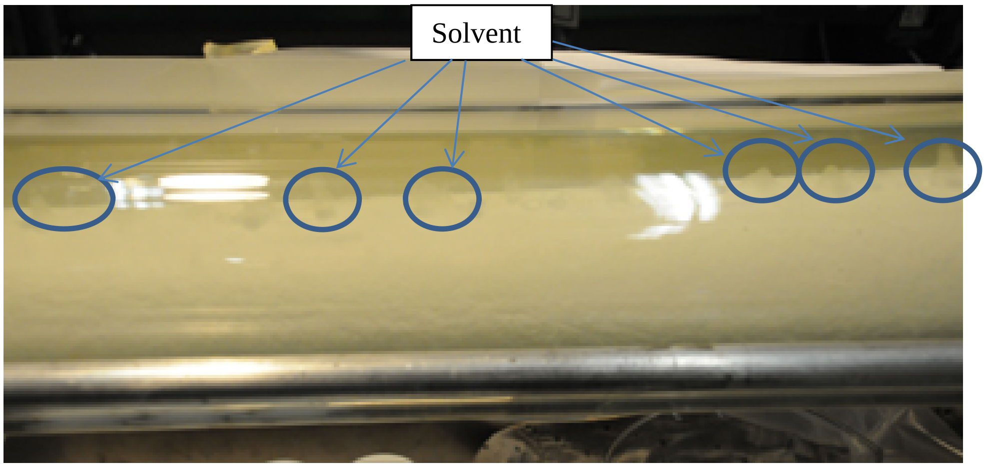

Figure 4-24. Photo of Coalescer Operation at 4 gpm Aqueous, 1 gpm Organic Flow Rates (Test 5 and Test 5AR)

No significant difference was noted visually in the coalescer housing between Test 5A and Test 5AR.

For Test 5B, with coalescer #1, the inlet pressure to the coalescer continued to increase throughout the test, but it was found that if the flow was pulsed (i.e., started and stopped within a few seconds) some pressure was recovered. Therefore, a criterion was chosen to pulse each time the feed pressure reached 30 psid. The test pressures are shown in Figure 4-25. At the end of Test 5B, the aqueous pump seal failed and the pump was replaced.

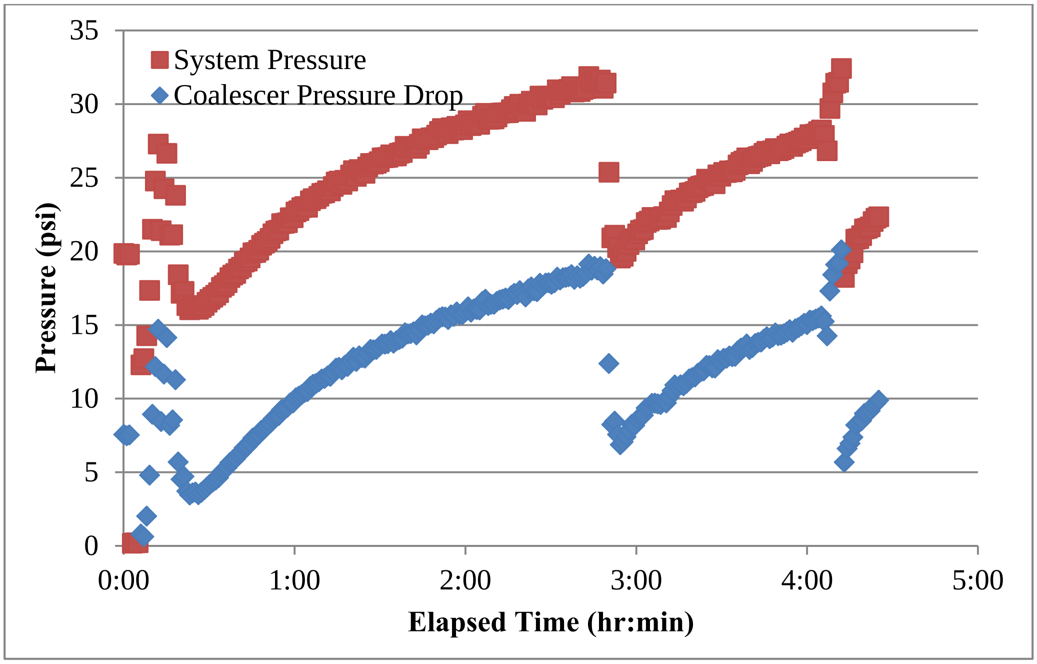

Figure 4-25. Test 5B (8 gpm Aqueous, 2 gpm Organic Flow Rates) System Pressure and Coalescer Pressure Drop

During Test 5B, more solvent was observed on the coalescer than for Tests 5A and 5AR. The increased flow rate resulted in greater accumulation of solvent on the coalescer element with larger “globs” of solvent breaking loose and being carried out by the flow. A photo of the coalescer in operation during Test 5B is shown as Figure 4-26.

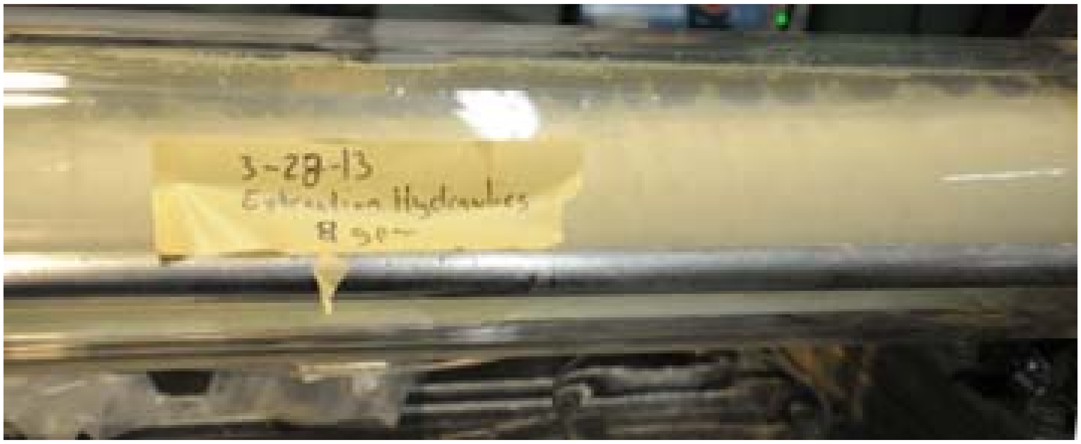

Figure 4-26. Photo of Coalescer Operation at 8 gpm Aqueous, 2 gpm Organic Flow Rates (Test 5B)

For Test 5C, with coalescer #1, the inlet pressure to the coalescer also increased throughout the test but the criterion was changed to pulse the filter when the aqueous flow rate dropped from 12 gpm to 11.5 gpm. The pressure drop and system pressure for Test 5C are the maximums reached during the campaign and at the end of the test the aqueous pump was at its limit to maintain flow at 12 gpm. The coalescer was changed out approximately 2 hours into Test 5C. The new coalescer (coalescer #2) was from the same manufacturer's lot as the previous coalescer but exhibited significantly improved behavior. System pressure and pressure drop were significantly reduced. Figure 4-27 shows the system pressure and coalescer pressure drop for the duration of the test. Note the rapid increase and reduction in pressure as the system was "pulsed". It is also worth noting that the effectiveness of the pulses was consistent. In other words, each pulse resulted in approximately the same reduction in pressures and suggests that pulsing the system would have continued being effective.

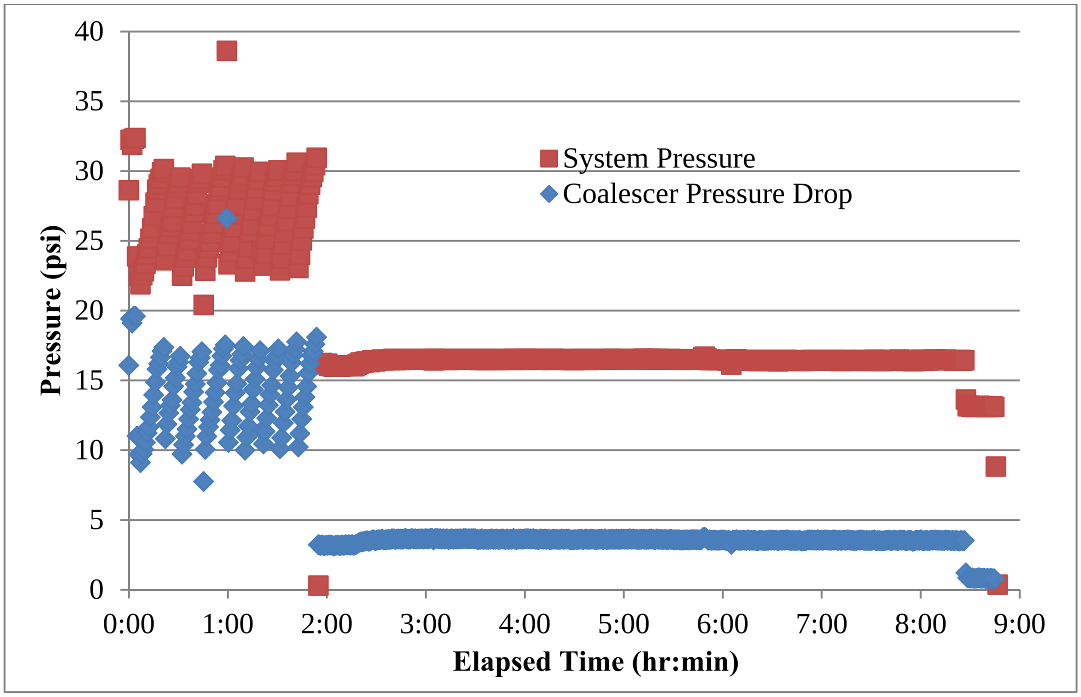

Figure 4-27. Test 5C System Pressure and Coalescer Pressure Drop (3 gpm Organic, 12 gpm Aqueous Flow Rates)

Once the coalescer element was changed all issues with system pressure and pressure drop were remedied. Pressures remained constant and showed no signs of degradation for the remainder of the test as well as subsequent operation. The pressure drops of the new coalescer element were also consistent with the pressure drops throughout the 2011 testing.[6]

At the end of testing, a full set of samples was taken simultaneously from the three sample ports. This final set of samples was sent for analysis to determine the amount of solvent carryover. The results of the analyses are presented in Table 4-12.

Table 4-12. SVOA and HPLC Analysis of Aqueous Samples during Extraction Hydraulic Testing

Flow Rates O:A (gpm)	Test Identifier	SVOA Isopar (mg/L)	SVOA Modifier (mg/L)	HPLC Modifier (mg/L)
1/4	5A_AQ_POST_CONT	370	81	106
1/4	5A_AQ_PRE_COAL	279	51	81
1/4	5A_AQ_POST_COAL	<10	<10	<10
1/4	5AR_AQ_POST_CONT	370	35	182
1/4	5AR_AQ_PRE_COAL	410	37	192
1/4	5AR_AQ_POST_COAL	39	32	12
2/8	5B_AQ_POST_CONT	450	58	217
2/8	5B_AQ_PRE_COAL	400	49	151
2/8	5B_AQ_POST_COAL	19	<10	10
3/12	5C_AQ_POST_CONT	480	71	222
3/12	5C_AQ_PRE_COAL	480	60	177
3/12	5C_AQ_POST_COAL	44	<10	22

Presented are the analyses for Isopar™ L and Modifier by SVOA and HPLC. Generally, SVOA is considered to have a lower uncertainty for Isopar™ L than for Modifier and the HPLC a lower uncertainty for Modifier. The data show that the impact of the feed tank and centrifugal pump between the contactor outlet and the coalescer inlet has a small impact on the carryover numbers as the values at the two sample points show no consistent trend. The values at the contactor discharge and the coalescer inlet are very similar. This implies that the entrained droplets being sampled have insufficient time to coalesce in the 80-gallon feed tank. As a reminder, the contactor effluent returns to the top of the feed tank and the pump suction is on the bottom of the feed tank. The relatively large diameter of the tank reduces the superficial velocity giving the solvent the opportunity to separate and not reach the pump suction.

The analysis shows that there is an increase in the amount of Isopar™ L and Modifier carryover as flow rates increase, though with the analytical uncertainty it does not appear to be significant. There is a significant drop, an order of magnitude, in the amount of Isopar™ L (by SVOA) and Modifier (by HPLC) after passing through the coalescer. The post-coalescer data presented here were used as input to the ARES Corporation’s decanter model and will be discussed in section 4.3 of this report. As previously discussed, the large tank used as a decanter in testing was not intended to replicate the plant decanter.

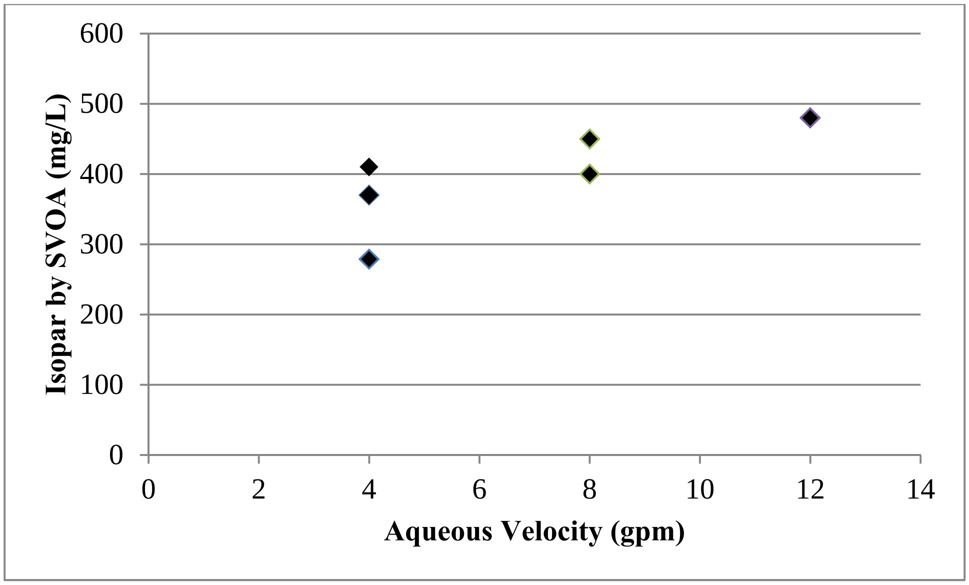

Figure 4-28. Extraction Hydraulics - Isopar Carryover as a Function of Aqueous Flow Rate

In addition to the amount of carryover, droplet size was also measured. The mean value of each sample analysis is shown in Figure 4-29, Figure 4-30, and Figure 4-31 for the three different test flow rates. Due to the density difference between the solvent and aqueous streams, large droplets float to the top of the flow stream. With the sample location at the center of the flow field, these large droplets are not collected in the sample. With the test configuration as designed, the feed tank acts as a settling tank. Large droplets would be expected to separate from the solution and not return to the system. As the flow rates increased, it was expected that the carryover would also increase since this would reduce the amount of time for the solvent to separate. The increased velocity through the coalescer is expected to reduce coalescence. Additionally, the higher velocity tends to increase the disengagement of the Solvent from the coalescer media. This is reflected in the solvent entrainment presented in Table 4-12. However, for each test flow rate, the post-contactor and pre-coalescer sample means were consistently near 10 µm as shown in Figure 4-29, Figure 4-30 and Figure 4-31. There was a slight increase in the post-coalescer mean value for each test which was approximately 4µm for Test 5A, 6µm for Test 5B and 8µm for Test 5C. The exception to this pattern was the first pre-coalescer sample in the Test 5C. This value was inconsistently high, but was measured high in all three sample analyses.

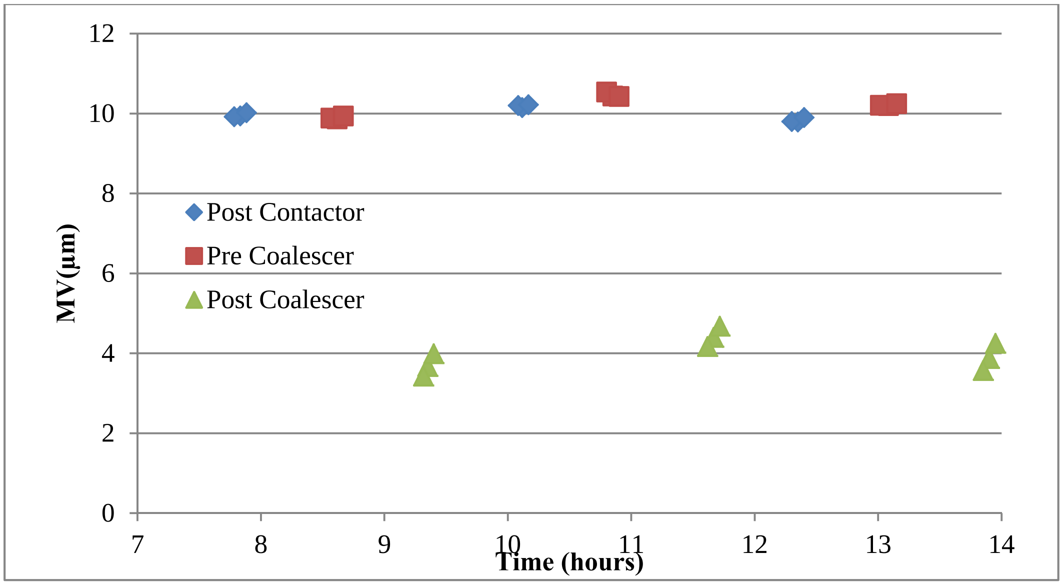

Figure 4-29. Mean Droplet Size Date for Test 5AR (1 gpm Organic, 4 gpm Aqueous Flow Rates)

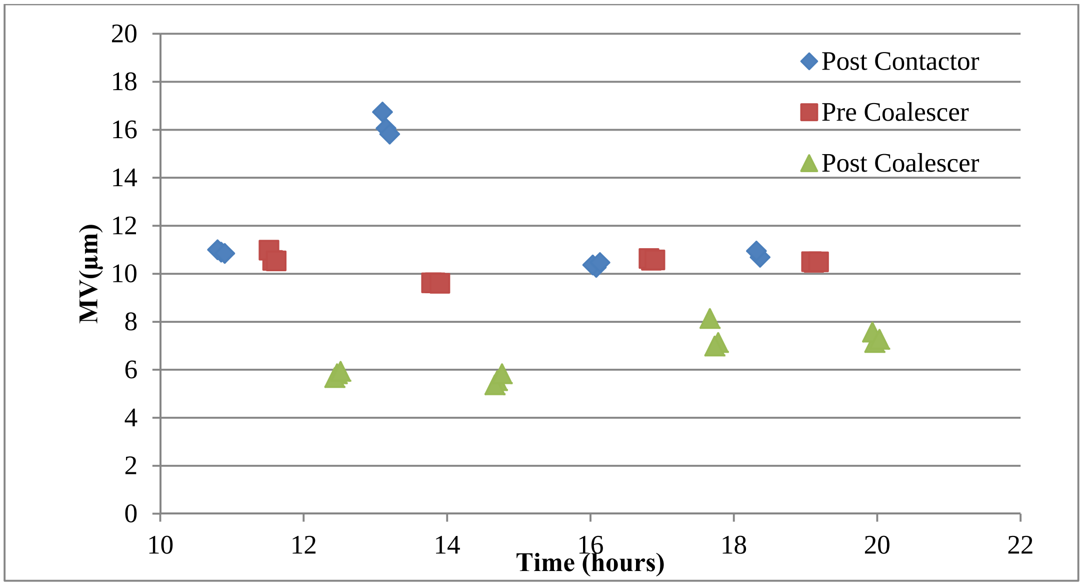

Figure 4-30. Mean Droplet Size Date for Test 5B (2 gpm Organic, 8 gpm Aqueous Flow Rates)

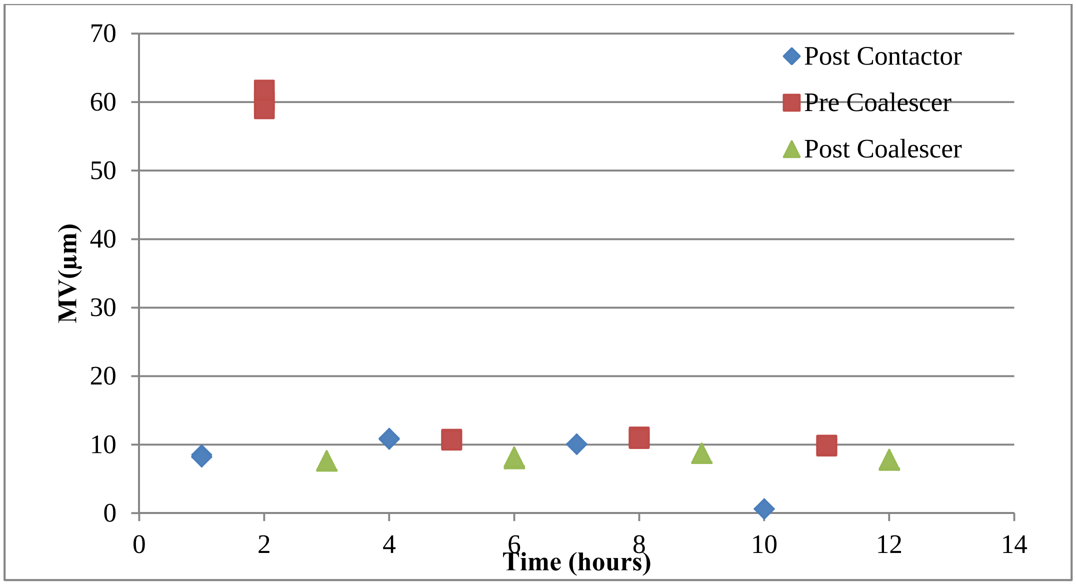

Figure 4-31. Mean Droplet Size Date for Test 5C (3 gpm Organic, 12 gpm Aqueous Flow Rates)

After the extraction testing was complete, the aqueous feed tank was decanted to remove the solvent that had carried over to the aqueous side. As with the strip testing, a black material was observed between the aqueous and solvent. The material was sampled and the resulting analysis is shown as Figure 4-32.

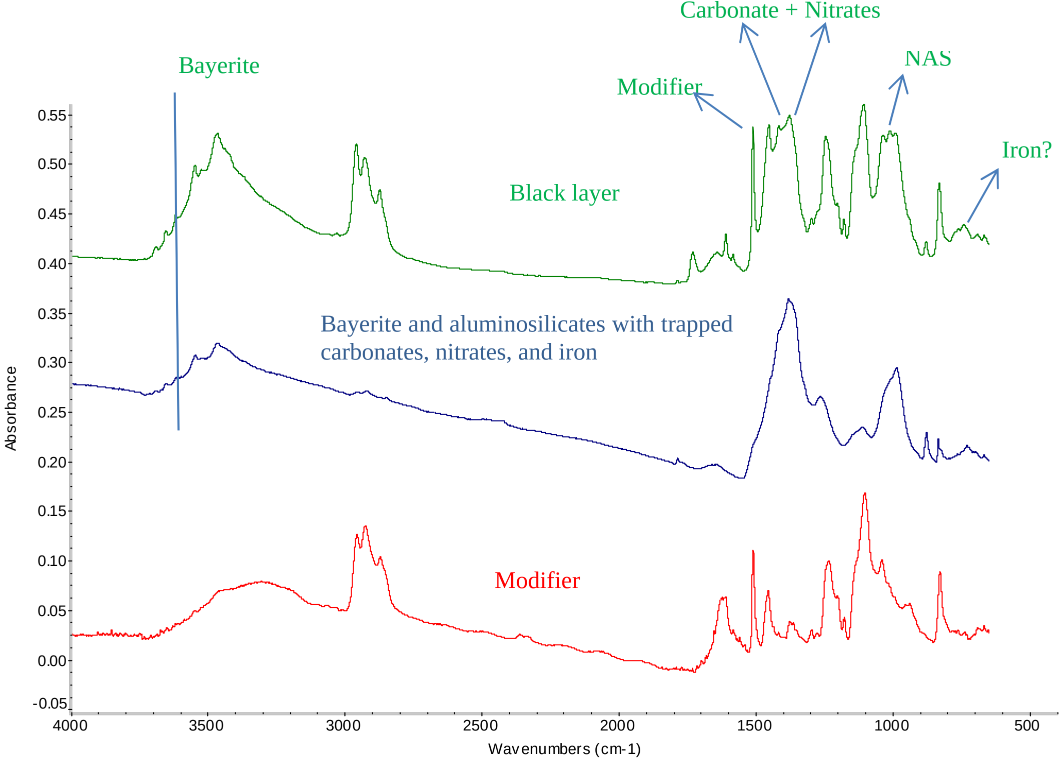

Figure 4-32. Spectrum of Black Layer between Extractant and Solvent

The black material was found to be a composite of Modifier, nitrates, carbonates, bayerite (~Aluminosilicate) with trace amounts of sec-butyl phenol. The sec butyl phenol was identified after subtraction of the other spectra.

None of the material was found in the organic tanks. Therefore, none is expected to accumulate in the solvent and this material should be removed in the wash contactors. Note that a wash, which is performed in MCU, was not performed in this testing.

4.2.3 *Turbidity*

Turbidity samples were obtained during hydraulic testing starting with Test 4B. After the samples for PSD analysis were taken, pre- and post-coalescer samples were taken and turbidity was measured. The sample results are presented in Table 4-13.

