INEEL/EXT-04-01933

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Prepared for the
U.S. Department of Energy
Under DOE Idaho Operations Office
Contract DE-AC07-99ID13727

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ABSTRACT

The ability to more rapidly process high-level waste sludge and supernate, without sacrificing cost savings, continues to be a crucial challenge facing the Savannah River Site (SRS). There has, to date, not been any extensive investigation of alternative filter technologies for the SRS baseline process. To address this problem, a focused investigation into alternative, state-of-the art filtration technologies to facilitate the strontium and actinide removal process, which can be cost effectively implemented in existing facilities and current equipment designs, was completed. Filter technologies manufactured by Mott (0.1 μm and 0.5 μm) Graver (0.07 μm), Pall (0.1 μm and 0.8 μm) and GKN (0.1 μm) were evaluated. Membranes had a nominal inside diameter of 3/8 inches and an active membrane length of 2 feet. The investigation was performed in two phases. The first phase of testing evaluated the consistency or variability in flux through the different membranes using water and a standard 5.0 wt% strontium carbonate slurry. The second phase of testing evaluated the achievable permeate flux and clarity through the various membranes using the SRS average salt supernate simulant at solids loadings of 0.06, 0.29 and 4.5 wt%. Membrane variation data indicate that membranes having an asymmetric ceramic coating (Pall 0.1 μm and Graver 0.07 μm), typically displayed the lowest variability with water. Membranes without a ceramic asymmetric coating (Mott 0.5 μm and GKN 0.1 μm) displayed the highest variability. This is most likely associated with the experimental uncertainties in measuring large volumes of permeate in a short amount of time and to the impact of impurities in the water. In general, variability ranging from 4-56% was observed when using water for all membranes. In the case of variation testing using strontium carbonate, variability decreased to 3-12%. In addition, membrane structure or composition had little effect on the variability. Data obtained from SRS simulant testing, indicate that membranes having a ceramic asymmetric coating (Graver 0.07 μm, Pall 0.1 μm), typically achieved the highest average steady state fluxes for all solution concentrations evaluated. In general, the Graver 0.07 μm and Pall 0.1 μm membranes achieved fluxes approximately 13 to 21 percent higher than those observed with the baseline Mott 0.1 μm membrane using the SRS simulant at solids loadings of 0.29 and 4.5 wt%. Membranes without a ceramic asymmetric coating (GKN, Mott) achieved the lowest average steady state fluxes. It is postulated that small particles present in solution were unable to penetrate the ceramic layer, thus producing surface filtration where the filter cake acts as the filter medium. Conversely, membranes without the asymmetric ceramic coating were susceptible to the small particles present in solution penetrating into the internal pore structure of the membrane, thus producing depth filtration where the porosity is greatly reduced by particles trapped within the interstices of the internal structure. Turbidity data indicate that permeate from the alternative membranes provided reduced or equivalent turbidity measurements when compared to the baseline 0.1 μm Mott membrane.

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Alternative Ultrafiltration Membrane Testing for the SRS Baseline Process

1. INTRODUCTION

The ability to more rapidly process high-level waste sludge and supernate, without sacrificing cost savings, continues to be a crucial challenge facing the Savannah River Site (SRS). To address this problem, a focused investigation into unique, state-of-the art filtration technologies to facilitate the strontium and actinide removal process, which can be cost effectively implemented in existing facilities and current equipment designs, were evaluated. Specifically, the goal of this effort was to evaluate achievable permeate flux and clarity through membranes of similar structure and composition that are currently available commercially from different manufacturers as alternatives to the Mott product used in the current baseline. The Idaho National Engineering and Environmental Laboratory (INEEL) and the Savannah River National Laboratory (SRNL) received funding from the Department of Energy – Head Quarters (DOE-HQ), Office of Cleanup Technologies (EM-21), via the National Energy Technology Laboratory (NETL), to evaluate alternative filter media. The baseline crossflow unit operation uses filtration membranes provided by Mott Metallurgical as the prescribed filtration media. This work experimentally examined crossflow filtration media manufactured by Pall, GKN, Graver and Mott. The Mott, Graver and GKN media are all nominally rated at approximately 0.1 µm pore size, i.e. equivalent to the recommended Mott baseline. A Mott 0.5 µm membrane was also evaluated to provide a complete comparison of filter media. The Pall media were absolute rated at 0.1 and 0.8, respectively.

The current baseline treatment process at SRS for strontium and actinide removal involves sorption on particulate Monosodium Titanate (MST) followed by crossflow filtration to remove entrained sludge and radionuclide-containing MST solids. Not only is this same process incorporated in the baseline approach to process all of the existing wastes through the Salt Waste Processing Facility (SWPF), but it is also the baseline technology associated with the accelerated treatment option. The basic premise of the accelerated option is to segregate the waste by type and selectively process the different types. In the accelerated option, some wastes require strontium and actinide removal from the supernate liquid; this would be facilitated by sorption on particulate MST. Crossflow filtration would be used to concentrate the radionuclide-containing fraction (both sludge and MST solids are present) for vitrification as High-Level Waste (HLW) in the existing Defense Waste Processing Facility (DWPF). Treatment of wastes by MST and crossflow filtration assumes the use of existing facilities (such as Building 512-S); however, due to limited space in the facility, the filtration equipment must provide the highest possible processing rates.

The Mott product was extensively studied, at both the experimental and pilot scales, with regard to flux and cleanability using simulated and actual SRS wastes.[1-12] Fluxes through the Mott membranes are well documented and the current design basis is 0.02 gpm/square foot of filter area (gpm/ft^2), which has been used to size and cost the crossflow equipment in SWPF. Although the Mott product has undergone extensive study, little attention has been given to the application of other similar, commercially available products for the SRS-specific application. Higher processing rates, hence increased performance, may be obtained by a simple substitution of a different manufacturer's membrane for the Mott product. There is experimental evidence [13,14] with other streams that these alternative, commercially available membranes have the potential to provide permeate fluxes that are measurably higher than the current Mott design basis of 0.02 gpm/ft^2. An equally important aspect of the alternative membranes is that they must produce permeates of at least the same clarity (as determined by turbidity) as the Mott membranes. An increase in filter flux with the relatively simple change in membrane specification would have two positive impacts on the baseline process: 1) higher flux translates to faster processing rates in the same size crossflow equipment, thus resulting in accelerated throughput or processing rates, and 2) higher flux equates to lower membrane surface area for the same throughput, thereby reducing crossflow equipment size. In reality, a balance of these two advantages is possible, but such a balance would be established based on the priorities of the process and an engineering evaluation. An additional consideration in the selection of the commercially available membranes from each manufacturer is the consistency or variability in fluxes through the new membranes due to porosity differences or residual solid impurities from the manufacturing processes. An additional effort was included in this work to quantify the variations in flux through the different membranes samples.

2. EXPERIMENTAL

2.1 SRS Simulated Waste

The SRS simulant used in this testing was prepared according to methods developed by the Savannah River National Laboratory (SRNL) for the preparation of the SRS average salt supernate solution. The simulated SRS sludge and MST solids were provided directly from SRNL at a solids loading of approximately 7.25 wt%. The simulated SRS supernate solution was prepared at the INEEL using a standard recipe provided by SRNL. The proper proportions of MST and sludge were diluted to the required feed solids concentration for testing (0.06, 0.29 and 4.5 wt%) with the supernate solution. Twenty-one liters of each waste loading was prepared for testing to provide fresh feed solution for each membrane test. Particle size distribution analysis of the feed before and after testing was performed and will be discussed in a subsequent section. The composition of the supernate solution is indicated in Table 1 for a 1-liter batch.

Table 1. Composition of the average salt supernate.

Component	Source	Molecular Weight (g/mole)	Target Concentration (molar)	Amount Required (grams/L)
K^+	KNO_3	101.1	0.015	1.517
Cs^+	$CsNO_3$	194.92	0.00014	0.027
OH^-	NaOH	40.00	1.91	126.40
NO_3^-	$NaNO_3$	84.99	2.14	101.55
NO_2^-	$NaNO_2$	69.00	0.52	35.88
AlO_2^-	$Al(NO_3)_3•9H_2O$	375.14	0.31	116.29
CO_3^{2-}	$Na_2CO_3•H_2O$	124.01	0.16	19.84
SO_4^{2-}	Na_2SO_4	142.04	0.15	21.31
Cl^-	NaCl	58.44	0.025	1.461
F^-	NaF	41.99	0.032	1.344
PO_4^{3-}	$Na_2HPO_4•7H_2O$	268.09	0.010	2.681
$C_2O_4^{2-}$	$Na_2C_2O_4$	134.00	0.008	1.072
SiO_3^{2-}	$Na_2SiO_3•9H_2O$	284.2	0.004	1.137
MoO_4^{2-}	$Na_2MoO_4•2H_2O$	241.95	0.0002	0.048
Tributyl Phosphate		266.00		5.0 E-04
Dibutyl Phosphate		210.00		2.5E-02
Monobutyl Phosphate		154.00		2.5E-02
n-Butanol		74.00		2.0 E-03
Sodium Formate		68.00		1.5
Water				827.9
Total Weight				1258.0

2.2 Membrane Modules

The commercially available membranes evaluated in this study were selected based on similar specifications and materials of construction to the baseline Mott products. Furthermore, any tentative replacement to the baseline membrane would need to be predicated on a very similar design configuration for the specified product to facilitate a relative simple change without a major reconfiguration of the filtration equipment. The selection criteria included existing commercial availability, a 0.1 µm nominal and/or absolute particle size cutoff rating, sintered stainless steel composition, and modules available in nominal 3/8" tubular form. Membranes tested include:

- Mott Metallurgical (USA): Two Mott products were obtained for testing, 0.1 µm and 0.5 µm. Both Mott products are symmetric in design comprising solely of sintered stainless steel. The wall thickness for both Mott products was 0.062 inches. Extensive work has been performed on both Mott products throughout the DOE complex. The Mott 0.1 µm product was recently chosen as the current baseline. For comparative purposes and completeness of the evaluation, a 0.5 µm Mott membrane was also included in the experimental program. The 0.5 µm Mott membrane was the previous baseline. Evaluation of these membranes is necessary as a baseline for all data generated in this work and provides a valuable and necessary point of comparison with numerous studies by other researchers in similar efforts.
- GKN (Germany): asymmetric, sintered stainless steel substrate with a thinner layer of sintered metal deposited on the surface. The GKN membranes obtained for testing had a nominal pore size of 0.1 µm. The wall thickness for the GKN membrane was 0.079 inches
- Graver Technologies (USA): asymmetric, thin layer of sintered titania (TiO_2) deposited on sintered stainless steel substrate. The Graver membranes obtained from testing had a nominal pore size of 0.07 µm. The wall thickness for the Graver membrane was 0.055 inches.
- Pall Corp. (USA): Two Pall products were purchased for testing: 0.8 µm and 0.1 µm. The 0.1 µm product is absolute rated at 0.1 µm and is an asymmetric membrane comprised of a sintered zirconia (ZrO_2) layer on a sintered stainless steel support. The 0.8 µm product is absolute rated at 0.8 µm and is symmetric comprising solely of sintered stainless steel. The wall thickness for both Pall products is 0.035 inches.

The membranes modules obtained for evaluation consisted of a nominal 3/8-inch inside diameter with a single section of active membrane tube, 2 feet in length. Membranes modules were modified by the respective manufacture (per INEEL instruction) to insure compatibility with the test rigs. These modifications included welding VCO end fittings (O-ring face seal fittings) to the tubes and installing permeate and pressure ports.

2.3 Equipment

The Cells Unit Filter (CUF), depicted schematically in Figure 1 and pictorially in Figure 2, was used for flux measurements with the commercially available membrane modules.[15] Two identical and fully operational CUF systems exist for testing simulated (non-radioactive) wastes at the INEEL. The system consists of a 4 liter feed vessel, which feeds a modified Oberdorfer progressive cavity pump driven by a variable speed direct current (DC) motor. The feed solution (water, cleaning solution, or simulated waste) is recirculated from the feed vessel through a flowmeter, heat exchanger, and the interior of the tubular filter membrane, then back to the feed vessel. Maximum volumetric flow through the system is ~9 gpm, depending on the pressure head developed at the pump outlet. The discharge throttle valve, located on the discharge side of the filter module, is used to control transmembrane pressure by controlling pump head and flow rate. The permeate side of the membrane is at ambient pressure (0 psig)

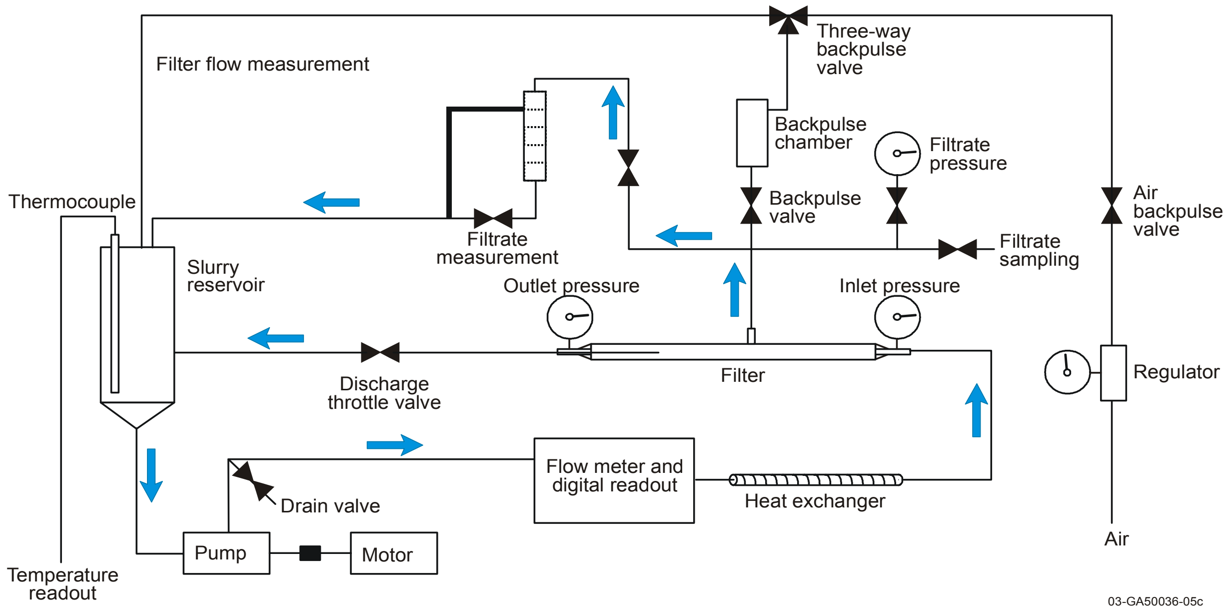

Figure 1. Schematic of the CUF apparatus.

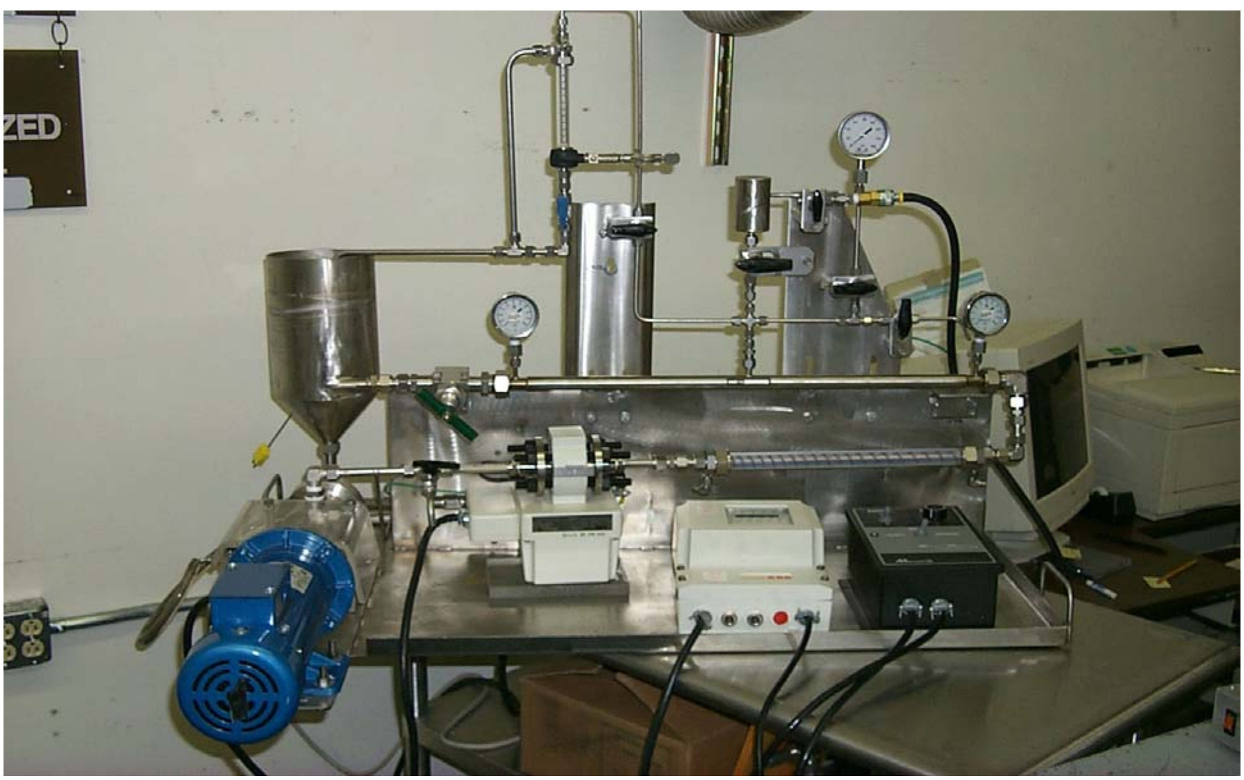

Figure 2. Photo of the CUF apparatus.

and transmembrane pressures of up to 100 psig can be easily achieved with this arrangement. The CUF is designed to accommodate a two-foot length of active membrane. The design incorporates a back-pulse system that pressurizes permeate (overpressure of up to 100 psig) collected in the small back-pulse vessel. The small volume of pressurized permeate can be routed back to the permeate side of the membrane module, thereby dislodging or re-suspending filter cake and solids entrained in the membrane surface from the feed side of the membrane. The back pulse system includes the necessary manual valves to collect, pressurize, and back-pulse the filter membrane. The permeate exiting on the low pressure side of the membrane was collected in the sample holder, routed through a graduated cylinder that can be used to manually measure permeate flux, and is typically routed back to the feed vessel. Permeate flux was corrected to 25°C, using the following equation.[13]

$$Flux = \frac{P}{A} * C$$

Where:

Flux	=	permeate flux at 25°C (gpm/ft^2)
P	=	permeate flow rate (gpm)
A	=	filter surface area (ft^2)
C	=	temperature correction factor = $e^{(2500*((1/(273+T))-(1/298)))}$
T	=	slurry/permeate temperature in degrees Celsius

The temperature correction factor corrects flux back to an equivalent flux at 25°C and accounts for changes in fluid viscosity and surface tension. Additional parameters recorded during testing include recirculation flow, axial velocity, membrane inlet pressure, membrane outlet pressure, permeate pressure, and slurry temperature.

2.4 Membrane Variation Testing

An important consideration in the selection of the commercially available membranes from each manufacturer is the consistency or variability in fluxes through the new membranes due to porosity differences or residual solid impurities from the manufacturing processes. Testing was used for the specific purpose of observing the variability within a specific membrane group or manufacturer and not as a basis of comparison between groups or manufactures.

An effort to quantify the variations in flux through the different membranes samples was completed. Five identical membrane modules were obtained from each respective manufacturer and fluxes were evaluated through the different membrane samples using the CUF apparatus. Membranes were evaluated for variation using the following test sequence.

1. Measure pristine water flux (benchmark flux).
2. Perform preconditioning procedure.
3. Re-measure water flux (evaluate potential increase or decrease in flux as a result of preconditioning).
4. Measure flux using standard 5.0 wt% strontium carbonate solution.

5. Perform acid rinse using 1.0 M nitric (in-situ to remove residual strontium carbonate from system).
6. Re-measure water flux (ensure complete removal of residual strontium carbonate).

Water flux variation tests were performed using Nanopure™ water at 7.0 ft/sec linear axial velocity (AV) and 10, 20, 30, 40 and 50 psig, transmembrane pressure (TMP), each condition being held for 0.5 hours.

The preconditioning procedure was performed to remove residual manufacturing impurities from the membranes and ensure reproducible "clean water" fluxes were obtained. The preconditioning procedure was performed using 0.1 M sodium hydroxide followed by 1.0 M nitric acid and then 0.5 M oxalic acid. Preconditioning solutions were routed through the system at 9.0 ft/sec linear axial velocity (AV) and 30 psig TMP for 0.5 hours each. A water rinse was performed between each conditioning solution.

Flux measurements using strontium carbonate ($SrCO_3$ precipitate in 0.2 M NaOH) were performed to ensure representative flux under conditions of solids loading. Fluxes measured under load are often more indicative of membrane performance than the clean water flux. The $SrCO_3$ flux test is useful since the particulate slurry can be easily prepared with a narrow particle size distribution (median particle size 3-4 μm) of solids and residual solids, potentially fouling the membrane, are easily cleaned. The recipe for the strontium carbonate solution is shown in Table 1 of Appendix A. Strontium carbonate flux was measured using a parametric study, indicated in Table 2. The test conditions used in the parametric study were collaboratively selected by the INEEL and SRNL and are based on historical testing and tentative operating conditions of the Actinide Removal Process (ARP) filtration plant.[12] It should be noted that the parametric conditions were also used in subsequent SRS simulant testing (*vide infra*). The eleven statistically designed test conditions vary transmembrane pressure (TMP) from 15 to 45 psig and axial velocity (AV) from 4 to 14 ft/sec. Three liters of 5.0 wt% strontium carbonate solution were used for testing of each membrane.

Table 2. Test matrix for evaluating flux through the different membranes.

Condition	Axial Velocity (ft/sec)	Transmembrane Pressure (psid)
1	9	30
2	12	40
3	4	30
4	9	15
5	12	20
6	9	30
7	6	40
8	9	45
9	14	30
10	6	20
11	9	30

2.5 Experimental Evaluation of Flux with Simulated SRS Solids

SRS simulant testing commenced by installing an average or typical membrane module from each membrane manufacturer (as statistically determined from water and strontium carbonate variation testing). Prior to waste addition, simulants were mixed using a Barnant (Series 10) mixer with accompanying stainless steel impeller and stand. Simulants were mixed for 0.25 hours to ensure complete homogeneity of the slurry prior to testing. A Cole-Parmer, Masterflex® peristaltic pump (Model 7518-12) was used for slurry transfer. Approximately 3.5 liters of slurry was used for each membrane test.

Simulant flux was measured using the parametric test matrix, as indicated in Table 2 (*vide supra*). The test conditions used in the parametric study were collaboratively selected by the INEEL and SRNL. The ranges of process variables to be tested were determined to envelope baseline design conditions of 6-9 ft/sec axial velocity and 30 – 40 psig transmembrane pressure.

Aside from permeate flux, the collected analytical data included the particle size distribution (PSD) of suspended solids prior to and following testing and permeate turbidity. PSD analysis was used to ensure consistent and verifiable feed slurries. In addition, the effects of shear and associated particle de-agglomeration were also evaluated using PSD analysis. Permeate turbidity analysis was performed by obtaining samples of permeate at test conditions 1, 6 and 11, (repeatable test conditions). An approximate 30 mL sample of permeate was obtained for turbidity analysis using a Hach® 2100P turbidmeter.

3. RESULTS AND DISCUSSION

3.1 Membrane Variation Testing

3.1.1 Graver 0.07 µm

A comparison for five 0.07µm Graver membranes is shown in Figure 3. Comparisons are shown for the (as-received) pristine water flux, water flux following the preconditioning sequence, final water flux (following $SrCO_3$ and the nitric acid rinse) and fluxes obtained from the 5.0 wt% $SrCO_3$ solution. Also shown is the average flux for the respective tests. When referring to the water flux data, an average increase of 30.2% can be observed following preconditioning. This increase is most evident with the C membrane. It should be noted that a cleaning procedure is recommended by Graver to remove residual manufacturing impurities. It should also be noted that a 23.9% reduction in flux was observed following the final water flux.