Table 4-13. Results of Turbidity Testing during Hydraulic Tests

Test Name	Sample Time in Test min.	Pre-Coalescer NTU	Post-Coalescer NTU
4B	180	88.3	5.8
4B	272	101.3	4.7
4B	367	96.3	5.0
4C	7	67.7	2.2
4C	94	60.5	3.3
4C	182	62.1	2.2
4C	270	61.3	5.2
4C	360	65.0	7.0
5A	52	231.7	26.0
5A	135	164.4	16.2
5A	282	37.1	6.7
5A	410	13.7	6.4
5A-2	15	59.8	39.3
5A-2	112	180.7	36.5
5B	95	259.3	20.2
5B	242	167.8	29.8
5B-2	64	226.6	57.3
5B-2	119	365.3	25.3
5B-2	250	337.3	44.5
5C	64	367.0	32.6
5C	106	301.6	24.2
5C-2*	11	294.2	21.0
5C-2	96	335.2	48.6
5C-2	231	418.8	33.9
5C-2	366	497.6	46.4
5AR	39	165.3	22.9
5AR	195	159.9	19.8
5AR	250	165.6	11.8
5AR	375	168.3	13.1

*Coalescer was changed for this test

As seen in the SVOA and HPLC analyses, there was a significant drop in turbidity between the pre- and post-coalescer samples. The turbidity data was plotted for the pre-coalescer and post-coalescer samples as shown in Figure 4-33 and Figure 4-34, respectively.

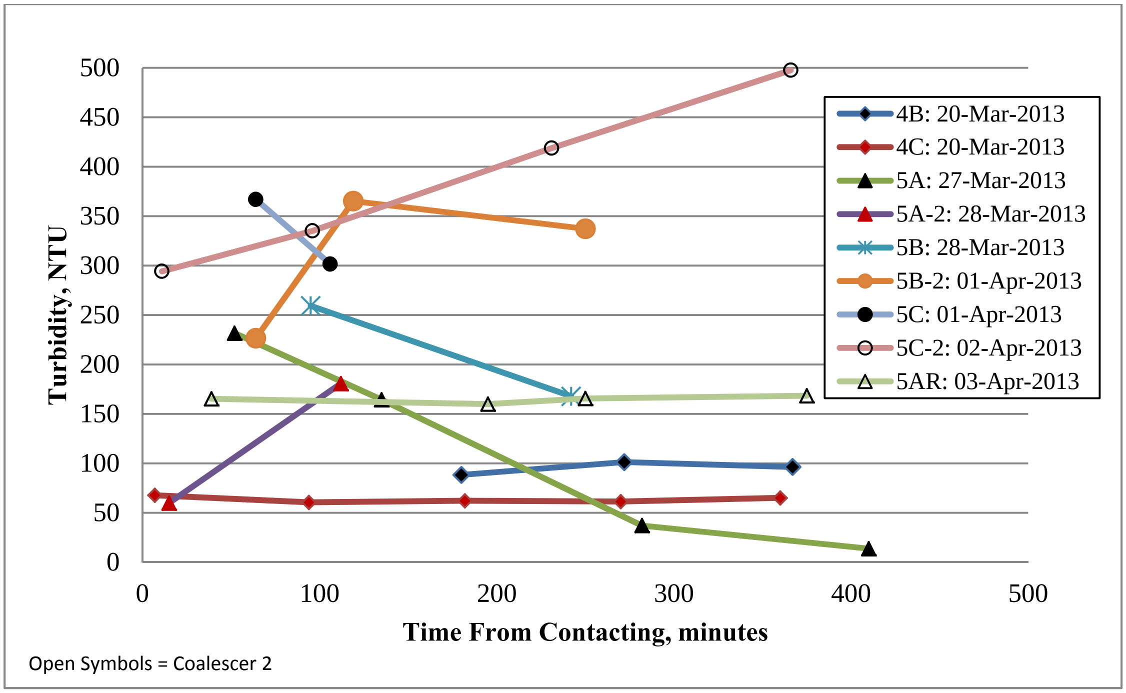

Figure 4-33. Turbidity Results Pre-Coalescer: NGS Hydraulic Tests

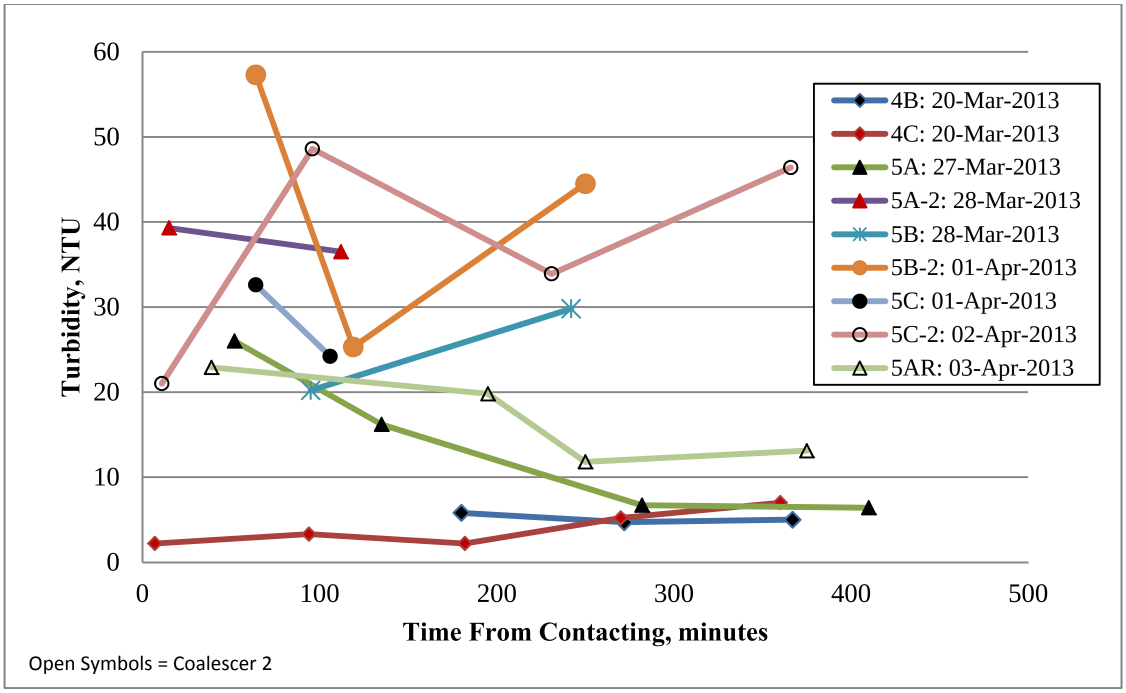

Figure 4-34. Turbidity Results Post-Coalescer: NGS Hydraulics Test

While there was some scatter in the data for some of the tests, in general, values were relatively constant for each test. This implies that the tests were at a quasi-steady state in that the general trend in turbidity did not change as the test progressed. The data also showed that changing the coalescer element did not have much impact on turbidity values.

Samples from the strip testing and extraction testing were tracked over time. A plot of the data is shown as Figure 4-35.

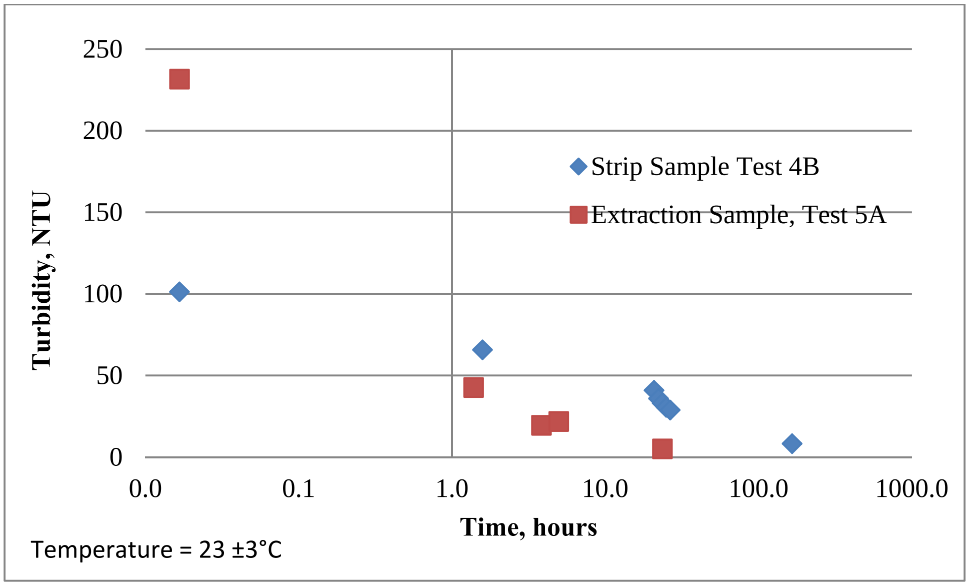

Figure 4-35. Change in Pre-Coalescer Sample Turbidity over Time

As can be seen from the plot, there is a significant drop in turbidity in the first couple of hours. The solutions clarify in a couple of days.

4.3 Decanter Modeling

4.3.1 *Background*

The coalescer-decanter at MCU consists of two sections, a coalescer and a gravity separator (i.e., a decanter). The purpose of the coalescer is to increase the size of the droplets exiting the first coalescer in the MCU process. The purpose of the decanter is to allow the coalesced droplets to rise and be recovered from the DSS or SE streams.

Coalescence is a three step process. The first step is the collection or capture of droplets, the second step is the combining of several small droplets into larger droplets, and the third step is the rise or fall of the enlarged droplets by buoyancy or gravity.

In the MCU coalescer-decanter, the droplets are captured by the direct-interception method. In direct interception, droplets are collected as they travel in laminar streamlines around fine wires or filaments. A general rule with direct interception is that the size of the target should be close to the average sized droplet in the dispersion.

Direct interception occurs when a droplet follows a streamline in proximity of a target and collides with the target. That occurs when the approach distance to the target is less than half the droplet diameter. Equation [1] describes the collection efficiency of a droplet on a single target.

$$n_D = \frac{E(1-\alpha)}{K}\frac{(d/D)^2}{1+(d/D)} \qquad [1]$$

where n_D is the collection efficiency, E is the effective multiplier length (0.4 for wire wool)[15], α is the volume fraction of fibers or wires, d is the droplet diameter, D is the target diameter, and K is Kuwabara's hydrodynamic factor (K= $-0.5 \ln\alpha - 0.25\,\alpha^2 + \alpha - 0.75$).[15] Equation 1 considers geometrical interception and ignores inertial effects. Equation [2] calculates the length of coalescer needed for recovery of the droplets

$$L = \frac{\pi D(1-\alpha)\ln(1-\Sigma)}{-4\eta_D \alpha} \qquad [2]$$

where Σ is the overall collection efficiency by direct interception (99.9% in this application) and L is the coalescer length required for removal of all droplets greater than a minimum size with 99.9% efficiency.[15]

The second step is to combine, aggregate, or coalesce the captured droplets. Once the droplets are collected on a wire or fiber, they tend to combine to minimize their interfacial energy.

Coalescers work better in laminar flow for several reasons. Droplets stay in streamlines around a wire or fiber target. High fluid velocities overcome surface tension forces and strip droplets out of the coalescer medium. Slower velocities lead to longer residence times in the medium, and therefore, more time for droplet-target impact and droplet-droplet collisions.

The final step is Stokes' settling of the coalesced droplets downstream of the medium. After the droplets have been increased in size by the coalescer, they are removed by Stokes' settling in the decanter. Equation [3] describes the rise velocity of the droplets

$$v_t = \frac{g\, d^2\, (\rho_2 - \rho_1)}{18\, \mu} \qquad [3]$$

where g is the acceleration due to gravity, d is the droplet diameter, ρ is density, μ is the viscosity of the continuous phase, and the subscripts 1 and 2 refer to the two liquids.

Equation [3] is used along with the flow rate and the dimensions of the decanter to determine whether the droplets formed have sufficient time to rise to the top of the decanter and be removed in the boot.

4.3.2 *Coalescer Calculations*

ARES Corporation designed the coalescer-decanter currently installed in the MCU that is downstream of the Pall coalescer. The coalescer-decanter system was not included in the SRNL test stand and its performance is therefore predicted using the model that was used in its design. To design the coalescer-decanter, they developed a spreadsheet to calculate the coalescence of MCU solvent droplets as a function of droplet size distribution and the rise of droplets in the decanter.

Table 4-14 shows the droplet size distribution (provided by SRS to ARES Corporation) used in the design of the MCU coalescer-decanter.

Table 4-14. SRS MCU Coalescer Decanter Feed Droplet Size Distribution

Droplet Size (micron)	Number Distribution (%)	Volume Distribution (%)
5	5	0.01
10	5	0.11
15	5	0.36
20	17.5	3.03
30	25	14.59
40	25	34.59
50	17.5	47.30

ARES Corporation looked at a variety of coalescer media, including fiberglass co-knits, Teflon™ co-knits, polyester co-knits, wire wool, and wire mesh. They selected wire wool as the best material to coalesce droplets of the size expected in the MCU process.

The DSS coalescer has a diameter of 11 inches and a length of 6 inches. The decanter is designed for a droplet rise of 15 inches and has a distance from the coalescer to the boot of 6 feet. The design flow rate is 9.07 gpm. The coalesced droplets in the DSS decanter are 70 micron.

The SE coalescer has a diameter of 2.5 inches and a length of 6 inches. The decanter is designed for a droplet rise of 7.25 inches and has a distance from the coalescer to the boot of 2.7 feet. The design flow rate is 0.6 gpm. The coalesced droplets in the SE decanter are 40 micron.

ARES Corporation developed a spreadsheet to calculate the effectiveness of a coalescer in recovering solvent droplets of a given size distribution. The spreadsheet uses equation [1] to calculate the efficiency and equation [2] to calculate the required length.

During testing, samples were obtained from the three sample points; post-contactor, pre-coalescer, and post-coalescer. The post-contactor sample was obtained immediately after discharge from the contactor. The pre-coalescer sample was obtained just prior to the coalescer and the post-coalescer sample at the coalescer outlet. To flow from the post-contactor to the pre-coalescer sample ports, the solution passes through the 80-gallon feed tank and centrifugal pump. Therefore, some differences in these samples are expected. Sample port locations in the test stand are shown in Figure 3-1.

Table 4-15 shows the calculated fraction of droplets recovered by the coalescer-decanter corresponding to each of the tests. The table also shows a few sample points corresponding to the testing performed for MCU at Wright Industries.[11] The calculations predict the DSS coalescer-decanter should recover a larger fraction of baseline solvent than NGS. With the SE coalescer-decanter, in some cases the baseline solvent was predicted to be recovered better, while in others the NGS was predicted to be recovered better.

Table 4-15. Fraction of Droplets Calculated to be Recovered by the Coalescer Decanter

Stream	Aq. Flow Rate (gpm)	Sample	Not Recovered	Recovered
DSS	4	5A-Aq-Post-Coal-032713-1430 v2	0.06%	99.94%
DSS	4	5A-Aq-Post-Coal-032713-1215 v2	0.03%	99.97%
DSS	4	5A-Aq-Post-Coal-032713-1215 v1	0.02%	99.98%
DSS	4	5A-Aq-Post-Coal-032713-1000 v2	1.38%	98.62%
DSS	4	5A-Aq-Post-Coal-032713-1000 v1	0.03%	99.97%
DSS	8	5B-Aq-Post-Coal-032813-1415 v2	62.07%	37.93%
DSS	8	5B-Aq-Post-Coal-040113-1115 v1	50.84%	49.16%
DSS	8	5B-Aq-Post-Coal-040113-1115 v2	49.44%	50.56%
DSS	8	5B-Aq-Post-Coal-040113-1330 v1	50.76%	49.24%
DSS	8	5B-Aq-Post-Coal-040113-1330 v2	49.77%	50.23%
DSS	12	5C-Aq-Post-Coal-040113-1545 v1	44.93%	55.07%
DSS	12	5C-Aq-Post-Coal-040113-1545 v2	44.58%	55.42%
DSS	12	5C-Aq-Post-Coal-040213-1045 v1	43.42%	56.58%
DSS	12	5C-Aq-Post-Coal-040213-1045 v2	41.87%	58.13%
DSS	12	5C-Aq-Post-Coal-040213-1300 v1	40.73%	59.27%
DSS	12	5C-Aq-Post-Coal-040213-1300 v2	39.71%	60.29%
DSS	12	5C-Aq-Post-Coal-040213-1515 v1	45.38%	54.62%
DSS	12	5C-Aq-Post-Coal-040213-1515 v2	44.81%	55.19%
DSS		WII DSS 8.6 gpm 715	0.00%	100.00%
SE	0.27	4A Aq Post Coal 031913 1200 v1	0.97%	99.03%
SE	0.27	4A Aq Post Coal 031913 1330 v1	9.05%	90.95%
SE	0.27	4A Aq Post Coal 031913 1330 v2	11.39%	88.61%
SE	0.27	4A Aq Post Coal 031913 1430 v1	13.94%	86.06%
SE	0.27	4A Aq Post Coal 031913 1500 v1rr	6.99%	93.01%
SE	0.54	4B Aq Post Coal 032013 0930 v1-a	32.64%	67.36%
SE	0.54	4B Aq Post Coal 032013 0930 v2	27.90%	72.10%
SE	0.54	4B Aq Post Coal 032013 1100 v1	27.91%	72.09%
SE	0.54	4B Aq Post Coal 032013 1100 v2	27.83%	72.17%
SE	0.54	4B Aq Post Coal 032013 1230 v1	22.94%	77.06%
SE	0.54	4B Aq Post Coal 032013 1230 v2	20.65%	79.35%
SE	0.54	4B Aq Post Coal 032013 1400 v1	9.13%	90.87%
SE	0.54	4B Aq Post Coal 032013 1400 v2	17.30%	82.70%
SE	0.8	4C Aq Post Coal 032113 0900 v1	10.00%	90.00%
SE	0.8	4C Aq Post Coal 032113 0900 v2	9.85%	90.15%
SE	0.8	4C Aq Post Coal 032113 1030 v1	27.79%	72.21%
SE	0.8	4C Aq Post Coal 032113 1030 v2	25.20%	74.80%
SE	0.8	4C Aq Post Coal 032113 1200 v1	17.07%	82.93%
SE	0.8	WII Strip 0.6 gpm 735	0.00%	100.00%
		WII Strip 0.6 gpm 721	81.90%	18.10%

During NGS testing, researchers observed large masses of organic material in the aqueous stream following passage through the coalescer. Analytical results showed the concentration of Isopar™ L in samples collected downstream of the coalescer to be significantly less than the concentration measured in samples collected at the inlet of the coalescer. Visual observation shows that a large fraction of the solvent has coalesced and has floated to the top of the coalescer housing. Since the sample point is mid-stream, this material would not be captured by the sampler. However, since this material has already coalesced and separated, it would be easily recovered in the MCU decanters. Table 4-16 shows the solvent that would be recovered in the decanter from the coalescer in the test stand from the measurements of the solvent carryover into the coalescer, the amount of solvent carryover in the post coalescer sample, and calculating the amount of solvent carryover that would be recovered based on the organic droplet size measured in the post coalescer sample.

Table 4-16. Solvent Recovery from Coalescer during Testing

Flow Rates O/A (gpm)	Sample ID	SVOA Isopar™ L (mg/L)	Isopar™ L Relative Conc.	Isopar™ L Recovery
STRIP				
1/0.27	4A_AQ_POST_CONT	25	1.00	0%
	4A_AQ_PRE_COAL	12	0.48	52%
	4A_AQ_POST_COAL	<10	0.40	**≥60%**
2/0.53	4B_AQ_POST_CONT	67	1.00	0%
	4B_AQ_PRE_COAL	69	1.03	-3%
	4B_AQ_POST_COAL	<10	0.15	**≥85%**
3/0.8	4C_AQ_POST_CONT	39	1.00	0%
	4C_AQ_PRE_COAL	29	0.74	26%
	4C_AQ_POST_COAL	<10	0.26	**≥74%**
EXTRACTION				
1/4	5A_AQ_POST_CONT	370	1.00	0%
	5A_AQ_PRE_COAL	279	0.75	25%
	5A_AQ_POST_COAL	<10	0.03	**≥97%**
2/8	5B_AQ_POST_CONT	450	1.00	0%
	5B_AQ_PRE_COAL	400	0.89	11%
	5B_AQ_POST_COAL	19	0.04	**96%**
3/12	5C_AQ_POST_CONT	480	1.00	0%
	5C_AQ_PRE_COAL	480	1.00	0%
	5C_AQ_POST_COAL	44	0.09	**91%**

Combining the data from Table 4-15 and Table 4-16 allows us to predict the overall recovery of NGS by both the coalescer and the coalescer-decanter for the DSS and SE streams. Table 4-17 shows more than 90% of the solvent is predicted to be recovered by both the coalescer and the coalescer decanter.

The testing occurred at 4, 8 and 12 gpm. However it should be noted that the model is designed for 9.07 gpm. Since increased velocity decreases coalescence, using the model to predict the results of a lower flow would result in better performance than the model prediction. Therefore, the 4 gpm results are expected to under predict the amount of solvent recovered. Consequently, the 12 gpm model prediction is expected to over predict the amount of solvent recovered.

Table 4-17. Predicted Overall Recovery of NGS

Stream	Sample	Aqueous Flow Rate (gpm)	Recovered from Decanter Inlet Coalescer	Recovered from In-line Coalescer[2]	Recovered Total	Post-Decanter Isopar (ppm)
DSS	5A-Aq-Post-Coal-032713-1430 v2	4	100%	97%	100%	0.007
DSS	5A-Aq-Post-Coal-032713-1215 v2	4	100%	97%	100%	0.003
DSS	5A-Aq-Post-Coal-032713-1215 v1	4	100%	97%	100%	0.002
DSS	5A-Aq-Post-Coal-032713-1000 v2	4	99%	97%	100%	0.153
DSS	5A-Aq-Post-Coal-032713-1000 v1	4	100%	97%	100%	0.003
DSS	5B-Aq-Post-Coal-032813-1415 v2	8	38%	96%	98%	11.2
DSS	5B-Aq-Post-Coal-040113-1115 v1	8	49%	96%	98%	9.2
DSS	5B-Aq-Post-Coal-040113-1115 v2	8	51%	96%	98%	8.9
DSS	5B-Aq-Post-Coal-040113-1330 v1	8	49%	96%	98%	9.1
DSS	5B-Aq-Post-Coal-040113-1330 v2	8	50%	96%	98%	9.0
DSS	5C-Aq-Post-Coal-040113-1545 v1	2	55%	91%	96%	19.4
DSS	5C-Aq-Post-Coal-040113-1545 v2	12	55%	91%	96%	19.3
DSS	5C-Aq-Post-Coal-040213-1045 v1	12	57%	91%	96%	18.8
DSS	5C-Aq-Post-Coal-040213-1045 v2	12	58%	91%	96%	18.1
DSS	5C-Aq-Post-Coal-040213-1300 v1	12	59%	91%	96%	17.6
DSS	5C-Aq-Post-Coal-040213-1300 v2	12	60%	91%	96%	17.2
DSS	5C-Aq-Post-Coal-040213-1515 v1	12	55%	91%	96%	19.6
DSS	5C-Aq-Post-Coal-040213-1515 v2	12	55%	91%	96%	19.4
SE	4A Aq Post Coal 031913 1200 v1	0.27	99%	60%	100%	0.1
SE	4A Aq Post Coal 031913 1330 v1	0.27	91%	60%	96%	0.9
SE	4A Aq Post Coal 031913 1330 v2	0.27	89%	60%	95%	1.1
SE	4A Aq Post Coal 031913 1430 v1	0.27	86%	60%	94%	1.4
SE	4A Aq Post Coal 031913 1500 v1	0.27	93%	60%	97%	0.7
SE	4B Aq Post Coal 032013 0930 v1	0.54	67%	85%	95%	3.3
SE	4B Aq Post Coal 032013 0930 v2	0.54	72%	85%	96%	2.8
SE	4B Aq Post Coal 032013 1100 v1	0.54	72%	85%	96%	2.8
SE	4B Aq Post Coal 032013 1100 v2	0.54	72%	85%	96%	2.8
SE	4B Aq Post Coal 032013 1230 v1	0.54	77%	85%	97%	2.3
SE	4B Aq Post Coal 032013 1230 v2	0.54	79%	85%	97%	2.1
SE	4B Aq Post Coal 032013 1400 v1	0.54	91%	85%	99%	0.9
SE	4B Aq Post Coal 032013 1400 v2	0.54	83%	85%	97%	1.7
SE	4C Aq Post Coal 032113 0900 v1	0.8	90%	74%	97%	1.0
SE	4C Aq Post Coal 032113 0900 v2	0.8	90%	74%	97%	1.0
SE	4C Aq Post Coal 032113 1030 v1	0.8	72%	74%	93%	2.8
SE	4C Aq Post Coal 032113 1030 v2	0.8	75%	74%	93%	2.6
SE	4C Aq Post Coal 032113 1200 v1	0.8	83%	74%	96%	1.7

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[2] * Pall Coalescer

More than 96% of the DSS droplets have coalesced to a large enough size (70 micron) to be removed in the decanter based on a design flow rate of 9.07 gpm. If the flow rate is increased above 9 gpm, the removal of droplets in the decanter must be reassessed. The higher flow rate reduces the residence time in the decanter, causing reduced recovery. In addition, at a flow rate of 12 – 15 gpm, the flow in the inlet to the coalescer-decanter would become turbulent. The energy and shear from turbulence could cause some shearing of the droplets and the formation of droplets that are too small to be removed in the decanter.

More than 93% of the SE droplets have coalesced to a large enough size (40 micron) to be removed in the SE decanter based on a design flow rate of 0.6 gpm. If the flow rate is increased above 0.6 gpm, the removal of droplets in the decanter must be reassessed. The higher flow rate reduces the residence time in the decanter, causing a decrease in recovery of droplets. Increasing the flow rate increases the Reynolds number in the inlet, which may move the flow field out of the laminar flow regime needed for efficient coalescence.