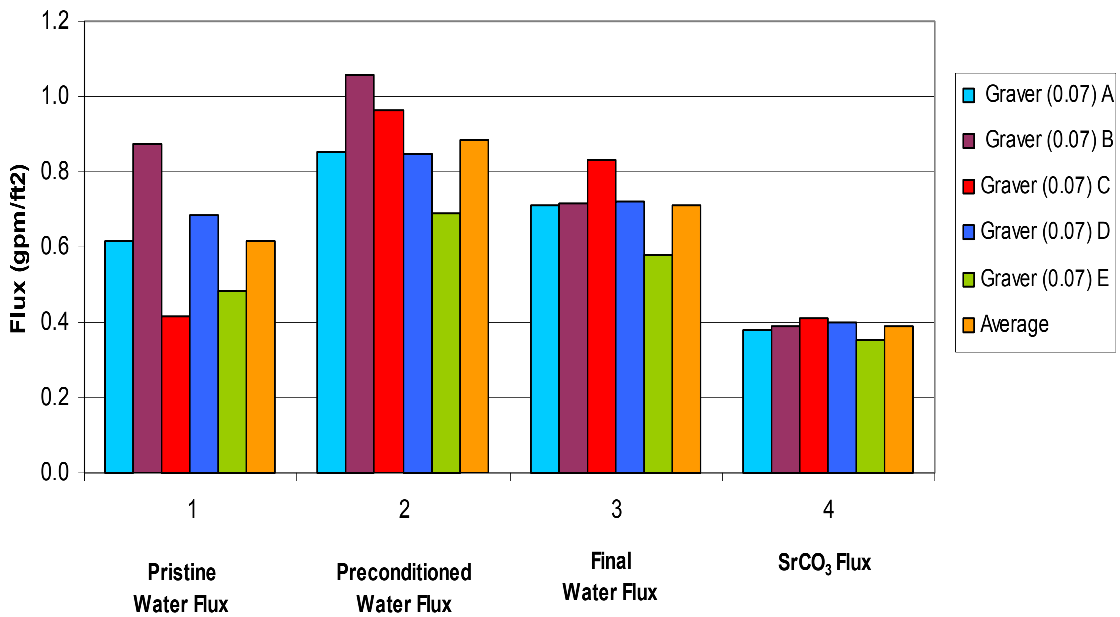

Figure 3. Fluxes for five Graver 0.07 µm membranes are compared for the pristine, preconditioned, final water and $SrCO_3$ tests.

Statistical analysis of variance techniques (ANOVA) applied to the complete set of water flux data for these membranes indicates no statistical differences are associated with these five Graver modules: all membranes are the same and none of them can be rejected on statistical grounds. In general, ANOVA analysis indicates that any of the five membrane modules could be chosen as the most representative for testing with the SRS simulated wastes. It should be noted that Graver module E had a very slight leak at the weld around the permeate port on the housing. The leak was not sufficient to impact the measurement of flux; however, the use of the E module was rejected based on the leak.

3.1.2 Mott 0.1 µm

A comparison for five 0.1 µm Mott membranes is shown in Figure 4. Comparisons are shown for the (as-received) pristine water flux, water flux following the preconditioning sequence, final water flux (following $SrCO_3$ and nitric acid rinse) and fluxes obtained from the 5.0 wt% $SrCO_3$ solution. Also shown is the average flux for the respective tests. The water permeation rate through the Mott membranes was quite consistent for the pristine (as-received) membranes and after preconditioning. However, an average increase in flux of 5.7% can be observed following preconditioning. The data indicate that the water permeation rates through the Mott 0.1 µm membranes were relatively high. Any variability associated with water flux is most likely due to experimental error as a result of the high permeation rates.

Statistical analysis of variance techniques (ANOVA) applied to the complete set of water flux data for the Mott 0.1 µm membranes indicate no statistical differences associated with the five modules: all membranes are the same and none of them can be rejected on statistical grounds. In general, ANOVA analysis indicates that any of the five membrane modules could be chosen for testing with the SRS simulated wastes.

3.1.3 Mott 0.5 µm

A comparison for five Mott 0.5 µm membranes is shown in Figure 5. Comparisons are shown for the (as-received) pristine water flux, water flux following the preconditioning sequence, final water flux (following $SrCO_3$ and nitric acid rinse) and fluxes obtained from the 5.0 wt% $SrCO_3$ solution. Also shown is the average flux for the respective tests.

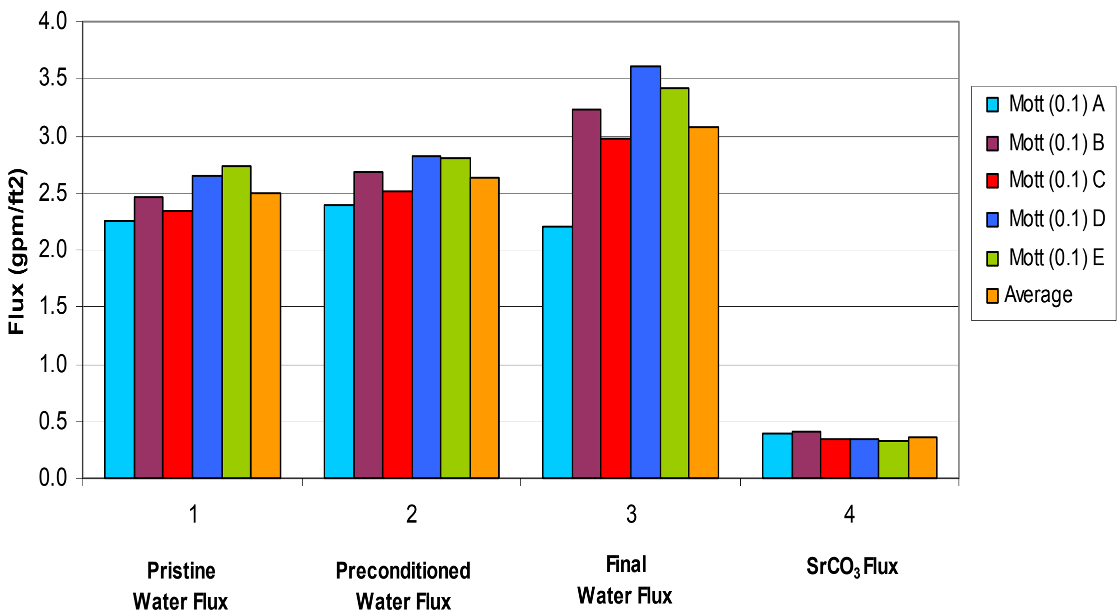

Figure 4. Fluxes for five Mott 0.1 µm membranes are compared for the pristine, preconditioned, final water and $SrCO_3$ tests.

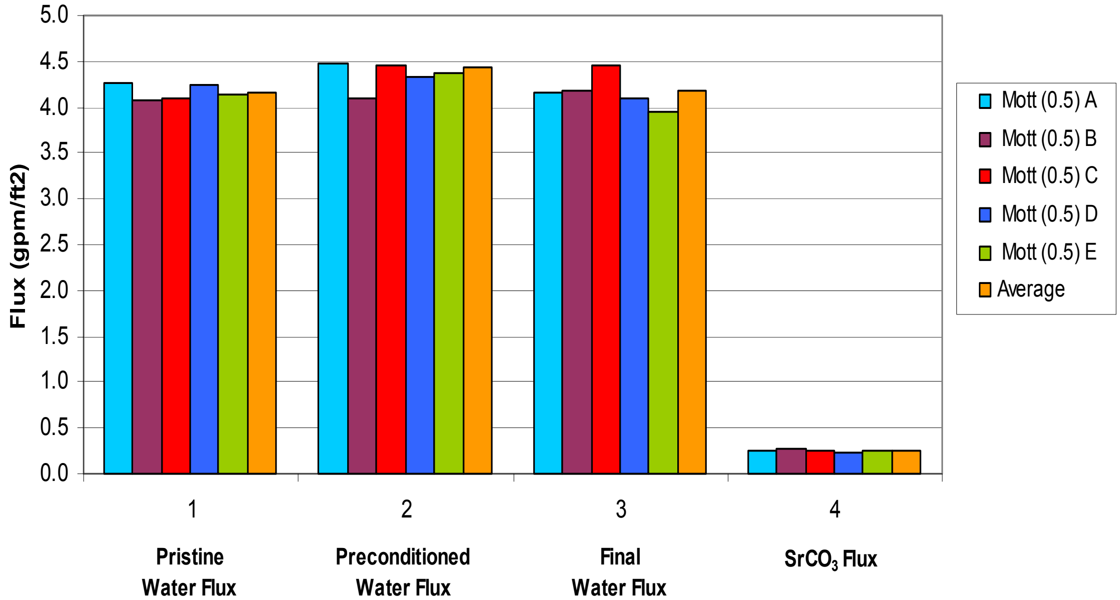

Figure 5. Fluxes for five Mott 0.5 µm membranes are compared for the pristine, preconditioned, final water and $SrCO_3$ tests.

The water permeation rate through the Mott 0.5 µm membranes was quite consistent for the pristine (as-received) membranes and after preconditioning. An overall increase in flux of 4.0% can be observed following preconditioning. Data obtained for the final water flux indicate an average decrease of 4.2% over the preconditioned water flux. Average water permeation rates for the pristine and final water fluxes are nearly identical. Water permeation rates through the Mott 0.5 µm membranes were nearly the highest among the membranes tested. As a result, a different measurement technique was adopted to handle the increased capacity. The variability associated with water flux is most likely due to experimental error related to the high water permeation rates.

Statistical analysis of variance techniques (ANOVA) applied to the complete set of water flux data for these membranes indicates no statistical differences are associated with the five Mott 0.5 µm modules: all membranes are the same among respective pore sizes and none of them can be rejected on statistical grounds. In general, ANOVA analysis indicates that any of the five membrane modules could be chosen for testing with the SRS simulated wastes.

3.1.4 Pall 0.1 µm

Fluxes for five Pall 0.1 µm membranes is shown in Figure 6. Comparisons are shown for the (as-received) pristine water flux, water flux following the preconditioning sequence, final water flux (following $SrCO_3$ and nitric acid rinse) and fluxes obtained from the 5.0 wt% $SrCO_3$ solution. Also shown is the average flux for the respective tests. The water permeation rate through the Pall membranes was quite consistent for all sets of water flux data. The absolute rating of the Pall membrane also affects the permeation rate. It should be noted that an average increase in flux of 7.5% is observed following preconditioning. This is possibly due to the removal of residual manufacturing impurities associated with the ceramic coating.

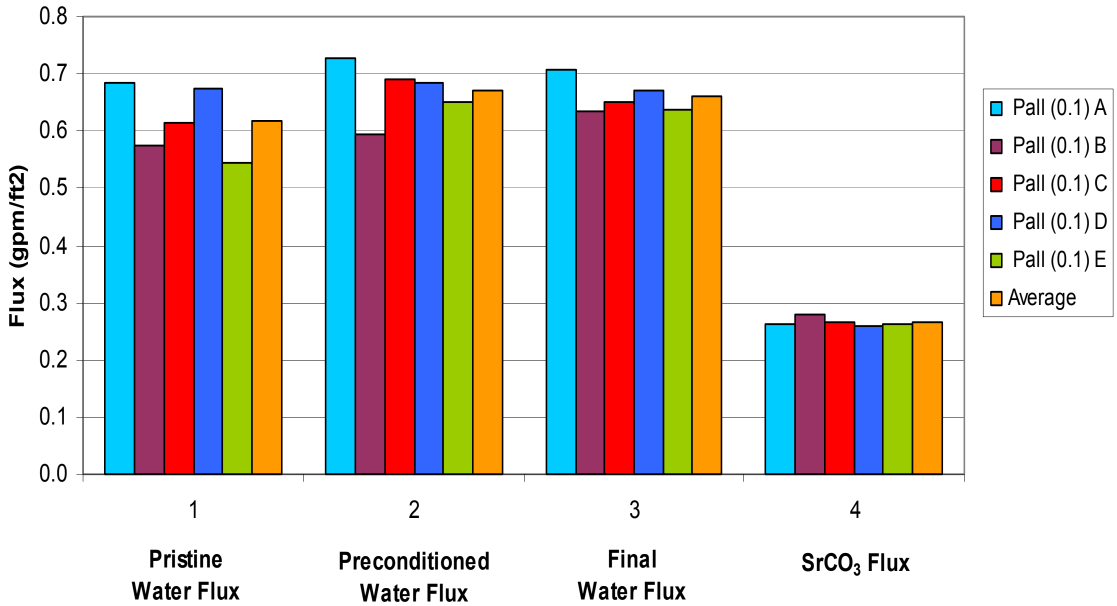

Figure 6. Fluxes for five Pall 0.1 µm membranes are compared for the pristine, preconditioned, final water and $SrCO_3$ tests.

Statistical analysis of variance techniques (ANOVA) applied to the complete set of water flux data for these membranes indicates no statistical differences are associated with the five Pall 0.1 µm modules: all membranes are the same among respective pore sizes and none of them can be rejected on statistical grounds. In general, ANOVA analysis indicates that any of the five membrane modules could be chosen for testing with the SRS simulated wastes.

3.1.5 Pall 0.8 µm

Fluxes for five Pall 0.8 µm membranes are shown in Figure 7. Comparisons are shown for the (as-received) pristine water flux, water flux following the preconditioning sequence, final water flux (following $SrCO_3$ and nitric acid rinse) and fluxes obtained from the 5.0 wt% $SrCO_3$ solution. Also shown is the average flux for the respective tests. The water fluxes through the membranes were quite inconsistent for all of the water flux data, and membrane C was consistently low and decreased further with each water flux test. The variability between the different membranes was statistically different based on ANOVA analysis, which indicated sample C was consistently low. All other modules were statistically the same when module C was removed from the ANOVA method. It is unknown why membrane C displayed such low fluxes. ANOVA analysis indicates that any of the four membrane modules (membrane C removed from testing) could be chosen for testing with the SRS simulated wastes.

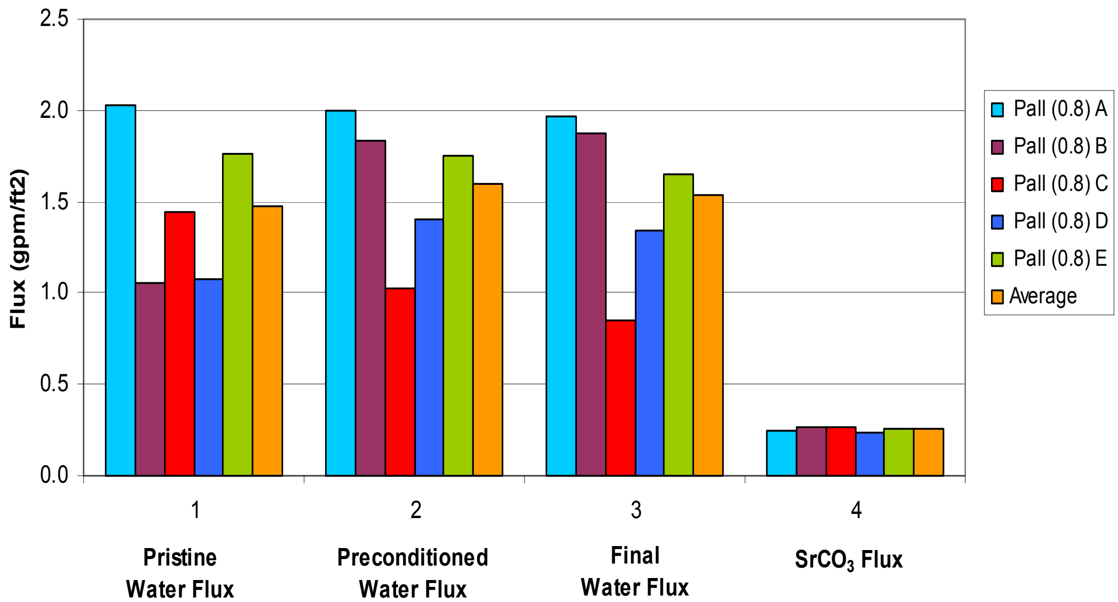

Figure 7. Fluxes for five Pall 0.8 µm membranes are compared for the pristine, preconditioned, final water and $SrCO_3$ tests.

3.1.6 GKN 0.1 µm

Fluxes for the five GKN 0.1 µm membranes are shown in Figure 8. Comparisons are shown for the (as-received) pristine water flux, water flux following the preconditioning sequence, final water flux (following $SrCO_3$ and nitric acid rinse) and fluxes obtained from the 5.0 wt% $SrCO_3$ solution. Also shown is the average flux for the respective tests. The data indicate that the water permeation rates through the GKN 0.1 µm membranes were relatively high. It is important to note that for the GKN membranes, the high water flux, particularly at the higher TMP, results in a large amount of experimental error associated with the water flux measurement.

Statistical analysis of variance techniques (ANOVA) applied to the complete set of water flux data for these different membranes indicates no statistical differences are associated with these five GKN modules: all membranes are the same and none of them can be rejected on statistical grounds. In general, ANOVA analysis indicates that any of the five membrane modules could be chosen for testing with the SRS simulated wastes.

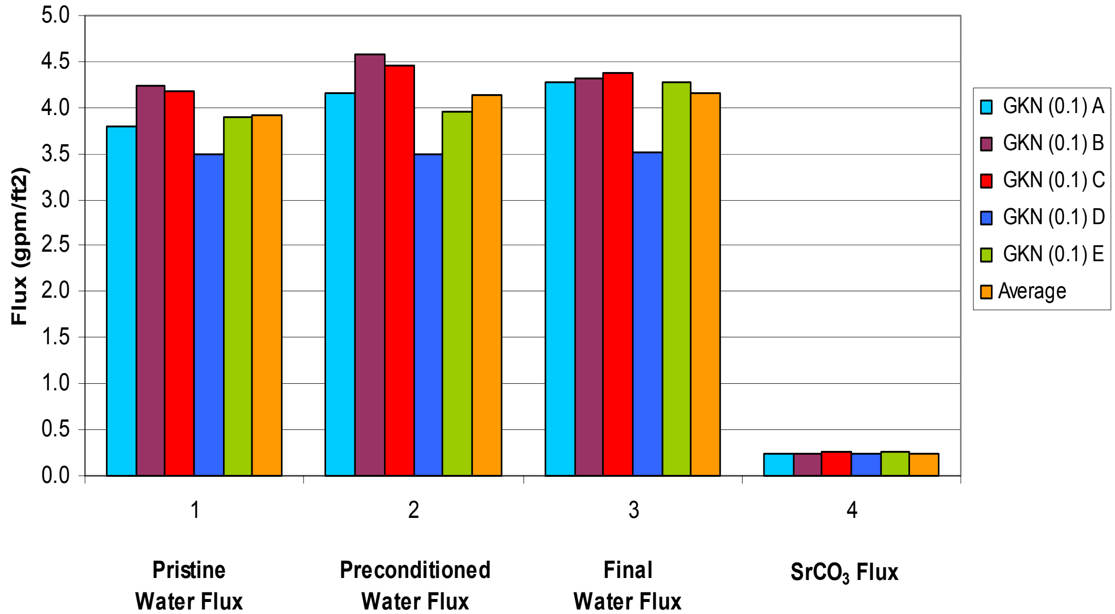

Figure 8. Fluxes for five GKN 0.1 µm membranes are compared for the pristine, preconditioned, final water and $SrCO_3$ tests.

Table 3 summarizes the average steady-state flux data for the different membrane modules and indicates which modules were selected for continued testing with the SRS simulated waste. Membranes for continued testing were selected by identifying the membrane that most closely resembled the average steady state flux of the five respective membranes. The variation is indicated by the associated standard deviations reported for each membrane set. The H_2O and $SrCO_3$ data are relative; the water data has units of flux/TMP or $(gpm/ft^2)/psig$, while the $SrCO_3$ flux data is in units of flux/AV or $(gpm/ft^2)/(ft/sec)$. In the case of the $SrCO_3$ permeate measurements, where the experimental errors associated with the measurements are relatively low, the variability (based on the standard deviations) ranges from 3 – 12%. In the case of the water flux measurements, the variations are substantially higher, ranging from 4 – 56%. Note also that in the water flux measurements, the higher flux membranes (GKN 0.1 µm and Mott 0.5 µm membranes) have the greatest amount of variability, associated with the experimental uncertainties in measuring a large volume of permeate in a short amount of time. The data indicate that the water permeation rate through the Graver (0.07 µm) and Pall (0.1 µm) membranes are lowest among the membranes tested and have the lowest variability in the as-received membranes. Less variability is most likely due to consistency of the pore structure associated with the asymmetric ceramic coating.

Again, it must be emphasized that the purpose of this comparison is only to provide a measure of variability for each set of samples, and the comparison of the different membranes must be based on a representative feed stream for which they will be used; in this case the SRS simulated sludge + MST waste.

Table 3. Summary of the average water and $SrCO_3$ flux data for the different membranes.

Membrane	Test Module Selected	Pristine Water (gpm/ft2)/psid	Preconditioned Water (gpm/ft2)/psid	Final Water (gpm/ft2)/psid	$SrCO_3$ (gpm/ft2)/(ft/sec)
Graver 0.07 µm	B	0.022 ± 0.006	0.030 ± 0.004	0.024 ± 0.003	0.043 ± 0.002
Mott 0.1 µm	B	0.102 ± 0.011	0.105 ± 0.012	0.105 ± 0.019	0.041 ± 0.005
Mott 0.5 µm	B	0.395 ± 0.046	0.435 ± 0.036	0.567 ± 0.187	0.029 ± 0.001
Pall 0.1 µm	C	0.021 ± 0.003	0.022 ± 0.002	0.023 ± 0.001	0.030 ± 0.001
Pall 0.8 µm	E	0.053 ± 0.016	0.056 ± 0.014	0.054 ± 0.017	0.029 ± 0.002
GKN 0.1 µm	C	0.768 ± 0.433	0.599 ± 0.219	0.595 ± 0.177	0.028 ± 0.001

3.2 Simulant Testing

3.2.1 0.29 wt%

The average steady-state flux for the five membranes using the 0.29 wt% SRS simulant is shown in Figure 9. The average steady-state flux was calculated by averaging the final (0.5 hour) steady state flux for each of the eleven parameters.

At 0.29 wt%, the Graver 0.07µm and Pall 0.1µm membranes displayed the highest average fluxes at 0.061 and 0.060 gpm/ft^2, respectively. Both membranes are of asymmetric construction with a ceramic coating on a stainless steel support. Interestingly, the GKN membrane, which is also of asymmetric construction, performed comparably to the asymmetric Pall 0.8 µm with fluxes of 0.058 and 0.058 gpm/ft^2. The lowest average steady-state fluxes were obtained by the baseline Mott 0.1 µm and Mott 0.5 µm membranes at 0.051 and 0.050 gpm/ft^2. The average steady-state flux through the membranes decreased in the order:

Graver 0.07µm >Pall 0.1µm >Pall 0.8µm >GKN 0.1µm >Mott 0.1µm >Mott 0.5µm

At the completion of the 0.29 wt% test, the simulated waste was drained from the CUF system and the system rinsed with DI water. Water rinses were performed approximately three times using 2 liters of water per rinse. This was typically performed with the permeate valve closed. This was followed by chemically cleaning the membranes using approximately 2 liters of 0.5 M oxalic acid for 0.5 hours at an axial velocity of 9 ft/sec and a transmembrane pressure of 30 psig. Multiple chemical cleaning steps were often needed depending on the cleanability of the respective membrane. Once chemical cleaning was complete, acid solutions were drained from the system and a water flux was performed. Water fluxes were used to observe how closely the membrane had returned to near pristine levels in preparation for the subsequent 4.5 wt% test. All membranes tested displayed a decrease in water flux following the 0.29 wt% test.