If MCU desires to increase the processing rate, testing should be conducted to evaluate the impact of the higher flow rate on the coalescer and the coalescer-decanter.

4.4 Extraction Coalescer

As previously discussed, the first coalescer element (coalescer #1) used during the extraction hydraulic testing developed a high pressure drop. During the low flow test (Test 5A) the resulting pressure was such that the target flow rate could not be maintained. This resulted in the repeating of the test. Replacing the coalescer eliminated the pressure drop issues. After all testing was completed (including the scoping test described in Section 4.5), coalescer #2 was removed and a third coalescer was installed. Coalescer #3 was the same length, pore size, and manufacturer's lot number as the previous two coalescers. The system was started and operated at various flow rates maximizing at 12 gpm. Test time was approximately 1.5 hours. Pressure drop and system pressure was identical to those with coalescer #2.

Coalescer #1 and coalescer #2 were sectioned to determine if the cause of the high pressure drop could be determined. A comparison of the entrance holes of the two coalescers showed a higher solids loading in coalescer #1. A photo of the two coalescers is shown as Figure 4-36.

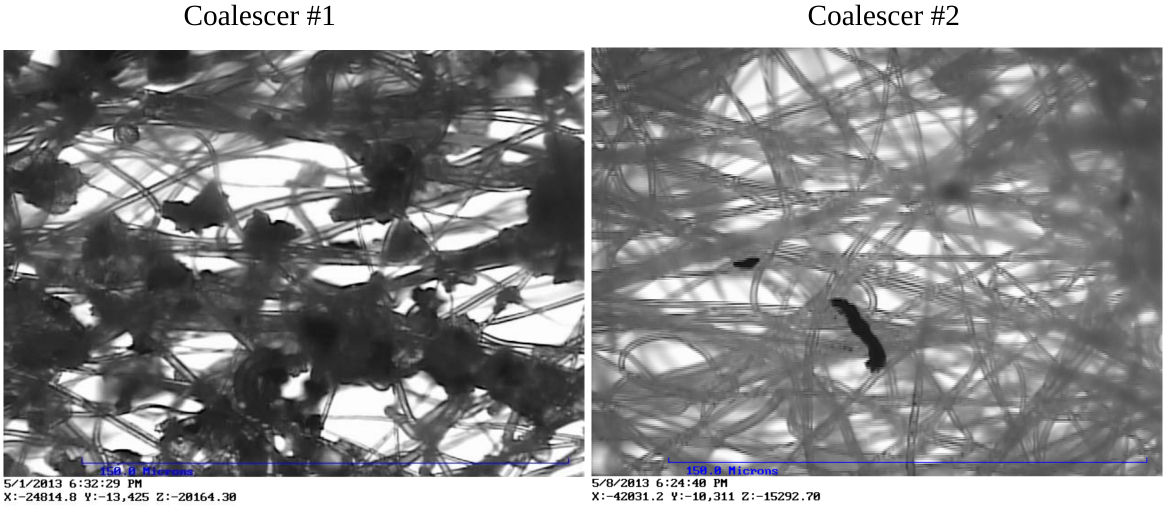

Figure 4-36. Comparison between Coalescer #1 and Coalescer #2 at the Entrance Hole

The solids capture was primarily from heterogeneous nucleation and growth on coalescer #1. Coalescer #2 contained solids that were primarily captured due to trapping with the heterogeneous nucleation occurring to a lesser extent. It should be noted that the salt solution from the vendor was filtered through a 5 micron sock filter as it was added to the system just prior to testing.

A few traces of sodium alumino-silicate and iron related compounds were seen on coalescer #2. The majority of the solids found wetted on the fibers were dried salts.

Fiber diameter and the apparent porosity appear consistent with coalescer #1 used earlier in the test. The solids are believed to have formed from the salt simulant. The solvent is believed to adhere to the solids as well as the coalescer material. Therefore, the clinging solvent would essentially block the obscured flow paths. When the system was "pulsed", the solvent was cleared resulting in the drop in pressure.

4.5 High Flow Scoping Test

After the completion of the test matrix, a scoping test was conducted in which the flow rates were increased above the 12 gpm aqueous/3 gpm solvent to the V-10 contactor. The test was conducted by increasing the aqueous flow rate in 2 gpm intervals while maintaining the 1:4 O:A ratio. The system was started with 4 gpm aqueous and 1 gpm organic, with the organic flow bypassing the contactor. Once both flows were steady, the organic was sent to the contactor. As flows were about to be increased, operator error caused the VFD for the contactor to trip. The system was restarted and the flow rates were increased in 2 gpm intervals for the aqueous flow and 0.5 gpm intervals for the organic flow. After each increase the flows were allowed to stabilize for 1 to 3 minutes prior to increasing again. The aqueous flow meter was calibrated for a maximum of 14.75 gpm and thus that was the limiting flow rate (the DAS would not allow a higher flow rate due to the programed range of the flow meter). The system was held at 14.75 gpm aqueous and 3.7 gpm organic for approximately 10 minutes. No abnormalities were observed during this time. The system was then ramped down in flow with the same 2 gpm aqueous/0.5 gpm organic steps until 8 gpm aqueous and 2 gpm organic flows were achieved. The system was then shut down.

The rate of flow increase during the test was chosen arbitrarily. The rate increase was selected to allow the increase in flow while maintaining the O:A ratio. By raising the flow in 2 gpm steps (aqueous), this allowed the test personnel to raise flow rates in a controlled manner without risk of deviating from the target O:A ratio. A chart of the aqueous and organic flows is shown as Figure 4-37.

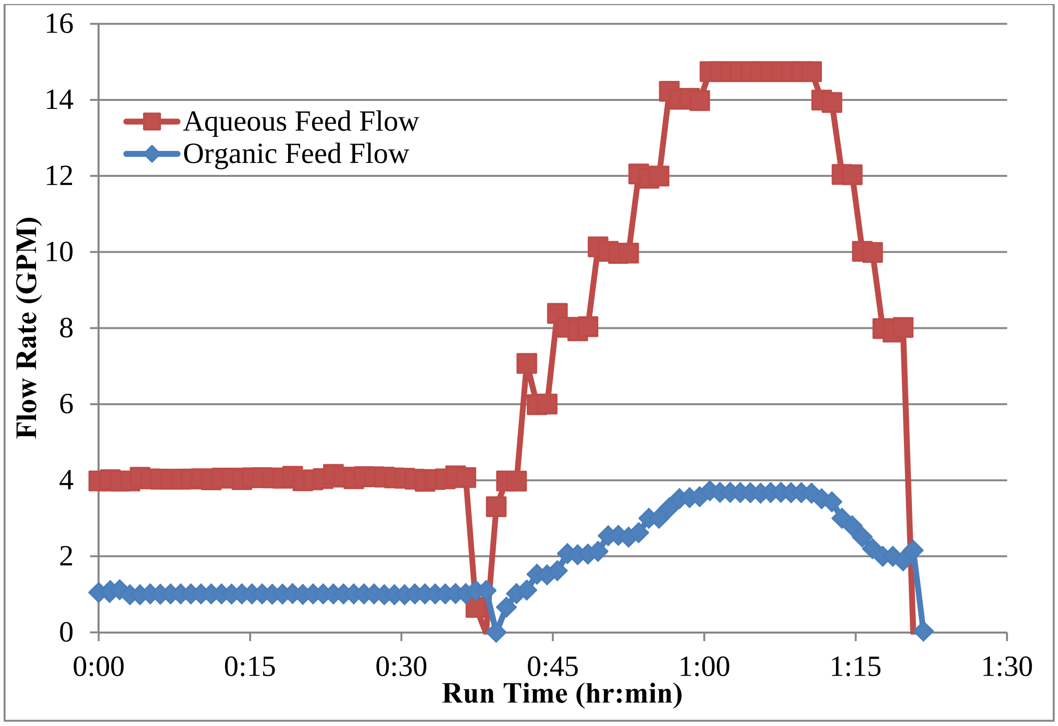

Figure 4-37. Aqueous and Organic Flow Rates for High Flow Scoping Test

Contactor speed for the test was a constant 1700 rpm. Aqueous solution was the simulated salt used in the extraction testing. Note the coalescer and decanter were also plumbed into the test. No samples were obtained during the test.

5.0 Conclusions

SRNL conducted single-stage pilot-scale testing utilizing full-scale strip/scrub (V-05) and extraction (V-10) contactors. Testing utilized a solvent blend of NGS components and the solvent currently in operation at MCU. The tests concluded that the blend solvent in the expected O:A ratio of 1:4 extraction and 3.75:1 strip produced no hydraulic issues at the tested flow rates. The extraction flow rates tested were 4 gpm, 8 gpm and 12 gpm (aqueous). The strip flow rates tested were 0.27 gpm, 0.54 gpm and 0.8 gpm (aqueous).

Increasing the flow rates had little effect on the performance of the solvent. Stage efficiency and mass distribution ratios were determined using Cs mass transfer measurements. The nominal D(Cs) measured was approximately 37-60, similar to ESS testing with real waste. The data indicate that equilibrium is achieved rapidly and maintained throughout sampling. The data showed greater than 95% stage efficiency for extraction. No statistically-significant differences were noted for operations at 12 gpm aqueous flow when compared with either 4 gpm or 8 gpm of aqueous flow.

The first scrub test yielded an average D value of 3.33 to 5.20, and the second scrub test produced an average value of 1.82 to 2.25. For stripping behavior, the D(Cs) values ranged from 0.039 to 0.077. The stage efficiency of the low flow (0.27 gpm aqueous) strip was calculated to be 82.7%.

The first extraction coalescer developed a high pressure drop that resulted in some issues maintaining the target flow rates. Once the coalescer was replaced with one from the same manufacturer's lot, pressure drop was no longer an issue. A third coalescer from the same manufacturer's lot was tested and performed comparable to the second one. An inspection of the first coalescer found excessive particulate in the coalescer which caused the loss of performance.

The concentrations of Isopar™ L and Modifier were measured using SVOA and HPLC to determine the amount of solvent carryover. For low-flow conditions in stripping, Isopar™ L concentration measured 25 mg/L. For moderate-flow conditions, Isopar™ L was ~69 mg/L. For high-flow conditions, Isopar™ L was 39 mg/L.

In extraction, the quantity of pre-coalescer Isopar™ L carryover was ~~280-410 mg/L at low flow, ~400-450 mg/L at moderate flow, and ~480 mg/L at high flow. The amount of post-coalescer (pre-decanter) Isopar™ L carryover was less than 45 mg/L for all flow rates.

Droplet-size data obtained by MicroTrac™ S3400 analyzer consistently shows that the droplet size post-coalescer is significantly greater that the post-contactor or pre-coalescer samples during strip hydraulic testing. Increased flow rates did not show a consistent impact on the droplet size results. For the extraction testing, droplet size analysis showed that the post-contactor and pre-coalescer samples were essentially the same. The post-coalescer droplet mean diameters were slightly less than the pre-coalescer samples with a very slight upward trend in mean as the flow rate was increased.

The carryover results and droplet size measurements were used in for the analysis of the decanter performance. Results show that over 93% of the solvent carryover from stripping is predicted to be recovered and over 96% solvent carryover from extraction is predicted to be recovered. However, increasing flow rates above 9.07 gpm for extraction might have a negative impact on the performance of the decanter.

6.0 Recommendations

After the implementation of NGS, the next logical step is the increase in facility throughput. If MCU desires to increase the processing rate, testing should be conducted to evaluate the impact of the higher flow rate on the coalescer and the coalescer-decanter. The evaluation completed as part of this study concluded that the high flows were transitioning into turbulent flow in the DSS decanter. Turbulent flow could have a significant impact on the performance of the current DSS decanter. The current DSS decanter model should be modified to calculate using the target flow rate. Since the current model is based on a flow rate of 9.07 gpm, this flow rate should be adjusted in the model to more accurately predict the target flow rate.

A scoping test was performed in which organic and aqueous flow rates were raised to a maximum flows of 14.5 gpm (aqueous) and 3.67 gpm (organic). These flows were limited by the calibration range of the aqueous flow meter. The flow meter range can easily be increased allowing the system to operate at higher flows. A test should be conducted to determine the maximum flow that can be successfully operated through the contactors.

Additionally, due to the expected DF and separation improvements of the NGS, there is an opportunity to operate MCU at different O:A ratios. Tests should be conducted to determine the benefits modifying the current ratio.

7.0 References

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Appendix A: **Instrument List**

DAS #	Loop ID#	Description	Instrument	M&TE#	Make	Model/Serial#	Raw Signal	Calibrated Range
0	TE01	Organic Feed Temp	Thermocouple	TR-40086	Omega	1/16", 48"L, Type E Omega # GEQSS-116(G)-48	Type E TC	0-100 C
1	TE02	Aqueous Feed Temp	Thermocouple	TR-40096	Omega	Same as Above	Type E TC	0-100 C
2	TE03	V-10 Organic Feed Temp	Thermocouple	TR-40099	Omega	Same as Above	Type E TC	0-100 C
3	TE04	V-10 Aqueous Feed Temp	Thermocouple	TR-40082	Omega	Same as Above	Type E TC	0-100 C
4	TE05	V-10 Organic Discharge Temp	Thermocouple	TR-40102	Omega	Same as Above	Type E TC	0-100 C
5	TE06	V-10 Aqueous Discharge Temp	Thermocouple	TR-40098	Omega	Same as Above	Type E TC	0-100 C
6	TE07	Aqueous Tank Temp	Thermocouple	TR-40101	Omega	Same as Above	Type E TC	0-100 C
7	TE08	Aqueous Tank Heater Temp	Thermocouple	TR-40100	Omega	Same as Above	Type E TC	0-100 C
8	TE09	V-5 Organic Feed Temp	Thermocouple	TR-40103	Omega	Same as Above	Type E TC	0-100 C
9	TE10	V-5 Aqueous Feed Temp	Thermocouple	TR-40104	Omega	Same as Above	Type E TC	0-100 C
10	TE11	V-5 Organic Discharge Temp	Thermocouple	TR-40031	Omega	Same as Above	Type E TC	0-100 C
11	TE12	V-5 Aqueous Discharge Temp	Thermocouple	TR-40032	Omega	Same as Above	Type E TC	0-100 C
14	FE01	Organic Feed Flow	Turbine Meter	TR-40111	Omega	FTB-1422/032111309	4-20 mADC	0-7.52 GPM
15	FE02	Aqueous Feed Flow	Magnetic Flowmeter	TR-40122	ABB	10D1475JN09PD29KC51C11 12C1 3K620000076989	4-20 mADC	0-14.75 GPM
16	FE03	Organic Supply Air Inleakage	Hot Wire Anemometer	TR-40091	Kurz	505-8-02	0-5 VDC	0-10 SCFM
17	FE04	Aqueous Discharge Air Vent	Hot Wire Anemometer	TR-40092	Kurz	505-8-02	0-5 VDC	0-10 SCFM
18	FE05	Organic Discharge Air Vent	Hot Wire Anemometer	TR-40093	Kurz	505-9-00	0-5 VDC	0-15 SCFM
19	FE06	Aqueous Supply Air InLeakage	Hot Wire Anemometer	TR-40094	Kurz	505-9A-0	0-5 VDC	0-25 SCFM
20	dPE12	Coalescer Pressure Drop	Diff. Press. Transducer	TR-40108	Rosemount	1151DP6E22/1368962	4-20 mADC	0-100 PSID
21	PE13	Coalescer Feed Pressure	Pressure Transducer	TR-40107	Rosemount	1144G-0600A22M1/445192	4-20 mADC	0-150 PSIG
22	V5RPM	V-5 RPM	Variable Freq. Drive	N/A	Leeson	5 HP Leeson VFD, PN 174919	0-10 VDC	0-3450 RPM
23	V10RPM	V-10 RPM	Variable Freq. Drive	N/A	Leeson	10 HP Leeson VFD, PN	0-10 VDC	0-1780 RPM
24	TURB1	Turbidity	Turbidity Meter	N/A	Thermo Scientific	AquaSensor DataStick w/AV38 Controller	4-20 mADC	0.1-800 NTU

Appendix B: Scope Change for Test 1A, 1B, 1C and 2A, 2B, 2C

From:	Mark Duignan/SRNL/Srs
To:	David Herman/SRNL/Srs@Srs
Cc:	Frank Pennebaker/SRNL/Srs@Srs, Michael Williams/SRNL/Srs@Srs
Date:	03/07/2013 05:03 PM
Subject:	MCU Test Update

Here is an update of the MCU testing so you can begin to come up to speed on where we stand.

I intended this week to have started and completed all the mass transfer runs, but circumstances caused us to delay slightly. The only tests complete were the extraction tests: 1A, 1B, and 1C.

Monday, 4 March:
I found that Williams put in ~1/3 of each of the three Cs spiked salt volumes. However, the Aq feed tank was at about the 70-gallon mark so there would be always be a question as to the starting Cs for each batch. I had Williams and Lee mix all three drums in the Aq system. That is, the Aq Contactor tubes were connected together to take the contactor out of the loop and then the contents of all three drums were mixed together. Afterwards, about 80 gallons were removed and drummed leaving approx 70 gallons to begin test 1A. At 4:35 PM we finally received the last Cs concentration number of 79.0 ug/ml, giving an average of (78.8+78.0+79.0)/3 = 78.6, which is good. By 1 PM we were ready to go, but there still was the open issue of Hazards training that you received an e-mail on. I went back and forth with Lynn Nelson, Mitch Stokes, Mike Restivo. It turns out that Restivo did give a "verbal" training session to about a dozen folks, but the training was never formalized. Neither Lynn or Mitch had any record of that training and the only evidence is Restivo's roster, which is attached to the eHAP. Frank gave a path forward by sending you an e-mail stating that those not trained will be trained by the SMEs, (you and me) and be documented in the notebook.

Furthermore, Williams measured the NGS density and it turned out to be 0.825 g/ml, which was under the stated acceptable range of 0.83 to 0.87 (His original measurement on making the solvent was 0.837 at 21.3°C). This new measurement was at 19°C and he did not mix the drum. Therefore, I asked him to remeasure the solvent and asked Peters if this range was still valid for NGS. Peters measured his sample and he got 0.833 at 21.5°C. Then Earl Brass answered Peter's question on the range and stated that a density of **0.82** would still be acceptable.

By the time all of the above was over it was getting close to the end of the day, so we decided to begin the first thing Tuesday morning.

Tuesday, 5 March
Williams measured the solvent to be 0.831 at 24°C.

Mike Lee and Dianne Scott were given training on the hazard alarms and then this was documented in the notebook.

We, (Williams, Lee, Dianne Scott, and me) walked through the Extraction Instruction in the morning and began Test 1A at 13:20 that day. We were finished by 13:47. It went well, but other things happened the prevented to continue on to Test 1B. During Test 1A, first Tom Peters came by to observe, then both Ed Ketusky and Annah Garrison (Steve Brown's replacement) surprised me with a visit to observe the test.

This was generally a positive experience, but the many questions did take my focus on the work. Annah is taciturn but Ed is inquisitive. Among other things, he couldn't understand why we were using 5.6 M Sodium Simulant because he believe the plant waste is much lower (3 or 4 M), so this was discussed for a while. Furthermore, it took considerable time to pump out the strip salt solution from the Aq receipt tank, which was drummed into the salt drum that was emptied after filling the Feed tank for Test 1A. The other issue was what to do with the 6 gallons of V-10 contactor solution that was drained into two SS pots. Unfortunately, the Instruction does discuss this. It only states to label and decant later, but not what to do with the decanted products. Furthermore, the past test notebook does not state what was done. I contacted Fink and he told me that the decanted solvent was saved for the hydraulic tests. The other problem was with having only two pots they had to be emptied to be ready to drain the V-10 after the next extraction test. Well, the decanting, done on the following day, took about an hour. After my visitors left Earl Brass showed up and he was full of questions, like why we were joining all three Cs-loaded solvent (from tests 1A, 1B, and 1C). At Wright Industries an Extraction, Scrub, and Strip was done in succession, before moving on to another solvent flowrate. By the time all of this activity died down the day was spent and Williams and Lee were ready to leave. I put off doing test 1B to the following day.

<u>Wednesday, 6 March</u>
On arriving Wed. morning I was ready to finish the extraction tests; however, I received and e-mail from Earl asked for us not to continue the test until we could all discuss the rationale of mixing the three Cs-loaded solvents together. We (Frank, Tom, and myself) had a telecon with Earl and Annah to discuss the issue, but I ask to postpone the conversation until we could all study the rationale of the current test program, but I was not familiar with it. Earl agreed to meet with us at 10 am in the 785-5A conference room at 10 am. From 8 to 9:30 I received feed back from Restivo, Fink, and Peters. They painted a clear picture at the logic behind the current test plan and why doing separate tests, i.e., Extraction, Scrub, and Strip. Would be time consuming, much more expensive, and create a lot more waste. Frank, Tom, and myself explained the rationale to Earl and he finally agreed that out current path forward was sound; however, Earl as Tom to determine if with the samples currently planned could he obtain Concentration Factor numbers and asked for testing to wait he gave the go ahead. I asked he why he was so surprised with the testing scheme because this is what was done in the past. He said he did not have a copy of the Work Instruction, so he did not know what was planned. I sent a copy to him, Annah, and Ed. At the end of the day we finally did get Earl's buy in, but he also asked us to change the Scrub logic such that we would scrub twice at each velocity, because in the plant he process scrubs twice. That is, 2A will scrub at one set of flow rates. The scrubbed solvent will be put back in the feed to be scrubbed again and a new charge of caustic will be put in the Aq. Feed tank. We are creating more waste, more 0.01 M NaOH, and double the number of scrub samples. However, all of that was worked out and we were prepared to finish the Extractions tests, 1B, and 1C on Thursday. Also, while we waited for word to proceed the contents of V-10 were decanted. The solvent was placed in a stainless steel container and the salt was placed in the spent test 1A salt drum. This freed up the two pots to drain the V-10 after test 1B.

<u>Thursday, 7 March</u>
With the green light to continue testing I invited the Earl, Ed , and Annah back to observe Extraction tests 1B and 1C.

Williams measured the solvent density for test 1B on the previous day at 0.836 g/ml at 23.7°C.

At 8:45 Earl and Annah arrived and at 8:55 test 1B began. Testing went smooth and we proceeded to prepare for test 1C but draining the Aq. receipt tank and refilling the Aq. feed tank with the last charge of Cs-spiked salt solution of which we only had ~40 gallons; just barely enough to complete the test. Furthermore, I got Earl's and Tom's buy in that there was no reason to save any of the solvent, but we could continue to extract until it was exhausted. This would free up the solvent drum so it could be used as the spend solvent drum.

Williams measured the solvent density for test 1C on the previous day at 0.834 g/ml at 22°C.

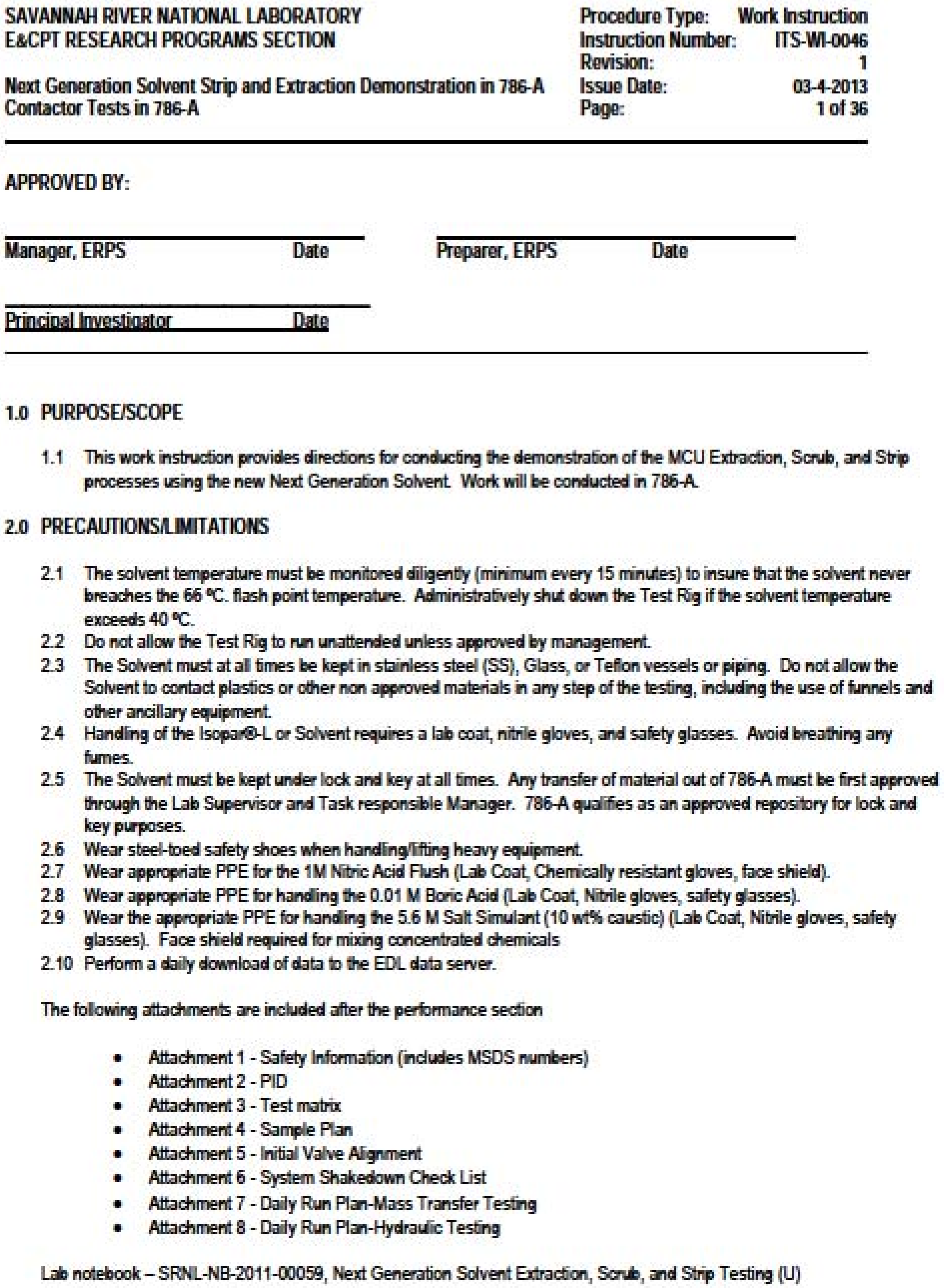
At 9:48 test 1C began; however, Earl, Annah, and Ed had to leave for a 10 am telecon. The test was done by 10.05.

After the telecon Earl and Tom decided that we needed to also obtain solvent/aqueous equilibrium samples, which would be taken from the decanted material drained from the V-10 contactor. Tom said this was done in the past, but the notebook, nor the WI make any mention of these samples. However, Thursday afternoon these samples were taken decanted from what was drained from V-!0 from test 1A 1B, and 1C. and given to Tom

By the end of Thursday the state of affair was the following:

- Existing 15 gallons of 0.025 M NaOH was pumped into the Aq Receipt tank and the walls of the Aq. Receipt and Feed tanks were washed down with the caustic, as well as the wall of the Aq. overflow pot. The V-10 was drained of test 1C solution into the pots and awaits decanting.
- The V-10 hosing needs to be switched to the V-5.
- Because of the new requirement of double scrubs another ~20 gallons of 0.025 M NaOH will have to be made up.
- Because of the new requirement of double scrubs another 12 sample bottles are needed. Williams believes the bottles he ordered will be here on Monday.
- Several WI changes will be necessary, so we can do this on Monday.
- DOE tour is set up for Thursday, when we should be into Hydraulic testing.

Appendix C: **Work Instruction (Double Click to Open Work Instruction)**



SAVANNAH RIVER NATIONAL LABORATORY
E&CPT RESEARCH PROGRAMS SECTION

Next Generation Solvent Strip and Extraction Demonstration in 786-A
Contactor Tests in 786-A

Procedure Type:	Work Instruction
Instruction Number:	ITS-WI-0046
Revision:	1
Issue Date:	03-4-2013
Page:	1 of 36

APPROVED BY:

Manager, ERPS Date

Preparer, ERPS Date

Principal Investigator Date

1.0 PURPOSE/SCOPE

1.1 This work instruction provides directions for conducting the demonstration of the MCU Extraction, Scrub, and Strip processes using the new Next Generation Solvent. Work will be conducted in 786-A.

2.0 PRECAUTIONS/LIMITATIONS

2.1 The solvent temperature must be monitored diligently (minimum every 15 minutes) to insure that the solvent never breaches the 66 ºC. flash point temperature. Administratively shut down the Test Rig if the solvent temperature exceeds 40 ºC.
2.2 Do not allow the Test Rig to run unattended unless approved by management.
2.3 The Solvent must at all times be kept in stainless steel (SS), Glass, or Teflon vessels or piping. Do not allow the Solvent to contact plastics or other non approved materials in any step of the testing, including the use of funnels and other ancillary equipment.
2.4 Handling of the Isopar®-L or Solvent requires a lab coat, nitrile gloves, and safety glasses. Avoid breathing any fumes.
2.5 The Solvent must be kept under lock and key at all times. Any transfer of material out of 786-A must be first approved through the Lab Supervisor and Task responsible Manager. 786-A qualifies as an approved repository for lock and key purposes.
2.6 Wear steel-toed safety shoes when handling/lifting heavy equipment.
2.7 Wear appropriate PPE for the 1M Nitric Acid Flush (Lab Coat, Chemically resistant gloves, face shield).
2.8 Wear appropriate PPE for handling the 0.01 M Boric Acid (Lab Coat, Nitrile gloves, safety glasses).
2.9 Wear the appropriate PPE for handling the 5.6 M Salt Simulant (10 wt% caustic) (Lab Coat, Nitrile gloves, safety glasses). Face shield required for mixing concentrated chemicals
2.10 Perform a daily download of data to the EDL data server.

The following attachments are included after the performance section

- Attachment 1 - Safety Information (includes MSDS numbers)
- Attachment 2 - PID
- Attachment 3 - Test matrix
- Attachment 4 - Sample Plan
- Attachment 5 - Initial Valve Alignment
- Attachment 6 - System Shakedown Check List
- Attachment 7 - Daily Run Plan-Mass Transfer Testing
- Attachment 8 - Daily Run Plan-Hydraulic Testing

Lab notebook – SRNL-NB-2011-00059, Next Generation Solvent Extraction, Scrub, and Strip Testing (U)

Appendix D: **Sample Matrix**

The next five pages show the Sample Matrix as it existed on 21 March 2013
In the table the following nomenclature is used:

FT = Feed Tank
RT = Receipt Tank
CR = Customer Request
Cont = Contactor
TOA = Trioctylamine
SVOA = Semi-Volatile Organic Analysis

NGS Sample List as of 21 March 2013

FT = Feed Tank, RT = Receipt Tank, CR = Customer Request, Cont = Contactor, TOA = Trioctylamine, SVOA = Semi-Volatile Organic Analysis

Test No.	Section	Step	Sample Number	Sample Size	Stream	Location	Notes
Clean, Flush, and Shakedown							
none	3.3	3.3.25	**0-Org-Archive-Date-Time**	50 mL	Organic	Drum	Archive
none	3.3	3.3.40	**0-Org-Archive-Date-Time**	50 mL	Organic	Recpt Tank	Analyze per PI instructions
0.9 A	3.5	3.5.17	**none**	150 mL	Organic	V-7	Allow to settle and record any separation in notebook - Return clean samples.
0.9 A	3.5	3.5.17	**none**	150 mL	Aqueous	V-10	Allow to settle and record any separation in notebook - Return clean samples.
0.9 A	3.5	3.5.26	**0.9-A-Archive-Date-Time**	50 mL	Organic	Feed Tank	Archive
0.9 B	3.5	3.5.43	**none**	150 mL	Organic	V-7	Allow to settle and record any separation in notebook - Return clean samples.
0.9 B	3.5	3.5.43	**none**	150 mL	Aqueous	V-10	Allow to settle and record any separation in notebook - Return clean samples.
0.9 B	3.5	3.5.49	**0.9-B-Phthalate-Date-Time**	150 mL	Organic	FT-grab	Analyze for Phthalate
0.9 B	3.5	3.5.49	**0.9-B-Phthalate-Date-Time**	150 mL	Aqueous	FT-grab	Analyze for Phthalate
0.9 B	3.5	3.5.53	**0.9-B-Archive-Date-Time**	50 mL	Organic	Waste-grab	Archive
Mass Transfer - Extraction - low flow							
1 A	4.1.2	3	**1A-Org-Cs-Date-Time**	100 mL	Organic	FT-grab	Measure for Density - Then submit for Cesium
1 A	4.1.2	3	**1A-Aq-Cs-Date-Time**	100 mL	Aqueous	FT-grab	Submit for Cesium
1 A	4.1.2	22	**1A-Org-6CRT-Date-Time**	30 mL	Organic	V-7	6 Contactor Residence Time
1 A	4.1.2	22	**1A-Org-7CRT-Date-Time**	30 mL	Organic	V-7	7 Contactor Residence Time
1 A	4.1.2	22	**1A-Org-8CRT-Date-Time**	30 mL	Organic	V-7	8 Contactor Residence Time
1 A	4.1.2	22	**1A-Aq-6CRT-Date-Time**	30 mL	Aqueous	V-10	6 Contactor Residence Time
1 A	4.1.2	22	**1A-Aq-7CRT-Date-Time**	30 mL	Aqueous	V-10	7 Contactor Residence Time
1 A	4.1.2	22	**1A-Aq-8CRT-Date-Time**	30 mL	Aqueous	V-10	8 Contactor Residence Time
1 A	4.1.2	31	**1A-Org-Archive-Date-Time**	50 mL	Organic	RT-grab	Archive
1 A	4.1.2	31	**1A-Aq-Archive-Date-Time**	100 mL	Aqueous	RT-grab	Archive
Mass Transfer - Extraction - medium flow							
1 B	4.1.3	3	**1B-Org-Cs-Date-Time**	100 mL	Organic	FT-grab	Measure for Density - Then submit for Cesium
1 B	4.1.3	3	**1B-Aq-Cs-Date-Time**	100 mL	Aqueous	FT-grab	Submit for Cesium
1 B	4.1.3	22	**1B-Org-6CRT-Date-Time**	30 mL	Organic	V-7	6 Contactor Residence Time
1 B	4.1.3	22	**1B-Org-7CRT-Date-Time**	30 mL	Organic	V-7	7 Contactor Residence Time
1 B	4.1.3	22	**1B-Org-8CRT-Date-Time**	30 mL	Organic	V-7	8 Contactor Residence Time
1 B	4.1.3	22	**1B-Aq-6CRT-Date-Time**	30 mL	Aqueous	V-10	6 Contactor Residence Time
1 B	4.1.3	22	**1B-Aq-7CRT-Date-Time**	30 mL	Aqueous	V-10	7 Contactor Residence Time
1 B	4.1.3	22	**1B-Aq-8CRT-Date-Time**	30 mL	Aqueous	V-10	8 Contactor Residence Time
1 B	4.1.3	31	**1B-Org-Archive-Date-Time**	50 mL	Organic	RT-grab	Archive
1 B	4.1.3	31	**1B-Aq-Archive-Date-Time**	100 mL	Aqueous	RT-grab	Archive
Mass Transfer - Extraction - high flow							
1 C	4.1.4	3	**1C-Org-Cs-Date-Time**	100 mL	Organic	FT-grab	Measure for Density - Then submit for Cesium
1 C	4.1.4	3	**1C-Aq-Cs-Date-Time**	100 mL	Aqueous	FT-grab	Submit for Cesium
1 C	4.1.4	22	**1C-Org-6CRT-Date-Time**	30 mL	Organic	V-7	6 Contactor Residence Time
1 C	4.1.4	22	**1C-Org-7CRT-Date-Time**	30 mL	Organic	V-7	7 Contactor Residence Time
1 C	4.1.4	22	**1C-Org-8CRT-Date-Time**	30 mL	Organic	V-7	8 Contactor Residence Time
1 C	4.1.4	22	**1C-Aq-6CRT-Date-Time**	30 mL	Aqueous	V-10	6 Contactor Residence Time
1 C	4.1.4	22	**1C-Aq-7CRT-Date-Time**	30 mL	Aqueous	V-10	7 Contactor Residence Time
1 C	4.1.4	22	**1C-Aq-8CRT-Date-Time**	30 mL	Aqueous	V-10	8 Contactor Residence Time
1 C	4.1.4	31	**1C-Org-Archive-Date-Time**	50 mL	Organic	RT-grab	Archive
1 C	4.1.4	31	**1C-Aq-Archive-Date-Time**	100 mL	Aqueous	RT-grab	Archive

Mass Transfer - Scrub - low flow							
2 A	4.1.5	3	**2A-Org-Cs-Date-Time**	100 mL	Organic	FT-grab	Measure for Density - Then submit for Cesium
2 A	4.1.5	3	**2A-Aq-Cs-Date-Time**	100 mL	Aqueous	FT-grab	Submit for Cesium
2 A	4.1.5	22	**2A-Org-6CRT-Date-Time**	30 mL	Organic	V-7	6 Contactor Residence Time
2 A	4.1.5	22	**2A-Org-7CRT-Date-Time**	30 mL	Organic	V-7	7 Contactor Residence Time
2 A	4.1.5	22	**2A-Org-8CRT-Date-Time**	30 mL	Organic	V-7	8 Contactor Residence Time
2 A	4.1.5	22	**2A-Org-10CRT-Date-Time**	30 mL	Organic	V-7	10 Contactor Residence Time
2 A	4.1.5	22	**2A-Aq-6CRT-Date-Time**	30 mL	Aqueous	V-10	6 Contactor Residence Time
2 A	4.1.5	22	**2A-Aq-7CRT-Date-Time**	30 mL	Aqueous	V-10	7 Contactor Residence Time
2 A	4.1.5	22	**2A-Aq-8CRT-Date-Time**	30 mL	Aqueous	V-10	8 Contactor Residence Time
2 A	4.1.5	22	**2A-Aq-10CRT-Date-Time**	30 mL	Aqueous	V-10	10 Contactor Residence Time
2 A	4.1.5	31	**2A-Org-Archive-Date-Time**	50 mL	Organic	RT-grab	Archive
2 A	4.1.5	31	**2A-Aq-Archive-Date-Time**	100 mL	Aqueous	RT-grab	Archive
2 A	4.1.5	3	**2A-2-Org-Cs-Date-Time**	100 mL	Organic	FT-grab	Submit for Cesium
2 A	4.1.5	3	**2A-2-Aq-Cs-Date-Time**	100 mL	Aqueous	FT-grab	Submit for Cesium
2 A	4.1.5	CR	**2A-2-Org-6CRT-Date-Time**	30 mL	Organic	V-7	6 Contactor Residence Time
2 A	4.1.5	CR	**2A-2-Org-7CRT-Date-Time**	30 mL	Organic	V-7	7 Contactor Residence Time
2 A	4.1.5	CR	**2A-2-2-Org-8CRT-Date-Time**	30 mL	Organic	V-7	8 Contactor Residence Time
2 A	4.1.5	CR	**2A-2-2-Org-10CRT-Date-Time**	30 mL	Organic	V-7	10 Contactor Residence Time
2 A	4.1.5	CR	**2A-2-Aq-6CRT-Date-Time**	30 mL	Aqueous	V-10	6 Contactor Residence Time
2 A	4.1.5	CR	**2A-2-Aq-7CRT-Date-Time**	30 mL	Aqueous	V-10	7 Contactor Residence Time
2 A	4.1.5	CR	**2A-2-Aq-8CRT-Date-Time**	30 mL	Aqueous	V-10	8 Contactor Residence Time
2 A	4.1.5	CR	**2A-2-Aq-10CRT-Date-Time**	30 mL	Aqueous	V-10	10 Contactor Residence Time
2 A	4.1.5	31	**2A-2-Org-Archive-Date-Time**	50 mL	Organic	RT-grab	Archive
2 A	4.1.5	31	**2A-2-Aq-Archive-Date-Time**	100 mL	Aqueous	RT-grab	Archive
Mass Transfer - Scrub - medium flow							
2 B	4.1.6	3	**2B-Org-Cs-Date-Time**	100 mL	Organic	FT-grab	Measure for Density - Then submit for Cesium
2 B	4.1.6	3	**2B-Aq-Cs-Date-Time**	100 mL	Aqueous	FT-grab	Submit for Cesium
2 B	4.1.6	22	**2B-Org-6CRT-Date-Time**	30 mL	Organic	V-7	6 Contactor Residence Time
2 B	4.1.6	22	**2B-Org-7CRT-Date-Time**	30 mL	Organic	V-7	7 Contactor Residence Time
2 B	4.1.6	22	**2B-Org-8CRT-Date-Time**	30 mL	Organic	V-7	8 Contactor Residence Time
2 B	4.1.6	22	**2B-Org-10CRT-Date-Time**	30 mL	Organic	V-7	10 Contactor Residence Time
2 B	4.1.6	22	**2B-Aq-6CRT-Date-Time**	30 mL	Aqueous	V-10	6 Contactor Residence Time
2 B	4.1.6	22	**2B-Aq-7CRT-Date-Time**	30 mL	Aqueous	V-10	7 Contactor Residence Time
2 B	4.1.6	22	**2B-Aq-8CRT-Date-Time**	30 mL	Aqueous	V-10	8 Contactor Residence Time
2 B	4.1.6	22	**2B-Aq-10CRT-Date-Time**	30 mL	Aqueous	V-10	10 Contactor Residence Time
2 B	4.1.6	31	**2B-Org-Archive-Date-Time**	50 mL	Organic	RT-grab	Archive
2 B	4.1.6	31	**2B-Aq-Archive-Date-Time**	100 mL	Aqueous	RT-grab	Archive
2 B	4.1.6	3	**2B-2-Org-Cs-Date-Time**	100 mL	Organic	FT-grab	Submit for Cesium
2 B	4.1.6	3	**2B-2-Aq-Cs-Date-Time**	100 mL	Aqueous	FT-grab	Submit for Cesium
2 B	4.1.6	CR	**2B-2-Org-7CRT-Date-Time**	30 mL	Organic	V-7	7 Contactor Residence Time
2 B	4.1.6	CR	**2B-2-Org-8CRT-Date-Time**	30 mL	Organic	V-7	8 Contactor Residence Time
2 B	4.1.6	CR	**2B-2-Org-10CRT-Date-Time**	30 mL	Organic	V-7	10 Contactor Residence Time
2 B	4.1.6	CR	**2B-2-Aq-6CRT-Date-Time**	30 mL	Aqueous	V-10	6 Contactor Residence Time
2 B	4.1.6	CR	**2B-2-Aq-7CRT-Date-Time**	30 mL	Aqueous	V-10	7 Contactor Residence Time
2 B	4.1.6	CR	**2B-2-Aq-8CRT-Date-Time**	30 mL	Aqueous	V-10	8 Contactor Residence Time
2 B	4.1.6	CR	**2B-2-Aq-10CRT-Date-Time**	30 mL	Aqueous	V-10	10 Contactor Residence Time
2 B	4.1.6	31	**2B-2-Org-Archive-Date-Time**	50 mL	Organic	RT-grab	Archive
2 B	4.1.6	31	**2B-2-Aq-Archive-Date-Time**	100 mL	Aqueous	RT-grab	Archive
Mass Transfer - Scrub - high flow							
2 C	4.1.7	3	**2C-Org-Cs-Date-Time**	100 mL	Organic	FT-grab	Measure for Density - Then submit for Cesium
2 C	4.1.7	3	**2C-Aq-Cs-Date-Time**	100 mL	Aqueous	FT-grab	Submit for Cesium
2 C	4.1.7	22	**2C-Org-6CRT-Date-Time**	30 mL	Organic	V-7	6 Contactor Residence Time
2 C	4.1.7	22	**2C-Org-7CRT-Date-Time**	30 mL	Organic	V-7	7 Contactor Residence Time
2 C	4.1.7	22	**2C-Org-8CRT-Date-Time**	30 mL	Organic	V-7	8 Contactor Residence Time
2 C	4.1.7	22	**2C-Org-10CRT-Date-Time**	30 mL	Organic	V-7	10 Contactor Residence Time
2 C	4.1.7	22	**2C-Aq-6CRT-Date-Time**	30 mL	Aqueous	V-10	6 Contactor Residence Time
2 C	4.1.7	22	**2C-Aq-7CRT-Date-Time**	30 mL	Aqueous	V-10	7 Contactor Residence Time
2 C	4.1.7	22	**2C-Aq-8CRT-Date-Time**	30 mL	Aqueous	V-10	8 Contactor Residence Time
2 C	4.1.7	22	**2C-Aq-10CRT-Date-Time**	30 mL	Aqueous	V-10	10 Contactor Residence Time
2 C	4.1.7	31	**2C-Org-Archive-Date-Time**	50 mL	Organic	RT-grab	Archive
2 C	4.1.7	31	**2C-Aq-Archive-Date-Time**	100 mL	Aqueous	RT-grab	Archive
2 C	4.1.7	3	**2C-2-Org-Cs-Date-Time**	100 mL	Organic	FT-grab	Measure for Density - Then submit for Cesium
2 C	4.1.7	3	**2C-2-Aq-Cs-Date-Time**	100 mL	Aqueous	FT-grab	Submit for Cesium
2 C	4.1.7	22	**2C-2-Org-6CRT-Date-Time**	30 mL	Organic	V-7	6 Contactor Residence Time
2 C	4.1.7	22	**2C-2-Org-7CRT-Date-Time**	30 mL	Organic	V-7	7 Contactor Residence Time
2 C	4.1.7	22	**2C-2-Org-8CRT-Date-Time**	30 mL	Organic	V-7	8 Contactor Residence Time
2 C	4.1.7	22	**2C-2-Org-10CRT-Date-Time**	30 mL	Organic	V-7	10 Contactor Residence Time
2 C	4.1.7	22	**2C-2-Aq-6CRT-Date-Time**	30 mL	Aqueous	V-10	6 Contactor Residence Time
2 C	4.1.7	22	**2C-2-Aq-7CRT-Date-Time**	30 mL	Aqueous	V-10	7 Contactor Residence Time
2 C	4.1.7	22	**2C-2-Aq-8CRT-Date-Time**	30 mL	Aqueous	V-10	8 Contactor Residence Time
2 C	4.1.7	22	**2C-2-Aq-10CRT-Date-Time**	30 mL	Aqueous	V-10	10 Contactor Residence Time
2 C	4.1.7	31	**2C-2-Org-Archive-Date-Time**	50 mL	Organic	RT-grab	Archive
2 C	4.1.7	31	**2C*2-Aq-Archive-Date-Time**	100 mL	Aqueous	RT-grab	Archive

Mass Transfer - Strip - low flow								
3 A	4.1.8	3	**3A-Org-Cs-Date-Time**	100 mL	Organic	FT-grab	Measure for Density - Then submit for Cesium
3 A	4.1.8	3	**3A-Aq-Cs-Date-Time**	100 mL	Aqueous	FT-grab	Submit for Cesium
3 A	4.1.8	22	**3A-Org-6CRT-Date-Time**	30 mL	Organic	V-7	6 Contactor Residence Time
3 A	4.1.8	22	**3A-Org-8CRT-Date-Time**	30 mL	Organic	V-7	8 Contactor Residence Time
3 A	4.1.8	22	**3A-Org-10CRT-Date-Time**	30 mL	Organic	V-7	10 Contactor Residence Time
3 A	4.1.8	22	**3A-Aq-6CRT-Date-Time**	30 mL	Aqueous	V-10	6 Contactor Residence Time
3 A	4.1.8	22	**3A-Aq-8CRT-Date-Time**	30 mL	Aqueous	V-10	8 Contactor Residence Time
3 A	4.1.8	22	**3A-Aq-10CRT-Date-Time**	30 mL	Aqueous	V-10	10 Contactor Residence Time
3 A	4.1.8	31	**3A-Org-Archive-Date-Time**	50 mL	Organic	RT-grab	Archive
3 A	4.1.8	31	**3A-Aq-Archive-Date-Time**	100 mL	Aqueous	RT-grab	Archive
Mass Transfer - Strip - medium flow								
3 B	4.1.9	3	**3B-Org-Cs-Date-Time**	100 mL	Organic	FT-grab	Measure for Density - Then submit for Cesium
3 B	4.1.9	3	**3B-Aq-Cs-Date-Time**	100 mL	Aqueous	FT-grab	Submit for Cesium
3 B	4.1.9	22	**3B-Org-6CRT-Date-Time**	30 mL	Organic	V-7	6 Contactor Residence Time
3 B	4.1.9	22	**3B-Org-8CRT-Date-Time**	30 mL	Organic	V-7	8 Contactor Residence Time
3 B	4.1.9	22	**3B-Org-10CRT-Date-Time**	30 mL	Organic	V-7	10 Contactor Residence Time
3 B	4.1.9	22	**3B-Aq-6CRT-Date-Time**	30 mL	Aqueous	V-10	6 Contactor Residence Time
3 B	4.1.9	22	**3B-Aq-8CRT-Date-Time**	30 mL	Aqueous	V-10	8 Contactor Residence Time
3 B	4.1.9	22	**3B-Aq-10CRT-Date-Time**	30 mL	Aqueous	V-10	10 Contactor Residence Time
3 B	4.1.9	31	**3B-Org-Archive-Date-Time**	50 mL	Organic	RT-grab	Archive
3 B	4.1.9	31	**3B-Aq-Archive-Date-Time**	100 mL	Aqueous	RT-grab	Archive
Mass Transfer - Strip - high flow								
3 C	4.1.10	3	**3C-Org-Cs-Date-Time**	100 mL	Organic	FT-grab	Measure for Density - Then submit for Cesium
3 C	4.1.10	3	**3C-Aq-Cs-Date-Time**	100 mL	Aqueous	FT-grab	Submit for Cesium
3 C	4.1.10	22	**3C-Org-6CRT-Date-Time**	30 mL	Organic	V-7	6 Contactor Residence Time
3 C	4.1.10	22	**3C-Org-8CRT-Date-Time**	30 mL	Organic	V-7	8 Contactor Residence Time
3 C	4.1.10	22	**3C-Org-10CRT-Date-Time**	30 mL	Organic	V-7	10 Contactor Residence Time
3 C	4.1.10	22	**3C-Aq-6CRT-Date-Time**	30 mL	Aqueous	V-10	6 Contactor Residence Time
3 C	4.1.10	22	**3C-Aq-8CRT-Date-Time**	30 mL	Aqueous	V-10	8 Contactor Residence Time
3 C	4.1.10	22	**3C-Aq-10CRT-Date-Time**	30 mL	Aqueous	V-10	10 Contactor Residence Time
3 C	4.1.10	31	**3C-Org-Archive-Date-Time**	50 mL	Organic	RT-grab	Archive
3 C	4.1.10	31	**3C-Aq-Archive-Date-Time**	100 mL	Aqueous	RT-grab	Archive