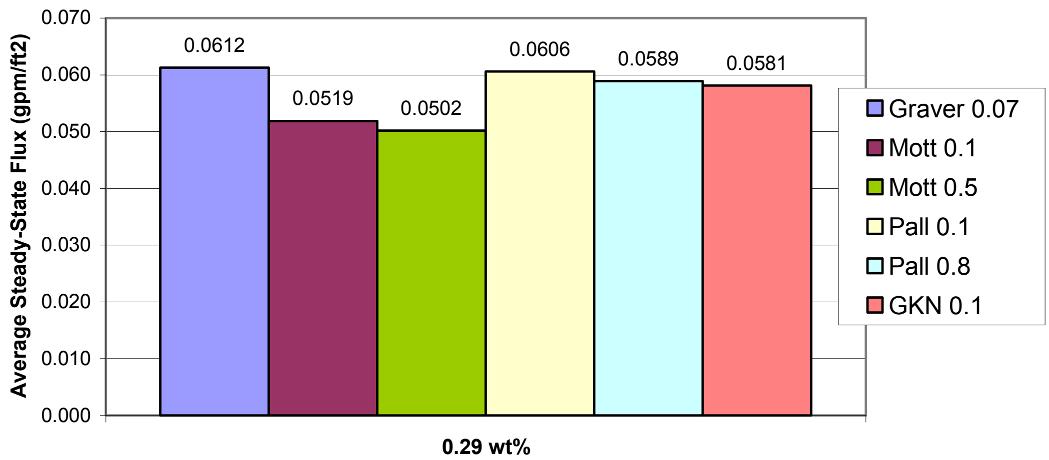

Figure 9. The average steady-state flux for the five membranes using the 0.29 wt% SRS simulant.

3.2.2 4.5 wt%

The average steady-state flux for the five membranes tested using the 4.5 wt% SRS simulant is shown in Figure 10. The average steady-state flux was calculated by averaging the final (0.5 hour) steady state flux for each of the eleven parameters. It should be noted that an additional test at 4.5 wt% was completed for the Mott 0.5 and GKN 0.1 membranes. Initial simulant tests at 4.5 wt% displayed lower fluxes than expected with the Mott 0.5 and GKN 0.1 membranes. The initial and repeated final steady-state fluxes were combined and averaged and are shown in Figure 10.

At 4.5 wt%, the Pall 0.1μm and Graver 0.07μm membranes display the highest average fluxes at 0.039 and 0.036 gpm/ft^2, respectively. Interestingly, the Pall 0.8 μm membrane, which displayed unusually low water fluxes prior to testing, performed comparably to the Graver membrane at 0.0366 gpm/ft^2. The lowest average steady state fluxes at 0.035, 0.034 and 0.032 gpm/ft^2 were obtained by the GKN, Mott 0.5 μm and the SRS baseline Mott 0.1 μm, respectively. The average steady-state flux through the membranes decreased in the order:

Pall 0.1μm > Graver 0.07μm > Pall 0.8μm > GKN 0.1μm > Mott 0.5μm > Mott 0.1μm

At the completion of the 4.5 wt% test, a similar chemical cleaning procedure, as performed in the 0.29 wt% test was performed. However, due to the increased solids loading, additional water and chemical cleaning steps were required to remove solids.

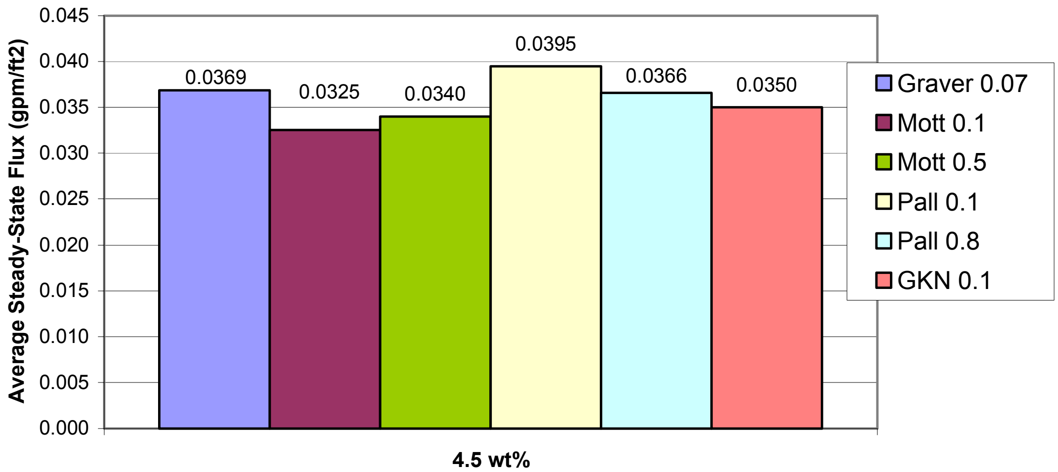

Figure 10. The average steady-state flux for the five membranes using the 4.5 wt% SRS simulant.

3.2.3 Statistical Analysis

The authors performed statistical analyses on the simulant flux data to determine which of the operating parameters (filter media, insoluble solids concentration, transmembrane pressure, and axial velocity) had a significant effect on filter flux. The analyses were performed (with JMP software) by developing a model to calculate the filter flux (in L/m^2hr) as a function of filter media, insoluble solids (wt%), transmembrane pressure (bar), and axial velocity (m/s).

The statistical analysis of all the filter media is shown in Table 1 of Appendix B. The analysis shows the insoluble solids concentration and axial velocity have the strongest effect on filter flux, and that the effects are statistically significant. The analysis also shows the transmembrane pressure and filter media have statistically significant effects on filter flux, but the effects are less than the effects of insoluble solids concentration and axial velocity. The 0.1 µm Pall and 0.07 µm Graver media produced the highest mean flux.

Additional statistical analysis was completed as a basis of comparison between the various alternative filter media. The following comparisons were evaluated:

- Pall 0.1 µm and Mott 0.1 µm
- Graver 0.07 µm and Mott 0.1 µm
- Graver 0.07 µm and Pall 0.1 µm
- Mott 0.1 µm and Mott 0.5 µm

The statistical analysis of the Pall 0.1 µm and Mott 0.1 µm filter media are shown in Table 2 of Appendix B. The analysis shows the insoluble solids concentration and axial velocity have the strongest effect on filter flux, and that the effects are statistically significant. The analysis shows the transmembrane pressure does nt have a statistically significant effect on filter flux. Filter media has a statistically significant effect on filter flux, but the effect is less than the effect of insoluble solids concentration and axial velocity.

The statistical analysis of the Graver 0.07 μm and Mott 0.1 μm filter media are shown in Table 3 of Appendix B. The analysis shows the insoluble solids concentration and axial velocity have the strongest effect on filter flux, and that the effects are statistically significant. The analysis shows the transmembrane pressure does not have a statistically significant effect on filter flux. Filter media has a statistically significant effect on filter flux, but the effect is less than the effect of insoluble solids concentration and axial velocity.

The statistical analysis of the Graver 0.07 μm and Pall 0.1 μm filter media are shown in Table 4 of Appendix B. The analysis shows the insoluble solids concentration and axial velocity have the strongest effect on filter flux, and that the effects are statistically significant. The analysis shows the transmembrane pressure does not have a statistically significant effect on filter flux. Filter media does not have a statistically significant effect on filter flux. Therefore, filter flux with the Pall 0.1 μm and the Graver 0.07 μm filters is statistically the same.

The statistical analysis of the Mott 0.5 μm and Mott 0.1 μm filter media are shown in Table 5 of Appendix B. The analysis shows the insoluble solids concentration and axial velocity have the strongest effect on filter flux, and that the effects are statistically significant. The analysis shows the transmembrane pressure does not have a statistically significant effect on filter flux. Filter media does not have a statistically significant effect on filter flux. Therefore, filter flux with the Mott 0.1 μm and the Mott 0.5 μm filters is statistically the same.

3.3 SRNL Comparison

After close examination of INEEL simulant flux data performed at 4.5 wt%, it was speculated that a discrepancy between the INEEL and prior Savannah River National Laboratory (SRNL) data existed. Personnel from the Savannah River National Laboratory and the University of South Carolina (USC) had previously conducted engineering-scale filtration tests using the Filtration Research Engineering Demonstration (FRED) facility and the Mott 0.1 μm membrane.[12]

Figure 11 displays flux as a function of axial velocity for the Mott 0.1 μm membrane at 4.5 wt% for tests performed at the INEEL and SRNL (FRED facility). Fluxes obtained at SRNL were approximately 20 –50 % higher than those obtained in the INEEL study. Similar tests conditions were utilized between the two tests, however, a few experimental differences were observed, which could account for the difference in flux. Table 4 displays the experimental differences for simulant tests performed with the Mott 0.1 μm at the INEEL and SRNL. In addition, the potential impacts in respect to the experimental differences are also shown.

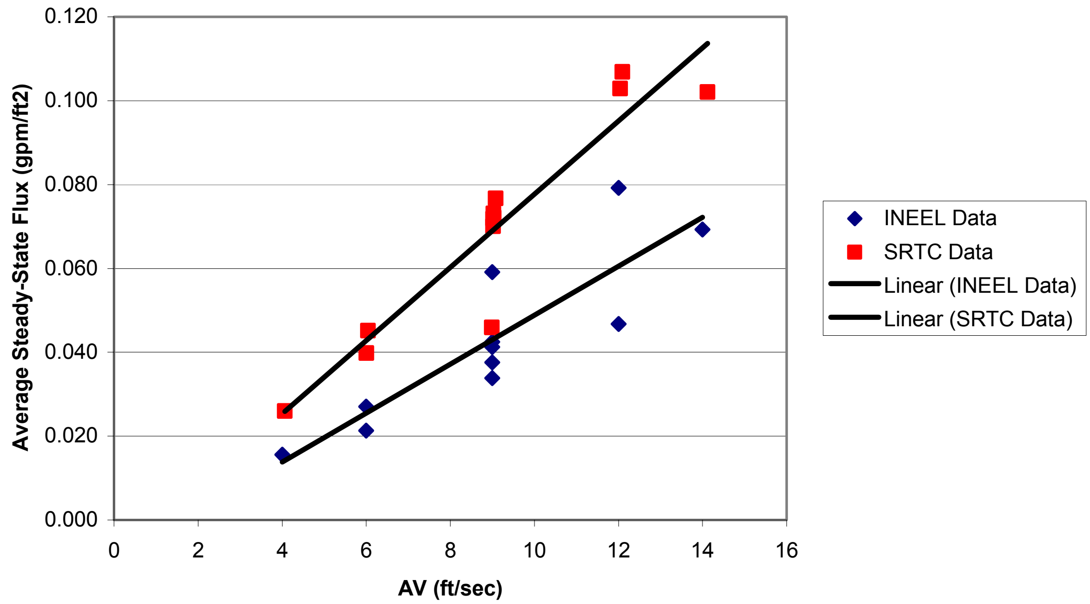

Figure 11. Flux as a function of axial velocity for the Mott 0.1 µm membrane at 4.5 wt% for tests performed at the INEEL and SRNL (FRED Facility).

Table 4. Experimental differences for simulant tests performed with the Mott 0.1 µm at the INEEL and SRNL (FRED facility).

	INEEL	(SRNL) FRED	Impacts
Particle Size Distribution in Feed	Particle size 4.32- 4.39 µm based on Microtrac analysis measured at SRTC	Particle size of 3.56 – 4.09 µm based on Microtrac analysis measured at SRTC	Smaller particles foul membrane or produce tighter cake, lower flux
Membrane Diameter	3/8"	5/8"	Smaller membrane would produce higher wall shear at same AV increasing flux
Number of Tubes	(1 tube, 2 ft long)	(7 tubes, 10 feet long)	Shorter length with less tubes = higher fraction is at the entrance region, which has higher mass transfer coefficient, increasing flux –
Temperature	25 °C	35 °C	Higher temperature yields higher flux due to change in viscosity
Backpulse Pressure	40 psig	100 psig	Higher backpulse pressure produces better particle removal efficiency
Insoluble Solids (wt%)	10.8 wt% feed stock	~ 7.0 wt% feed stock	Higher solids loading create added resistance and decreased flux

As a result of the differences described in Table 4, we performed additional testing to provide a direct comparison with tests performed at SRNL. Additional testing was completed on the Graver 0.07µm, Mott 0.1µm and Pall 0.1µm. These membranes displayed the highest average steady-state flux during original testing with SRS simulated waste at solids loadings of 0.29 and 4.5 wt%.

As a basis of comparison, two test conditions were changed: operating temperature and backpulse pressure. Operating temperatures were increased from 25°C to 35°C and backpulse pressures were increased from 40 psig to 90 psig. The 90 psig backpulse was selected, because the Pall 0.1 µm filter has a maximum operating pressure of 90 psig. Accordingly, backpulses were performed at 90 psig for all membranes. Flux was measured in accord with the matrix conditions indicated in Table 2 (*vide supra*). However, an additional "preflux" parameter (repeat of condition #1) was added to the test matrix to decrease the high variation in initial-flux measurements. Additional tests were performed with SRS simulated waste at solids loadings of 0.06 and 4.5 wt%. Figures 12 and 13 indicate the average steady-state flux for the Mott 0.1µm (FRED pilot facility), Mott 0.1µm (INEEL), Graver 0.07µm and Pall 0.1µm membranes using simulated SRS waste at 0.06 and 4.5 wt% at 35°C.

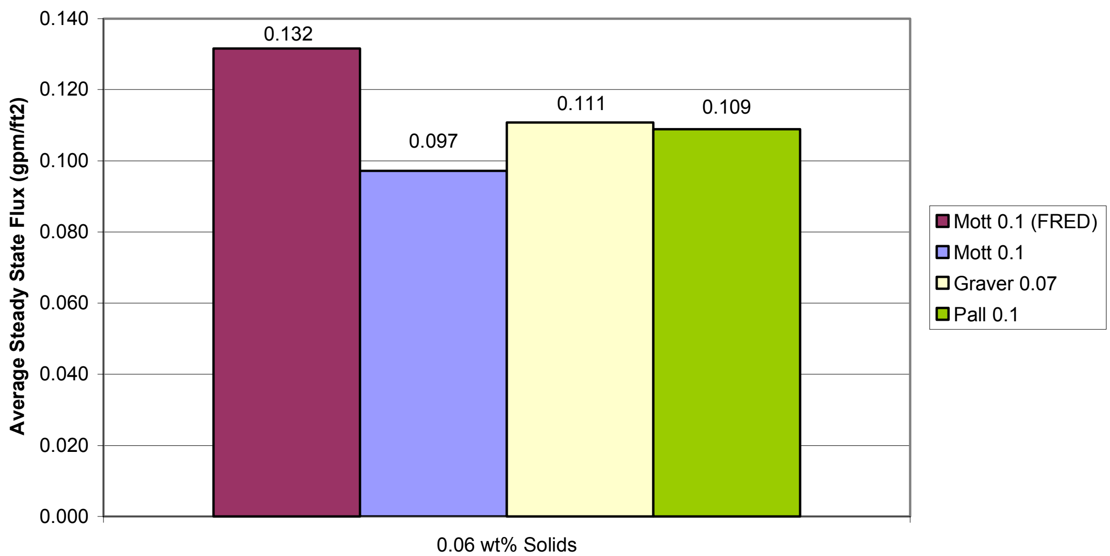

Figure 12. Average steady-state for the Mott 0.1 µm (FRED facility), Mott 0.1 µm (INEEL), Graver 0.07 µm and Pall 0.1 µm membranes using the SRS simulant at 0.06 wt% at 35 °C.

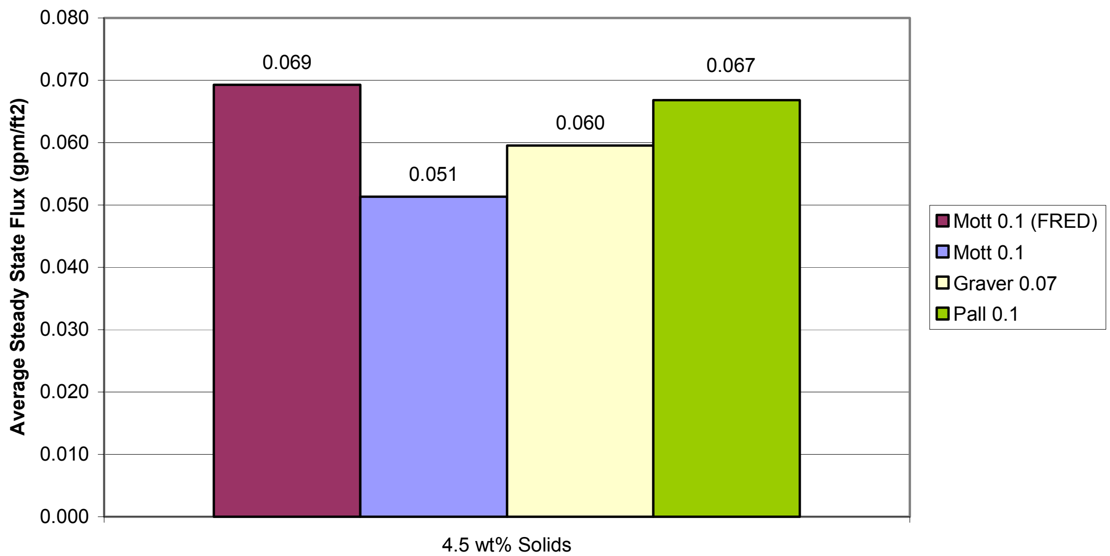

Figure 13. Average steady-state flux for the Mott 0.1 μm (FRED Facility), Mott 0.1μm (INEEL), Graver 0.07 μm and Pall 0.1 μm membranes using the SRS simulant at 4.5 wt% at 35 °C.

At 0.06 and 4.5 wt%, the Graver 0.07μm and Pall 0.1μm membranes displayed the highest average steady-state fluxes. Interestingly, the order of performance remained the same when compared to previous testing. The Graver membrane displayed the highest average steady-state flux at the low solids loading and the Pall membrane displayed the highest average steady-state flux at the high solids loading. In general, fluxes were 11- 31% higher for the Graver 0.07μm and Pall 0.1μm membranes when compared to the baseline Mott 0.1 μm membrane.

Statistical analysis of the data collected at 35 °C is shown in Table 6 of Appendix B. The analysis indicates the insoluble solids concentration and axial velocity have the strongest effect on filter flux, and that the effects are statistically significant. The analysis also shows the transmembrane pressure and filter media have statistically significant effects on filter flux, but the effects are less than the effects of insoluble solids concentration and axial velocity. This analysis is consistent with the results for the testing at 25 °C.

Although tests were performed in replication of tests performed at SRNL (FRED facility), flux values obtained at the INEEL were still approximately 25 percent lower. As an after thought, the discrepancies were discovered to be a difference in simulant test solutions, specifically solids loading and particle size diameter. The INEEL received simulated sludge and MST solids at a solids loading of approximately 7.25 wt%, as determined by SRNL. Following simulant testing at the INEEL, six samples of the 4.5 wt% test solutions were back-calculated to determine the solids loading of the actual as-received simulated sludge and MST solids. A solids loading of 10.8 wt% was determined. The solids loadings of test solutions utilized at the INEEL were approximately 33% higher than those tested at the FRED facility. Thus, the calculated solids loadings for the tests solutions were 0.09, 0.43 and 6.7 wt%, respectively. To substantiate this, Mott 0.1 μm flux data obtained at the FRED facility was interpolated using a solids loading of 6.7 wt%. The flux data was calculated at 0.051 gpm/ft^2. Fluxes obtained at the INEEL were also 0.051 gpm/ft^2. Moreover, interpolating the lower concentration data at 0.43 wt% (based on the natural log of the concentration), a flux of 0.096 gpm/ft^2 was calculated for the FRED facility.

Fluxes obtained at the INEEL were 0.097 gpm/ft^2. Consequently, the differences in the INEEL and SRNL data are largely attributed to the differences in percent solids loading between the feed solutions.

In addition to solids loading analysis, the authors performed particle size analyses with a Lasentec probe and with a Microtrac S3000 particle size analyzer. Personnel collected particle measurements with a Focused Beam Reflectance Measurement (FBRM) probe (Lasentec®). The probe works in the following manner. Personnel installed the probe in the feed tank. The laser beam projects through the window of the FBRM probe and focuses just outside the window surface. This focused beam follows a path around the circumference of the probe window. As particles pass by the window surface, the focused beam will intersect the edge of a particle. The particle will backscatter laser light. The particle will continue to backscatter the light until the focused beam reaches the opposite edge of the particle. The instrument collects the backscattered light and converts it into an electronic signal. The FBRM isolates the time of backscatter from one edge of an individual particle to its opposite edge. The software records the product of the time multiplied by the scan speed as a chord length. A chord length is a straight line between any two points on the edge of a particle or particle structure (agglomerate). FBRM typically measures tens of thousands of chords per second, resulting in a robust number-by-chord-length distribution. The chord-length distribution provides a means of tracking changes in both particle dimension and particle population. The calculations do not assume a particle shape. The chord-length distribution is essentially unique for any given particle size and shape distribution. Assuming the average particle shape remains constant over millions of particles, changes to the chord-length distribution reflect solely a function of the change in particle dimension and particle number. Slurry samples from the current test and the pilot-scale test were analyzed with the FBRM. Personnel obtained 200 ml slurry samples and placed them in a beaker. They agitated the slurry with an impeller and placed the FBRM probe into the slurry. Figure 14 shows the particle distribution measured. The slurry samples in the current test had a smaller media particle size than the samples in the pilot-scale test. The difference was 25% at the lower concentration and 17% at the higher concentration. Many filtration models predict filter flux to be proportional to particle size squared [16,17], this difference in particle size would correspond to a difference in filter flux of 35 – 55 %.

Following the FBRM measures, personnel submitted the samples to the SRNL Analytical Development Section for particle size analysis with a Microtrac S3000. The Microtrac instrument can measure smaller particle sizes than the FBRM (as small as 0.026 μm). The results are displayed in Figure 15. The low solids slurry used in the pilot-scale tests at FRED has a smaller median particle size than the low solids slurry used in the current tests. Moreover, when referring to the low particle size of the graph, the samples from the current test have more fine particles (< 1 micron) than the samples from the pilot-scale test. The fine particles could become trapped in the filter pores and decrease the filter permeability. In addition, the slurry from the current test performed at the INEEL has a wider particle size distribution. A wider distribution allows the particles to pack more tightly and decreases the filter cake permeability.

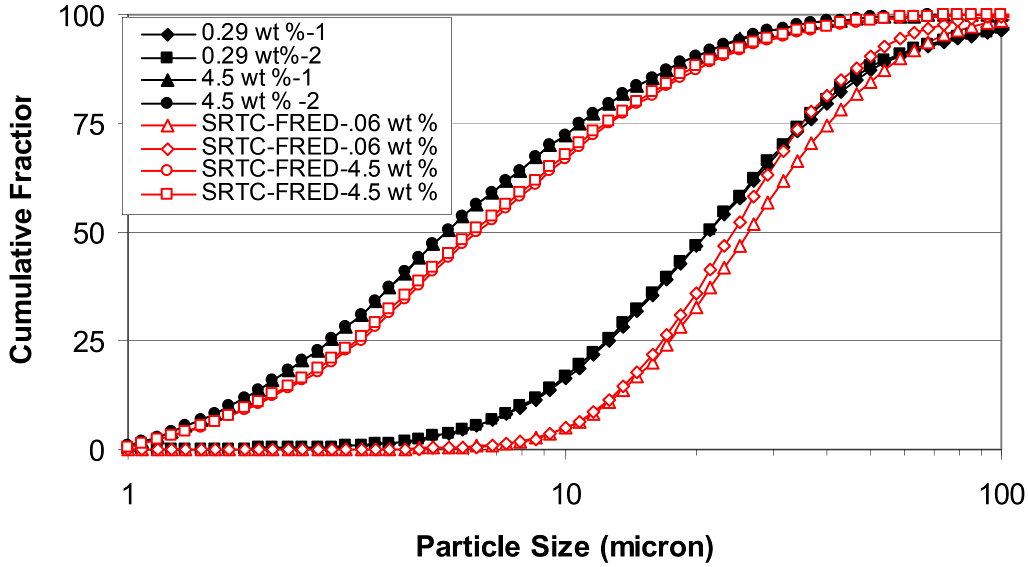

Figure 14. Focused Beam Reflectance Measurement (FBRM) of slurry samples.