Hydraulic - Strip - low flow								
4A	4.2.1	3	**none**	100 mL	Organic	FT-grab	Measure for Density - Clean sample can be returned or Archived.
4A	4.2.1	3	**4A-Aq-Archive-Date-Time**	100 mL	Aqueous	FT-grab	Archive
4A	4.2.1	32	**4A-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken 30 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4A	4.2.1	32	**4A-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken 60 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4A	4.2.1	32	**4A-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken 90 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4A	4.2.1	-	**4A-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4A	4.2.1	-	**4A-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4A	4.2.1	-	**4A-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4A	4.2.1	32	**4A-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken 120 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4A	4.2.1	32	**4A-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken 150 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4A	4.2.1	32	**4A-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken 180 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4A	4.2.1	-	**4A-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4A	4.2.1	-	**4A-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4A	4.2.1	-	**4A-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4A	4.2.1	32	**4A-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken 210 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4A	4.2.1	32	**4A-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken 240 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4A	4.2.1	32	**4A-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken 270 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4A	4.2.1	-	**4A-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4A	4.2.1	-	**4A-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4A	4.2.1	-	**4A-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4A	4.2.1	32	**4A-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken 300 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4A	4.2.1	32	**4A-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken 330 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4A	4.2.1	32	**4A-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken 360 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4A	4.2.1	32	**4A-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4A	4.2.1	32	**4A-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4A	4.2.1	32	**4A-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
Hydraulic - Strip - medium flow								
4B	4.2.2	4	**none**	50 mL	Organic	FT-grab	Measure for Density - Clean sample can be returned or Archived.
4B	4.2.2	4	**4B-Aq-Archive-Date-Time**	100 mL	Aqueous	FT-grab	Archive
4B	4.2.2	32	**4B-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken 30 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4B	4.2.2	32	**4B-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken 60 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4B	4.2.2	32	**4B-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken 90 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4B	4.2.2	-	**4B-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4B	4.2.2	-	**4B-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4B	4.2.2	-	**4B-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4B	4.2.2	32	**4B-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken 120 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4B	4.2.2	32	**4B-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken 150 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4B	4.2.2	32	**4B-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken 180 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4B	4.2.2	-	**4B-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4B	4.2.2	-	**4B-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4B	4.2.2	-	**4B-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4B	4.2.2	32	**4B-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken 210 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4B	4.2.2	32	**4B-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken 240 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4B	4.2.2	32	**4B-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken 270 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4B	4.2.2	-	**4B-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4B	4.2.2	-	**4B-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4B	4.2.2	-	**4B-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4B	4.2.2	32	**4B-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken 300 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4B	4.2.2	32	**4B-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken 330 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4B	4.2.2	33	**4B-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken 360 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4B	4.2.2	34	**4B-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4B	4.2.2	34	**4B-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4B	4.2.2	32	**4B-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
HYD - Strip - high flow								
4C	4.2.3	3	**none**	50 mL	Organic	FT-grab	Measure for Density - Clean sample can be returned or Archived.
4C	4.2.3	3	**4C-Aq-Archive-Date-Time**	100 mL	Aqueous	FT-grab	Archive
4C	4.2.3	32	**4C-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken 30 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4C	4.2.3	32	**4C-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken 60 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4C	4.2.3	32	**4C-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken 90 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4C	4.2.3	-	**4C-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4C	4.2.3	-	**4C-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4C	4.2.3	-	**4C-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4C	4.2.3	32	**4C-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken 120 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4C	4.2.3	32	**4C-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken 150 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4C	4.2.3	32	**4C-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken 180 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4C	4.2.3	-	**4C-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4C	4.2.3	-	**4C-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4C	4.2.3	-	**4C-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4C	4.2.3	32	**4C-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken 210 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4C	4.2.3	32	**4C-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken 240 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4C	4.2.3	32	**4C-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken 270 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4C	4.2.3	-	**4C-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4C	4.2.3	-	**4C-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4C	4.2.3	-	**4C-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4C	4.2.3	32	**4C-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken 300 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4C	4.2.3	32	**4C-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken 330 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4C	4.2.3	32	**4C-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken 360 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
4C	4.2.3	32	**4C-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4C	4.2.3	32	**4C-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
4C	4.2.3	32	**4C-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA

HYD - Extraction - low flow							
5A	4.3.0	4	**none**	50 mL	Organic	FT-grab	Measure for Density - Clean sample can be returned or Archived.
5A	4.3.0	4	**5A-Aq-Archive-Date-Time**	100 mL	Aqueous	FT-grab	Archive
5A	4.3.0	33	**5A-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken 45 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5A	4.3.0	33	**5A-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken 90 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5A	4.3.0	33	**5A-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken 135 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5A	4.3.0	-	**5A-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5A	4.3.0	-	**5A-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5A	4.3.0	-	**5A-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5A	4.3.0	33	**5A-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken 180 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5A	4.3.0	33	**5A-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken 215 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5A	4.3.0	33	**5A-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken 260 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5A	4.3.0	-	**5A-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5A	4.3.0	-	**5A-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5A	4.3.0	-	**5A-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5A	4.3.0	33	**5A-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken 305 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5A	4.3.0	33	**5A-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken 350 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5A	4.3.0	33	**5A-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken 395 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5A	4.3.0	-	**5A-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5A	4.3.0	-	**5A-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5A	4.3.0	-	**5A-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
Finish Test 5A on Following Day							
5A	4.3.0	33	**5A-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken 440 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5A	4.3.0	33	**5A-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken 485 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5A	4.3.0	33	**5A-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken 530 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5A	4.3.0	33	**5A-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5A	4.3.0	33	**5A-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5A	4.3.0	33	**5A-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
Hydraulic - Extraction - medium flow							
5B	4.3.1	4	**none**	50 mL	Organic	FT-grab	Measure for Density - Clean sample can be returned or Archived.
5B	4.3.1	4	**5B-Aq-Archive-Date-Time**	100 mL	Aqueous	FT-grab	Archive
5B	4.3.1	33	**5B-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken 30 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5B	4.3.1	33	**5B-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken 60 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5B	4.3.1	33	**5B-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken 90 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5B	4.3.1	-	**5B-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5B	4.3.1	-	**5B-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5B	4.3.1	-	**5B-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5B	4.3.1	33	**5B-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken 120 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5B	4.3.1	33	**5B-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken 150 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5B	4.3.1	33	**5B-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken 180 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5B	4.3.1	-	**5B-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5B	4.3.1	-	**5B-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5B	4.3.1	-	**5B-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
Finish Test 5B on Following Day							
5B	4.3.1	33	**5B-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken 210 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5B	4.3.1	33	**5B-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken 240 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5B	4.3.1	33	**5B-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken 270 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5B	4.3.1	-	**5B-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5B	4.3.1	-	**5B-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5B	4.3.1	-	**5B-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5B	4.3.1	33	**5B-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken 300 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5B	4.3.1	33	**5B-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken 330 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5B	4.3.1	33	**5B-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken 360 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5B	4.3.1	33	**5B-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5B	4.3.1	33	**5B-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5B	4.3.1	33	**5B-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
HYD - Extraction - high flow							
5C	4.3.2	4	**none**	50 mL	Organic	FT-grab	Measure for Density - Clean sample can be returned or Archived.
5C	4.3.2	4	**5C-Aq-Archive-Date-Time**	100 mL	Aqueous	FT-grab	Archive
5C	4.3.2	33	**5C-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken 30 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5C	4.3.2	33	**5C-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken 60 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5C	4.3.2	33	**5C-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken 90 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5C	4.3.2	-	**5C-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5C	4.3.2	-	**5C-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5C	4.3.2	-	**5C-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
Finish Test 5C on Following Day							
5C	4.3.2	33	**5C-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken 120 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5C	4.3.2	33	**5C-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken 150 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5C	4.3.2	33	**5C-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken 180 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5C	4.3.2	-	**5C-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5C	4.3.2	-	**5C-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5C	4.3.2	-	**5C-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5C	4.3.2	33	**5C-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken 210 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5C	4.3.2	33	**5C-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken 240 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5C	4.3.2	33	**5C-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken 270 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5C	4.3.2	-	**5C-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5C	4.3.2	-	**5C-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5C	4.3.2	-	**5C-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5C	4.3.2	33	**5C-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken 300 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5C	4.3.2	33	**5C-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken 330 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5C	4.3.2	33	**5C-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken 360 minutes after V-6 is turned to Contactor - Microtrac in 5 minutes
5C	4.3.2	33	**5C-Aq-Post-Cont-Date-Time**	100 mL	Aqueous	V-10	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5C	4.3.2	33	**5C-Aq-Pre-Coal-Date-Time**	100 mL	Aqueous	V-22	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA
5C	4.3.2	33	**5C-Aq-Post-Coal-Date-Time**	100 mL	Aqueous	V-25	Taken immediately after the Post-Coalescer sample - PPM/TOA/SVOA

Appendix E: SASSE Input

Input flow rates

Table 7-1. SASSE Input

Case #	Organic Flow Rate (gpm)	Extraction		Scrub			Strip		Stage Efficiency
		Flow Rate (gpm)	D(Cs)	Flow Rate (gpm)	Scrub #1 D(Cs)	Scrub #2 D(Cs)	Flow Rate (gpm)	D(Cs)*	%
1	1	4	60.13	0.27	3.33	2.2	0.27	0.077	80
2	2	8	38.78	0.54	4.71	2.25	0.54	0.073	80
3	3	12	37.38	0.8	5.2	1.82	0.8	0.039	80
4	1	4	60.13	0.27	3.33	2.2	0.27	0.077	90
5	2	8	38.78	0.54	4.71	2.25	0.54	0.073	90
6	3	12	37.38	0.8	5.2	1.82	0.8	0.039	90
7	1	4	60.13	0.27	3.33	2.2	0.27	0.077	95 extraction 80 scrub/strip
8	2	8	38.78	0.54	4.71	2.25	0.54	0.073	95 extraction 80 scrub/strip
9	3	12	37.38	0.8	5.2	1.82	0.8	0.039	95 extraction 80 scrub/strip

Contactor Stages
7 Extraction
2 Scrub
7 Strip

Compositions
Organic composition:

(As Implemented)
Blended solvent

MaxCalix = 0.0465 M
Cs-7SB = 0.500 M
BOBCalixC6 = 0.0035 M
TiDG = 0.003 M
TOA = 0.0015 M
Isopar-L balance (74 wt %)

Aqueous composition

Table 7-2. Analyses of Vendor-Provided 5.6 M Na Simulant Salt Solution

Analyte	Specification (1)	(2)	(3)	(4)
NaOH	1.854 - 2.266 M	2.2 M	N/A (5)	N/A
Al	0.252 - 0.308 M	0.275 M	0.305 M	0.290 M
Na	4.98 - 6.09 M	5.5 M	5.02 M	5.33 M
K	0.013 - 0.016 M	0.015 M	0.015 M	<0.0003 M
Si	0.0063 - 0.0077 M	0.0063 M	0.0066 M	0.0065 M
Mo	6.48E-05 - 7.92E-05 M	6.8E-05 M	7.16E-05 M	<1.04E-05 M
PO_4	0.0063 - 0.0077 M	0.0068 M	N/A	N/A
SO_4	0.126 - 0.154 M	0.13 M	0.146 M	0.041 M
NO_2	N/A	N/A	0.570 M	0.488 M
NO_3	N/A	N/A	1.97 M	2.00 M
Cl	N/A	N/A	0.0086 M	0.0244 M
C_2O_4	N/A	N/A	0.0031 M	0.0083 M
Cs (6)	0 M	N/A	78.6 mg/L	N/A
Specific Gravity	1.24 - 1.27	1.257	1.254	1.254
Clarity	< 5 NTU	0.8 NTU	< 1.0 NTU	< 1.0 NTU
pH	N/A	N/A	13.7	13.8
		Total Solids =	29.1 mg/L	29.1 mg/L
		Soluble Solids =	29.1 mg/L	29.1 mg/L

Notes:
1. From the Certificate of Analysis - Harrell Industries
2. Results from Harrell Industries
3. Process Systems Analytical Lab. - SRNL: ± 20%: on 2/14/2013 Test Start
4. Process Systems Analytical Lab. - SRNL: ± 20%: on 4/25/2013 Test End
5. N/A = Not Available
6. Simulant was spiked with cesium just before testing in three batches that were subsequently mixed together. ICP-MS Analytical results were: 78.8, 78.0, and 79.0 mg/L

Temperatures Aq and O
Shown above

Aqueous scrub stream
scrub solution was 0.025 M NaOH

Aqueous strip stream
strip solution was 0.010 M H_3BO_3

Aqueous organic volumes in each stage
Volumes: V-05 = 0.6 gallons, V-10= 6 gallons

Entrainment ratios

4 gpm aqueous 1 gpm organic contactor feeds resulted experimentally in 370 mg/L isopar in aqueous

8 gpm aqueous 2 gpm organic contactor feeds resulted experimentally in 450 mg/L isopar in aqueous

12 gpm aqueous 3 gpm organic contactor feeds resulted experimentally in 480 mg/L isopar in aqueous

CS			DF
ExF	Aq Feed In	78.6	3359.11
ExW	Aq Feed Out	0.023399	
ScW	Aq Scrub Out	105.4802	
StW	Aq Strip Out	1164.034	
StP	Org Out	0.968619	

General Notes

Section Number	Stages	Section Name	Section Letter
1	7	Extraction	Ex
2	2	Scrub	Sc
3	7	Strip	St

Component Number	Component Name	Rows Needed	Organic Feed Concn, M
1	Cs-137	1	1E-15

imum D Value	D_max	1E+15
Value if Error	D_error	1
imum D Value	D_min	1E-15
ic Mean Value	D_geo	1.1
and FOI Value	FEOI_min	1E-09
cle (Yes or No)	Recycle	Yes
tion Efficiency	Ea_default	0.8
xtr. Efficiency	Ea_min	0.1

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put values Okay
put values Okay
put values Okay

User Specifie

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Code_O_in	ExX															
Code_O_out																StP
Code_A_in							ExF		ScF							StF
Code_A_out	ExW							ScW		StW						
Ea	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
FOI_input	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
FAI_input	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037
VOI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
VAI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
QSOI_input																
QSAI_input																
FEOI_input																1
FEAI_input	1									1						
QFOI	1															
QFAI							4		0.27							0.27
xf_1							78.6									
yf_1	0.9686188															
proc_temp																
density																
init_density																
CCD_loading																
PEG_loading																

D Values

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
D(Cs-137)	60.13	60.13	60.13	60.13	60.13	60.13	60.13	3.33	2.2	0.077	0.077	0.077	0.077	0.077	0.077	0.077

Summary of th

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
QEOI	1.00158E-09	1.00158E-09	1.00158E-09	1.00158E-09	1.00158E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1
QEAI	4.26999									0.270009						
x_1	0.023399057	0.04489429	0.125273633	0.425837606	1.54974206	5.752379	21.46747	105.4802	111.8972	1164.034	531.6229	241.3057	108.0469	46.87959	18.80315	5.915757
y_1	1.060948292	1.405660286	2.694648261	7.514584979	25.53786219	92.93116	343.7483	345.4769	315.2676	144.4924	66.11452	30.13823	13.62472	6.044831	2.565581	0.968619
SRTO	0.998422009	0.99842201	0.998422011	0.998422012	0.998422013	0.998422	0.9999	0.9999	1	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	1
SRTA	0.234192586	0.234192037	0.234192037	0.234192037	0.234192037	0.234192	0.234192	3.703704	3.703704	3.703574	3.703574	3.703574	3.703574	3.703574	3.703574	3.703567

Flow Balance

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FOI	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
FAI	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037
QSOI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
QSAI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FEOI	0.000000001	0.000000001	0.000000001	0.000000001	0.000000001	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1
FEAI	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
ROI	1.00001E-05	1.00001E-05	1.00001E-05	1.00001E-05	1.00001E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05
RAI	0.000370137	0.000370137	0.000370137	0.000370137	0.000370137	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037
AUX_1		1.00001E-14	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-05
AUX_2			-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14
FBAI	0	1.00001E-14	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-05
FBBI	1	1.00001E-05	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-1E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-1E-05
FBCI	-1	-1E-05	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	0	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	0
FBDI	-1E-05	0	0	0	0	0	-4E-14	4E-14	-2.7E-15	2.7E-15	0	0	0	0	0	-2.7E-15
FBETA	1	1.00001E-05	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14
FGAMMA	-1E-05	1.00001E-14	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	4	9.47E-15	0.27	9.47E-15	9.47E-15	9.47E-15	9.47E-15	9.47E-15	9.47E-15	0.270009
QAI	4.26999	4.270000016	4.270000016	4.270000016	4.270000016	4.27	4.27	0.27	0.27	0.270009	0.270009	0.270009	0.270009	0.270009	0.270009	0.270009
QOI	1.001580485	1.001580484	1.001580483	1.001580482	1.001580481	1.00158	1.0001	1.0001	1	1.0001	1.0001	1.0001	1.0001	1.0001	1.0001	1
RQI	0.234562174	0.234931759	0.234931759	0.234931759	0.234931759	0.234932	0.234585	3.704307	3.703937	3.703807	3.704177	3.704177	3.704177	3.704177	3.704177	3.703944
Ea_final	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8

Mass Balanc

Mass Balance f

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Dcomp_1	60.13	60.13	60.13	60.13	60.13	60.13	60.13	3.33	2.2	0.077	0.077	0.077	0.077	0.077	0.077	0.077
x_trap_1	0.023399057	0.04489429	0.125273633	0.425837606	1.54974206	5.752379	21.46747	105.4802	111.8972	1164.034	531.6229	241.3057	108.0469	46.87959	18.80315	5.915757
y_iM1_1	0	1.060948292	1.405660286	2.694648261	7.514584979	25.53786	92.93116	343.7483	345.4769	315.2676	144.4924	66.11452	30.13823	13.62472	6.044831	2.565581
y_iP1_1	1.405660286	2.694648261	7.514584979	25.53786219	92.93115795	343.7483	345.4769	315.2676	144.4924	66.11452	30.13823	13.62472	6.044831	2.565581	0.968619	0
Denom_y_1	1.001580485	1.003160969	1.003160968	1.003160967	1.003160966	1.003161	1.00168	1.0002	1.0001	1.0001	1.0002	1.0002	1.0002	1.0002	1.0002	1.0001
Avg_y_iM1_1	0.969308482	1.063522194	1.415284925	2.730637851	7.649159189	26.0392	92.95635	343.7455	345.4769	315.2427	144.4809	66.10928	30.13582	13.62361	6.044324	2.565581
S_1_new	41.42510793	23.68947548	11.29754831	6.412392457	4.935762788	4.526684	4.330103	3.258862	3.087448	0.270819	0.271773	0.273965	0.278914	0.290609	0.321453	0.433686
S_1	41.42510793	23.68947548	11.29754831	6.412392457	4.935762788	4.526684	4.330103	3.258862	3.087448	0.270819	0.271773	0.273965	0.278914	0.290609	0.321453	0.433686
Deff_1	45.3414968	31.31044662	21.51009904	17.64659785	16.47878241	16.15526	16.01252	3.275277	2.817474	0.124131	0.124364	0.124896	0.1261	0.128944	0.136444	0.163735
MBAI_1	0	-45.4131683	-31.3599423	-21.5441054	-17.674498	-16.5048	-16.1808	-16.0141	-3.27561	-2.81748	-0.12415	-0.12439	-0.12492	-0.12612	-0.12897	-0.13647
MBBI_1	49.68315836	35.67942799	25.84810179	21.97238819	20.80088131	20.47633	20.30944	3.545941	3.087766	0.394163	0.394408	0.394941	0.396145	0.398989	0.406491	0.433761
MBCI_1	-4.3194857	-4.3039964	-4.2978902	-4.29604448	-4.29553315	-4.29531	-0.27033	-0.27028	0	-0.27002	-0.27002	-0.27002	-0.27002	-0.27002	-0.27003	0
MBDI_1	0.9686188	0	0	0	0	0	314.4	0	0	0	0	0	0	0	0	0
BETA_1	49.68315836	31.73117796	21.59445956	17.68451986	16.50727141	16.18143	16.0143	3.275617	2.817484	0.394163	0.309357	0.286371	0.278357	0.276643	0.28061	0.302441
GAMMA_1	0.019495919	0.027902256	0.040520261	0.049363668	0.052854166	0.053911	19.68692	96.24722	111.8972	799.8442	320.9992	139.4271	62.57098	28.52638	13.11053	5.915757
X_1	0.023399058	0.044894291	0.125273633	0.425837606	1.54974206	5.752379	21.46747	105.4802	111.8972	1164.034	531.6229	241.3057	108.0469	46.87959	18.80315	5.915757
Y_1	1.060948292	1.405660286	2.694648261	7.51458498	25.53786219	92.93116	343.7483	345.4769	315.2676	144.4924	66.11452	30.13823	13.62472	6.044831	2.565581	0.968619

Case 1

NOTE: ONLY THOSE FEEDS AND EFFLUENTS WITH A "REPORT CODE" WILL APPEAR IN THE
Influent/effluent REPORTS CREATED BY report_generator.
Report code for organic (O) feeds
Report code for organic (O) effluents
Report code for aqueous (A) feeds
Report code for aqueous (A) effluents
Fractional extraction efficiency for each stage
Fraction of A in O (1E-09 is min. value allowed for O going to the next stage; 0.0 for O effluents)
Fraction of O in exiting A at each stage (applies only to A returned to the next stage; 0.0 for A effluents)
Volume of organic (O) phase in each stage, L (or mL)
Volume of aqueous (A) phase in each stage, L (or mL)
Volumetric flow rate for organic (O) sampling stream from each stage, L/min (or mL/min)
Volumetric flow rate for aqueous (A) sampling stream from each stage, L/min (or mL/min)
Fraction of exiting O taken as an effluent from each stage (1E-09 is minimum value allowed)
Fraction of exiting A taken as an effluent from each stage
Volumetric flow rate for O feed to each stage, L/min (or mL/min)
Volumetric flow rate for A feed to each stage, L/min (or mL/min)
Concentration of component 1 in aqueous feed to each stage (need only if there is a feed), M
Concentration of component 1 in organic feed to each stage (need only if there is a feed), M
Process temperature in each stage
Final Aq density in each stage
Initial Aq density in feed stage
% Loading CCD
% Loading PEG

Case 1

D values used for component 1 (Cs-137)

Volumetric flow rate for organic (O) effluent from each stage, L/min (or mL/min
Volumetric flow rate for aqueous (A) effluent from each stage, L/min (or mL/min
Concentration of component 1 in aqueous (A) phase exiting each stage including any effluent taken, M
Concentration of component 1 in organic (O) phase exiting each stage including any effluent taken, M
Stage residence time for the organic (O) phase, min
Stage residence time for the aqueous (A) phase, min

Case 2

CS			DF
ExF	Aq Feed In	78.6	2021.007
ExW	Aq Feed Out	0.038892	
ScW	Aq Scrub Out	80.6602	
StW	Aq Strip Out	1185.744	
StP	Org Out	0.862589	

Case 2

General Notes

Section Number	Stages	Section Name	Section Letter
1	7	Extraction	Ex
2	2	Scrub	Sc
3	7	Strip	St

Component Number	Component Name	Rows Needed	Organic Feed Concn, M
1	Cs-137	1	1E-15

imum D Value	D_max	1E+15
Value if Error	D_error	1
imum D Value	D_min	1E-15
ic Mean Value	D_geo	1.1
and FOI Value	FEOI_min	1E-09
cle (Yes or No)	Recycle	Yes
tion Efficiency	Ea_default	0.8
xtr. Efficiency	Ea_min	0.1

put values	Okay
put values	Okay
put values	Okay
put values	Okay
put values	Okay
put values	Okay

User Specifie

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Code_O_in	ExX															
Code_O_out																StP
Code_A_in							ExF		ScF							StF
Code_A_out	ExW							ScW		StW						
Ea	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
FOI_input	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
FAI_input	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045
VOI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
VAI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
QSOI_input																
QSAI_input																
FEOI_input																1
FEAI_input	1									1						
QFOI	2															
QFAI							8		0.53							0.53
xf_1							78.6									
yf_1	0.862588807															
proc_temp																
density																
init_density																
CCD_loading																
PEG_loading																

Case 2

D Values

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
D(Cs-137)	38.78	38.78	38.78	38.78	38.78	38.78	38.78	4.71	2.25	0.073	0.073	0.073	0.073	0.073	0.073	0.073

Summary of th

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
QEOI	2.00384E-09	2.00384E-09	2.00384E-09	2.00384E-09	2.00384E-09	2E-09	2E-09	2E-09	2E-09	2E-09	2E-09	2E-09	2E-09	2E-09	2E-09	2
QEAI	8.52998									0.53002						
x_1	0.038891508	0.081786403	0.22306549	0.688364392	2.220813914	7.267896	23.89046	80.6602	109.4566	1185.744	531.9239	237.2428	104.4451	44.60001	17.6309	5.477299
y_1	1.046697629	1.651917731	3.645193994	10.2099962	31.83099512	103.0377	336.4723	344.0984	315.0956	141.8066	63.72479	28.53733	12.68014	5.534124	2.313779	0.862589
SRTO	0.499041783	0.499041783	0.499041784	0.499041784	0.499041785	0.499042	0.49994	0.49994	0.5	0.49994	0.49994	0.49994	0.49994	0.49994	0.49994	0.5
SRTA	0.117233569	0.117233294	0.117233294	0.117233294	0.117233294	0.117233	0.117233	1.886792	1.886792	1.886721	1.886721	1.886721	1.886721	1.886721	1.886721	1.886721

Flow Balance

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FOI	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
FAI	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045
QSOI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
QSAI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FEOI	0.000000001	0.000000001	0.000000001	0.000000001	0.000000001	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1
FEAI	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
ROI	1.00001E-05	1.00001E-05	1.00001E-05	1.00001E-05	1.00001E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05
RAI	0.000450203	0.000450203	0.000450203	0.000450203	0.000450203	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045
AUX_1		1.00001E-14	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-05
AUX_2			-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14
FBAI	0	1.00001E-14	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-05
FBBI	1	1.00001E-05	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-1E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-1E-05
FBCI	-1	-1E-05	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	0	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	0
FBDI	-2E-05	0	0	0	0	0	-8E-14	8E-14	-5.3E-15	5.3E-15	0	0	0	0	0	-5.3E-15
FBETA	1	1.00001E-05	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14
FGAMMA	-2E-05	2.00002E-14	2.00002E-14	2.00002E-14	2.00002E-14	2E-14	8	2.02E-14	0.53	2.01E-14	2.01E-14	2.01E-14	2.01E-14	2.01E-14	2.01E-14	0.53002
QAI	8.52998	8.530000038	8.530000038	8.530000038	8.530000038	8.53	8.53	0.53	0.53	0.53002	0.53002	0.53002	0.53002	0.53002	0.53002	0.53002
QOI	2.003840228	2.003840226	2.003840224	2.003840222	2.00384022	2.00384	2.000239	2.000239	2	2.000239	2.000239	2.000239	2.000239	2.000239	2.000239	2
RQI	0.23491679	0.235366439	0.235366439	0.235366439	0.235366439	0.235366	0.234944	3.774343	3.773893	3.773749	3.7742	3.7742	3.7742	3.7742	3.7742	3.773892
Ea_final	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8

Mass Balanc

Mass Balance f

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Dcomp_1	38.78	38.78	38.78	38.78	38.78	38.78	38.78	4.71	2.25	0.073	0.073	0.073	0.073	0.073	0.073	0.073
x_trap_1	0.038891508	0.081786403	0.22306549	0.688364392	2.220813914	7.267896	23.89046	80.6602	109.4566	1185.744	531.9239	237.2428	104.4451	44.60001	17.6309	5.477299
y_iM1_1	0	1.046697629	1.651917731	3.645193994	10.2099962	31.831	103.0377	336.4723	344.0984	315.0956	141.8066	63.72479	28.53733	12.68014	5.534124	2.313779
y_iP1_1	1.651917731	3.645193994	10.2099962	31.83099512	103.0376943	336.4723	344.0984	315.0956	141.8066	63.72479	28.53733	12.68014	5.534124	2.313779	0.862589	0
Denom_y_1	2.003840228	2.007680454	2.007680452	2.00768045	2.007680448	2.00768	2.004079	2.000477	2.000239	2.000239	2.000477	2.000477	2.000477	2.000477	2.000477	2.000239
Avg_y_iM1_1	0.864101504	1.051667951	1.668287354	3.69910691	10.38755411	32.4137	103.0664	336.4698	344.0984	315.0656	141.7931	63.7187	28.53459	12.67891	5.533566	2.313779
S_1_new	22.21825686	12.8587138	7.47891284	5.373762723	4.677363573	4.459847	4.314123	4.171448	3.143698	0.265711	0.266566	0.26858	0.273202	0.28428	0.313856	0.422431
S_1	22.21825686	12.8587138	7.47891284	5.373762723	4.677363573	4.459847	4.314123	4.171448	3.143698	0.265711	0.266566	0.26858	0.273202	0.28428	0.313856	0.422431
Deff_1	26.91326956	20.19795057	16.34136235	14.83225501	14.3330312	14.1771	14.08396	4.266025	2.878727	0.119593	0.119801	0.120287	0.121405	0.124083	0.131234	0.157484
MBAI_1	0	-53.9299122	-40.4734858	-32.7454992	-29.7214892	-28.7211	-28.4087	-28.1713	-8.53309	-5.75747	-0.23923	-0.23965	-0.24062	-0.24286	-0.24822	-0.26252
MBBI_1	62.45989226	49.08105066	41.33825383	38.30844849	37.30616658	36.99311	36.75539	9.064106	6.288161	0.769254	0.769698	0.770672	0.772908	0.778266	0.792571	0.845026
MBCI_1	-8.60756478	-8.5927546	-8.58695928	-8.58504215	-8.58444334	-8.58409	-0.53102	-0.53069	0	-0.53005	-0.53005	-0.53005	-0.53005	-0.53005	-0.53006	0
MBDI_1	1.725177615	0	0	0	0	0	628.8	0	0	0	0	0	0	0	0	0
BETA_1	62.45989226	41.64899793	32.98802336	29.78461955	28.73932096	28.4141	28.17294	8.533119	5.757476	0.769254	0.604856	0.560662	0.545423	0.542253	0.54994	0.591997
GAMMA_1	0.027620567	0.03576496	0.043880549	0.048242701	0.049891399	0.05043	22.37014	73.85294	109.4566	819.2262	324.0227	138.5005	61.10215	27.36583	12.35162	5.477299
X_1	0.038891508	0.081786403	0.22306549	0.688364393	2.220813917	7.267896	23.89046	80.6602	109.4566	1185.744	531.9239	237.2428	104.4451	44.60001	17.6309	5.477299
Y_1	1.046697629	1.651917732	3.645194	10.20999621	31.83099515	103.0377	336.4723	344.0984	315.0956	141.8066	63.72479	28.53733	12.68014	5.534124	2.313779	0.862589

Case 2

NOTE: ONLY THOSE FEEDS AND EFFLUENTS WITH A "REPORT CODE" WILL APPEAR IN THE
Influent/effluent REPORTS CREATED BY report_generator.
Report code for organic (O) feeds
Report code for organic (O) effluents
Report code for aqueous (A) feeds
Report code for aqueous (A) effluents
Fractional extraction efficiency for each stage
Fraction of A in O (1E-09 is min. value allowed for O going to the next stage; 0.0 for O effluents)
Fraction of O in exiting A at each stage (applies only to A returned to the next stage; 0.0 for A effluents)
Volume of organic (O) phase in each stage, L (or mL)
Volume of aqueous (A) phase in each stage, L (or mL)
Volumetric flow rate for organic (O) sampling stream from each stage, L/min (or mL/min)
Volumetric flow rate for aqueous (A) sampling stream from each stage, L/min (or mL/min)
Fraction of exiting O taken as an effluent from each stage (1E-09 is minimum value allowed)
Fraction of exiting A taken as an effluent from each stage
Volumetric flow rate for O feed to each stage, L/min (or mL/min)
Volumetric flow rate for A feed to each stage, L/min (or mL/min)
Concentration of component 1 in aqueous feed to each stage (need only if there is a feed), M
Concentration of component 1 in organic feed to each stage (need only if there is a feed), M
Process temperature in each stage
Final Aq density in each stage
Initial Aq density in feed stage
% Loading CCD
% Loading PEG

Case 2

D values used for component 1 (Cs-137)

Volumetric flow rate for organic (O) effluent from each stage, L/min (or mL/min
Volumetric flow rate for aqueous (A) effluent from each stage, L/min (or mL/min
Concentration of component 1 in aqueous (A) phase exiting each stage including any effluent taken, M
Concentration of component 1 in organic (O) phase exiting each stage including any effluent taken, M
Stage residence time for the organic (O) phase, min
Stage residence time for the aqueous (A) phase, min

Case 3

CS			DF
ExF	Aq Feed In	78.6	3636.697
ExW	Aq Feed Out	0.021613	
ScW	Aq Scrub Out	81.28194	
StW	Aq Strip Out	1178.627	
StP	Org Out	0.130906	

General Notes

Section Number	Stages	Section Name	Section Letter
1	7	Extraction	Ex
2	2	Scrub	Sc
3	7	Strip	St

Component Number	Component Name	Rows Needed	Organic Feed Concn, M
1	Cs-137	1	1E-15

imum D Value	D_max	1E+15
Value if Error	D_error	1
imum D Value	D_min	1E-15
ic Mean Value	D_geo	1.1
and FOI Value	FEOI_min	1E-09
cle (Yes or No)	Recycle	Yes
tion Efficiency	Ea_default	0.8
xtr. Efficiency	Ea_min	0.1

put values Okay
put values Okay
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put values Okay
put values Okay
put values Okay

User Specifie

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Code_O_in	ExX															
Code_O_out																StP
Code_A_in							ExF		ScF							StF
Code_A_out	ExW							ScW		StW						
Ea	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
FOI_input	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
FAI_input	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048
VOI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
VAI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
QSOI_input																
QSAI_input																
FEOI_input																1
FEAI_input	1									1						
QFOI	3															
QFAI							12		0.8							0.8
xf_1							78.6									
yf_1	0.13090576															
proc_temp																
density																
init_density																
CCD_loading																
PEG_loading																

D Values

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
D(Cs-137)	37.38	37.38	37.38	37.38	37.38	37.38	37.38	5.2	1.82	0.039	0.039	0.039	0.039	0.039	0.039	0.039

Summary of th

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
QEOI	3.00615E-09	3.00615E-09	3.00615E-09	3.00615E-09	3.00615E-09	3.01E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3
QEAI	12.79997									0.800019						
x_1	0.02161302	0.067651913	0.217387566	0.704361324	2.288108656	7.438809	24.19019	81.28194	134.2803	1178.627	396.1656	132.8917	44.32429	14.52948	4.506272	1.134382
y_1	0.32865348	0.970487056	3.057873076	9.846518218	31.92470477	103.7263	336.1154	350.2414	314.4373	105.7568	35.56254	11.94865	4.00474	1.332346	0.433331	0.130906
SRTO	0.332651735	0.332651736	0.332651736	0.332651736	0.332651737	0.332652	0.333291	0.333291	0.333333	0.333291	0.333291	0.333291	0.333291	0.333291	0.333291	0.333333
SRTA	0.078125183	0.078125	0.078125	0.078125	0.078125	0.078125	0.078125	1.25	1.25	1.249971	1.249971	1.249971	1.249971	1.249971	1.249971	1.249953

Flow Balance

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FOI	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
FAI	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048
QSOI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
QSAI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FEOI	0.000000001	0.000000001	0.000000001	0.000000001	0.000000001	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1
FEAI	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
ROI	1.00001E-05	1.00001E-05	1.00001E-05	1.00001E-05	1.00001E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05
RAI	0.000480231	0.000480231	0.000480231	0.000480231	0.000480231	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048
AUX_1		1.00001E-14	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-05
AUX_2			-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14
FBAI	0	1.00001E-14	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-05
FBBI	1	1.00001E-05	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-1E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-1E-05
FBCI	-1	-1E-05	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	0	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	0
FBDI	-3E-05	0	0	0	0	0	-1.2E-13	1.2E-13	-8E-15	8E-15	0	0	0	0	0	-8E-15
FBETA	1	1.00001E-05	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14
FGAMMA	-3E-05	3.00003E-14	3.00003E-14	3.00003E-14	3.00003E-14	3E-14	12	2.02E-14	0.8	1.92E-14	1.92E-14	1.92E-14	1.92E-14	1.92E-14	1.92E-14	0.800019
QAI	12.79997	12.80000006	12.80000006	12.80000006	12.80000006	12.8	12.8	0.8	0.8	0.800019	0.800019	0.800019	0.800019	0.800019	0.800019	0.800019
QOI	3.006146951	3.006146948	3.006146945	3.006146942	3.006146939	3.006147	3.000384	3.000384	3	3.000384	3.000384	3.000384	3.000384	3.000384	3.000384	3
RQI	0.234855229	0.235334907	0.235334907	0.235334906	0.235334906	0.235335	0.234885	3.75082	3.75034	3.750252	3.750732	3.750732	3.750732	3.750732	3.750732	3.750392
Ea_final	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8

Mass Balanc

Case 3

Mass Balance f

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Dcomp_1	37.38	37.38	37.38	37.38	37.38	37.38	37.38	5.2	1.82	0.039	0.039	0.039	0.039	0.039	0.039	0.039
x_trap_1	0.02161302	0.067651913	0.217387566	0.704361324	2.288108656	7.438809	24.19019	81.28194	134.2803	1178.627	396.1656	132.8917	44.32429	14.52948	4.506272	1.134382
y_iM1_1	0	0.32865348	0.970487056	3.057873076	9.846518218	31.9247	103.7263	336.1154	350.2414	314.4373	105.7568	35.56254	11.94865	4.00474	1.332346	0.433331
y_iP1_1	0.970487056	3.057873076	9.846518218	31.92470477	103.7262642	336.1154	350.2414	314.4373	105.7568	35.56254	11.94865	4.00474	1.332346	0.433331	0.130906	0
Denom_y_1	3.006146951	3.012293898	3.012293895	3.012293892	3.012293889	3.012294	3.006531	3.000768	3.000384	3.000384	3.000768	3.000768	3.000768	3.000768	3.000768	3.000384
Avg_y_iM1_1	0.132622531	0.334222783	0.988599673	3.116779342	10.03809121	32.54544	103.7578	336.1127	350.2414	314.4016	105.7447	35.5585	11.94729	4.004283	1.332192	0.433331
S_1_new	6.136233285	4.940330107	4.547636693	4.42497229	4.387069288	4.375088	4.289249	4.135146	2.608285	0.266753	0.266921	0.267575	0.269543	0.275597	0.295631	0.381997
S_1	6.136233285	4.940330107	4.547636693	4.42497229	4.387069288	4.375088	4.289249	4.135146	2.608285	0.266753	0.266921	0.267575	0.269543	0.275597	0.295631	0.381997
Deff_1	15.20627308	14.34530101	14.06645802	13.97935672	13.95244264	13.94394	13.8947	4.308969	2.341649	0.089729	0.089767	0.089913	0.090351	0.091699	0.096162	0.115398
MBAI_1	0	-45.7123215	-43.1241129	-42.2858698	-42.0240305	-41.9431	-41.9175	-41.6895	-12.9286	-7.02498	-0.26925	-0.26937	-0.2698	-0.27112	-0.27516	-0.28855
MBBI_1	58.51229152	56.01229282	55.17233576	54.909961	54.82888783	54.80326	54.57488	13.73025	7.825876	1.06927	1.069418	1.069856	1.071171	1.075218	1.088608	1.146258
MBCI_1	-12.8881799	-12.8864659	-12.8859305	-12.885765	-12.8857127	-12.8854	-0.80166	-0.8009	0	-0.80005	-0.80005	-0.80005	-0.80005	-0.80006	-0.80006	0
MBDI_1	0.392717281	0	0	0	0	0	943.2	0	0	0	0	0	0	0	0	0
BETA_1	58.51229152	45.94349175	43.0766637	42.26058819	42.0152521	41.93967	41.69626	12.92872	7.024984	1.06927	0.867958	0.821564	0.808433	0.80691	0.815782	0.863266
GAMMA_1	0.006711706	0.006677935	0.006685291	0.00668929	0.006690688	0.006691	22.62746	72.96364	134.2803	882.206	273.6707	89.72799	29.94539	10.06149	3.393747	1.134382
X_1	0.02161302	0.067651913	0.217387566	0.704361324	2.288108654	7.438809	24.19019	81.28194	134.2803	1178.627	396.1656	132.8917	44.32429	14.52948	4.506272	1.134382
Y_1	0.328653479	0.970487055	3.057873073	9.846518211	31.92470475	103.7263	336.1154	350.2414	314.4373	105.7568	35.56254	11.94865	4.00474	1.332346	0.433331	0.130906

Case 3

NOTE: ONLY THOSE FEEDS AND EFFLUENTS WITH A "REPORT CODE" WILL APPEAR IN THE
Influent/effluent REPORTS CREATED BY report_generator.
Report code for organic (O) feeds
Report code for organic (O) effluents
Report code for aqueous (A) feeds
Report code for aqueous (A) effluents
Fractional extraction efficiency for each stage
Fraction of A in O (1E-09 is min. value allowed for O going to the next stage; 0.0 for O effluents)
Fraction of O in exiting A at each stage (applies only to A returned to the next stage; 0.0 for A effluents)
Volume of organic (O) phase in each stage, L (or mL)
Volume of aqueous (A) phase in each stage, L (or mL)
Volumetric flow rate for organic (O) sampling stream from each stage, L/min (or mL/min)
Volumetric flow rate for aqueous (A) sampling stream from each stage, L/min (or mL/min)
Fraction of exiting O taken as an effluent from each stage (1E-09 is minimum value allowed)
Fraction of exiting A taken as an effluent from each stage
Volumetric flow rate for O feed to each stage, L/min (or mL/min)
Volumetric flow rate for A feed to each stage, L/min (or mL/min)
Concentration of component 1 in aqueous feed to each stage (need only if there is a feed), M
Concentration of component 1 in organic feed to each stage (need only if there is a feed), M
Process temperature in each stage
Final Aq density in each stage
Initial Aq density in feed stage
% Loading CCD
% Loading PEG

Case 3

D values used for component 1 (Cs-137)

Volumetric flow rate for organic (O) effluent from each stage, L/min (or mL/min
Volumetric flow rate for aqueous (A) effluent from each stage, L/min (or mL/min
Concentration of component 1 in aqueous (A) phase exiting each stage including any effluent taken, M
Concentration of component 1 in organic (O) phase exiting each stage including any effluent taken, M
Stage residence time for the organic (O) phase, min
Stage residence time for the aqueous (A) phase, min

CS			DF
ExF	Aq Feed In	78.6	18821.55
ExW	Aq Feed Out	0.004176	
ScW	Aq Scrub Out	107.1839	
StW	Aq Strip Out	1164.338	
StP	Org Out	0.232515	

Case 4

General Notes

Section Number	Stages	Section Name	Section Letter
1	7	Extraction	Ex
2	2	Scrub	Sc
3	7	Strip	St

Component Number	Component Name	Rows Needed	Organic Feed Concn, M
1	Cs-137	1	1E-15

imum D Value	D_max	1E+15
Value if Error	D_error	1
imum D Value	D_min	1E-15
ic Mean Value	D_geo	1.1
and FOI Value	FEOI_min	1E-09
cle (Yes or No)	Recycle	Yes
tion Efficiency	Ea_default	0.9
xtr. Efficiency	Ea_min	0.1

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User Specifie

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Code_O_in	ExX															
Code_O_out																StP
Code_A_in							ExF		ScF							StF
Code_A_out	ExW							ScW		StW						
Ea	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
FOI_input	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
FAI_input	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037
VOI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
VAI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
QSOI_input																
QSAI_input																
FEOI_input																1
FEAI_input	1									1						
QFOI	1															
QFAI							4		0.27							0.27
xf_1							78.6									
yf_1	0.232515															
proc_temp																
density																
init_density																
CCD_loading																
PEG_loading																

Case 4

D Values

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
D(Cs-137)	60.13	60.13	60.13	60.13	60.13	60.13	60.13	3.33	2.2	0.077	0.077	0.077	0.077	0.077	0.077	0.077

Summary of th

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
QEOI	1.00158E-09	1.00158E-09	1.00158E-09	1.00158E-09	1.00158E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1
QEAI	4.26999									0.270009						
x_1	0.004176063	0.005797695	0.015321086	0.07124866	0.399691903	2.328525	13.65613	107.1839	127.1456	1164.338	435.3442	162.295	60.03047	21.72955	7.384788	2.012275
y_1	0.239504213	0.280484674	0.521148709	1.934485128	10.23451819	58.97609	343.5547	348.9395	314.6134	117.7606	44.04659	16.43865	6.098712	2.226116	0.77572	0.232515
SRTO	0.998422009	0.99842201	0.998422011	0.998422012	0.998422013	0.998422	0.9999	0.9999	1	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	1
SRTA	0.234192586	0.234192037	0.234192037	0.234192037	0.234192037	0.234192	0.234192	3.703704	3.703704	3.703574	3.703574	3.703574	3.703574	3.703574	3.703574	3.703567

Flow Balance

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FOI	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
FAI	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037
QSOI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
QSAI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FEOI	0.000000001	0.000000001	0.000000001	0.000000001	0.000000001	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1
FEAI	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
ROI	1.00001E-05	1.00001E-05	1.00001E-05	1.00001E-05	1.00001E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05
RAI	0.000370137	0.000370137	0.000370137	0.000370137	0.000370137	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037
AUX_1		1.00001E-14	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-05
AUX_2			-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14
FBAI	0	1.00001E-14	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-05
FBBI	1	1.00001E-05	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-1E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-1E-05
FBCI	-1	-1E-05	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	0	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	0
FBDI	-1E-05	0	0	0	0	0	-4E-14	4E-14	-2.7E-15	2.7E-15	0	0	0	0	0	-2.7E-15
FBETA	1	1.00001E-05	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14
FGAMMA	-1E-05	1.00001E-14	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	4	9.47E-15	0.27	9.47E-15	9.47E-15	9.47E-15	9.47E-15	9.47E-15	9.47E-15	0.270009
QAI	4.26999	4.270000016	4.270000016	4.270000016	4.270000016	4.27	4.27	0.27	0.27	0.270009	0.270009	0.270009	0.270009	0.270009	0.270009	0.270009
QOI	1.001580485	1.001580484	1.001580483	1.001580482	1.001580481	1.00158	1.0001	1.0001	1	1.0001	1.0001	1.0001	1.0001	1.0001	1.0001	1
RQI	0.234562174	0.234931759	0.234931759	0.234931759	0.234931759	0.234932	0.234585	3.704307	3.703937	3.703807	3.704177	3.704177	3.704177	3.704177	3.704177	3.703944
Ea_final	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Mass Balanc

Case 4

Mass Balance f

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Dcomp_1	60.13	60.13	60.13	60.13	60.13	60.13	60.13	3.33	2.2	0.077	0.077	0.077	0.077	0.077	0.077	0.077
x_trap_1	0.004176063	0.005797695	0.015321086	0.07124866	0.399691903	2.328525	13.65613	107.1839	127.1456	1164.338	435.3442	162.295	60.03047	21.72955	7.384788	2.012275
y_iM1_1	0	0.239504213	0.280484674	0.521148709	1.934485128	10.23452	58.97609	343.5547	348.9395	314.6134	117.7606	44.04659	16.43865	6.098712	2.226116	0.77572
y_iP1_1	0.280484674	0.521148709	1.934485128	10.23451819	58.97609473	343.5547	348.9395	314.6134	117.7606	44.04659	16.43865	6.098712	2.226116	0.77572	0.232515	0
Denom_y_1	1.001580485	1.003160969	1.003160968	1.003160967	1.003160966	1.003161	1.00168	1.0002	1.0001	1.0001	1.0002	1.0002	1.0002	1.0002	1.0002	1.0001
Avg_y_iM1_1	0.232590771	0.239947946	0.28309056	0.536452168	2.02435445	10.75967	59.00502	343.5518	348.9395	314.5864	117.7504	44.0428	16.43723	6.09818	2.225916	0.77572
S_1_new	55.69618133	41.38678146	18.47718586	7.529294876	5.064787236	4.620807	4.320773	3.205256	2.744409	0.270185	0.270477	0.271375	0.273815	0.28064	0.301419	0.385494
S_1	55.69618133	41.38678146	18.47718586	7.529294876	5.064787236	4.620807	4.320773	3.205256	2.744409	0.270185	0.270477	0.271375	0.273815	0.28064	0.301419	0.385494
Deff_1	57.35167411	48.37865097	34.01512779	27.15117923	25.60601829	25.32766	25.15755	3.255521	2.474434	0.10114	0.101176	0.101289	0.101594	0.102446	0.105043	0.115548
MBAI_1	0	-57.4423275	-48.4551226	-34.0688981	-27.1941012	-25.6465	-25.3677	-25.1601	-3.25586	-2.47444	-0.10116	-0.1012	-0.10131	-0.10161	-0.10247	-0.10506
MBBI_1	61.71231758	52.80158439	38.39265854	31.50701323	29.95696806	29.67773	29.46984	3.526182	2.744691	0.371169	0.371216	0.371328	0.371633	0.372486	0.375083	0.385569
MBCI_1	-4.34646174	-4.32376041	-4.31291204	-4.31046994	-4.31002999	-4.30976	-0.27033	-0.27025	0	-0.27002	-0.27002	-0.27002	-0.27002	-0.27002	-0.27002	0
MBDI_1	0.232515	0	0	0	0	0	314.4	0	0	0	0	0	0	0	0	0
BETA_1	61.71231758	48.75586243	34.0955683	27.19747483	25.64703281	25.36779	25.16009	3.255857	2.474444	0.371169	0.297624	0.279518	0.273767	0.272264	0.273461	0.281828
GAMMA_1	0.003767726	0.004438993	0.006308501	0.00790234	0.008379021	0.008471	12.50452	96.63038	127.1456	847.6316	288.102	104.3044	38.59836	14.40562	5.397828	2.012275
X_1	0.004176063	0.005797695	0.015321086	0.07124866	0.399691903	2.328525	13.65613	107.1839	127.1456	1164.338	435.3442	162.295	60.03047	21.72955	7.384788	2.012275
Y_1	0.239504213	0.280484674	0.521148709	1.934485128	10.23451819	58.97609	343.5547	348.9395	314.6134	117.7606	44.04659	16.43865	6.098712	2.226116	0.77572	0.232515