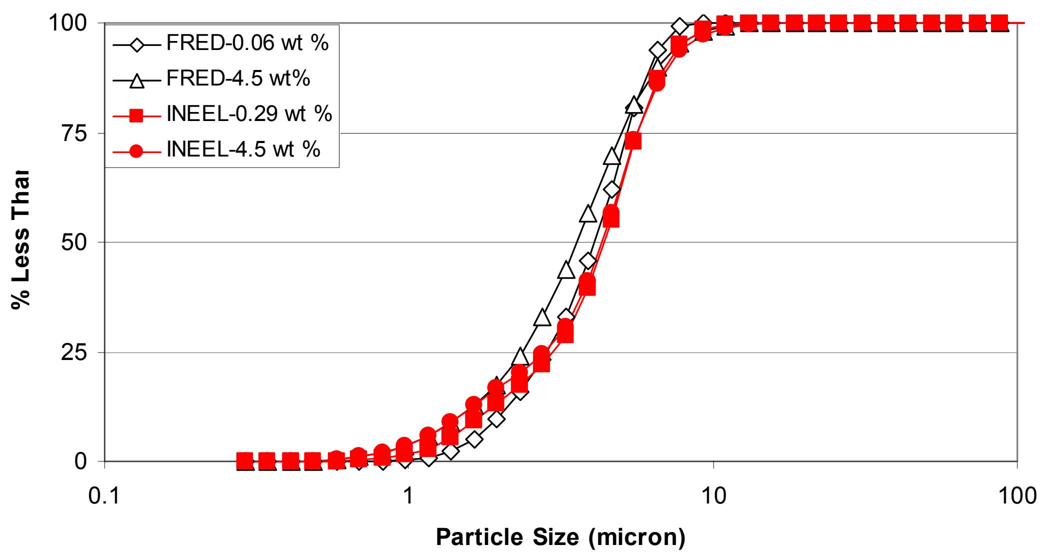

Figure 15. Microtrac S3000 Particle Size Measurements.

It is unknown why or how the differences in solids loading and/or particle size diameter occurred between the two tests. However, it was postulated that the finer particles observed in the current tests were the result of shear effects within the CUF apparatus. To evaluate this theory, particle size measurements were performed on samples of the stock SRS simulant (as supplied by SRNL and not tested at the INEEL) and simulant solutions following testing. Samples of test solutions were obtained prior to and after testing to validate test solutions and identify potential de-agglomeration of solids due to shear effects experienced during testing.

Particle size analysis was performed using the Microtrac-FRA-9200 particle size analyzer. The Microtrac-FRA-9200 (Leeds & Northrup) particle size analyzer consists of a small volume sample recirculator, measurement module and computer. The Microtrac FRA-9200 utilizes the phenomenon of low-angle forward scattered light from a laser beam projected through a stream of particles. The amount and direction of light scattered by the particles is measured by an optical detector array and then analyzed by the computer, which calculates the size distribution of the particles in the sample. The Mircortrac-FRA9200 provides particle size analysis in the range of 0.12 to 704 microns.

Figures 16 and 17 display the particle size data collected for the as-received SRS solids and slurry samples obtained at the completion of the 0.29 wt% and 4.5 wt% tests for each membrane. The median particle size for the as-received sample was 4.11μm. The average median particle size for the slurry samples obtained at the completion of testing at 0.29 and 4.5 wt% was 4.14 ± 0.05 and 4.16 ± 0.06, respectively. Slurry samples were obtained prior to testing for each membrane, but are not shown. Slurry samples obtained prior to testing were nearly identical to the as-received SRS solids. It is postulated that de-agglomeration due to shear did not occur, as evidenced by the static PSD analysis prior to and following testing.

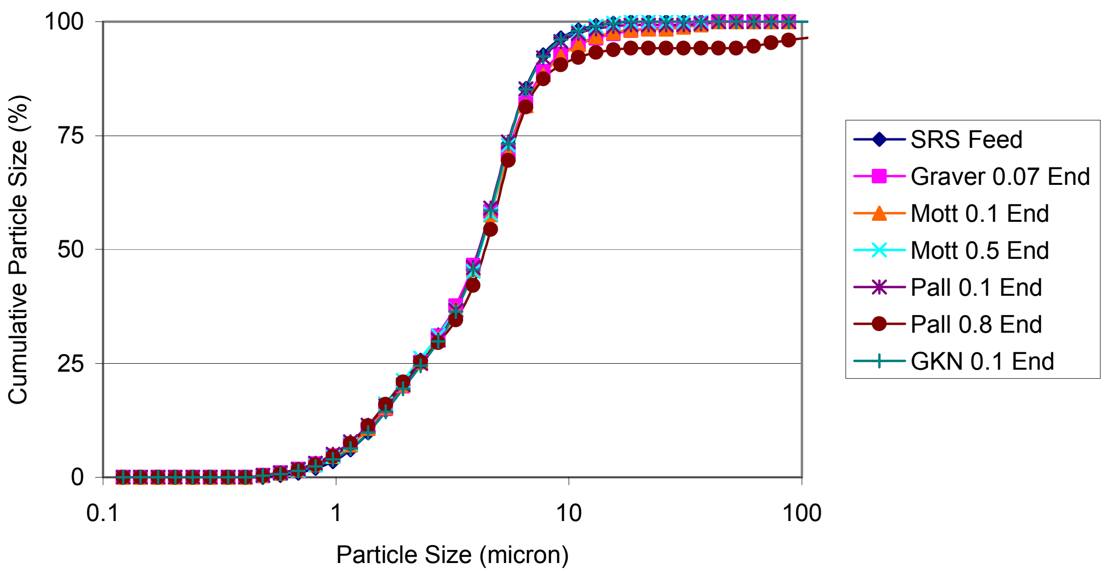

Figure 16. Particle size data collected for the as-received SRS solids and slurry samples obtained at the completion of the 0.29 wt% simulant tests for each membrane.

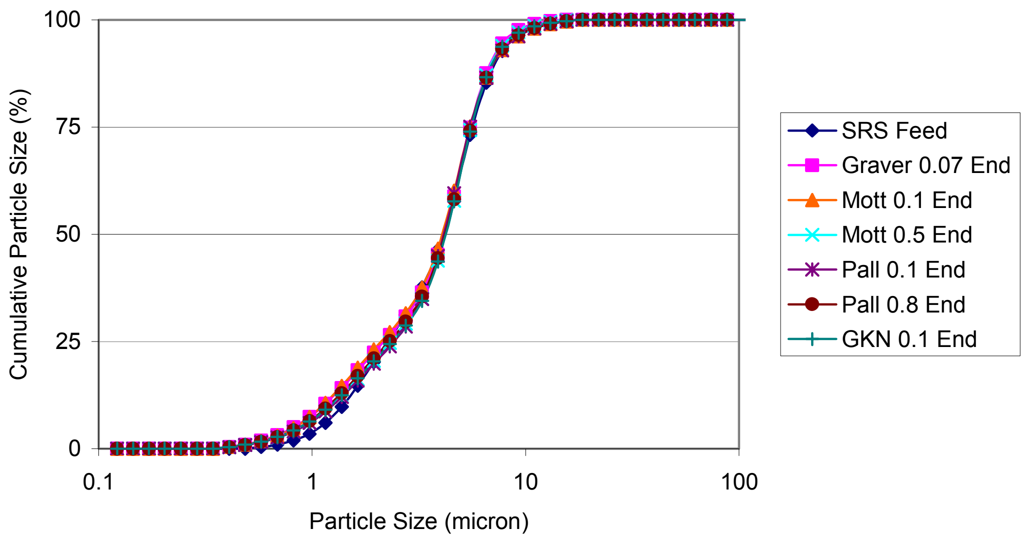

Figure 17. Particle size data collected for the as-received SRS solids and slurry samples obtained at the completion for the 4.5 wt% simulant tests for each membrane.

3.4 SEM Analysis

Analysis using the Scanning Electron Microscope (SEM) was completed on the five membrane samples following simulant testing. The purpose of the additional analysis was to qualitatively observe the membranes under high magnification in order to identify potential fouling phenomena within the pore structure of the membranes. At the completion of the repeated 4.5 wt% simulant testing, membranes were not chemically cleaned with 0.5 M oxalic acid. Instead, membranes were water rinsed (in-situ). This method allowed for the removal of the bulk solids or cake from the system, but left particulate potentially fouled within the pores intact.

Membranes were prepared by first removing the active membrane from the respective permeate housings. Cutting a 6-inch section from the center of the 24-inch long membrane followed this. The 6-inch sections were then cut in half along the length of the membrane. To finish, the partial 6-inch section of membrane was scarred and fractured into small 0.5-inch pieces. The final 0.5-inch pieces were then used for SEM analysis.

Figure 18 displays a SEM micrograph of the Graver 0.07 µm membrane at 1000X magnification. The SEM micrograph is taken at the inner surface of the membrane. The Graver membrane consists of an asymmetric TiO_2 layer on a sintered stainless steel support. The TiO_2 layer is defined by the dark material. The TiO_2 layer can be further defined by observing cracks along its surface. The support material cannot be seen in the micrograph, as it resides beneath the ceramic layer. The lighter material present on the surface of the ceramic layer is possibly residual solids or crystallized sodium hydroxide.

In general, the pore structure of the Graver membrane cannot be defined. In fact, earlier work has shown that a magnification of 20,000 or greater is needed to see the TiO_2 pore structure. It is believed that the dense TiO_2 layer, which provided relatively low water fluxes when compared to the other membranes evaluated, also provided relatively high fluxes with the SRS simulant. Small particles were unable to penetrate the TiO_2 layer, thus producing surface filtration where the filter cake acts as the filter medium.[18,19]

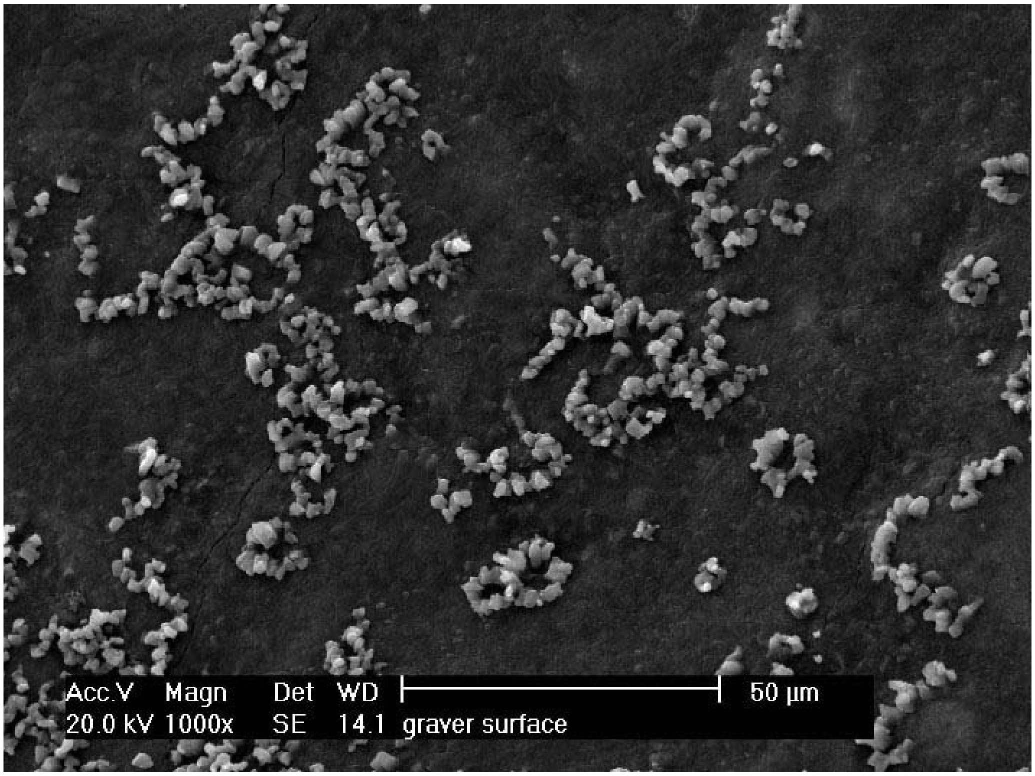

Figure 18. SEM micrograph of the Graver 0.07 µm membrane at 1000X magnification.

Figures 19 and 20 display SEM micrographs of the Mott 0.1 µm and Mott 0.5 µm membranes at 2000X magnification. The SEM micrographs are taken at the inner surface of the membranes. The Mott membranes consist solely of sintered stainless steel as defined in the micrograph by the light globular material. A dark "cake-like" material can be observed between the sintered metal of the Mott 0.1 µm membrane and is most likely residual solids. This "cake like" material can be further defined by the cracks along its surface. This dark material is not observed within the pores of the Mott 0.5 µm membrane. However, due to the relatively large pore structure, this dark material may reside deeper within the pores and is not evident through SEM analysis. It should be noted that a lighter crystalline material can be observed at the pore opening of the Mott 0.5 µm membrane.

In general, it is believed that the open pore structure of both Mott membranes provided relatively high water fluxes when compared to the other membranes evaluated, but provided relatively low fluxes with respect to the SRS simulant. Small particles were able to penetrate within the pore structure (as evidenced by SEM analysis), thus producing depth filtration where the porosity is greatly reduced by particles trapped within the interstices of the internal structure.[18,19]

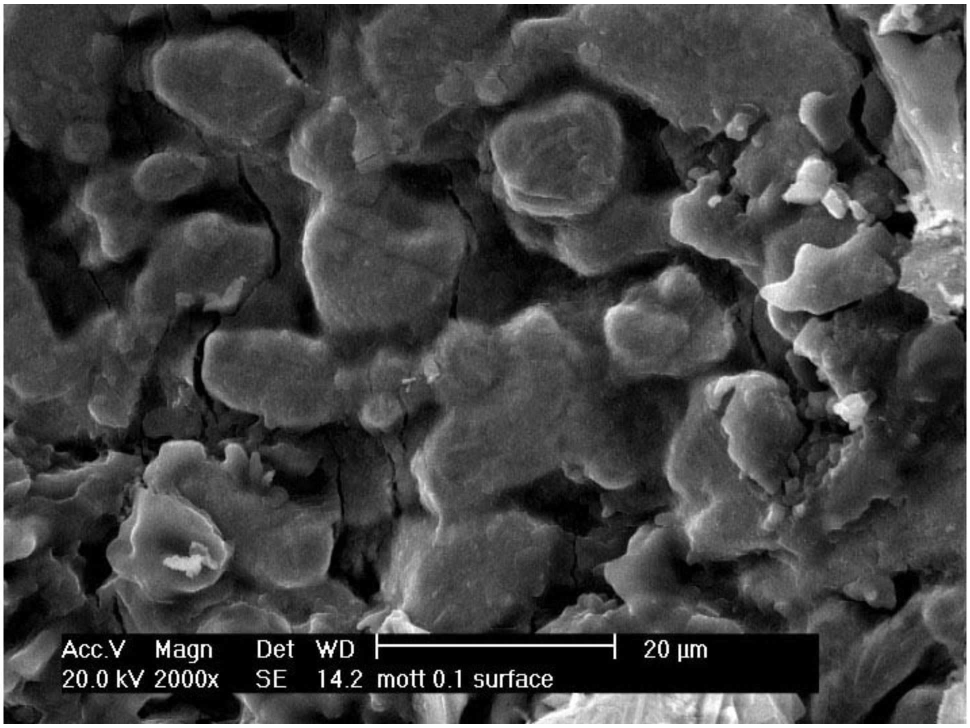

Figure 19. SEM micrograph of the Mott 0.1 µm membrane at 2000X magnification.

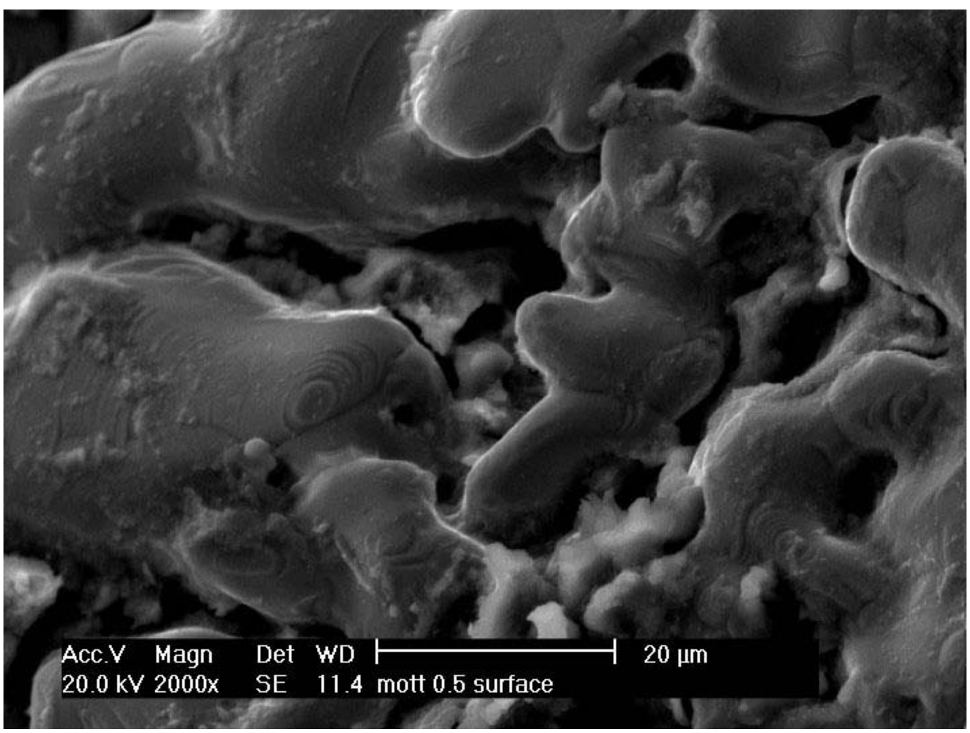

Figure 20. SEM micrograph of the Mott 0.5 µm membrane at 2000X magnification.

Figure 21 displays a SEM micrograph of the Pall 0.1 μm membrane at 1000X magnification. The SEM micrograph is taken at the inner surface of the membrane. The Pall 0.1 μm membrane consists of an asymmetric ZrO_2 layer on a sintered stainless steel support. The ZrO_2 layer is defined by the dark material. The ZrO_2 layer can be further defined by observing cracks along its surface. The cracks are most likely due to the preparation (cutting and fracturing) of the sample for SEM analysis. In addition, large depressions are prevalent throughout the membrane surface and are most likely due to manufacturing. The support material cannot be seen in the micrograph since it lies beneath the ZrO_2 layer. The small amount of lighter colored material present on the surface is possibly residual solids or crystallized sodium hydroxide.

In general, the pore structure of the Pall 0.1 μm membrane cannot be defined. Much like the Graver membrane, it is postulated that a much higher magnification would be needed to see the ZrO_2 pore structure. It is believed that the dense ZrO_2 layer, which provided relatively low water fluxes when compared to the other membranes evaluated, also provided relatively high fluxes with the respect to the SRS simulant. Small particles were unable to penetrate the TiO_2 layer, thus producing surface filtration where the filter cake acts as the filter medium. It should be noted that the Graver 0.07 μm and Pall 0.1μm membranes observed the lowest water fluxes and the highest simulant fluxes when compared to the other membranes tested. Both membranes consist of a ceramic coating on a sintered metal support.

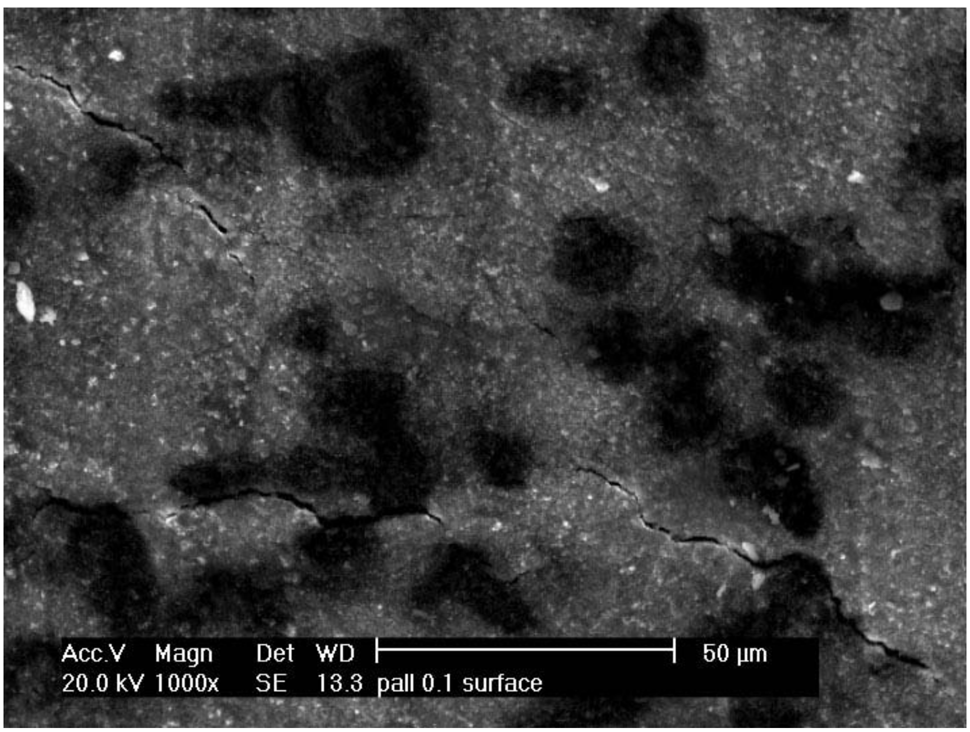

Figure 21. SEM micrograph of the Pall 0.1μm membrane at 1000X magnification.

Figure 22 displays the SEM micrograph of the GKN 0.1 μm membrane at 2000X magnification. The SEM micrographs are taken at the inner surface of the membrane. The GKN membrane consists of a fine asymmetric stainless steel layer on a larger sintered stainless steel support. The GKN membrane is different in respect to the other asymmetric membranes, as the pore structure is very evident. The stainless steel asymmetric layer is not defined by the light globular material, as shown in the Mott micrographs but, light spherical material. A dark “cake-like” material can be observed between the asymmetric metal layer and is most likely fouled solids.

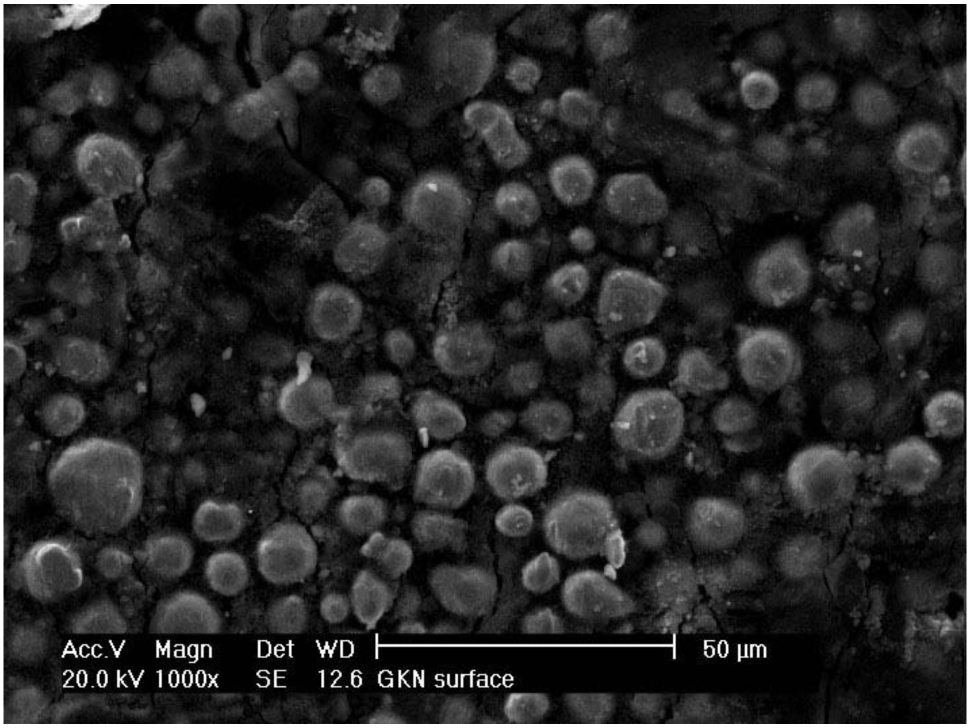

Figure 22. SEM micrograph of the GKN 0.1 μm membrane at 1000X magnification.