Case 4

NOTE: ONLY THOSE FEEDS AND EFFLUENTS WITH A "REPORT CODE" WILL APPEAR IN THE
Influent/effluent REPORTS CREATED BY report_generator.
Report code for organic (O) feeds
Report code for organic (O) effluents
Report code for aqueous (A) feeds
Report code for aqueous (A) effluents
Fractional extraction efficiency for each stage
Fraction of A in O (1E-09 is min. value allowed for O going to the next stage; 0.0 for O effluents)
Fraction of O in exiting A at each stage (applies only to A returned to the next stage; 0.0 for A effluents)
Volume of organic (O) phase in each stage, L (or mL)
Volume of aqueous (A) phase in each stage, L (or mL)
Volumetric flow rate for organic (O) sampling stream from each stage, L/min (or mL/min)
Volumetric flow rate for aqueous (A) sampling stream from each stage, L/min (or mL/min)
Fraction of exiting O taken as an effluent from each stage (1E-09 is minimum value allowed)
Fraction of exiting A taken as an effluent from each stage
Volumetric flow rate for O feed to each stage, L/min (or mL/min)
Volumetric flow rate for A feed to each stage, L/min (or mL/min)
Concentration of component 1 in aqueous feed to each stage (need only if there is a feed), M
Concentration of component 1 in organic feed to each stage (need only if there is a feed), M
Process temperature in each stage
Final Aq density in each stage
Initial Aq density in feed stage
% Loading CCD
% Loading PEG

Case 4

D values used for component 1 (Cs-137)

Volumetric flow rate for organic (O) effluent from each stage, L/min (or mL/min
Volumetric flow rate for aqueous (A) effluent from each stage, L/min (or mL/min
Concentration of component 1 in aqueous (A) phase exiting each stage including any effluent taken, M
Concentration of component 1 in organic (O) phase exiting each stage including any effluent taken, M
Stage residence time for the organic (O) phase, min
Stage residence time for the aqueous (A) phase, min

CS			DF
ExF	Aq Feed In	78.6	12466.07
ExW	Aq Feed Out	0.006305	
ScW	Aq Scrub Out	79.09629	
StW	Aq Strip Out	1186.269	
StP	Org Out	0.198365	

General Notes

Section Number	Stages	Section Name	Section Letter
1	7	Extraction	Ex
2	2	Scrub	Sc
3	7	Strip	St

Component Number	Component Name	Rows Needed	Organic Feed Concn, M
1	Cs-137	1	1E-15

imum D Value	D_max	1E+15
) Value if Error	D_error	1
imum D Value	D_min	1E-15
ic Mean Value	D_geo	1.1
and FOI Value	FEOI_min	1E-09
cle (Yes or No)	Recycle	Yes
tion Efficiency	Ea_default	0.9
xtr. Efficiency	Ea_min	0.1

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Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Code_O_in	ExX															
Code_O_out																StP
Code_A_in							ExF		ScF							StF
Code_A_out	ExW							ScW		StW						
Ea	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
FOI_input	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
FAI_input	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045
VOI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
VAI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
QSOI_input																
QSAI_input																
FEOI_input																1
FEAI_input	1									1						
QFOI	2															
QFAI							8		0.53							0.53
xf_1							78.6									
yf_1	0.198365258															
proc_temp																
density																
init_density																
CCD_loading																
PEG_loading																

Case 5

D Values

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
D(Cs-137)	38.78	38.78	38.78	38.78	38.78	38.78	38.78	4.71	2.25	0.073	0.073	0.073	0.073	0.073	0.073	0.073

Summary of th

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
QEOI	2.00384E-09	2.00384E-09	2.00384E-09	2.00384E-09	2.00384E-09	2E-09	2E-09	2E-09	2E-09	2E-09	2E-09	2E-09	2E-09	2E-09	2E-09	2
QEAI	8.52998									0.53002						
x_1	0.006305113	0.01138377	0.035756222	0.152717045	0.713999689	3.407536	16.33381	79.09629	124.3638	1186.269	432.8656	157.5264	56.90922	20.14072	6.70441	1.794383
y_1	0.22022679	0.324939051	0.827442136	3.23890139	14.81123841	70.34434	335.5333	347.5232	314.5702	114.8915	41.93693	15.27714	5.534864	1.974745	0.673771	0.198365
SRTO	0.499041783	0.499041783	0.499041784	0.499041784	0.499041785	0.499042	0.49994	0.49994	0.5	0.49994	0.49994	0.49994	0.49994	0.49994	0.49994	0.5
SRTA	0.117233569	0.117233294	0.117233294	0.117233294	0.117233294	0.117233	0.117233	1.886792	1.886792	1.886721	1.886721	1.886721	1.886721	1.886721	1.886721	1.886721

Flow Balance

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FOI	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
FAI	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045
QSOI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
QSAI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FEOI	0.000000001	0.000000001	0.000000001	0.000000001	0.000000001	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1
FEAI	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
ROI	1.00001E-05	1.00001E-05	1.00001E-05	1.00001E-05	1.00001E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05
RAI	0.000450203	0.000450203	0.000450203	0.000450203	0.000450203	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045
AUX_1		1.00001E-14	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-05
AUX_2			-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14
FBAI	0	1.00001E-14	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-05
FBBI	1	1.00001E-05	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-1E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-1E-05
FBCI	-1	-1E-05	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	0	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	0
FBDI	-2E-05	0	0	0	0	0	-8E-14	8E-14	-5.3E-15	5.3E-15	0	0	0	0	0	-5.3E-15
FBETA	1	1.00001E-05	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14
FGAMMA	-2E-05	2.00002E-14	2.00002E-14	2.00002E-14	2.00002E-14	2E-14	8	2.02E-14	0.53	2.01E-14	2.01E-14	2.01E-14	2.01E-14	2.01E-14	2.01E-14	0.53002
QAI	8.52998	8.530000038	8.530000038	8.530000038	8.530000038	8.53	8.53	0.53	0.53	0.53002	0.53002	0.53002	0.53002	0.53002	0.53002	0.53002
QOI	2.003840228	2.003840226	2.003840224	2.003840222	2.00384022	2.00384	2.000239	2.000239	2	2.000239	2.000239	2.000239	2.000239	2.000239	2.000239	2
RQI	0.23491679	0.235366439	0.235366439	0.235366439	0.235366439	0.235366	0.234944	3.774343	3.773893	3.773749	3.7742	3.7742	3.7742	3.7742	3.7742	3.773892
Ea_final	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Case 5

Mass Balanc

Mass Balance f

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Dcomp_1	38.78	38.78	38.78	38.78	38.78	38.78	38.78	4.71	2.25	0.073	0.073	0.073	0.073	0.073	0.073	0.073
x_trap_1	0.006305113	0.01138377	0.035756222	0.152717045	0.713999689	3.407536	16.33381	79.09629	124.3638	1186.269	432.8656	157.5264	56.90922	20.14072	6.70441	1.794383
y_iM1_1	0	0.22022679	0.324939051	0.827442136	3.23890139	14.81124	70.34434	335.5333	347.5232	314.5702	114.8915	41.93693	15.27714	5.534864	1.974745	0.673771
y_iP1_1	0.324939051	0.827442136	3.23890139	14.81123841	70.34434104	335.5333	347.5232	314.5702	114.8915	41.93693	15.27714	5.534864	1.974745	0.673771	0.198365	0
Denom_y_1	2.003840228	2.007680454	2.007680452	2.00768045	2.007680448	2.00768	2.004079	2.000477	2.000239	2.000239	2.000477	2.000477	2.000477	2.000477	2.000477	2.000239
Avg_y_iM1_1	0.198607828	0.221388252	0.330512786	0.854189903	3.367258567	15.42471	70.37734	335.5308	347.5232	314.5377	114.8797	41.93259	15.27556	5.534284	1.974533	0.673771
S_1_new	31.4994897	19.44771022	9.243504262	5.593284635	4.716050466	4.526645	4.308691	4.242054	2.794407	0.265149	0.265393	0.266194	0.26842	0.274781	0.294513	0.375489
S_1	31.4994897	19.44771022	9.243504262	5.593284635	4.716050466	4.526645	4.308691	4.242054	2.794407	0.265149	0.265393	0.266194	0.26842	0.274781	0.294513	0.375489
Deff_1	34.92828834	28.54406428	23.14120733	21.20851267	20.74404041	20.64376	20.54225	4.393672	2.529435	0.096851	0.096882	0.096981	0.097258	0.098047	0.100497	0.110548
MBAI_1	0	-69.9907292	-57.1977642	-46.3713021	-42.4984907	-41.5678	-41.3668	-41.0894	-8.78841	-5.05889	-0.19375	-0.19381	-0.19401	-0.19456	-0.19614	-0.20104
MBBI_1	78.52070932	65.83738002	54.99016968	51.10993634	50.17742442	49.97608	49.69831	9.319461	5.589494	0.723766	0.723851	0.724049	0.724602	0.726182	0.731081	0.751142
MBCI_1	-8.63961576	-8.61886755	-8.61144557	-8.60966189	-8.60927677	-8.60889	-0.53105	-0.5306	0	-0.53004	-0.53004	-0.53004	-0.53004	-0.53004	-0.53005	0
MBDI_1	0.396730516	0	0	0	0	0	628.8	0	0	0	0	0	0	0	0	0
BETA_1	78.52070932	58.13631603	46.510445	42.5242532	41.57297852	41.36789	41.08965	8.788415	5.058891	0.723766	0.581963	0.547532	0.536793	0.534069	0.536422	0.552494
GAMMA_1	0.005052559	0.006082812	0.00748054	0.008157284	0.008338884	0.008379	15.31156	71.58778	124.3638	869.2634	289.3929	102.4349	37.02174	13.48684	4.931352	1.794383
X_1	0.006305113	0.01138377	0.035756222	0.152717045	0.713999689	3.407536	16.33381	79.09629	124.3638	1186.269	432.8656	157.5264	56.90922	20.14072	6.70441	1.794383
Y_1	0.22022679	0.324939051	0.827442136	3.23890139	14.81123841	70.34434	335.5333	347.5232	314.5702	114.8915	41.93693	15.27714	5.534864	1.974745	0.673771	0.198365

Case 5

NOTE: ONLY THOSE FEEDS AND EFFLUENTS WITH A "REPORT CODE" WILL APPEAR IN THE
Influent/effluent REPORTS CREATED BY report_generator.
Report code for organic (O) feeds
Report code for organic (O) effluents
Report code for aqueous (A) feeds
Report code for aqueous (A) effluents
Fractional extraction efficiency for each stage
Fraction of A in O (1E-09 is min. value allowed for O going to the next stage; 0.0 for O effluents)
Fraction of O in exiting A at each stage (applies only to A returned to the next stage; 0.0 for A effluents)
Volume of organic (O) phase in each stage, L (or mL)
Volume of aqueous (A) phase in each stage, L (or mL)
Volumetric flow rate for organic (O) sampling stream from each stage, L/min (or mL/min)
Volumetric flow rate for aqueous (A) sampling stream from each stage, L/min (or mL/min)
Fraction of exiting O taken as an effluent from each stage (1E-09 is minimum value allowed)
Fraction of exiting A taken as an effluent from each stage
Volumetric flow rate for O feed to each stage, L/min (or mL/min)
Volumetric flow rate for A feed to each stage, L/min (or mL/min)
Concentration of component 1 in aqueous feed to each stage (need only if there is a feed), M
Concentration of component 1 in organic feed to each stage (need only if there is a feed), M
Process temperature in each stage
Final Aq density in each stage
Initial Aq density in feed stage
% Loading CCD
% Loading PEG

Case 5

D values used for component 1 (Cs-137)

Volumetric flow rate for organic (O) effluent from each stage, L/min (or mL/min
Volumetric flow rate for aqueous (A) effluent from each stage, L/min (or mL/min
Concentration of component 1 in aqueous (A) phase exiting each stage including any effluent taken, M
Concentration of component 1 in organic (O) phase exiting each stage including any effluent taken, M
Stage residence time for the organic (O) phase, min
Stage residence time for the aqueous (A) phase, min

CS			DF
ExF	Aq Feed In	78.6	45939.12
ExW	Aq Feed Out	0.001711	
ScW	Aq Scrub Out	77.19984	
StW	Aq Strip Out	1178.945	
StP	Org Out	0.01332	

Case 6

General Notes

Section Number	Stages	Section Name	Section Letter
1	7	Extraction	Ex
2	2	Scrub	Sc
3	7	Strip	St

Component Number	Component Name	Rows Needed	Organic Feed Concn, M
1	Cs-137	1	1E-15

imum D Value	D_max	1E+15
Value if Error	D_error	1
imum D Value	D_min	1E-15
ic Mean Value	D_geo	1.1
and FOI Value	FEOI_min	1E-09
cle (Yes or No)	Recycle	Yes
tion Efficiency	Ea_default	0.9
xtr. Efficiency	Ea_min	0.1

put values	Okay
put values	Okay
put values	Okay
put values	Okay
put values	Okay
put values	Okay

User Specifie

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Code_O_in	ExX															
Code_O_out																StP
Code_A_in							ExF		ScF							StF
Code_A_out	ExW							ScW		StW						
Ea	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
FOI_input	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
FAI_input	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048
VOI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
VAI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
QSOI_input																
QSAI_input																
FEOI_input																1
FEAI_input	1									1						
QFOI	3															
QFAI							12		0.8							0.8
xf_1							78.6									
yf_1	0.013320055															
proc_temp																
density																
init_density																
CCD_loading																
PEG_loading																

D Values

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
D(Cs-137)	37.38	37.38	37.38	37.38	37.38	37.38	37.38	5.2	1.82	0.039	0.039	0.039	0.039	0.039	0.039	0.039

Summary of th

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
QEOI	3.00615E-09	3.00615E-09	3.00615E-09	3.00615E-09	3.00615E-09	3.01E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3
QEAI	12.79997									0.800019						
x_1	0.00171096	0.007378345	0.034053145	0.159601066	0.750506358	3.531668	16.62183	77.19984	153.2302	1178.945	286.1388	69.40691	16.80204	4.033862	0.934786	0.182583
y_1	0.037735883	0.152419303	0.692189609	3.23267875	15.18977269	71.46575	334.9951	355.2614	314.4045	76.2996	18.5176	4.492839	1.088768	0.262536	0.061994	0.01332
SRTO	0.332651735	0.332651736	0.332651736	0.332651736	0.332651737	0.332652	0.333291	0.333291	0.333333	0.333291	0.333291	0.333291	0.333291	0.333291	0.333291	0.333333
SRTA	0.078125183	0.078125	0.078125	0.078125	0.078125	0.078125	0.078125	1.25	1.25	1.249971	1.249971	1.249971	1.249971	1.249971	1.249971	1.249953

Flow Balance

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FOI	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
FAI	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048
QSOI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
QSAI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FEOI	0.000000001	0.000000001	0.000000001	0.000000001	0.000000001	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1
FEAI	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
ROI	1.00001E-05	1.00001E-05	1.00001E-05	1.00001E-05	1.00001E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05
RAI	0.000480231	0.000480231	0.000480231	0.000480231	0.000480231	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048
AUX_1		1.00001E-14	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-05
AUX_2			-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14
FBAI	0	1.00001E-14	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-05
FBBI	1	1.00001E-05	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-1E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-1E-05
FBCI	-1	-1E-05	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	0	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	0
FBDI	-3E-05	0	0	0	0	0	-1.2E-13	1.2E-13	-8E-15	8E-15	0	0	0	0	0	-8E-15
FBETA	1	1.00001E-05	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14
FGAMMA	-3E-05	3.00003E-14	3.00003E-14	3.00003E-14	3.00003E-14	3E-14	12	2.02E-14	0.8	1.92E-14	1.92E-14	1.92E-14	1.92E-14	1.92E-14	1.92E-14	0.800019
QAI	12.79997	12.80000006	12.80000006	12.80000006	12.80000006	12.8	12.8	0.8	0.8	0.800019	0.800019	0.800019	0.800019	0.800019	0.800019	0.800019
QOI	3.006146951	3.006146948	3.006146945	3.006146942	3.006146939	3.006147	3.000384	3.000384	3	3.000384	3.000384	3.000384	3.000384	3.000384	3.000384	3
RQI	0.234855229	0.235334907	0.235334907	0.235334906	0.235334906	0.235335	0.234885	3.75082	3.75034	3.750252	3.750732	3.750732	3.750732	3.750732	3.750732	3.750392
Ea_final	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Mass Balanc

Case 6

Mass Balance f

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Dcomp_1	37.38	37.38	37.38	37.38	37.38	37.38	37.38	5.2	1.82	0.039	0.039	0.039	0.039	0.039	0.039	0.039
x_trap_1	0.00171096	0.007378345	0.034053145	0.159601066	0.750506358	3.531668	16.62183	77.19984	153.2302	1178.945	286.1388	69.40691	16.80204	4.033862	0.934786	0.182583
y_iM1_1	0	0.037735883	0.152419303	0.692189609	3.23267875	15.18977	71.46575	334.9951	355.2614	314.4045	76.2996	18.5176	4.492839	1.088768	0.262536	0.061994
y_iP1_1	0.152419303	0.692189609	3.23267875	15.18977269	71.46574879	334.9951	355.2614	314.4045	76.2996	18.5176	4.492839	1.088768	0.262536	0.061994	0.01332	0
Denom_y_1	3.006146951	3.012293898	3.012293895	3.012293892	3.012293889	3.012294	3.006531	3.000768	3.000384	3.000384	3.000768	3.000768	3.000768	3.000768	3.000768	3.000384
Avg_y_iM1_1	0.013604485	0.039071375	0.158704945	0.721773684	3.371916594	15.84237	71.50201	334.9924	355.2614	314.3666	76.2904	18.51537	4.492298	1.088636	0.262504	0.061994
S_1_new	7.951374712	5.295411692	4.660507706	4.522361288	4.492855469	4.485805	4.301694	4.339289	2.318482	0.266651	0.26662	0.266766	0.267366	0.269874	0.280817	0.339541
S_1	7.951374712	5.295411692	4.660507706	4.522361288	4.492855469	4.485805	4.301694	4.339289	2.318482	0.266651	0.26662	0.266766	0.267366	0.269874	0.280817	0.339541
Deff_1	22.05538454	20.6576545	20.32674536	20.25474406	20.23936577	20.23569	20.15393	4.601841	2.051845	0.064719	0.064715	0.064732	0.0648	0.065083	0.066319	0.072953
MBAI_1	0	-66.301757	-62.099975	-61.1052135	-60.8887669	-60.8425	-60.8315	-60.4696	-13.8073	-6.15556	-0.19421	-0.1942	-0.19425	-0.19445	-0.1953	-0.19901
MBBI_1	79.10172704	75.02695672	74.03016108	73.81327195	73.76694795	73.75588	73.39344	14.60909	6.956353	0.994229	0.994245	0.994294	0.994498	0.995348	0.999058	1.018907
MBCI_1	-12.9269816	-12.9249476	-12.924505	-12.9244104	-12.9243879	-12.9239	-0.80177	-0.80079	0	-0.80004	-0.80004	-0.80004	-0.80004	-0.80004	-0.80005	0
MBDI_1	0.039960166	0	0	0	0	0	943.2	0	0	0	0	0	0	0	0	0
BETA_1	79.10172704	64.1917749	61.52639526	60.97724228	60.86129027	60.83547	60.4704	13.80733	6.155565	0.994229	0.837966	0.808881	0.80237	0.801458	0.804098	0.820896
GAMMA_1	0.000505174	0.000521779	0.000526644	0.000527749	0.000527987	0.000528	15.59825	68.3129	153.2302	948.6928	219.8729	52.78845	12.77987	3.100724	0.753123	0.182583
X_1	0.00171096	0.007378345	0.034053145	0.159601066	0.750506358	3.531668	16.62183	77.19984	153.2302	1178.945	286.1388	69.40691	16.80204	4.033862	0.934786	0.182583
Y_1	0.037735883	0.152419303	0.692189609	3.23267875	15.18977269	71.46575	334.9951	355.2614	314.4045	76.2996	18.5176	4.492839	1.088768	0.262536	0.061994	0.01332

Case 6

NOTE: ONLY THOSE FEEDS AND EFFLUENTS WITH A "REPORT CODE" WILL APPEAR IN THE
Influent/effluent REPORTS CREATED BY report_generator.
Report code for organic (O) feeds
Report code for organic (O) effluents
Report code for aqueous (A) feeds
Report code for aqueous (A) effluents
Fractional extraction efficiency for each stage
Fraction of A in O (1E-09 is min. value allowed for O going to the next stage; 0.0 for O effluents)
Fraction of O in exiting A at each stage (applies only to A returned to the next stage; 0.0 for A effluents)
Volume of organic (O) phase in each stage, L (or mL)
Volume of aqueous (A) phase in each stage, L (or mL)
Volumetric flow rate for organic (O) sampling stream from each stage, L/min (or mL/min)
Volumetric flow rate for aqueous (A) sampling stream from each stage, L/min (or mL/min)
Fraction of exiting O taken as an effluent from each stage (1E-09 is minimum value allowed)
Fraction of exiting A taken as an effluent from each stage
Volumetric flow rate for O feed to each stage, L/min (or mL/min)
Volumetric flow rate for A feed to each stage, L/min (or mL/min)
Concentration of component 1 in aqueous feed to each stage (need only if there is a feed), M
Concentration of component 1 in organic feed to each stage (need only if there is a feed), M
Process temperature in each stage
Final Aq density in each stage
Initial Aq density in feed stage
% Loading CCD
% Loading PEG

Case 6

D values used for component 1 (Cs-137)

Volumetric flow rate for organic (O) effluent from each stage, L/min (or mL/min
Volumetric flow rate for aqueous (A) effluent from each stage, L/min (or mL/min
Concentration of component 1 in aqueous (A) phase exiting each stage including any effluent taken, M
Concentration of component 1 in organic (O) phase exiting each stage including any effluent taken, M
Stage residence time for the organic (O) phase, min
Stage residence time for the aqueous (A) phase, min

CS			DF
ExF	Aq Feed In	78.6	4870.173
ExW	Aq Feed Out	0.016139	
ScW	Aq Scrub Out	105.4905	
StW	Aq Strip Out	1164.148	
StP	Org Out	0.968714	

General Notes

Section Number	Stages	Section Name	Section Letter
1	7	Extraction	Ex
2	2	Scrub	Sc
3	7	Strip	St

Component Number	Component Name	Rows Needed	Organic Feed Concn, M
1	Cs-137	1	1E-15

imum D Value	D_max	1E+15
) Value if Error	D_error	1
imum D Value	D_min	1E-15
ic Mean Value	D_geo	1.1
and FOI Value	FEOI_min	1E-09
cle (Yes or No)	Recycle	Yes
tion Efficiency	Ea_default	0.8
xtr. Efficiency	Ea_min	0.1

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Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Code_O_in	ExX															
Code_O_out																StP
Code_A_in							ExF		ScF							StF
Code_A_out	ExW							ScW		StW						
Ea	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
FOI_input	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
FAI_input	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037
VOI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
VAI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
QSOI_input																
QSAI_input																
FEOI_input																1
FEAI_input	1									1						
QFOI	1															
QFAI							4		0.27							0.27
xf_1							78.6									
yf_1	0.968714372															
proc_temp																
density																
init_density																
CCD_loading																
PEG_loading																

Case 7

D Values

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
D(Cs-137)	60.13	60.13	60.13	60.13	60.13	60.13	60.13	3.33	2.2	0.077	0.077	0.077	0.077	0.077	0.077	0.077

Summary of th

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
QEOI	1.00158E-09	1.00158E-09	1.00158E-09	1.00158E-09	1.00158E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1
QEAI	4.26999									0.270009						
x_1	0.016139056	0.016362902	0.018207501	0.033407786	0.158664676	1.190836	9.696727	105.4905	111.9083	1164.148	531.6754	241.3295	108.0575	46.88422	18.80501	5.91634
y_1	0.969682787	0.977650397	1.043306931	1.584345007	6.042730547	42.78054	343.7823	345.511	315.2987	144.5066	66.12104	30.1412	13.62606	6.045428	2.565835	0.968714
SRTO	0.998422009	0.99842201	0.998422011	0.998422012	0.998422013	0.998422	0.9999	0.9999	1	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	1
SRTA	0.234192586	0.234192037	0.234192037	0.234192037	0.234192037	0.234192	0.234192	3.703704	3.703704	3.703574	3.703574	3.703574	3.703574	3.703574	3.703574	3.703567

Flow Balance

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FOI	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
FAI	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037
QSOI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
QSAI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FEOI	0.000000001	0.000000001	0.000000001	0.000000001	0.000000001	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1
FEAI	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
ROI	1.00001E-05	1.00001E-05	1.00001E-05	1.00001E-05	1.00001E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05
RAI	0.000370137	0.000370137	0.000370137	0.000370137	0.000370137	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037
AUX_1		1.00001E-14	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-05
AUX_2			-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14
FBAI	0	1.00001E-14	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-05
FBBI	1	1.00001E-05	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-1E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-1E-05
FBCI	-1	-1E-05	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	0	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	0
FBDI	-1E-05	0	0	0	0	0	-4E-14	4E-14	-2.7E-15	2.7E-15	0	0	0	0	0	-2.7E-15
FBETA	1	1.00001E-05	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14
FGAMMA	-1E-05	1.00001E-14	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	4	9.47E-15	0.27	9.47E-15	9.47E-15	9.47E-15	9.47E-15	9.47E-15	9.47E-15	0.270009
QAI	4.26999	4.270000016	4.270000016	4.270000016	4.270000016	4.27	4.27	0.27	0.27	0.270009	0.270009	0.270009	0.270009	0.270009	0.270009	0.270009
QOI	1.001580485	1.001580484	1.001580483	1.001580482	1.001580481	1.00158	1.0001	1.0001	1	1.0001	1.0001	1.0001	1.0001	1.0001	1.0001	1
RQI	0.234562174	0.234931759	0.234931759	0.234931759	0.234931759	0.234932	0.234585	3.704307	3.703937	3.703807	3.704177	3.704177	3.704177	3.704177	3.704177	3.703944
Ea_final	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8

Mass Balanc

Case 7

Mass Balance f

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Dcomp_1	60.13	60.13	60.13	60.13	60.13	60.13	60.13	3.33	2.2	0.077	0.077	0.077	0.077	0.077	0.077	0.077
x_trap_1	0.016139056	0.016362902	0.018207501	0.033407786	0.158664676	1.190836	9.696727	105.4905	111.9083	1164.148	531.6754	241.3295	108.0575	46.88422	18.80501	5.91634
y_iM1_1	0	0.969682787	0.977650397	1.043306931	1.584345007	6.042731	42.78054	343.7823	345.511	315.2987	144.5066	66.12104	30.1412	13.62606	6.045428	2.565835
y_iP1_1	0.977650397	1.043306931	1.584345007	6.042730547	42.78054165	343.7823	345.511	315.2987	144.5066	66.12104	30.1412	13.62606	6.045428	2.565835	0.968714	0
Denom_y_1	1.001580485	1.003160969	1.003160968	1.003160967	1.003160966	1.003161	1.00168	1.0002	1.0001	1.0001	1.0002	1.0002	1.0002	1.0002	1.0002	1.0001
Avg_y_iM1_1	0.968728473	0.969798782	0.978606247	1.051183547	1.649249807	6.574841	42.81074	343.7795	345.511	315.2738	144.4952	66.1158	30.13879	13.62495	6.04492	2.565835
S_1_new	60.02386272	59.26814121	53.74742386	31.46522616	10.39456198	5.5212	4.414969	3.258866	3.087448	0.270819	0.271773	0.273965	0.278914	0.290609	0.321453	0.433686
S_1	60.02386272	59.26814121	53.74742386	31.46522616	10.39456198	5.5212	4.414969	3.258866	3.087448	0.270819	0.271773	0.273965	0.278914	0.290609	0.321453	0.433686
Deff_1	60.08299347	59.74798364	57.30094198	47.42442368	38.08491405	35.92481	35.45344	3.27528	2.817474	0.124131	0.124364	0.124896	0.1261	0.128944	0.136444	0.163735
MBAI_1	0	-60.1779637	-59.8424243	-57.3915151	-47.4993871	-38.1451	-35.9816	-35.457	-3.27562	-2.81748	-0.12415	-0.12439	-0.12492	-0.12612	-0.12897	-0.13647
MBBI_1	64.44795374	64.20685517	61.75207843	51.84434073	42.47530918	40.30838	39.78303	3.545944	3.087766	0.394163	0.394408	0.394941	0.396145	0.398989	0.406491	0.433761
MBCI_1	-4.36443079	-4.36056328	-4.3449536	-4.33019264	-4.32677863	-4.32603	-0.27033	-0.27028	0	-0.27002	-0.27002	-0.27002	-0.27002	-0.27002	-0.27003	0
MBDI_1	0.968714372	0	0	0	0	0	314.4	0	0	0	0	0	0	0	0	0
BETA_1	64.44795374	60.13158912	57.41248452	47.5009741	38.14526121	35.98162	35.45699	3.275617	2.817484	0.394163	0.309357	0.286371	0.278357	0.276643	0.28061	0.302441
GAMMA_1	0.015030956	0.015042548	0.015679213	0.018943902	0.023589397	0.025008	8.892458	96.25662	111.9083	799.9231	321.0309	139.4408	62.57715	28.52919	13.11183	5.91634
X_1	0.016139056	0.016362902	0.018207501	0.033407786	0.158664677	1.190836	9.696727	105.4905	111.9083	1164.148	531.6754	241.3295	108.0575	46.88422	18.80501	5.91634
Y_1	0.969682787	0.977650397	1.043306932	1.584345011	6.042730569	42.78054	343.7823	345.511	315.2987	144.5066	66.12104	30.1412	13.62606	6.045428	2.565835	0.968714

Case 7

NOTE: ONLY THOSE FEEDS AND EFFLUENTS WITH A "REPORT CODE" WILL APPEAR IN THE
Influent/effluent REPORTS CREATED BY report_generator.
Report code for organic (O) feeds
Report code for organic (O) effluents
Report code for aqueous (A) feeds
Report code for aqueous (A) effluents
Fractional extraction efficiency for each stage
Fraction of A in O (1E-09 is min. value allowed for O going to the next stage; 0.0 for O effluents)
Fraction of O in exiting A at each stage (applies only to A returned to the next stage; 0.0 for A effluents)
Volume of organic (O) phase in each stage, L (or mL)
Volume of aqueous (A) phase in each stage, L (or mL)
Volumetric flow rate for organic (O) sampling stream from each stage, L/min (or mL/min)
Volumetric flow rate for aqueous (A) sampling stream from each stage, L/min (or mL/min)
Fraction of exiting O taken as an effluent from each stage (1E-09 is minimum value allowed)
Fraction of exiting A taken as an effluent from each stage
Volumetric flow rate for O feed to each stage, L/min (or mL/min)
Volumetric flow rate for A feed to each stage, L/min (or mL/min)
Concentration of component 1 in aqueous feed to each stage (need only if there is a feed), M
Concentration of component 1 in organic feed to each stage (need only if there is a feed), M
Process temperature in each stage
Final Aq density in each stage
Initial Aq density in feed stage
% Loading CCD
% Loading PEG

Case 7

D values used for component 1 (Cs-137)

Volumetric flow rate for organic (O) effluent from each stage, L/min (or mL/min
Volumetric flow rate for aqueous (A) effluent from each stage, L/min (or mL/min
Concentration of component 1 in aqueous (A) phase exiting each stage including any effluent taken, M
Concentration of component 1 in organic (O) phase exiting each stage including any effluent taken, M
Stage residence time for the organic (O) phase, min
Stage residence time for the aqueous (A) phase, min

CS			DF
ExF	Aq Feed In	78.6	3503.283
ExW	Aq Feed Out	0.022436	
ScW	Aq Scrub Out	80.67811	
StW	Aq Strip Out	1186.009	
StP	Org Out	0.862781	

Case 8

General Notes

Section Number	Stages	Section Name	Section Letter
1	7	Extraction	Ex
2	2	Scrub	Sc
3	7	Strip	St

Component Number	Component Name	Rows Needed	Organic Feed Concn, M
1	Cs-137	1	1E-15

imum D Value	D_max	1E+15
Value if Error	D_error	1
imum D Value	D_min	1E-15
ic Mean Value	D_geo	1.1
and FOI Value	FEOI_min	1E-09
cle (Yes or No)	Recycle	Yes
tion Efficiency	Ea_default	0.8
xtr. Efficiency	Ea_min	0.1

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Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Code_O_in	ExX															
Code_O_out																StP
Code_A_in							ExF		ScF							StF
Code_A_out	ExW							ScW		StW						
Ea	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
FOI_input	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
FAI_input	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045
VOI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
VAI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
QSOI_input																
QSAI_input																
FEOI_input																1
FEAI_input	1									1						
QFOI	2															
QFAI							8		0.53							0.53
xf_1							78.6									
yf_1	0.862781461															
proc_temp																
density																
init_density																
CCD_loading																
PEG_loading																

D Values

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
D(Cs-137)	38.78	38.78	38.78	38.78	38.78	38.78	38.78	4.71	2.25	0.073	0.073	0.073	0.073	0.073	0.073	0.073

Summary of th

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
QEOI	2.00384E-09	2.00384E-09	2.00384E-09	2.00384E-09	2.00384E-09	2E-09	2E-09	2E-09	2E-09	2E-09	2E-09	2E-09	2E-09	2E-09	2E-09	2
QEAI	8.52998									0.53002						
x_1	0.022436097	0.02354376	0.030460516	0.073651446	0.343352494	2.027471	12.54412	80.67811	109.481	1186.009	532.0427	237.2958	104.4684	44.60997	17.63483	5.478522
y_1	0.867562865	0.8973629	1.083445969	2.245421393	9.501249593	54.8087	336.5476	344.1753	315.166	141.8383	63.73903	28.5437	12.68298	5.53536	2.314295	0.862781
SRTO	0.499041783	0.499041783	0.499041784	0.499041784	0.499041785	0.499042	0.49994	0.49994	0.5	0.49994	0.49994	0.49994	0.49994	0.49994	0.49994	0.5
SRTA	0.117233569	0.117233294	0.117233294	0.117233294	0.117233294	0.117233	0.117233	1.886792	1.886792	1.886721	1.886721	1.886721	1.886721	1.886721	1.886721	1.886721

Flow Balance

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FOI	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
FAI	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045
QSOI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
QSAI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FEOI	0.000000001	0.000000001	0.000000001	0.000000001	0.000000001	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1
FEAI	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
ROI	1.00001E-05	1.00001E-05	1.00001E-05	1.00001E-05	1.00001E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05
RAI	0.000450203	0.000450203	0.000450203	0.000450203	0.000450203	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045
AUX_1		1.00001E-14	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-05
AUX_2			-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14
FBAI	0	1.00001E-14	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-05
FBBI	1	1.00001E-05	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-1E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-1E-05
FBCI	-1	-1E-05	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	0	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	0
FBDI	-2E-05	0	0	0	0	0	-8E-14	8E-14	-5.3E-15	5.3E-15	0	0	0	0	0	-5.3E-15
FBETA	1	1.00001E-05	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14
FGAMMA	-2E-05	2.00002E-14	2.00002E-14	2.00002E-14	2.00002E-14	2E-14	8	2.02E-14	0.53	2.01E-14	2.01E-14	2.01E-14	2.01E-14	2.01E-14	2.01E-14	0.53002
QAI	8.52998	8.530000038	8.530000038	8.530000038	8.530000038	8.53	8.53	0.53	0.53	0.53002	0.53002	0.53002	0.53002	0.53002	0.53002	0.53002
QOI	2.003840228	2.003840226	2.003840224	2.003840222	2.00384022	2.00384	2.000239	2.000239	2	2.000239	2.000239	2.000239	2.000239	2.000239	2.000239	2
RQI	0.23491679	0.235366439	0.235366439	0.235366439	0.235366439	0.235366	0.234944	3.774343	3.773893	3.773749	3.7742	3.7742	3.7742	3.7742	3.7742	3.773892
Ea_final	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8

Mass Balanc

Mass Balance f

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Dcomp_1	38.78	38.78	38.78	38.78	38.78	38.78	38.78	4.71	2.25	0.073	0.073	0.073	0.073	0.073	0.073	0.073
x_trap_1	0.022436097	0.02354376	0.030460516	0.073651446	0.343352494	2.027471	12.54412	80.67811	109.481	1186.009	532.0427	237.2958	104.4684	44.60997	17.63483	5.478522
y_iM1_1	0	0.867562865	0.8973629	1.083445969	2.245421393	9.50125	54.8087	336.5476	344.1753	315.166	141.8383	63.73903	28.5437	12.68298	5.53536	2.314295
y_iP1_1	0.8973629	1.083445969	2.245421393	9.501249593	54.80869854	336.5476	344.1753	315.166	141.8383	63.73903	28.5437	12.68298	5.53536	2.314295	0.862781	0
Denom_y_1	2.003840228	2.007680454	2.007680452	2.00768045	2.007680448	2.00768	2.004079	2.000477	2.000239	2.000239	2.000477	2.000477	2.000477	2.000477	2.000477	2.000239
Avg_y_iM1_1	0.862847734	0.867975799	0.899941424	1.09954728	2.345962779	10.12681	54.84315	336.545	344.1753	315.136	141.8248	63.73294	28.54096	12.68174	5.534802	2.314295
S_1_new	38.45801467	36.86649027	29.54452303	14.92906573	6.832519993	4.9948	4.372022	4.171454	3.143698	0.265711	0.266566	0.26858	0.273202	0.28428	0.313856	0.422431
S_1	38.45801467	36.86649027	29.54452303	14.92906573	6.832519993	4.9948	4.372022	4.171454	3.143698	0.265711	0.266566	0.26858	0.273202	0.28428	0.313856	0.422431
Deff_1	38.66817289	38.11468087	35.56886426	30.48713242	27.6719982	27.03303	26.82912	4.266031	2.878727	0.119593	0.119801	0.120287	0.121405	0.124083	0.131234	0.157484
MBAI_1	0	-77.4848604	-76.3757507	-71.2743409	-61.0913622	-55.4503	-54.1699	-53.6647	-8.5331	-5.75747	-0.23923	-0.23965	-0.24062	-0.24286	-0.24822	-0.26252
MBBI_1	86.01484043	85.05211988	79.94093355	69.73843983	64.08654982	62.80371	62.29769	9.064117	6.288161	0.769254	0.769698	0.770672	0.772908	0.778266	0.792571	0.845026
MBCI_1	-8.67636911	-8.66659259	-8.64707758	-8.63626682	-8.63381304	-8.63303	-0.53102	-0.53069	0	-0.53005	-0.53005	-0.53005	-0.53005	-0.53005	-0.53006	0
MBDI_1	1.725562922	0	0	0	0	0	628.8	0	0	0	0	0	0	0	0	0
BETA_1	86.01484043	77.23617503	71.3708883	61.10305964	55.45193631	54.17015	53.6647	8.5331	5.757474	0.769254	0.604856	0.560662	0.545423	0.542253	0.54994	0.591997
GAMMA_1	0.020061223	0.020125817	0.021537133	0.025122228	0.027677142	0.028331	11.7458	73.86931	109.481	819.4092	324.0951	138.5314	61.1158	27.37194	12.35438	5.478522
X_1	0.022436097	0.02354376	0.030460516	0.073651447	0.343352497	2.027471	12.54412	80.67811	109.481	1186.009	532.0427	237.2958	104.4684	44.60997	17.63483	5.478522
Y_1	0.867562865	0.897362901	1.083445973	2.24542141	9.501249672	54.8087	336.5476	344.1753	315.166	141.8383	63.73903	28.5437	12.68298	5.53536	2.314295	0.862781

Case 8

NOTE: ONLY THOSE FEEDS AND EFFLUENTS WITH A "REPORT CODE" WILL APPEAR IN THE
Influent/effluent REPORTS CREATED BY report_generator.
Report code for organic (O) feeds
Report code for organic (O) effluents
Report code for aqueous (A) feeds
Report code for aqueous (A) effluents
Fractional extraction efficiency for each stage
Fraction of A in O (1E-09 is min. value allowed for O going to the next stage; 0.0 for O effluents)
Fraction of O in exiting A at each stage (applies only to A returned to the next stage; 0.0 for A effluents)
Volume of organic (O) phase in each stage, L (or mL)
Volume of aqueous (A) phase in each stage, L (or mL)
Volumetric flow rate for organic (O) sampling stream from each stage, L/min (or mL/min)
Volumetric flow rate for aqueous (A) sampling stream from each stage, L/min (or mL/min)
Fraction of exiting O taken as an effluent from each stage (1E-09 is minimum value allowed)
Fraction of exiting A taken as an effluent from each stage
Volumetric flow rate for O feed to each stage, L/min (or mL/min)
Volumetric flow rate for A feed to each stage, L/min (or mL/min)
Concentration of component 1 in aqueous feed to each stage (need only if there is a feed), M
Concentration of component 1 in organic feed to each stage (need only if there is a feed), M
Process temperature in each stage
Final Aq density in each stage
Initial Aq density in feed stage
% Loading CCD
% Loading PEG

Case 8

D values used for component 1 (Cs-137)

Volumetric flow rate for organic (O) effluent from each stage, L/min (or mL/min
Volumetric flow rate for aqueous (A) effluent from each stage, L/min (or mL/min
Concentration of component 1 in aqueous (A) phase exiting each stage including any effluent taken, M
Concentration of component 1 in organic (O) phase exiting each stage including any effluent taken, M
Stage residence time for the organic (O) phase, min
Stage residence time for the aqueous (A) phase, min

CS			DF
ExF	Aq Feed In	78.6	21088.74
ExW	Aq Feed Out	0.003727	
ScW	Aq Scrub Out	81.30159	
StW	Aq Strip Out	1178.913	
StP	Org Out	0.130938	

General Notes

Section Number	Stages	Section Name	Section Letter
1	7	Extraction	Ex
2	2	Scrub	Sc
3	7	Strip	St

Component Number	Component Name	Rows Needed	Organic Feed Concn, M
1	Cs-137	1	1E-15

imum D Value	D_max	1E+15
) Value if Error	D_error	1
imum D Value	D_min	1E-15
ic Mean Value	D_geo	1.1
and FOI Value	FEOI_min	1E-09
cle (Yes or No)	Recycle	Yes
tion Efficiency	Ea_default	0.8
Extr. Efficiency	Ea_min	0.1

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User Specifie

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Code_O_in	ExX															
Code_O_out																StP
Code_A_in							ExF		ScF							StF
Code_A_out	ExW							ScW		StW						
Ea	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
FOI_input	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
FAI_input	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048
VOI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
VAI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
QSOI_input																
QSAI_input																
FEOI_input																1
FEAI_input	1									1						
QFOI	3															
QFAI							12		0.8							0.8
xf_1							78.6									
yf_1	0.130937544															
proc_temp																
density																
init_density																
CCD_loading																
PEG_loading																

Case 9

D Values

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
D(Cs-137)	37.38	37.38	37.38	37.38	37.38	37.38	37.38	5.2	1.82	0.039	0.039	0.039	0.039	0.039	0.039	0.039

Summary of th

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
QEOI	3.00615E-09	3.00615E-09	3.00615E-09	3.00615E-09	3.00615E-09	3.01E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3
QEAI	12.79997									0.800019						
x_1	0.003727108	0.005014253	0.012847157	0.060513615	0.350583734	2.115781	12.85811	81.30159	134.3129	1178.913	396.2618	132.924	44.33505	14.53301	4.507366	1.134657
y_1	0.136498563	0.170270843	0.375789139	1.626453009	9.237259559	55.55134	336.1971	350.3264	314.5137	105.7824	35.57118	11.95155	4.005712	1.332669	0.433436	0.130938
SRTO	0.332651735	0.332651736	0.332651736	0.332651736	0.332651737	0.332652	0.333291	0.333291	0.333333	0.333291	0.333291	0.333291	0.333291	0.333291	0.333291	0.333333
SRTA	0.078125183	0.078125	0.078125	0.078125	0.078125	0.078125	0.078125	1.25	1.25	1.249971	1.249971	1.249971	1.249971	1.249971	1.249971	1.249953

Flow Balance

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FOI	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
FAI	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048
QSOI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
QSAI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FEOI	0.000000001	0.000000001	0.000000001	0.000000001	0.000000001	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09	1
FEAI	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
ROI	1.00001E-05	1.00001E-05	1.00001E-05	1.00001E-05	1.00001E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05
RAI	0.000480231	0.000480231	0.000480231	0.000480231	0.000480231	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048	0.00048
AUX_1		1.00001E-14	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-05
AUX_2			-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14
FBAI	0	1.00001E-14	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	1E-05
FBBI	1	1.00001E-05	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-1E-14	-2E-14	-2E-14	-2E-14	-2E-14	-2E-14	-1E-05
FBCI	-1	-1E-05	1.00001E-14	1.00001E-14	1.00001E-14	1E-14	1E-14	1E-14	0	1E-14	1E-14	1E-14	1E-14	1E-14	1E-14	0
FBDI	-3E-05	0	0	0	0	0	-1.2E-13	1.2E-13	-8E-15	8E-15	0	0	0	0	0	-8E-15
FBETA	1	1.00001E-05	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14	-1E-14
FGAMMA	-3E-05	3.00003E-14	3.00003E-14	3.00003E-14	3.00003E-14	3E-14	12	2.02E-14	0.8	1.92E-14	1.92E-14	1.92E-14	1.92E-14	1.92E-14	1.92E-14	0.800019
QAI	12.79997	12.80000006	12.80000006	12.80000006	12.80000006	12.8	12.8	0.8	0.8	0.800019	0.800019	0.800019	0.800019	0.800019	0.800019	0.800019
QOI	3.006146951	3.006146948	3.006146945	3.006146942	3.006146939	3.006147	3.000384	3.000384	3	3.000384	3.000384	3.000384	3.000384	3.000384	3.000384	3
RQI	0.234855229	0.235334907	0.235334907	0.235334906	0.235334906	0.235335	0.234885	3.75082	3.75034	3.750252	3.750732	3.750732	3.750732	3.750732	3.750732	3.750392
Ea_final	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8

Mass Balanc

Case 9

Mass Balance f

Section No.	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3
Stage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Dcomp_1	37.38	37.38	37.38	37.38	37.38	37.38	37.38	5.2	1.82	0.039	0.039	0.039	0.039	0.039	0.039	0.039
x_trap_1	0.003727108	0.005014253	0.012847157	0.060513615	0.350583734	2.115781	12.85811	81.30159	134.3129	1178.913	396.2618	132.924	44.33505	14.53301	4.507366	1.134657
y_iM1_1	0	0.136498563	0.170270843	0.375789139	1.626453009	9.23726	55.55134	336.1971	350.3264	314.5137	105.7824	35.57118	11.95155	4.005712	1.332669	0.433436
y_iP1_1	0.170270843	0.375789139	1.626453009	9.237259559	55.55134337	336.1971	350.3264	314.5137	105.7824	35.57118	11.95155	4.005712	1.332669	0.433436	0.130938	0
Denom_y_1	3.006146951	3.012293898	3.012293895	3.012293892	3.012293889	3.012294	3.006531	3.000768	3.000384	3.000384	3.000768	3.000768	3.000768	3.000768	3.000768	3.000384
Avg_y_iM1_1	0.131017972	0.136986864	0.173242359	0.393872043	1.73649328	9.904461	55.58901	336.1944	350.3264	314.478	105.7704	35.56714	11.95019	4.005255	1.332515	0.433436
S_1_new	35.15271515	27.31949317	13.48487921	6.508816965	4.953148452	4.681232	4.323263	4.135151	2.608285	0.266753	0.266921	0.267575	0.269543	0.275597	0.295631	0.381997
S_1	35.15271515	27.31949317	13.48487921	6.508816965	4.953148452	4.681232	4.323263	4.135151	2.608285	0.266753	0.266921	0.267575	0.269543	0.275597	0.295631	0.381997
Deff_1	36.62318237	33.95736629	29.25076286	26.87747232	26.34822628	26.25572	26.14669	4.308974	2.341649	0.089729	0.089767	0.089913	0.090351	0.091699	0.096162	0.115398
MBAI_1	0	-110.094698	-102.080863	-87.9321214	-80.7976612	-79.2067	-78.9286	-78.4501	-12.9286	-7.02498	-0.26925	-0.26937	-0.2698	-0.27112	-0.27516	-0.28855
MBBI_1	122.8946681	115.0895974	100.9119245	93.76287584	92.16863114	91.88997	91.41087	13.73026	7.825876	1.06927	1.069418	1.069856	1.071171	1.075218	1.088608	1.146258
MBCI_1	-13.0087343	-12.9798031	-12.9652146	-12.9619613	-12.9613927	-12.9607	-0.80166	-0.8009	0	-0.80005	-0.80005	-0.80005	-0.80005	-0.80006	-0.80006	0
MBDI_1	0.392812631	0	0	0	0	0	943.2	0	0	0	0	0	0	0	0	0
BETA_1	122.8946681	103.4357747	88.10214472	80.82268212	79.21068257	78.92924	78.45025	12.92861	7.024976	1.06927	0.867958	0.821564	0.808433	0.80691	0.815782	0.863266
GAMMA_1	0.003196336	0.003402108	0.003941903	0.004288646	0.004374568	0.00439	12.02732	72.98119	134.3129	882.4202	273.7371	89.74978	29.95266	10.06393	3.394571	1.134657
X_1	0.003727108	0.005014253	0.012847157	0.060513615	0.350583734	2.115781	12.85811	81.30159	134.3129	1178.913	396.2618	132.924	44.33505	14.53301	4.507366	1.134657
Y_1	0.136498563	0.170270843	0.375789139	1.626453008	9.237259551	55.55134	336.1971	350.3264	314.5137	105.7824	35.57118	11.95155	4.005712	1.332669	0.433436	0.130938

Case 9

NOTE: ONLY THOSE FEEDS AND EFFLUENTS WITH A "REPORT CODE" WILL APPEAR IN THE
Influent/effluent REPORTS CREATED BY report_generator.
Report code for organic (O) feeds
Report code for organic (O) effluents
Report code for aqueous (A) feeds
Report code for aqueous (A) effluents
Fractional extraction efficiency for each stage
Fraction of A in O (1E-09 is min. value allowed for O going to the next stage; 0.0 for O effluents)
Fraction of O in exiting A at each stage (applies only to A returned to the next stage; 0.0 for A effluents)
Volume of organic (O) phase in each stage, L (or mL)
Volume of aqueous (A) phase in each stage, L (or mL)
Volumetric flow rate for organic (O) sampling stream from each stage, L/min (or mL/min)
Volumetric flow rate for aqueous (A) sampling stream from each stage, L/min (or mL/min)
Fraction of exiting O taken as an effluent from each stage (1E-09 is minimum value allowed)
Fraction of exiting A taken as an effluent from each stage
Volumetric flow rate for O feed to each stage, L/min (or mL/min)
Volumetric flow rate for A feed to each stage, L/min (or mL/min)
Concentration of component 1 in aqueous feed to each stage (need only if there is a feed), M
Concentration of component 1 in organic feed to each stage (need only if there is a feed), M
Process temperature in each stage
Final Aq density in each stage
Initial Aq density in feed stage
% Loading CCD
% Loading PEG

Case 9

D values used for component 1 (Cs-137)

Volumetric flow rate for organic (O) effluent from each stage, L/min (or mL/min
Volumetric flow rate for aqueous (A) effluent from each stage, L/min (or mL/min
Concentration of component 1 in aqueous (A) phase exiting each stage including any effluent taken, M
Concentration of component 1 in organic (O) phase exiting each stage including any effluent taken, M
Stage residence time for the organic (O) phase, min
Stage residence time for the aqueous (A) phase, min