In general, it is believed that the open pore structure of the GKN membrane provided the highest water fluxes when compared to the other membranes evaluated, but provided nearly the lowest fluxes with respect to the SRS simulant. It is postulated that the small particles were able to penetrate the spherical asymmetric layer, thus producing depth filtration where the porosity is greatly reduced by particles trapped within the interstices of the internal structure.[18,19]

The Pall 0.8 μm membrane was evaluated using SEM. However, water flux could not be restored to near pristine levels despite numerous chemical and physical cleaning attempts. As a result, the Pall 0.8 μm was not included in the additional simulant tests at 0.6 and 4.5 wt%. The Pall 0.8 μm membrane was cleaned with 0.5 M oxalic acid removing any solids present within the pore structure. Thus, the SEM micrographs depict a membrane free of any solids. A SEM of the Pall 0.8 μm membrane is not shown.

3.5 Permeate Turbidity Analysis (NTU)

An important aspect of this evaluation was the permeate quality and whether the alternative membranes produce permeates of at least the same clarity as the baseline Mott 0.1 μm membrane. The average Nephelometric Turbidity Units (NTU) and standard deviation for permeate samples are shown in Table 5. Samples of permeate were obtained during testing from the respective membranes at solids loadings of 0.29 and 4.5 wt%. A 15 mL sample was obtained at test conditions 1,6 and 11 shown in the parametric test matrix in Table 2. These three measurements were averaged and are shown in Table 5. A Hach® 2100P turbidmeter was used to determine permeate quality. The turbidmeter works by transmitting a beam of light through the sample. The light beam reflects off particles in the solution, and the resultant light intensity is measured by a photodetector positioned at 90 degrees to the light beam. The detected light intensity is directly proportional to the turbidity of the solution. The Hach® 2100P turbidmeter has an analysis range of 0 to 1000 NTU.

Table 5. The average Nephelometric Turbidity Units (NTU) and standard deviation for permeate samples for all membranes tested at 0.29 and 4.5 wt%.

	0.29 wt%		4.5 wt%	
Membrane	Average NTU	Average Std. Deviation	Average NTU	Average Std. Deviation
Graver 0.07 µm	2.4	0.21	0.6	0.04
Mott 0.1 µm	2.8	0.21	0.7	0.05
Mott 0.5 µm	1.1	0.09	0.4	0.02
Pall 0.1 µm	0.9	0.05	0.6	0.03
Pall 0.8 µm	0.3	0.05	0.4	0.03
GKN 0.1 µm	1.9	0.08	1.0	0.03

The main objective of the NTU analysis was to compare the permeate quality to the baseline Mott 0.1 µm membrane. The maximum acceptable turbidity measurement is 5-10 NTU.[3] Referring to Table 5, NTU measurements of 2.8 and 0.7 at 0.29 and 4.5 wt%, respectively were obtained with the Mott 0.1µm membrane. At 0.29 wt% the baseline Mott 0.1µm displayed the highest NTU and at 4.5 wt% displayed the second highest NTU measurement. The highest NTU measurement obtained was with the GKN 0.1 µm membrane at 4.5 wt%. All alternative membranes provided reduced or equivalent turbidity measurements when compared to the baseline Mott 0.1 µm membrane.

4. COST BENEFIT ANALYSIS

Filter manufacturers, Graver Technologies, Pall Corporation and GKN were each requested to provide a budgetary quote for a retrofit filter bundle and associated housing to replace the existing crossflow filter (Hypulse LSX) located in 512-S. Each manufacturer was provided with drawings of the existing filter (7020346 Rev D and S511-205-030-00-F) as provided by SRNL. The overall length of the retrofit housing and total area (ft^2) of the filter bundle was to remain unchanged. However, some alteration could be made to the diameter of the filter housing. Moreover, manufacturers were provided with the necessary operational parameters (AV, TMP, pressures, etc.) and waste specifications (PSD, viscosity, density, etc.) to complete the budgetary quote. Table 6 compares the budgetary quote for the Graver (0.07μm), Pall (0.1 μm and 0.8 μm) GKN (0.1 μm) and Mott (0.1 μm) filter products. Graver, Pall and GKN provided estimates based on replacing the existing Mott filters in 512-S with their technology. The proposal includes the supply of a housing and membrane filter bundle for retrofit into the previously installed crossflow filter in 512-S.

Table 6. Budgetary quote for retrofit into the existing crossflow filter located in 512-S.

Membrane	Budgetary Quote ($)
Graver 0.07μm	44,000.00
Pall 0.1 μm	100,000.00
Pall 0.8 μm	140,000.00
GKN 0.1μm	475,000.00
Mott 0.1μm	270,000.00

Reproductions of the actual budgetary quotes obtained from Graver, Pall and GKN are shown in Tables 1, 2 and 3 of Appendix I. An added engineering design cost was added to the quote provided by GKN. This cost is a one-time cost for multiple housings. It should be noted that an engineering design cost is already included in the quotes provided by Pall Corporation and Graver Technologies. In addition, three quotes were supplied by Graver Technologies. However, option 1C should be used in this cost benefit analysis since it is closest to the current design. A budgetary quote for the Mott 0.1 μm was provided by SRNL and is shown in Table 4 of Appendix I as a personal email.

5. POTENTIAL IMPACTS ON HIGH LEVEL WASTE PROCESSING

The Pall and Graver filters offer increased flux over the 0.1 and 0.5 µm Mott filters. As part of the development of the rotary microfilter, the authors investigated the impact of the technology on the SRS High Level Waste system.

The Pall and Graver filters add no new chemicals to the actinide removal process. With the technology, the feed to 512-S is contacted with monosodium titanate (MST) for as long as 24 hours, and filtered to remove the strontium and actinide species that sorb to the MST.

The Pall and Graver filters produce higher throughput, so they will facilitate faster treatment of the SRS High Level Waste that needs alpha removal. The flowsheet for the these filters shows that replacing the 0.5 µm crossflow filter in 512-S with the same size Pall or Graver filter would increase the annual throughput of 512-S by 3 – 6 % (assuming a 24 hr MST strike). If the MST contact, or strike, time is reduced to 4 hours, the degree of improved throughput with the Pall and Graver filters increases further (6 – 12 %). If the MST contact, or strike, time is reduced to 0 hours, the degree of improved throughput with the Pall and Graver filters increases even further (8 – 16 %).(20)

Since the Pall and Graver filters produce higher filter flux than the baseline crossflow filter technology, they will likely require less frequent chemical cleaning, and add fewer cleaning chemicals, such as oxalic acid, to the SRS High Level Waste System.

The Pall and Graver filters have the following positive impacts to the SRS High Level Waste System:

- They add no new chemicals to the actinide removal process:
- The Pall and Graver filters will require less frequent chemical cleaning, so they add fewer cleaning chemicals to the SRS High Level Waste System.
- The Pall and Graver filters produce higher filtrate throughput, so they will allow faster treatment of the SRS High Level Waste needing actinide removal. Replacing the crossflow filter in 512-S with an equivalent sized Pall or Graver filter would increase the ARP processing rate by 3 – 16 %, depending on the MST strike time.

The Pall and Graver filters have the following negative impacts to the SRS High Level Waste System:

- There is a cost to procure the new filters and to install them in 512-S, and the replacement would require time.
- We would lose the historical database that we have built from all of the testing with 0.1 and 0.5 µm Mott filter media.

6. COMPONENTS OF FUTURE WORK

The authors recommend that the following additional testing be performed with membranes to confirm improved performance observed in these tests: actual waste filtration tests, pilot-scale filtration tests, and filter cleaning tests. SRNL should conduct bench-scale testing with actual waste using both the 0.1 μm Pall filter media and the 0.07 μm Graver media. In addition to the actual waste testing, SRNL should conduct pilot-scale testing with the Pall or Graver media. Moreover, additional bench-scale and pilot-scale testing should include the Mott 0.1 μm media as a basis of comparison. The media selected for the pilot-scale testing should be based upon the results of the current tests and the actual waste tests. The actual waste and pilot-scale filtration tests should include an evaluation of filter cleaning for each media tested.

7. NEW AND EXISTING FACILITIES

The Pall or Graver filters would be placed in the existing 512-S facility. The vendors have provided estimates based on replacing the existing filters in 512-S with their technology.

8. RISK ASSESSMENT

If we replace the Mott 0.1 μm filter with the Pall or Graver filters, we lose the historical test database that includes bench-scale simulant testing, actual waste testing and pilot-scale simulant testing. The database also includes sludge only feed, sludge plus MST and sludge plus manganese dioxide feed.

9. CONCLUSIONS

Membrane variation data indicate that membranes having an asymmetric ceramic coating (Pall 0.1μm and Graver 0.07μm), typically displayed the lowest variability with water. Membranes without a ceramic asymmetric coating (Mott 0.1 μm, Mott 0.5 μm, Pall 0.8 μm, and GKN 0.1 μm), displayed the highest variability, which is most likely associated with the experimental uncertainties in measuring large volumes of permeate in a short amount of time. Statistical analysis of variance techniques (ANOVA) applied to the complete set of water flux data indicate no statistical differences are associated among the five modules within each manufacture. In the case of variation testing using strontium carbonate, variability decreased to 3-12% as compared with the water flux. In addition, membrane structure or composition had little effect on the variability.

Data obtained from SRS simulant testing, indicate that membranes having a ceramic asymmetric coating (Pall 0.1 μm and Graver 0.07μm), achieved the highest average steady state fluxes for all solids loadings evaluated. In general, the Graver and Pall membranes achieved fluxes nearly 13 to 21 percent higher than those observed with the baseline Mott 0.1 μm membrane at solids loadings of 0.29 and 4.5 wt%. It is postulated that small particles present in solution were unable to penetrate the ceramic layer, thus producing surface filtration where the filter cake acts as the filter medium. Conversely, membranes without the ceramic asymmetric coating were susceptible to the small particles present in solution penetrating into the internal pore structure of the membrane, thus producing depth filtration where the porosity is greatly reduced by particles trapped within the interstices of the internal structure. Statistical analyses (with JMP software) of the simulant flux data indicate that the insoluble solids concentration and axial velocity had the strongest effect on filter flux, and that the effects are statistically significant. The analysis also shows the transmembrane pressure and filter media have statistically significant effects on filter flux, but the effects are less than the effects of insoluble solids concentration and axial velocity. Statistical comparative analysis among various alternative membranes indicate that the Pall 0.1 μm and Mott 0.1 μm membranes are statistically different. In addition, the Graver 0.07 μm and Mott 0.1 μm are also statistically different. Conversely, the Pall 0.1 μm and the Graver 0.07 μm filters were determined to be statistically the same. Also, the Mott 0.5 μm and Mott 0.1 μm membranes were determined to be statistically the same.

After close examination of INEEL simulant flux data performed at 4.5 wt%, it was speculated that a discrepancy between the INEEL and prior SRNL data existed. Personnel from the SRNL and USC had previously conducted engineering-scale filtration tests using the FRED facility and the Mott 0.1 μm membrane. As a basis of comparison, additional tests were performed with SRS simulated waste at solids loadings of 0.06 and 4.5 wt%. Two test conditions were changed. Operating temperatures were increased from 25 °C to 35°C and backpulse pressures were adjusted from 40 psig to 90 psig. The additional flux data indicate that the fluxes obtained with the Graver 0.07 μm and the Pall 0.1 μm were 11- 31% higher when compared to the baseline Mott 0.1 μm membrane. However, despite tests being performed in replication of tests performed at SRNL (FRED facility), flux values obtained at the INEEL were approximately 26 percent lower. The discrepancies were discovered to be a difference in simulant test solutions, specifically solids loading and particle size diameter. The solids loadings of test solutions utilized at the INEEL were approximately 33% higher than those tested at the FRED facility. Actual test solutions were calculated at 0.09, 0.43 and 6.7 wt%, respectively. In addition, PSD analysis displayed more fine particles (< 1 micron) present in test solutions utilized at the INEEL. Statistical analysis of the data collected at 35 ºC indicate that the insoluble solids concentration and axial velocity have the strongest effect on filter flux, and that the effects are statistically significant. The analysis also shows the transmembrane pressure and filter media have statistically significant effects on filter flux, but the effects are less than the effects of insoluble solids concentration and axial velocity.

Turbidity data indicate that permeate from the alternative membranes provided reduced or equivalent turbidity measurements when compared to the baseline 0.1 μm Mott. All filters produced acceptable turbidity.

The authors recommend that additional testing be performed with the Pall 0.1 μm and Graver 0.07 μm membranes to validate the improved performance observed in these tests. Additional testing should also include the Mott 0.1 μm membrane as a basis of comparison. Testing should include actual waste, pilot-scale and filter cleaning tests. The media selected for the pilot-scale testing should be based upon the results of the current tests and the actual waste tests. The actual waste and pilot-scale filtration tests should include an evaluation of filter cleaning for each media tested.

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Appendix A

Strontium Carbonate Recipe

Appendix A

Strontium Carbonate Recipe

Table A-1. Strontium carbonate recipe.

Component	Concentration (M)	FW	grams/1.5 L
NaOH	0.2	40	12
$NaNO_3$	1	84.99	127.49
$Na_2CO_3 \cdot 1\ H_2O$	0.5	124	93
$Sr(NO_3)_2$	0.35	211.63	111.11

Directions:

Add 0.2M NaOH, 1M $NaNO_3$, and 0.5M Na_2CO_3 to $Sr(NO_3)_2$, stir well and cook at 50°C for 4 hours, cool and let sit for 2 days.

Then dilute to 2-liter mark.

Now it is ready to test.

Appendix B

JMP Statistical Analysis

Appendix B

JMP Statistical Analysis

The analysis of variance table shows the basic statistical calculations for a linear model. Since 132 tests were conducted and one degree of freedom is used to calculate the mean, there are 131 degrees of freedom to calculate the variance. Since three replicates of the center point were performed with each filter membrane and each solids loading, the analysis had 24 degrees of freedom to calculate the random error (2 from replicates x 6 filters x 2 solids loadings = 24). The remaining 99 degrees of freedom were used to develop the model. The JMP software calculated the variance in the flux due to the model and the variance in the flux due to random error. Each variance was divided by the number of degrees of freedom, and the ratio of the mean variances was calculated to produce an F ratio. The software calculated the probability of obtaining a greater F value by chance alone. If the probability is less than 0.05, the model contains at least one significant regression factor (with 95% confidence).

The parameter effects table shows the estimates of each parameter in the model and a t test for the hypothesis that each parameter is zero. The Prob>|t| is the probability of obtaining an even greater t statistic, given the hypothesis that the parameter is zero. If the probability is less than 0.05, the parameter is not zero (with 95% confidence).

The effects test table shows the results of tests conducted to determine whether the individual effects are zero. Continuous effects have one parameter, and nominal effects have one less parameter than the number of levels. Ordinarily the degrees of freedom and the number of parameters are the same. The sum of squares is the variance due to the effect in the model. The F ratio is the ratio of the mean square for the effect divided by the mean square for the error. Prob > F is the probability that the null hypothesis is true (i.e., the variance measured is due to random error). Values less than 0.05 indicate the effect is statistically significant (with 95% confidence).

Table B-1. Statistical Analysis of All Filter Media.

Response Flux

Whole Model

Summary of Fit

RSquare	0.750206
RSquare Adj	0.733959
Root Mean Square Error	24.64512
Mean of Response	113.0465
Observations (or Sum Wgts)	132

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	8	224370.02	28046.3	46.1757
Error	123	74707.96	607.4	Prob > F*
C. Total	131	299077.97		<.0001

Lack Of Fit

Source	DF	Sum of Squares	Mean Square	F Ratio
Lack Of Fit	99	41992.455	424.17	0.3112
Pure Error	24	32715.501	1363.15	Prob > F*
Total Error	123	74707.956		1.0000
				Max RSq
				0.8906

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|*
Intercept	27.574706	10.56861	2.61	0.0102
TIS	-12.27107	1.019041	-12.04	<.0001
TMP	7.4986542	3.536548	2.12	0.0360
Vel	36.221476	2.515297	14.40	<.0001
Filter[0.1 Mott]	-9.885606	4.796549	-2.06	0.0414
Filter[0.1 Pall]	9.2712121	4.796549	1.93	0.0555
Filter[0.5 Mott]	-10.07106	4.796549	-2.10	0.0378
Filter[0.8 Pall]	3.6721212	4.796549	0.77	0.4454
Filter[GKN]	0.1321212	4.796549	0.03	0.9781

Table B-1. Statistical Analysis of All Filter Media (continued).

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F*
TIS	1	1	88073.07	145.0045	<.0001
TMP	1	1	2730.67	4.4958	0.0360
Vel	1	1	125954.98	207.3737	<.0001
Filter	5	5	7611.12	2.5062	0.0338

Filter

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
0.1 Mott	103.16091	5.2543564	103.161
0.1 Pall	122.31773	5.2543564	122.318
0.5 Mott	102.97545	5.2543564	102.975
0.8 Pall	116.71864	5.2543564	116.719
GKN	113.17864	5.2543564	113.179
Graver	119.92773	5.2543564	119.928

Values less than 0.05 indicate statistically significant effects

Table B-2. Statistical Analysis of 0.1 μm Pall and 0.1 μm Mott Media.

Response Flux

Whole Model

Summary of Fit

RSquare	0.749622
RSquare Adj	0.723942
Root Mean Square Error	25.6317
Mean of Response	112.7393
Observations (or Sum Wgts)	44

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	4	76712.48	19178.1	29.1912
Error	39	25622.37	657.0	Prob > F*
C. Total	43	102334.85		<.0001

Lack Of Fit

Source	DF	Sum of Squares	Mean Square	F Ratio
Lack Of Fit	31	14141.263	456.17	0.3179
Pure Error	8	11481.105	1435.14	Prob > F*
Total Error	39	25622.368		0.9900
				Max RSq
				0.8878

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|*
Intercept	24.426162	19.03815	1.28	0.2071
TIS	-11.74401	1.835688	-6.40	<.0001
TMP	6.5130541	6.370692	1.02	0.3129
Vel	37.540719	4.531025	8.29	<.0001
Filter[0.1 Mott]	-9.578409	3.864123	-2.48	0.0176

Table B-2. Statistical Analysis of 0.1 μm Pall and 0.1 μm Mott Media (continued).

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F*
TIS	1	1	26889.922	40.9294	<.0001
TMP	1	1	686.674	1.0452	0.3129
Vel	1	1	45099.009	68.6455	<.0001
Filter	1	1	4036.821	6.1445	0.0176

Filter

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
0.1 Mott	103.16091	5.4646958	103.161
0.1 Pall	122.31773	5.4646958	122.318

* Values less than 0.05 indicate statistically significant effects

Table B-3. Statistical Analysis of Graver and 0.1 μm Mott Media.

Response Flux

Whole Model

Summary of Fit

RSquare	0.775697
RSquare Adj	0.752692
Root Mean Square Error	23.68235
Mean of Response	111.5443
Observations (or Sum Wgts)	44

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	4	75643.413	18910.9	33.7180
Error	39	21873.294	560.9	Prob > F*
C. Total	43	97516.706		<.0001

Lack Of Fit

Source	DF	Sum of Squares	Mean Square	F Ratio
Lack Of Fit	31	11126.270	358.91	0.2672
Pure Error	8	10747.024	1343.38	Prob > F*
Total Error	39	21873.294		0.9964
				Max RSq
				0.8898

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|*
Intercept	27.39599	17.59026	1.56	0.1274
TIS	-12.69499	1.69608	-7.48	<.0001
TMP	8.5259228	5.886187	1.45	0.1555
Vel	35.334144	4.18643	8.44	<.0001
Filter[0.1 Mott]	-8.383409	3.570249	-2.35	0.0240

Table B-3. Statistical Analysis of Graver and 0.1 μm Mott Media (continued).

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F*
TIS	1	1	31421.117	56.0237	<.0001
TMP	1	1	1176.696	2.0980	0.1555
Vel	1	1	39953.146	71.2363	<.0001
Filter	1	1	3092.388	5.5137	0.0240

Filter

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
0.1 Mott	103.16091	5.0490939	103.161
Graver	119.92773	5.0490939	119.928

* Values less than 0.05 indicate statistically significant effects

Table B-4. Statistical Analysis of 0.1 μm Pall and Graver Media.

Response Flux

Whole Model

Summary of Fit

RSquare	0.759814
RSquare Adj	0.73518
Root Mean Square Error	26.51919
Mean of Response	121.1227
Observations (or Sum Wgts)	44

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	4	86765.18	21691.3	30.8436
Error	39	27427.44	703.3	Prob > F*
C. Total	43	114192.61		<.0001

Lack Of Fit

Source	DF	Sum of Squares	Mean Square	F Ratio
Lack Of Fit	31	14179.280	457.40	0.2762
Pure Error	8	13248.155	1656.02	Prob > F*
Total Error	39	27427.435		0.9956
				Max RSq
				0.8840

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|*
Intercept	29.523339	19.69735	1.50	0.1420
TIS	-13.19305	1.899249	-6.95	<.0001
TMP	6.0132893	6.591277	0.91	0.3672
Vel	40.381227	4.687911	8.61	<.0001
Filter[0.1 Pall]	1.195	3.997919	0.30	0.7666

Table B-4. Statistical Analysis of 0.1 μm Pall and Graver Media (continued).

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F*
TIS	1	1	33934.940	48.2532	<.0001
TMP	1	1	585.337	0.8323	0.3672
Vel	1	1	52182.016	74.1994	<.0001
Filter	1	1	62.833	0.0893	0.7666

Filter

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
0.1 Pall	122.31773	5.6539108	122.318
Graver	119.92773	5.6539108	119.928

* Values less than 0.05 indicate statistically significant effects

Table B-5. Statistical Analysis of 0.1 μm Mott and 0.5 μm Mott Media.

Response Flux

Whole Model

Summary of Fit

RSquare	0.708038
RSquare Adj	0.678093
Root Mean Square Error	23.26767
Mean of Response	103.0682
Observations (or Sum Wgts)	44

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	4	51203.640	12800.9	23.6448
Error	39	21114.000	541.4	Prob > F*
C. Total	43	72317.640		<.0001

Lack Of Fit

Source	DF	Sum of Squares	Mean Square	F Ratio
Lack Of Fit	31	12165.153	392.42	0.3508
Pure Error	8	8948.846	1118.61	Prob > F*
Total Error	39	21114.000		0.9830
				Max RSq
				0.8763

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|*
Intercept	25.594162	17.28226	1.48	0.1467
TIS	-10.31095	1.666382	-6.19	<.0001
TMP	9.454631	5.78312	1.63	0.1101
Vel	30.118288	4.113126	7.32	<.0001
Filter[0.1 Mott]	0.0927273	3.507734	0.03	0.9790

Table B-5. Statistical Analysis of 0.1 μm Mott and 0.5 μm Mott Media (continued).

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F*
TIS	1	1	20727.841	38.2867	<.0001
TMP	1	1	1447.007	2.6728	0.1101
Vel	1	1	29028.352	53.6187	<.0001
Filter	1	1	0.378	0.0007	0.9790

Filter

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
0.1 Mott	103.16091	4.9606846	103.161
0.5 Mott	102.97545	4.9606846	102.975

* Values less than 0.05 indicate statistically significant effects

Table B-6. Statistical Data for tests performed at 35 °C.

Response Flux@35C

Whole Model

Summary of Fit

RSquare	0.820902
RSquare Adj	0.805977
Root Mean Square Error	0.013713
Mean of Response	0.082455
Observations (or Sum Wgts)	66

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	5	0.05171385	0.010343	55.0025
Error	60	0.01128251	0.000188	Prob > F*
C. Total	65	0.06299636		<.0001

Lack Of Fit

Source	DF	Sum of Squares	Mean Square	F Ratio
Lack Of Fit	48	0.00946784	0.000197	1.3044
Pure Error	12	0.00181467	0.000151	Prob > F*
Total Error	60	0.01128251		0.3196
				Max RSq
				0.9712

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|*
Intercept	0.0464884	0.008329	5.58	<.0001
Filter[0.1 Mott]	-0.008275	0.002387	-3.47	0.0010
Filter[0.1 Pall]	0.0056855	0.002387	2.38	0.0204
TIS	-0.010435	0.00076	-13.72	<.0001
TMP	0.0004765	0.000192	2.48	0.0159
Axial Velocity	0.005067	0.000614	8.26	<.0001

Table B-6. Statistical Data for tests performed at 35 °C (continued).

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F*
Filter	2	2	0.00236471	6.2877	0.0033
TIS	1	1	0.03542117	188.3685	<.0001
TMP	1	1	0.00115782	6.1573	0.0159
Axial Velocity	1	1	0.01282412	68.1982	<.0001

Filter

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
0.1 Mott	0.07417999	0.00292363	0.074318
0.1 Pall	0.08814002	0.00292378	0.087864
Graver	0.08504363	0.00292363	0.085182

* Values less than 0.05 indicate statistically significant effects

Appendix C

Variation Testing

Water Flux

Appendix C

Variation Testing

Water Flux

Table C-1. Pristine Water Flux (Graver 0.07 μm).

Pristine Water Flux Graver 0.07														
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.07	2:00	na	0.244	0.013	0.054	10	7	10	10	0	10	23	0.276	0.292
A-0.07	2:30	na	0.153	0.013	0.087	20	7	20	20	0	20	23	0.441	0.467
A-0.07	3:00	na	0.108	0.013	0.123	30	7	31	30	0	30.5	24	0.626	0.644
A-0.07	3:30	na	0.084	0.013	0.158	40	7	41	40	0	40.5	26	0.803	0.781
A-0.07	4:00	na	0.069	0.013	0.192	50	7	50	50	0	50	28	0.978	0.899
B-0.07	12:10	na	0.182	0.013	0.073	10	7	12	10	0	11	22	0.370	0.403
B-0.07	12:40	na	0.115	0.013	0.115	20	7	22	20	0	21	22	0.587	0.639
B-0.07	1:10	na	0.076	0.013	0.175	30	7	32	30	0	31	24	0.891	0.917
B-0.07	1:40	na	0.057	0.013	0.230	40	7	42	40	0	41	26	1.174	1.141
B-0.07	2:10	na	0.047	0.013	0.281	50	7	52	50	0	51	29	1.432	1.281
C-0.07	6:50	na	0.289	0.013	0.046	10	7	10	10	0	10	21	0.233	0.261
C-0.07	7:20	na	0.187	0.013	0.071	20	7	20	20	0	20	22	0.360	0.392
C-0.07	7:50	na	0.154	0.013	0.086	30	7	30	30	0	30	24	0.438	0.450
C-0.07	8:20	na	0.141	0.013	0.094	40	7	41	40	0	40.5	26	0.477	0.464
C-0.07	8:50	na	0.120	0.013	0.110	50	7	51	50	0	50.5	29	0.562	0.503
D-0.07	9:30	na	0.271	0.013	0.049	10	7	10	10	0	10	22	0.248	0.270
D-0.07	10:00	na	0.144	0.013	0.092	20	7	20	20	0	20	23	0.468	0.496
D-0.07	10:30	na	0.098	0.013	0.135	30	7	31	30	0	30.5	24	0.688	0.708
D-0.07	11:00	na	0.073	0.013	0.180	40	7	40	40	0	40	26	0.918	0.892
D-0.07	11:30	na	0.057	0.013	0.232	50	7	50	50	0	50	29	1.184	1.060
E-0.07	10:45	na	0.314	0.016	0.050	10	7	10	10	0	10	25	0.257	0.257
E-0.07	11:15	na	0.154	0.013	0.086	20	7	20	20	0	20	27	0.437	0.414
E-0.07	11:45	na	0.104	0.013	0.127	30	7	31	30	0	30.5	29	0.649	0.581
E-0.07	12:15	na	0.093	0.013	0.142	40	7	40	40	0	40	29	0.722	0.646
E-0.07	12:45	na	0.112	0.013	0.118	50	7	50	50	0	50	31	0.604	0.511

Table C-2. Conditioning Sequence (Graver 0.07 μm).

Conditioning Sequence Graver 0.01 (0.01M NaOH)														
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.07	7:25	na	0.129	0.013	0.102	30	9	31	30	0	30.5	26	0.521	0.507
B-0.07	12:45	na	0.086	0.013	0.153	30	9	32	30	0	31	26	0.781	0.759
C-0.07	2:15	na	0.214	0.013	0.062	30	9	33	30	0	31.5	25	0.314	0.314
D-0.07	7:50	na	0.102	0.013	0.130	30	9	32	30	0	31	25	0.663	0.663
E-0.07	10:35	na	0.213	0.013	0.062	30	9	31	30	0	30.5	23	0.316	0.335
Conditioning Sequence Graver 0.01 (1.0M $HNO_{3)}$														
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.07	8:00	na	0.075	0.013	0.177	30	9	31	30	0	30.5	26	0.899	0.874
B-0.07	1:20	na	0.066	0.013	0.201	30	9	33	30	0	31.5	25	1.022	1.022
C-0.07	2:50	na	0.068	0.013	0.193	30	9	32.5	30	0	31.25	26	0.985	0.958
D-0.07	8:25	na	0.086	0.013	0.154	30	9	32	30	0	31	23	0.784	0.830
E-0.07	11:25	na	0.113	0.013	0.117	30	9	31	30	0	30.5	25	0.596	0.596
Conditioning Sequene Graver 0.01 (0.5M Oxalic Acid)														
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.07	8:45	na	0.081	0.013	0.163	30	9	31	30	0	30.5	25	0.833	0.833
B-0.07	1:55	na	0.068	0.013	0.194	30	9	33	30	0	31.5	25	0.990	0.990
C-0.07	3:30	na	0.075	0.013	0.177	30	9	33	30	0	31.5	25	0.899	0.899
D-0.07	9:20	na	0.088	0.013	0.150	30	9	32	30	0	31	24	0.765	0.787
E-0.07	12:30	na	0.109	0.013	0.121	30	9	31	30	0	30.5	25	0.616	0.616

Table C-3. Repeated Water Flux (Graver 0.07 µm).

Repeated Water Flux Graver 0.07														
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.07	9:25	na	0.228	0.013	0.058	10	7	10	10	0	10	21	0.296	0.331
A-0.07	9:55	na	0.128	0.013	0.103	20	7	20.5	20	0	20.25	21	0.526	0.589
A-0.07	10:25	na	0.089	0.013	0.149	30	7	31	30	0	30.5	22	0.760	0.828
A-0.07	10:55	na	0.060	0.013	0.220	40	7	41	40	0	40.5	24	1.118	1.151
A-0.07	11:25	na	0.046	0.013	0.285	50	7	50.5	50	0	50.25	27	1.452	1.373
B-0.07	2:30	na	0.176	0.013	0.075	10	7	12	10	0	11	21	0.382	0.429
B-0.07	3:00	na	0.104	0.013	0.128	20	7	22	20	0	21	21	0.650	0.729
B-0.07	3:30	na	0.066	0.013	0.200	30	7	32	30	0	31	22	1.017	1.108
B-0.07	4:00	na	0.049	0.013	0.272	40	7	42	40	0	41	25	1.388	1.388
B-0.07	4:30	na	0.039	0.013	0.337	50	7	51	50	0	50.5	27	1.718	1.625
C-0.07	4:10	na	0.187	0.013	0.071	10	7	12	10	0	11	20	0.360	0.415
C-0.07	4:40	na	0.112	0.013	0.118	20	7	22	20	0	21	21	0.601	0.673
C-0.07	5:10	na	0.076	0.013	0.175	30	7	32	30	0	31	22	0.891	0.971
C-0.07	6:40	na	0.054	0.013	0.246	40	7	42	40	0	41	25	1.254	1.254
C-0.07	7:10	na	0.043	0.013	0.311	50	7	52	50	0	51	27	1.583	1.497
D-0.07	10:00	na	0.221	0.013	0.060	10	7	12	10	0	11	20	0.305	0.352
D-0.07	10:30	na	0.123	0.013	0.108	20	7	21	20	0	20.5	21	0.548	0.614
D-0.07	11:00	na	0.086	0.013	0.154	30	7	32	30	0	31	23	0.784	0.830
D-0.07	11:30	na	0.061	0.013	0.217	40	7	42	40	0	41	25	1.103	1.103
D-0.07	12:00	na	0.046	0.013	0.287	50	7	52	50	0	51	28	1.463	1.346
E-0.07	1:30	na	0.282	0.013	0.047	10	7	10	10	0	10	20	0.238	0.275
E-0.07	2:00	na	0.154	0.013	0.086	20	7	20	20	0	20	21	0.437	0.489
E-0.07	2:30	na	0.107	0.013	0.124	30	7	30	30	0	30	23	0.630	0.667
E-0.07	3:00	na	0.076	0.013	0.175	40	7	41	40	0	40.5	25	0.889	0.889
E-0.07	3:30	na	0.055	0.013	0.239	50	7	51	50	0	50.5	28	1.216	1.119

Table C-4. Final Water Flux (Graver 0.07 µm).

Final Water Flux Graver 0.07 (Following $SrCO_3$ Flux)														
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psid)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.07	2:20	na	0.311	0.013	0.042	10	7	10	10	0	10	19	0.216	0.257
A-0.07	2:50	na	0.155	0.013	0.085	20	7	20	20	0	20	20	0.433	0.500
A-0.07	3:20	na	0.101	0.013	0.131	30	7	30	30	0	30	21	0.670	0.751
A-0.07	3:50	na	0.077	0.013	0.171	40	7	40.5	39.5	0	40	22	0.872	0.950
A-0.07	4:20	na	0.061	0.013	0.215	50	7	49.5	50.5	0	50	25	1.097	1.097
B-0.07	2:20	na	0.300	0.013	0.044	10	7	10	10	0	10	21	0.225	0.252
B-0.07	2:50	na	0.154	0.013	0.086	20	7	19.5	20.5	0	20	21	0.438	0.491
B-0.07	3:20	na	0.104	0.013	0.127	30	7	29.5	30.5	0	30	22	0.646	0.704
B-0.07	3:50	na	0.077	0.013	0.172	40	7	39.5	40.5	0	40	22	0.874	0.952
B-0.07	4:20	na	0.060	0.013	0.220	50	7	49	51	0	50	23	1.122	1.187
C-0.07	2:55	na	0.282	0.013	0.047	10	7	10	10	0	10	22	0.239	0.260
C-0.07	3:25	na	0.140	0.013	0.095	20	7	20	20	0	20	20	0.482	0.557
C-0.07	3:55	na	0.087	0.013	0.152	30	7	30	30	0	30	21	0.772	0.865
C-0.07	4:25	na	0.063	0.013	0.209	40	7	40.5	39.5	0	40	23	1.063	1.125
C-0.07	4:55	na	0.049	0.013	0.271	50	7	50.5	49.5	0	50	26	1.383	1.345
D-0.07	2:10	na	0.320	0.013	0.041	10	7	10	10	0	10	19	0.210	0.250
D-0.07	2:40	na	0.159	0.013	0.083	20	7	20	20	0	20	20	0.422	0.487
D-0.07	3:10	na	0.103	0.013	0.129	30	7	30	30	0	30	21	0.655	0.735
D-0.07	3:40	na	0.075	0.013	0.177	40	7	40.5	39.5	0	40	23	0.899	0.952
D-0.07	4:10	na	0.056	0.013	0.234	50	7	51	49	0	50	25	1.195	1.195
E-0.07	8:55	na	0.352	0.013	0.038	10	7	10	10	0	10	19	0.191	0.227
E-0.07	9:25	na	0.186	0.013	0.071	20	7	20	20	0	20	19	0.361	0.429
E-0.07	9:55	na	0.126	0.013	0.105	30	7	30.5	29.5	0	30	20	0.533	0.615
E-0.07	10:25	na	0.093	0.013	0.142	40	7	40.5	39.5	0	40	23	0.725	0.767
E-0.07	10:55	na	0.079	0.013	0.167	50	7	50.5	49.5	0	50	25	0.852	0.852

Table C-5. Pristine Water Flux (Mott 0.1 µm).

Pristine Water Flux Mott 0.1														
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.1	1:45	na	0.347	0.053	0.152	10	7	10	10	0	10	25	0.776	0.776
A-0.1	2:15	na	0.166	0.053	0.319	20	7	19	20	3	16.5	24	1.625	1.671
A-0.1	2:45	na	0.118	0.053	0.448	30	7	30	30	4	26	24	2.284	2.350
A-0.1	3:15	na	0.093	0.053	0.569	40	7	41	40	6	34.5	24	2.900	2.983
A-0.1	3:45	na	0.080	0.053	0.663	50	7	51	50	10	40.5	24	3.379	3.476
B-0.1	12:35	na	0.287	0.053	0.184	10	7	10	10	0	10	24	0.937	0.964
B-0.1	1:05	na	0.147	0.053	0.360	20	7	20	20	3	17	24	1.833	1.886
B-0.1	1:35	na	0.104	0.053	0.509	30	7	30	30	5	25	25	2.592	2.592
B-0.1	2:05	na	0.083	0.053	0.635	40	7	40	40	8	32	25	3.237	3.237
B-0.1	2:35	na	0.073	0.053	0.729	50	7	51	50	12	38.5	26	3.713	3.610
C-0.1	7:00	na	0.319	0.053	0.166	10	7	10	10	0	10	23	0.843	0.893
C-0.1	7:30	na	0.165	0.053	0.320	20	7	19	20	3	16.5	24	1.631	1.678
C-0.1	8:00	na	0.111	0.053	0.475	30	7	30	30	4	26	24	2.421	2.491
C-0.1	8:30	na	0.086	0.053	0.617	40	7	40	40	8	32	25	3.142	3.142
C-0.1	9:00	na	0.074	0.053	0.711	50	7	51	50	10	40.5	26	3.621	3.521
D-0.1	9:55	na	0.277	0.053	0.191	10	7	10	10	0	10	24	0.971	0.998
D-0.1	10:25	na	0.141	0.053	0.375	20	7	20	20	3	17	24	1.909	1.964
D-0.1	10:55	na	0.097	0.053	0.543	30	7	30	30	6	24	25	2.766	2.766
D-0.1	11:25	na	0.076	0.053	0.698	40	7	40	40	9	31	25	3.557	3.557
D-0.1	11:55	na	0.066	0.053	0.807	50	7	51	50	14	36.5	26	4.110	3.996
E-0.1	10:30	na	0.279	0.053	0.189	10	7	10	10	0	10	21	0.964	1.081
E-0.1	11:00	na	0.144	0.053	0.367	20	7	20	20	3	17	23	1.867	1.976
E-0.1	11:30	na	0.086	0.053	0.618	30	7	30	30	5	25	25	3.148	3.148
E-0.1	12:00	na	0.076	0.053	0.695	40	7	40	40	10	30	25	3.542	3.542
E-0.1	12:30	na	0.068	0.053	0.773	50	7	51	50	14	36.5	25	3.939	3.939

Table C-6. Conditioning Sequence (Mott 0.1 µm).

Conditioning Sequence															
Mott 0.1 (0.01M NaOH)															
Membrane Number	Clock Time	Cumulative Time (min)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.1	7:30	na	0.121	0.053	0.437	30	9	30	30	3	27	24	2.228	2.292
B-0.1	12:30	na	0.105	0.053	0.502	30	9	30	30	5	25	25	2.556	2.556
C-0.1	2:30	na	0.119	0.053	0.445	30	9	30	30	4	26	24	2.265	2.330
D-0.1	8:00	na	0.095	0.053	0.559	30	9	31	30	6	24.5	24	2.848	2.930
E-0.1	10:40	na	0.094	0.053	0.560	30	9	31	30	6	24.5	24	2.854	2.935
Conditioning Sequence														
Mott 0.1 (1.0M HNO_3)														
Membrane Number	Clock Time	Cumulative Time (min)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.1	8:05	na	0.117	0.053	0.453	30	9	30	30	5	25	24	2.307	2.373
B-0.1	1:05	na	0.100	0.053	0.527	30	9	31	30	6	24.5	25	2.683	2.683
C-0.1	3:05	na	0.114	0.053	0.466	30	9	30	30	5	25	24	2.372	2.440
D-0.1	8:30	na	0.092	0.053	0.573	30	9	31.5	30	6	24.75	24	2.921	3.004
E-0.1	11:20	na	0.095	0.053	0.556	30	9	31	30	6.5	24	25	2.833	2.833
Conditioning Sequence														
Mott 0.1 (0.5M Oxalic Acid)														
Membrane Number	Clock Time	Cumulative Time (min)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.1	8:50	na	0.122	0.053	0.433	30	9	30	30	4	26	24	2.203	2.267
B-0.1	1:40	na	0.109	0.053	0.486	30	9	30	30	5	25	25	2.477	2.477
C-0.1	3:45	na	0.114	0.053	0.464	30	9	30	30	4	26	24	2.361	2.429
D-0.1	9:15	na	0.094	0.053	0.560	30	9	31	30	6	24.5	24	2.854	2.935
E-0.1	12:25	na	0.102	0.053	0.520	30	9	31	30	6	24.5	24	2.648	2.724

Table C-7. Repeated Water Flux (Mott 0.1 µm).

Repeated Water Flux														
Mott 0.1														
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.1	9:35	na	0.335	0.053	0.158	10	7	10	10	0	10	24	0.803	0.826
A-0.1	10:05	na	0.170	0.053	0.311	20	7	20	20	0	20	24	1.587	1.632
A-0.1	10:35	na	0.114	0.053	0.464	30	7	30	30	3.5	26.5	24	2.361	2.429
A-0.1	11:05	na	0.091	0.053	0.581	40	7	40.5	40	7	33.25	24	2.958	3.043
A-0.1	11:35	na	0.069	0.053	0.766	50	7	51	50	11	39.5	24	3.901	4.013
B-0.1	2:15	na	0.293	0.053	0.180	10	7	10	10	0	10	24	0.919	0.946
B-0.1	2:45	na	0.143	0.053	0.370	20	7	20	20	3	17	24	1.882	1.936
B-0.1	3:15	na	0.101	0.053	0.526	30	7	30	30	5	25	24	2.678	2.755
B-0.1	3:45	na	0.079	0.053	0.669	40	7	40	40	9	31	24	3.407	3.505
B-0.1	4:15	na	0.065	0.053	0.811	50	7	51	50	12	38.5	24	4.131	4.249
C-0.1	4:15	na	0.327	0.053	0.162	10	7	10	10	0	10	24	0.824	0.847
C-0.1	4:45	na	0.154	0.053	0.343	20	7	20	20	0	20	24	1.750	1.800
C-0.1	5:15	na	0.104	0.053	0.508	30	7	30	30	4	26	23	2.588	2.739
C-0.1	6:45	na	0.084	0.053	0.633	40	7	40	40	7.5	32.5	24	3.224	3.316
C-0.1	7:15	na	0.072	0.053	0.736	50	7	50.5	50	11	39.25	24	3.747	3.855
D-0.1	9:55	na	0.239	0.053	0.221	10	7	11	10	0	10.5	24	1.125	1.158
D-0.1	10:25	na	0.129	0.053	0.410	20	7	21	20	3	17.5	24	2.087	2.146
D-0.1	10:55	na	0.095	0.053	0.558	30	7	31	30	6	24.5	24	2.843	2.925
D-0.1	11:25	na	0.077	0.053	0.683	40	7	41	40	10	30.5	24	3.481	3.581
D-0.1	11:55	na	0.062	0.053	0.848	50	7	50.5	50	14	36.25	25	4.318	4.318
E-0.1	1:20	na	0.244	0.053	0.217	10	7	12	10	0	11	24	1.105	1.136
E-0.1	1:50	na	0.135	0.053	0.393	20	7	21	20	3	17.5	24	2.001	2.059
E-0.1	2:20	na	0.097	0.053	0.544	30	7	31	30	6	24.5	24	2.770	2.850
E-0.1	2:50	na	0.076	0.053	0.698	40	7	40	40	10	30	24	3.557	3.659
E-0.1	3:20	na	0.065	0.053	0.817	50	7	50	50	14	36	24	4.163	4.282

Table C-8. Final Water Flux (Mott 0.1 µm).

Final Water Flux														
Mott 0.1 (Following $SrCO_3$ Flux)														
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.1	2:45	na	0.335	0.053	0.158	10	7	10	10	0	10	24	0.804	0.827
A-0.1	3:15	na	0.179	0.053	0.296	20	7	20	20	0	20	24	1.508	1.551
A-0.1	3:45	na	0.135	0.053	0.391	30	7	33	33	3	30	23	1.991	2.108
A-0.1	4:15	na	0.096	0.053	0.552	40	7	45	45	5	40	23	2.814	2.978
A-0.1	4:45	na	0.079	0.053	0.672	50	7	59	59	9	50	24	3.422	3.520
B-0.1	12:50	na	0.240	0.053	0.220	10	7	10	10	0	10	24	1.122	1.154
B-0.1	1:20	na	0.140	0.053	0.377	20	7	20	20	0	20	24	1.920	1.975
B-0.1	1:50	na	0.083	0.053	0.634	30	7	37	37	7	30	25	3.230	3.230
B-0.1	2:20	na	0.095	0.079	0.833	40	7	55	55	15	40	26	4.243	4.125
B-0.1	2:50	na	0.070	0.079	1.138	50	7	72	72	22	50	26	5.796	5.635
C-0.1	3:50	na	0.250	0.053	0.211	10	7	10	10	0	10	24	1.076	1.107
C-0.1	4:20	na	0.129	0.053	0.410	20	7	23	23	3	20	24	2.089	2.149
C-0.1	4:50	na	0.092	0.053	0.574	30	7	36	36	6	30	25	2.926	2.926
C-0.1	6:55	na	0.106	0.079	0.748	40	7	50	50	10	40	24	3.809	3.918
C-0.1	7:25	na	0.083	0.079	0.959	50	7	67	67	17	50	26	4.884	4.749
D-0.1	2:20	na	0.207	0.053	0.255	10	7	10	10	0	10	24	1.299	1.337
D-0.1	2:50	na	0.104	0.053	0.508	20	7	24	24	4	20	24	2.588	2.662
D-0.1	3:20	na	0.073	0.053	0.727	30	7	39	39	9	30	25	3.704	3.704
D-0.1	3:50	na	0.055	0.053	0.958	40	7	55	55	15	40	26	4.879	4.744
D-0.1	4:20	na	0.091	0.106	1.159	50	7	76	76	26	50	27	5.905	5.584
E-0.1	8:30	na	0.228	0.053	0.232	10	7	10	10	0	10	24	1.183	1.217
E-0.1	9:00	na	0.121	0.053	0.436	20	7	23	23	3	20	23	2.219	2.348
E-0.1	9:30	na	0.083	0.053	0.637	30	7	37	37	7	30	23	3.243	3.432
E-0.1	10:00	na	0.063	0.053	0.834	40	7	53	53	13	40	23	4.250	4.498
E-0.1	10:30	na	0.099	0.106	1.069	50	7	70	70	20	50	24	5.447	5.603

Table C-9. Pristine Water Flux (Mott 0.5 µm).

Pristine Water Flux Mott 0.5														
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.5	10:45	na	0.201	0.079	0.395	10	7	9	10	4	5.5	19	2.014	2.393
A-0.5	11:15	na	0.129	0.079	0.615	20	7	19	21	12	8	20	3.134	3.616
A-0.5	11:45	na	0.094	0.079	0.846	30	7	30	30	21	9	22	4.311	4.696
A-0.5	12:15	na	0.079	0.079	1.010	40	7	40	40	29	11	24	5.144	5.291
A-0.5	12:45	na	0.072	0.079	1.101	50	7	49	50	38	11.5	27	5.608	5.303
B-0.5	6:50	na	0.217	0.079	0.365	10	7	9	10	4	5.5	19	1.859	2.209
B-0.5	7:20	na	0.130	0.079	0.608	20	7	19	20	11	8.5	19	3.098	3.681
B-0.5	7:50	na	0.104	0.079	0.762	30	7	29	30	19	10.5	21	3.882	4.352
B-0.5	8:20	na	0.087	0.079	0.916	40	7	39	40	26	13.5	24	4.668	4.802
B-0.5	8:50	na	0.073	0.079	1.081	50	7	49	50	35	14.5	26	5.506	5.354
C-0.5	1:35	na	0.199	0.079	0.399	10	7	9	11	4	6	19	2.034	2.417
C-0.5	2:05	na	0.132	0.079	0.601	20	7	19	21	11	9	20	3.063	3.534
C-0.5	2:35	na	0.101	0.079	0.786	30	7	29	30	19	10.5	21	4.004	4.488
C-0.5	3:05	na	0.086	0.079	0.923	40	7	39	40	27	12.5	24	4.704	4.839
C-0.5	3:35	na	0.075	0.079	1.052	50	7	49	50	36	14.5	26	5.360	5.211
D-0.5	9:45	na	0.180	0.079	0.441	10	7	14	10	0	12	19	2.245	2.668
D-0.5	10:15	na	0.122	0.079	0.651	20	7	23	20	13	8.5	20	3.319	3.829
D-0.5	10:45	na	0.097	0.079	0.819	30	7	32	30	20	11	22	4.170	4.541
D-0.5	11:15	na	0.084	0.079	0.949	40	7	42	40	29	12	24	4.836	4.974
D-0.5	11:45	na	0.076	0.079	1.054	50	7	52	50	32	19	26	5.372	5.223
E-0.5	7:45	na	0.217	0.079	0.366	10	7	9	11	3	7	18	1.865	2.282
E-0.5	8:15	na	0.132	0.079	0.603	20	7	19	21	10	10	19	3.071	3.648
E-0.5	8:45	na	0.106	0.079	0.745	30	7	29	30	18	11.5	20	3.797	4.382
E-0.5	9:15	na	0.090	0.079	0.884	40	7	39	40	27	12.5	22	4.503	4.904
E-0.5	9:45	na	0.073	0.079	1.083	50	7	49	51	34	16	25	5.519	5.519

Table C-10. Conditioning Sequence (Mott 0.5 µm).

Conditioning Sequence Mott 0.5 (0.01M NaOH)														
Membrane Number	Clock Time	Cumulative Time (min)	Time (min)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.5	9:15	na	0.095	0.079	0.836	30	9	31	29	20	10	25	4.258	4.258
B-0.5	6:45	na	0.107	0.079	0.741	30	9	29	30	18	11.5	22	3.774	4.110
C-0.5	5:40	na	0.112	0.079	0.708	30	9	29	30	17	12.5	28	3.605	3.316
D-0.5	10:20	na	0.105	0.079	0.757	30	9	29	30	20	9.5	22	3.858	4.201
E-0.5	1:00	na	0.102	0.079	0.776	30	9	32	30	18	13	22	3.952	4.304
Conditioning Sequence Mott 0.5 (1.0M HNO_3)														
Membrane Number	Clock Time	Cumulative Time (min)	Time (min)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.5	9:55	na	0.097	0.079	0.814	30	9	31	29	20	10	25	4.148	4.148
B-0.5	7:25	na	0.102	0.079	0.778	30	9	29	30	18	11.5	22	3.965	4.318
C-0.5	6:25	na	0.106	0.079	0.745	30	9	29	30	19	10.5	22	3.797	4.135
D-0.5	10:55	na	0.100	0.079	0.795	30	9	29	30	20	9.5	22	4.051	4.412
E-0.5	1:35	na	0.100	0.079	0.797	30	9	32	30	20	11	23	4.058	4.296
Conditioning Sequence Mott 0.5 (0.5M Oxalic Acid)														
Membrane Number	Clock Time	Cumulative Time (min)	Time (min)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.5	10:50	na	0.095	0.079	0.833	30	9	31	29	21	9	24	4.243	4.364
B-0.5	8:30	na	0.107	0.079	0.741	30	9	29	30	19	10.5	23	3.774	3.994
C-0.5	7:15	na	0.105	0.079	0.758	30	9	29	30	18	11.5	22	3.864	4.208
D-0.5	11:35	na	0.105	0.079	0.757	30	9	28	30	19	10	22	3.858	4.201
E-0.5	2:10	na	0.102	0.079	0.776	30	9	33	30	20	11.5	24	3.952	4.066

Table C-11. Repeated Water Flux (Mott 0.5 µm).

Repeated Water Flux Mott 0.5														
Membrane Number	Clock Time	Cumulative Time (min)	Time (min)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.5	1:40	na	0.176	0.079	0.451	10	7	12	10	5	6	19	2.299	2.731
A-0.5	2:20	na	0.117	0.079	0.677	20	7	23	20	14	7.5	19	3.451	4.100
A-0.5	2:50	na	0.096	0.079	0.827	30	7	33	30	22	9.6	21	4.213	4.723
A-0.5	3:20	na	0.081	0.079	0.983	40	7	42	40	30	11	23	5.006	5.297
A-0.5	3:50	na	0.072	0.079	1.106	50	7	52	50	38	13	26	5.634	5.478
B-0.5	9:05	na	0.221	0.079	0.358	10	7	8	10	3	6	18	1.824	2.232
B-0.5	9:35	na	0.138	0.079	0.573	20	7	18	20	10	9	18	2.919	3.571
B-0.5	10:05	na	0.106	0.079	0.751	30	7	29	31	19	11	20	3.827	4.416
B-0.5	10:35	na	0.086	0.079	0.929	40	7	39	41	27	13	23	4.732	5.008
B-0.5	11:05	na	0.074	0.079	1.066	50	7	49	51	35	15	26	5.432	5.282
C-0.5	7:55	na	0.208	0.079	0.381	10	7	9	10	4	5.5	18	1.941	2.375
C-0.5	8:25	na	0.132	0.079	0.600	20	7	19	20	11	8.5	18	3.059	3.743
C-0.5	8:55	na	0.099	0.079	0.805	30	7	29	30	19	10.5	20	4.099	4.730
C-0.5	9:25	na	0.081	0.079	0.981	40	7	39	40	27	12.5	22	4.996	5.440
C-0.5	9:55	na	0.072	0.079	1.109	50	7	49	51	35	15	23	5.647	5.976
D-0.5	12:20	na	0.203	0.079	0.390	10	7	9	11	4	6	18	1.987	2.432
D-0.5	12:50	na	0.125	0.079	0.632	20	7	19	21	12	8	19	3.222	3.828
D-0.5	1:20	na	0.104	0.079	0.766	30	7	29	31	20	10	20	3.901	4.502
D-0.5	1:50	na	0.086	0.079	0.938	40	7	39	41	28	12	23	4.778	5.057
D-0.5	2:20	na	0.073	0.079	1.083	50	7	49	50	35	14.5	23	5.519	5.840
E-0.5	6:55	na	0.190	0.079	0.418	10	7	13	10	5	6.5	18	2.129	2.605
E-0.5	7:25	na	0.126	0.079	0.632	20	7	23	20	11	10.5	19	3.217	3.823
E-0.5	7:55	na	0.101	0.079	0.782	30	7	32	20	20	6	20	3.985	4.598
E-0.5	8:25	na	0.089	0.079	0.896	40	7	42	40	27	14	22	4.562	4.969
E-0.5	8:55	na	0.069	0.079	1.149	50	7	51	50	35	15.5	25	5.852	5.852

Table C-12. Final Water Flux (Mott 0.5 μm).

Final Water Flux Mott 0.5 (Following $SrCO_3$ Flux)														
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.5	1:50	na	0.192	0.079	0.414	10	7	9.5	10.5	5	5	20	2.107	2.431
A-0.5	2:20	na	0.118	0.079	0.675	20	7	19.5	20.5	13	7	21	3.436	3.852
A-0.5	2:50	na	0.099	0.079	0.802	30	7	29.5	30.5	21	9	23	4.085	4.324
A-0.5	3:20	na	0.085	0.079	0.932	40	7	39.5	40.5	29	11	25	4.750	4.750
A-0.5	3:50	na	0.068	0.079	1.171	50	7	49.5	50.5	38	12	28	5.967	5.488
B-0.5	1:40	na	0.179	0.079	0.444	10	7	10.5	9.5	8	2	19	2.262	2.688
B-0.5	2:10	na	0.121	0.079	0.658	20	7	20.5	19.5	15	5	20	3.351	3.867
B-0.5	2:40	na	0.100	0.079	0.797	30	7	30.5	29.5	23	7	22	4.058	4.419
B-0.5	3:10	na	0.084	0.079	0.944	40	7	40.5	39.5	31	9	25	4.807	4.807
B-0.5	3:40	na	0.075	0.079	1.059	50	7	50.5	49.5	39	11	27	5.396	5.102
C-0.5	2:40	na	0.172	0.079	0.460	10	7	10.5	9.5	8	2	19	2.343	2.784
C-0.5	3:10	na	0.121	0.079	0.654	20	7	20.5	19.5	15	5	20	3.332	3.845
C-0.5	3:40	na	0.094	0.079	0.842	30	7	30.5	29.5	23	7	22	4.288	4.670
C-0.5	4:10	na	0.079	0.079	1.003	40	7	40.5	39.5	31	9	24	5.111	5.257
C-0.5	4:40	na	0.068	0.079	1.163	50	7	51	49	39	11	26	5.923	5.759
D-0.5	1:40	na	0.194	0.079	0.409	10	7	9	11	4.5	5.5	19	2.081	2.473
D-0.5	2:10	na	0.121	0.079	0.657	20	7	19	21	12	8	21	3.346	3.751
D-0.5	2:40	na	0.099	0.079	0.799	30	7	29	31	20	10	22	4.072	4.434
D-0.5	3:10	na	0.084	0.079	0.944	40	7	39.5	40.5	28	12	25	4.807	4.807
D-0.5	3:40	na	0.074	0.079	1.078	50	7	49	51	37	13	28	5.493	5.053
E-0.5	1:20	na	0.132	0.053	0.402	10	7	9	10	4	5.5	22	2.047	2.229
E-0.5	1:50	na	0.087	0.053	0.605	20	7	19	20	11	8.5	21	3.082	3.455
E-0.5	2:20	na	0.069	0.053	0.768	30	7	29	30	19	10.5	23	3.911	4.139
E-0.5	2:50	na	0.087	0.079	0.908	40	7	39	40	27	12.5	25	4.623	4.623
E-0.5	3:20	na	0.072	0.079	1.109	50	7	50	50	35	15	27	5.647	5.340

Table C-13. Pristine Water Flux (Pall 0.1 μm).

Pristine Water Flux Pall 0.1														
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.1	10:40	na	0.299	0.013	0.044	10	7	9.5	10.5	0	10	20	0.206	0.238
A-0.1	11:10	na	0.144	0.013	0.092	20	7	19	20	0	19.5	21	0.426	0.478
A-0.1	11:40	na	0.099	0.013	0.133	30	7	29.5	30.5	0	30	22	0.621	0.676
A-0.1	12:10	na	0.071	0.013	0.187	40	7	39.5	40.5	0	40	23	0.873	0.924
A-0.1	12:40	na	0.057	0.013	0.231	50	7	49.5	50.5	0	50	24	1.076	1.107
B-0.1	6:45	na	0.323	0.013	0.041	10	7	12	10	0	11	21	0.191	0.214
B-0.1	7:15	na	0.163	0.013	0.081	20	7	23	20	0	21.5	21	0.377	0.423
B-0.1	7:45	na	0.116	0.013	0.114	30	7	33	30	0	31.5	22	0.533	0.580
B-0.1	8:15	na	0.089	0.013	0.149	40	7	43	40	0	41.5	22	0.695	0.757
B-0.1	8:45	na	0.070	0.013	0.188	50	7	53	50	0	51.5	24	0.877	0.902
C-0.1	1:30	na	0.296	0.013	0.045	10	7	10	10	0	10	21	0.208	0.233
C-0.1	2:00	na	0.154	0.013	0.086	20	7	19	20	0	19.5	21	0.400	0.448
C-0.1	2:30	na	0.116	0.013	0.114	30	7	29	30	0	29.5	22	0.531	0.579
C-0.1	3:00	na	0.080	0.013	0.165	40	7	39	40	0	39.5	23	0.768	0.812
C-0.1	3:30	na	0.064	0.013	0.207	50	7	49	50	0	49.5	24	0.967	0.994
D-0.1	9:40	na	0.263	0.013	0.050	10	7	13	10	0	11.5	21	0.234	0.262
D-0.1	10:10	na	0.141	0.013	0.094	20	7	23	20	0	21.5	21	0.437	0.490
D-0.1	10:40	na	0.102	0.013	0.130	30	7	32	20	0	26	22	0.603	0.657
D-0.1	11:10	na	0.075	0.013	0.177	40	7	42	20	0	31	23	0.822	0.870
D-0.1	11:40	na	0.059	0.013	0.226	50	7	53	50	0	51.5	24	1.052	1.082
E-0.1	7:40	na	0.382	0.013	0.035	10	7	9	10	0	9.5	21	0.161	0.181
E-0.1	8:10	na	0.188	0.013	0.070	20	7	19	20	0	19.5	21	0.327	0.367
E-0.1	8:40	na	0.123	0.013	0.108	30	7	29	30	0	29.5	22	0.501	0.546
E-0.1	9:10	na	0.094	0.013	0.141	40	7	39	40	0	39.5	22	0.655	0.713
E-0.1	9:40	na	0.071	0.013	0.187	50	7	49	51	0	50	23	0.873	0.924

Table C-14. Conditioning Sequence (Pall 0.1 μm).

Conditioning Sequence Pall 0.1 (0.01M NaOH)														
Membrane Number	Clock Time	Cumulative Time (min)	Time (min)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.1	6:55	na	0.217	0.013	0.061	30	9	29	30	0	29.5	24	0.284	0.292
B-0.1	4:30	na	0.150	0.013	0.088	30	9	29	30	0	29.5	24	0.409	0.421
C-0.1	6:30	na	0.349	0.013	0.038	30	9	34	30	0	32	23	0.176	0.187
D-0.1	11:50	na	0.153	0.013	0.086	30	9	29	30	0	29.5	25	0.402	0.402
E-0.1	11:50	na	0.401	0.013	0.033	30	9	33	30	0	31.5	25	0.154	0.154

Conditioning Sequence Pall 0.1 (1.0M HNO_3)														
Membrane Number	Clock Time	Cumulative Time (min)	Time (min)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.1	7:30	na	0.090	0.013	0.147	30	9	29	30	0	29.5	25	0.686	0.686
B-0.1	5:00	na	0.106	0.013	0.125	30	9	29	30	0	29.5	25	0.581	0.581
C-0.1	7:35	na	0.092	0.013	0.143	30	9	34	30	0	32	22	0.666	0.726
D-0.1	12:25	na	0.094	0.013	0.141	30	9	29	30	0	29.5	25	0.656	0.656
E-0.1	12:25	na	0.093	0.013	0.143	30	9	33	30	0	31.5	25	0.665	0.665

Conditioning Sequence Pall 0.1 (0.5M Oxalic Acid)														
Membrane Number	Clock Time	Cumulative Time (min)	Time (min)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.1	8:15	na	0.090	0.013	0.147	30	9	29	30	0	29.5	25	0.685	0.685
B-0.1	5:30	na	0.107	0.013	0.124	30	9	29	30	0	29.5	25	0.576	0.576
C-0.1	8:30	na	0.099	0.013	0.133	30	9	33	30	0	31.5	23	0.619	0.656
D-0.1	1:10	na	0.095	0.013	0.139	30	9	33	30	0	31.5	25	0.648	0.648
E-0.1	1:00	na	0.098	0.013	0.135	30	9	33	30	0	31.5	25	0.630	0.630

Table C-15. Repeated Water Flux (Pall 0.1 μm).

Repeated Water Flux														
Pall 0.1														
Membrane Number	Clock Time	Cumulative Time (min)	Time (min)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.1	8:55	na	0.254	0.013	0.052	10	7	9	10	0	9.5	23	0.243	0.257
A-0.1	9:30	na	0.130	0.013	0.102	20	7	19	20	0	19.5	23	0.473	0.501
A-0.1	10:05	na	0.086	0.013	0.155	30	7	29	30	0	29.5	24	0.724	0.745
A-0.1	10:40	na	0.064	0.013	0.207	40	7	39	40	0	39.5	25	0.964	0.964
A-0.1	11:10	na	0.052	0.013	0.257	50	7	49	50	0	49.5	26	1.195	1.162
B-0.1	6:45	na	0.329	0.013	0.040	10	7	9	10	0	9.5	23	0.187	0.198
B-0.1	7:20	na	0.160	0.013	0.083	20	7	19	20	0	19.5	23	0.385	0.407
B-0.1	7:55	na	0.106	0.013	0.125	30	7	29	30	0	29.5	24	0.581	0.597
B-0.1	8:30	na	0.078	0.013	0.170	40	7	39	40	0	39.5	25	0.791	0.791
B-0.1	9:05	na	0.061	0.013	0.215	50	7	49	50	0	49.5	26	1.003	0.976
C-0.1	9:10	na	0.260	0.013	0.051	10	7	13	10	0	11.5	21	0.237	0.265
C-0.1	9:40	na	0.136	0.013	0.097	20	7	23	20	0	21.5	23	0.454	0.480
C-0.1	10:10	na	0.091	0.013	0.145	30	7	33	30	0	31.5	24	0.674	0.693
C-0.1	10:40	na	0.068	0.013	0.193	40	7	43	40	0	41.5	25	0.901	0.901
C-0.1	11:10	na	0.054	0.013	0.245	50	7	53	50	0	51.5	26	1.143	1.111
D-0.1	1:50	na	0.266	0.013	0.050	10	7	9	11	0	10	23	0.232	0.245
D-0.1	2:20	na	0.138	0.013	0.096	20	7	19	20	0	19.5	23	0.445	0.471
D-0.1	2:50	na	0.092	0.013	0.144	30	7	29	30	0	29.5	24	0.669	0.688
D-0.1	3:20	na	0.067	0.013	0.198	40	7	39	40	0	39.5	25	0.923	0.923
D-0.1	3:50	na	0.055	0.013	0.242	50	7	49	50	0	49.5	26	1.129	1.098
E-0.1	1:35	na	0.263	0.013	0.050	10	7	13	10	0	11.5	23	0.234	0.247
E-0.1	2:05	na	0.141	0.013	0.094	20	7	23	20	0	21.5	23	0.438	0.464
E-0.1	2:35	na	0.096	0.013	0.137	30	7	33	30	0	31.5	24	0.639	0.657
E-0.1	3:05	na	0.073	0.013	0.181	40	7	43	40	0	41.5	25	0.841	0.841
E-0.1	3:35	na	0.057	0.013	0.231	50	7	53	50	0	51.5	26	1.076	1.047

Table C-16. Final Water Flux (Pall 0.1 μm).

Final Water Flux														
Pall 0.1 (Following $SrCO_3$ Flux)														
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.1	1:30	na	0.501	0.026	0.053	10	7	9.5	10.5	0	10	21	0.246	0.275
A-0.1	2:00	na	0.273	0.026	0.097	20	7	19.5	20.5	0	20	21	0.451	0.506
A-0.1	2:30	na	0.191	0.026	0.138	30	7	29.5	30.5	0	30	22	0.644	0.701
A-0.1	3:00	na	0.141	0.026	0.187	40	7	39.5	40.5	0	40	23	0.872	0.923
A-0.1	3:30	na	0.113	0.026	0.234	50	7	49.5	50.5	0	50	24	1.092	1.124
B-0.1	1:20	na	0.621	0.026	0.043	10	7	11	9	0	10	20	0.198	0.229
B-0.1	1:50	na	0.334	0.026	0.079	20	7	21	19	0	20	21	0.368	0.413
B-0.1	2:20	na	0.419	0.053	0.126	30	7	31.5	28.5	0	30	22	0.588	0.640
B-0.1	2:50	na	0.318	0.053	0.166	40	7	41.5	38.5	0	40	22	0.773	0.842
B-0.1	3:20	na	0.247	0.053	0.214	50	7	51.5	48.5	0	50	23	0.996	1.054
C-0.1	1:38	na	0.574	0.026	0.046	10	7	9.5	10.5	0	10	21	0.215	0.240
C-0.1	2:08	na	0.596	0.053	0.089	20	7	19.5	20.5	0	20	21	0.413	0.463
C-0.1	2:38	na	0.413	0.053	0.128	30	7	29.5	30.5	0	30	22	0.596	0.649
C-0.1	3:08	na	0.310	0.053	0.170	40	7	39.5	40.5	0	40	22	0.794	0.865
C-0.1	3:38	na	0.251	0.053	0.211	50	7	49.5	50.5	0	50	23	0.981	1.039
D-0.1	1:45	na	0.560	0.026	0.048	10	7	11.5	8.5	0	10	21	0.224	0.251
D-0.1	2:15	na	0.589	0.053	0.090	20	7	21.5	18.5	0	20	21	0.418	0.468
D-0.1	2:45	na	0.388	0.053	0.136	30	7	31.5	28.5	0	30	22	0.635	0.692
D-0.1	3:15	na	0.303	0.053	0.174	40	7	41.5	38.5	0	40	23	0.812	0.859
D-0.1	3:45	na	0.235	0.053	0.225	50	7	51.5	48.5	0	50	24	1.046	1.076
E-0.1	1:50	na	1.184	0.053	0.045	10	7	9.5	10.5	0	10	21	0.208	0.233
E-0.1	2:20	na	0.611	0.053	0.087	20	7	19.5	20.5	0	20	21	0.403	0.452
E-0.1	2:50	na	0.420	0.053	0.126	30	7	29.5	30.5	0	30	22	0.587	0.639
E-0.1	3:20	na	0.315	0.053	0.168	40	7	39.5	40.5	0	40	23	0.782	0.828
E-0.1	3:50	na	0.244	0.053	0.217	50	7	49.5	50.5	0	50	24	1.010	1.039

Table C-17. Pristine Water Flux (Pall 0.8 μm).

Pristine Water Flux														
Pall 0.8														
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.8	10:25	na	0.400	0.053	0.13	10	7	9	10	0	9.5	21	0.743	0.833
A-0.8	10:55	na	0.218	0.053	0.24	20	7	19	20	0	19.5	21	1.363	1.527
A-0.8	11:25	na	0.152	0.053	0.35	30	7	29	30	0	29.5	22	1.959	2.134
A-0.8	11:55	na	0.115	0.053	0.46	40	7	39	40	3	36.5	25	2.589	2.589
A-0.8	12:25	na	0.097	0.053	0.54	50	7	49	50	4	45.5	25	3.060	3.060
B-0.8	8:15	na	0.448	0.053	0.12	10	7	9	11	0	10	22	0.663	0.722
B-0.8	8:45	na	0.355	0.053	0.15	20	7	19.5	20.5	0	20	23	0.835	0.884
B-0.8	9:15	na	0.301	0.053	0.18	30	7	29.5	30.5	0	30	24	0.988	1.016
B-0.8	9:45	na	0.242	0.053	0.22	40	7	39.5	40.5	0	40	24	1.228	1.263
B-0.8	10:15	na	0.212	0.053	0.25	50	7	49.5	50.5	0	50	25	1.403	1.403
C-0.8	10:55	na	0.572	0.053	0.09	10	7	9.5	10.5	0	10	22	0.519	0.565
C-0.8	11:25	na	0.298	0.053	0.18	20	7	19.5	20.5	0	20	23	0.998	1.056
C-0.8	11:55	na	0.209	0.053	0.25	30	7	29.5	30.5	0	30	23	1.421	1.504
C-0.8	12:25	na	0.166	0.053	0.32	40	7	39.5	40.5	0	40	24	1.793	1.845
C-0.8	12:55	na	0.131	0.053	0.40	50	7	49.5	50.5	3	47	25	2.260	2.260
D-0.8	1:10	na	0.729	0.053	0.07	10	7	13	10	0	11.5	23	0.407	0.431
D-0.8	1:40	na	0.427	0.053	0.12	20	7	23	20	0	21.5	23	0.695	0.736
D-0.8	2:10	na	0.289	0.053	0.18	30	7	33	30	0	31.5	23	1.029	1.089
D-0.8	2:40	na	0.221	0.053	0.24	40	7	43	40	0	41.5	24	1.341	1.379
D-0.8	3:10	na	0.177	0.053	0.30	50	7	53	50	0	51.5	24	1.675	1.723
E-0.8	7:40	na	0.134	0.013	0.10	10	7	9	10	0	9.5	21	0.552	0.619
E-0.8	8:10	na	0.259	0.053	0.20	20	7	19	20	0	19.5	22	1.147	1.249
E-0.8	8:40	na	0.179	0.053	0.29	30	7	29	30	0	29.5	22	1.657	1.804
E-0.8	9:10	na	0.135	0.053	0.39	40	7	39	40	3	36.5	23	2.199	2.327
E-0.8	9:40	na	0.109	0.053	0.48	50	7	49	50	4	45.5	24	2.715	2.793

Table C-18. Conditioning Sequence (Pall 0.8 μm).

Conditioning Sequence

Pall 0.8 (0.01M NaOH)

Membrane Number	Clock Time	Cumulative Time (min)	Time (min)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.8	9:00	na	0.259	0.053	0.204	30	9	31.5	28.5	0	30	22	1.145	1.246
B-0.8	6:50	na	0.585	0.026	0.045	30	9	33	30	0	31.5	25	0.254	0.254
C-0.8	5:50	na	1.304	0.013	0.010	30	9	30	30	0	30	22	0.057	0.062
D-0.8	10:25	na	0.505	0.026	0.052	30	9	32	30	0	31	21	0.294	0.329
E-0.8	1:30	na	1.142	0.013	0.012	30	9	34	30	0	32	30	0.065	0.057

Conditioning Sequence

Pall 0.8 (1.0M HNO_3)

Membrane Number	Clock Time	Cumulative Time (min)	Time (min)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.8	9:40	na	0.166	0.053	0.321	30	9	31.5	28.5	3	27	22	1.804	1.966
B-0.8	7:30	na	0.107	0.026	0.247	30	9	33	30	0	31.5	22	1.385	1.508
C-0.8	6:20	na	0.195	0.026	0.135	30	9	30	30	0	30	22	0.760	0.828
D-0.8	11:00	na	0.252	0.053	0.210	30	9	33	29	0	31	22	1.179	1.284
E-0.8	2:05	na	0.053	0.013	0.252	30	9	34	30	0	32	22	1.413	1.539

Conditioning Sequence

Pall 0.8 (0.5M Oxalic Acid)

Membrane Number	Clock Time	Cumulative Time (min)	Time (min)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.8	10:45	na	0.167	0.053	0.317	30	9	31.5	28.5	0	30	22	1.781	1.940
B-0.8	8:35	na	0.090	0.026	0.293	30	9	33	30	0	31.5	22	1.646	1.793
C-0.8	7:10	na	0.157	0.026	0.168	30	9	30	30	0	30	22	0.944	1.028
D-0.8	11:40	na	0.224	0.053	0.236	30	9	33	30	0	31.5	21	1.326	1.486
E-0.8	2:45	na	0.044	0.013	0.298	30	9	34	30	0	32	22	1.674	1.823

Table C-19. Repeated Water Flux (Pall 0.8 μm).

Repeated Water Flux

Pall 0.8

Membrane Number	Clock Time	Cumulative Time (min)	Time (min)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.8	1:45	na	0.366	0.053	0.145	10	7	13	10	0	11.5	25	0.812	0.812
A-0.8	2:15	na	0.241	0.053	0.219	20	7	22	20	0	21	20	1.232	1.421
A-0.8	2:45	na	0.166	0.053	0.319	30	7	33	30	0	31.5	21	1.793	2.010
A-0.8	3:15	na	0.126	0.053	0.420	40	7	43	40	4	37.5	21	2.359	2.644
A-0.8	3:45	na	0.104	0.053	0.508	50	7	52	50	5	46	22	2.854	3.108
B-0.8	9:10	na	0.237	0.026	0.112	10	7	13	10	0	11.5	20	0.627	0.724
B-0.8	9:40	na	0.139	0.026	0.191	20	7	22	19	9	11.5	20	1.070	1.235
B-0.8	10:10	na	0.092	0.026	0.287	30	7	32	29	0	30.5	21	1.613	1.808
B-0.8	10:40	na	0.140	0.053	0.378	40	7	42	39	3	37.5	21	2.123	2.379
B-0.8	11:10	na	0.107	0.053	0.494	50	7	52	49	5	45.5	22	2.774	3.021
C-0.8	7:45	na	0.392	0.026	0.067	10	7	9	10	0	9.5	20	0.379	0.437
C-0.8	8:15	na	0.414	0.053	0.128	20	7	19	21	0	20	20	0.717	0.828
C-0.8	8:45	na	0.159	0.026	0.166	30	7	29	30	0	29.5	21	0.933	1.046
C-0.8	9:15	na	0.253	0.053	0.209	40	7	39	41	0	40	21	1.173	1.315
C-0.8	9:45	na	0.217	0.053	0.244	50	7	49	51	0	50	22	1.368	1.490
D-0.8	12:25	na	0.600	0.053	0.088	10	7	12	10	0	11	20	0.495	0.571
D-0.8	12:55	na	0.330	0.053	0.160	20	7	22	19	0	20.5	20	0.899	1.037
D-0.8	1:25	na	0.241	0.053	0.219	30	7	32	29	0	30.5	21	1.230	1.379
D-0.8	1:55	na	0.187	0.053	0.282	40	7	42	38	0	40	21	1.586	1.778
D-0.8	2:25	na	0.145	0.053	0.365	50	7	52	48	3	47	22	2.052	2.234
E-0.8	6:50	na	0.127	0.013	0.104	10	7	13	10	0	11.5	20	0.586	0.676
E-0.8	7:20	na	0.066	0.013	0.199	20	7	23	20	0	21.5	20	1.119	1.291
E-0.8	7:50	na	0.280	0.079	0.283	30	7	33	30	0	31.5	21	1.591	1.783
E-0.8	8:20	na	0.217	0.079	0.365	40	7	43	40	3	38.5	22	2.049	2.231
E-0.8	8:50	na	0.174	0.079	0.455	50	7	53	50	5	46.5	22	2.556	2.784

Table C-20. Final Water Flux (Pall 0.8 μm).

Final Water Flux

Pall 0.8 (Following $SrCO_3$ Flux)

Membrane Number	Clock Time	Cumulative Time (min)	Time (min)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.8	2:25	na	0.392	0.053	0.135	10	7	9.5	10.5	0	10	23	0.757	0.801
A-0.8	2:55	na	0.218	0.053	0.242	20	7	19.5	20.5	0	20	23	1.359	1.439
A-0.8	3:25	na	0.151	0.053	0.350	30	7	29	31	0	30	24	1.968	2.024
A-0.8	3:55	na	0.122	0.053	0.433	40	7	39	41	3	37	25	2.433	2.433
A-0.8	4:25	na	0.095	0.053	0.555	50	7	49.5	50.5	5	45	25	3.119	3.119
B-0.8	1:15	na	0.438	0.053	0.121	10	7	9.5	10.5	0	10	22	0.678	0.738
B-0.8	1:45	na	0.229	0.053	0.230	20	7	19.5	20.5	0	20	23	1.294	1.370
B-0.8	2:15	na	0.161	0.053	0.328	30	7	29.5	30.5	0	30	24	1.844	1.896
B-0.8	2:45	na	0.124	0.053	0.425	40	7	39.5	40.5	3	37	24	2.387	2.456
B-0.8	3:15	na	0.102	0.053	0.516	50	7	49	51	4	46	25	2.901	2.901
C-0.8	3:00	na	0.938	0.053	0.056	10	7	9.5	10.5	0	10	20	0.316	0.365
C-0.8	3:30	na	0.554	0.053	0.095	20	7	19.5	20.5	0	20	21	0.536	0.601
C-0.8	4:00	na	0.387	0.053	0.137	30	7	29.5	30.5	0	30	21	0.768	0.860
C-0.8	4:30	na	0.305	0.053	0.173	40	7	39.5	40.5	0	40	22	0.973	1.060
C-0.8	5:00	na	0.240	0.053	0.221	50	7	49.5	50.5	0	50	22	1.239	1.350
D-0.8	1:45	na	0.635	0.053	0.083	10	7	9.5	10.5	0	10	23	0.468	0.495
D-0.8	2:15	na	0.344	0.053	0.154	20	7	19.5	20.5	0	20	23	0.863	0.913
D-0.8	2:45	na	0.220	0.053	0.240	30	7	29.5	30.5	0	30	24	1.347	1.386
D-0.8	3:15	na	0.169	0.053	0.312	40	7	39.5	40.5	0	40	25	1.755	1.755
D-0.8	3:45	na	0.137	0.053	0.385	50	7	49	51	3	47	25	2.161	2.161
E-0.8	3:30	na	0.520	0.053	0.102	10	7	9.5	10.5	0	10	23	0.571	0.604
E-0.8	4:00	na	0.261	0.053	0.202	20	7	19.5	20.5	0	20	23	1.137	1.204
E-0.8	4:30	na	0.186	0.053	0.285	30	7	29.5	30.5	0	30	23	1.599	1.692
E-0.8	5:00	na	0.213	0.079	0.373	40	7	39.5	40.5	0	40	24	2.094	2.154
E-0.8	5:30	na	0.173	0.079	0.458	50	7	50	53	4	47.5	25	2.571	2.571

Table C-21. Pristine Water Flux (GKN 0.1 μm).

Pristine Water Flux														
GKN 0.1														
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.1	9:50	na	0.124	0.053	0.428	10	7	9.5	10.5	8	2	21	2.180	2.443
A-0.1	10:25	na	0.089	0.053	0.596	20	7	19.5	20.5	14	6	21	3.036	3.403
A-0.1	10:55	na	0.105	0.079	0.758	30	7	30.5	29.5	21	9	23	3.864	4.089
A-0.1	11:30	na	0.090	0.079	0.884	40	7	40.5	39.5	28	12	26	4.503	4.370
A-0.1	12:00	na	0.080	0.079	0.995	50	7	50.5	49.5	35	15	28	5.068	4.662
B-0.1	9:30	na	0.168	0.079	0.471	10	7	11	9	9	1	22	2.401	2.615
B-0.1	10:05	na	0.103	0.079	0.770	20	7	20.5	19.5	16	4	23	3.920	4.149
B-0.1	10:40	na	0.092	0.079	0.858	30	7	30.5	20.5	23	2.5	23	4.373	4.628
B-0.1	11:15	na	0.079	0.079	1.005	40	7	40.5	39.5	31	9	26	5.122	4.980
B-0.1	11:50	na	0.100	0.106	1.053	50	7	50.5	49.5	38	12	29	5.366	4.801
C-0.1	12:45	na	0.107	0.053	0.495	10	7	10.5	9.5	9	1	22	2.524	2.748
C-0.1	1:15	na	0.072	0.053	0.736	20	7	20.5	19.5	17	3	22	3.747	4.081
C-0.1	1:45	na	0.094	0.079	0.845	30	7	30.5	29.5	24	6	23	4.303	4.554
C-0.1	2:15	na	0.084	0.079	0.949	40	7	40.5	39.5	32	8	26	4.836	4.702
C-0.1	2:45	na	0.100	0.106	1.062	50	7	50.5	49.5	40	10	29	5.411	4.842
D-0.1	6:10	na	0.217	0.079	0.365	10	7	10.5	9.5	6	4	19	1.859	2.209
D-0.1	6:45	na	0.148	0.079	0.536	20	7	20.5	19.5	11	9	20	2.728	3.148
D-0.1	7:20	na	0.120	0.079	0.663	30	7	30.5	29.5	15	15	22	3.379	3.680
D-0.1	7:55	na	0.096	0.079	0.830	40	7	40.5	39.5	20	20	24	4.228	4.349
D-0.1	8:30	na	0.091	0.079	0.869	50	7	50.5	49.5	26	24	28	4.429	4.074
E-0.1	6:53	na	0.129	0.053	0.411	10	7	10	10	7	3	18	2.092	2.560
E-0.1	7:26	na	0.088	0.053	0.598	20	7	20	20	13	7	19	3.047	3.621
E-0.1	8:00	na	0.072	0.053	0.739	30	7	30	30	20	10	21	3.765	4.220
E-0.1	8:35	na	0.093	0.079	0.851	40	7	40	40	26	14	24	4.334	4.458
E-0.1	9:10	na	0.083	0.079	0.959	50	7	50	50	31	19	27	4.884	4.619

Table C-22. Conditioning Sequence (GKN 0.1 μm).

Conditioning Sequence														
GKN 0.1 (0.01M NaOH)														
Membrane Number	Clock Time	Cumulative Time (min)	Time (min)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.1	11:40	na	0.124	0.079	0.640	30	9	30	30	20	10	21	3.261	3.655
B-0.1	6:18	na	0.132	0.079	0.599	30	9	30	30	21	9	23	3.051	3.229
C-0.1	6:25	na	0.107	0.079	0.741	30	9	30	30	19	11	22	3.774	4.110
D-0.1	10:50	na	0.136	0.079	0.584	30	9	30	30	14	16	22	2.976	3.241
E-0.1	6:40	na	0.108	0.079	0.736	30	9	31	29	20	10	20	3.750	4.327
Conditioning Sequence														
GKN 0.1 (1.0M HNO_3)														
Membrane Number	Clock Time	Cumulative Time (min)	Time (min)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.1	12:15	na	0.105	0.079	0.755	30	9	30	30	19	11	24	3.845	3.956
B-0.1	6:55	na	0.100	0.079	0.797	30	9	30	30	22	8	23	4.058	4.295
C-0.1	7:00	na	0.097	0.079	0.819	30	9	30	30	23	7	22	4.170	4.541
D-0.1	11:25	na	0.121	0.079	0.657	30	9	30	30	15	15	23	3.346	3.541
E-0.1	7:15	na	0.105	0.079	0.752	30	9	31	29	20	10	23	3.833	4.057
Conditioning Sequence														
GKN 0.1 (0.5M Oxalic Acid)														
Membrane Number	Clock Time	Cumulative Time (min)	Time (min)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.1	12:50	na	0.103	0.079	0.767	30	9	30	30	20	10	24	3.907	4.019
B-0.1	7:30	na	0.098	0.079	0.810	30	9	30	30	22	8	22	4.127	4.495
C-0.1	7:35	na	0.096	0.079	0.827	30	9	30	30	23	7	23	4.213	4.459
D-0.1	12:00	na	0.112	0.079	0.707	30	9	30	30	16	14	25	3.600	3.600
E-0.1	7:50	na	0.102	0.079	0.776	30	9	31	29	20	10	23	3.952	4.183

Table C-23. Repeated Water Flux (GKN 0.1 μm).

Repeated Water Flux														
GKN 0.1														
Membrane Number	Clock Time	Cumulative Time (min)	Time (min)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.1	1:30	na	0.184	0.079	0.430	10	7	10	10	7	3	20	2.190	2.528
A-0.1	2:00	na	0.128	0.079	0.619	20	7	20	20	14	6	20	3.154	3.640
A-0.1	2:30	na	0.097	0.079	0.814	30	7	30	30	21	9	21	4.148	4.650
A-0.1	3:00	na	0.087	0.079	0.909	40	7	40	40	28	12	24	4.632	4.765
A-0.1	3:30	na	0.101	0.106	1.043	50	7	50	50	35	15	26	5.313	5.166
B-0.1	8:10	na	0.177	0.079	0.448	10	7	10	10	8	2	18	2.283	2.794
B-0.1	8:40	na	0.118	0.079	0.670	20	7	20	20	15	5	19	3.412	4.054
B-0.1	9:10	na	0.095	0.079	0.839	30	7	30	30	23	7	21	4.273	4.789
B-0.1	9:40	na	0.081	0.079	0.981	40	7	40	40	31	9	23	4.995	5.286
B-0.1	10:10	na	0.088	0.106	1.205	50	7	50	50	40	10	26	6.141	5.971
C-0.1	8:10	na	0.195	0.079	0.407	10	7	10	10	8	2	19	2.072	2.462
C-0.1	8:40	na	0.110	0.079	0.721	20	7	20	20	16	4	20	3.671	4.236
C-0.1	9:10	na	0.095	0.079	0.831	30	7	30	30	23	7	21	4.235	4.747
C-0.1	9:40	na	0.081	0.079	0.981	40	7	40	40	31	9	23	4.995	5.286
C-0.1	10:10	na	0.094	0.106	1.120	50	7	50	50	40	10	26	5.707	5.549
D-0.1	1:18	na	0.212	0.079	0.375	10	7	10	10	6	4	20	1.909	2.203
D-0.1	1:48	na	0.145	0.079	0.547	20	7	20	20	11	9	21	2.785	3.121
D-0.1	2:18	na	0.119	0.079	0.668	30	7	30	30	16	14	22	3.403	3.706
D-0.1	2:48	na	0.102	0.079	0.781	40	7	40	40	21	19	24	3.978	4.092
D-0.1	3:18	na	0.120	0.106	0.878	50	7	50	50	26	24	26	4.474	4.350
E-0.1	8:30	na	0.126	0.053	0.419	10	7	11	9	7	3	19	2.136	2.538
E-0.1	9:05	na	0.127	0.079	0.623	20	7	20.5	19.5	14	6	20	3.175	3.664
E-0.1	9:40	na	0.104	0.079	0.762	30	7	30.5	29.5	20	10	21	3.882	4.352
E-0.1	10:15	na	0.093	0.079	0.857	40	7	40.5	39.5	27	13	24	4.365	4.490
E-0.1	10:50	na	0.111	0.106	0.955	50	7	50.5	49.5	33	17	26	4.865	4.730

Table C-24. Final Water Flux (GKN 0.1 µm).

Final Water Flux														
GKN 0.1 (Following $SrCO_3$ Flux)														
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp °C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.1	2:00	na	0.180	0.079	0.440	10	7	10	10	7	3	19	2.241	2.663
A-0.1	2:30	na	0.127	0.079	0.623	20	7	20	20	14	6	19	3.175	3.772
A-0.1	3:00	na	0.102	0.079	0.781	30	7	30	30	21	9	21	3.978	4.459
A-0.1	3:30	na	0.083	0.079	0.955	40	7	40	40	27	13	23	4.865	5.148
A-0.1	4:00	na	0.073	0.079	1.081	50	7	50	50	35	15	26	5.506	5.354
B-0.1	12:35	na	0.189	0.079	0.420	10	7	10	10	8	2	19	2.138	2.541
B-0.1	1:05	na	0.121	0.079	0.658	20	7	20	20	15	5	20	3.351	3.867
B-0.1	1:35	na	0.102	0.079	0.776	30	7	30	30	23	7	22	3.952	4.304
B-0.1	2:05	na	0.080	0.079	0.991	40	7	40	40	31	9	23	5.047	5.341
B-0.1	2:35	na	0.072	0.079	1.109	50	7	50	50	39	11	26	5.647	5.491
C-0.1	12:55	na	0.176	0.079	0.449	10	7	10	10	7	3	19	2.290	2.721
C-0.1	1:25	na	0.118	0.079	0.672	20	7	20	20	16	4	20	3.422	3.948
C-0.1	1:55	na	0.091	0.079	0.871	30	7	30	30	23	7	22	4.437	4.832
C-0.1	2:25	na	0.083	0.079	0.955	40	7	40	40	31	9	24	4.865	5.004
C-0.1	2:55	na	0.073	0.079	1.086	50	7	50	50	40	10	26	5.531	5.378
D-0.1	12:50	na	0.224	0.079	0.355	10	7	10	10	6	4	18	1.807	2.211
D-0.1	1:20	na	0.146	0.079	0.544	20	7	20	20	11	9	19	2.772	3.293
D-0.1	1:50	na	0.125	0.079	0.636	30	7	30	30	16	14	21	3.239	3.630
D-0.1	2:20	na	0.105	0.079	0.757	40	7	40	40	21	19	23	3.858	4.083
D-0.1	2:50	na	0.092	0.079	0.863	50	7	50	50	26	24	25	4.397	4.397
E-0.1	2:20	na	0.182	0.079	0.436	10	7	10	10	8	2	19	2.223	2.641
E-0.1	2:50	na	0.128	0.079	0.621	20	7	20	20	14	6	19	3.163	3.758
E-0.1	3:20	na	0.100	0.079	0.790	30	7	30	30	20	10	20	4.024	4.644
E-0.1	3:50	na	0.084	0.079	0.949	40	7	40	40	27	13	23	4.836	5.118
E-0.1	4:20	na	0.077	0.079	1.027	50	7	50	50	33	17	25	5.232	5.232

Appendix D

Variation Testing

$SrCO_3$ Flux

Appendix D

Variation Testing

$SrCO_3$ Flux

Table D-1. Strontium Carbonate Flux (Graver 0.07 μm).

$SrCO_3$ Flux Graver 0.07															
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psid)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.07	7:05	0	0.140	0.013	0.095	30	9	30.5	29.5	0	30	22	0.482	0.525
A-0.07	7:15	10	0.179	0.013	0.074	30	9	30.5	29.5	0	30	22	0.376	0.409
A-0.07	7:25	20	0.170	0.013	0.078	30	9	30.5	29.5	0	30	26	0.395	0.384
A-0.07	7:35	30	0.163	0.013	0.081	30	9	30.5	29.5	0	30	29	0.412	0.369
A-0.07	7:40	0	0.093	0.013	0.143	40	12	42	38	0	40	29	0.726	0.650
A-0.07	7:50	10	0.109	0.013	0.122	40	12	42	38	0	40	32	0.619	0.511
A-0.07	8:00	20	0.108	0.013	0.122	40	12	42	38	0	40	33	0.623	0.500
A-0.07	8:10	30	0.108	0.013	0.122	40	12	42	38	0	40	33	0.623	0.500
A-0.07	8:15	0	0.147	0.013	0.090	30	4	30	30	0	30	32	0.458	0.378
A-0.07	8:25	10	0.293	0.013	0.045	30	4	30	30	0	30	27	0.229	0.217
A-0.07	8:35	20	0.339	0.013	0.039	30	4	30	30	0	30	25	0.199	0.199
A-0.07	8:45	30	0.378	0.013	0.035	30	4	30	30	0	30	24	0.178	0.183
A-0.07	8:50	0	0.190	0.013	0.070	15	9	15.5	14.5	0	15	23	0.354	0.375
A-0.07	9:00	10	0.216	0.013	0.061	15	9	15.5	14.5	0	15	23	0.311	0.329
A-0.07	9:10	20	0.218	0.013	0.061	15	9	15.5	14.5	0	15	22	0.309	0.336
A-0.07	9:20	30	0.214	0.013	0.062	15	9	15.5	14.5	0	15	22	0.314	0.342
A-0.07	9:25	0	0.157	0.013	0.084	20	12	21	19	0	20	22	0.430	0.468
A-0.07	9:35	10	0.153	0.013	0.087	20	12	21.5	18.5	0	20	23	0.441	0.467
A-0.07	9:45	20	0.153	0.013	0.087	20	12	21.5	18.5	0	20	24	0.441	0.453
A-0.07	9:55	30	0.149	0.013	0.089	20	12	21.5	18.5	0	20	25	0.453	0.453
A-0.07	10:00	0	0.135	0.013	0.098	30	9	30.5	29.5	0	30	25	0.500	0.500
A-0.07	10:10	10	0.173	0.013	0.076	30	9	30.5	29.5	0	30	25	0.389	0.389
A-0.07	10:20	20	0.173	0.013	0.076	30	9	30.5	29.5	0	30	25	0.389	0.389
A-0.07	10:30	30	0.176	0.013	0.075	30	9	30.5	29.5	0	30	25	0.383	0.383
A-0.07	10:35	0	0.146	0.013	0.091	40	6	39.5	40.5	0	40	24	0.463	0.476
A-0.07	10:45	10	0.223	0.013	0.059	40	6	39.5	40.5	0	40	24	0.302	0.310
A-0.07	10:55	20	0.231	0.013	0.057	40	6	39.5	40.5	0	40	24	0.292	0.300
A-0.07	11:05	30	0.233	0.013	0.057	40	6	39.5	40.5	0	40	24	0.289	0.297
A-0.07	11:08	0	0.126	0.013	0.105	45	9	43.5	46.5	0	45	24	0.536	0.551
A-0.07	11:18	10	0.153	0.013	0.086	45	9	43.5	46.5	0	45	27	0.440	0.416
A-0.07	11:28	20	0.155	0.013	0.085	45	9	43.5	46.5	0	45	28	0.435	0.400
A-0.07	11:38	30	0.154	0.013	0.086	45	9	43.5	46.5	0	45	29	0.437	0.391
A-0.07	11:40	0	0.094	0.013	0.141	30	14	28	32	0	30	29	0.716	0.641
A-0.07	11:50	10	0.089	0.013	0.148	30	14	28	32	0	30	31	0.755	0.640
A-0.07	12:00	20	0.088	0.013	0.150	30	14	28	32	0	30	33	0.762	0.612
A-0.07	12:10	30	0.086	0.013	0.153	30	14	28	32	0	30	34	0.779	0.610
A-0.07	12:15	0	0.189	0.013	0.070	20	6	20	20	0	20	32	0.357	0.294
A-0.07	12:25	10	0.231	0.013	0.057	20	6	20	20	0	20	29	0.292	0.261
A-0.07	12:35	20	0.257	0.013	0.051	20	6	20	20	0	20	27	0.262	0.248
A-0.07	12:45	30	0.256	0.013	0.052	20	6	20	20	0	20	25	0.263	0.263
A-0.07	12:47	0	0.138	0.013	0.096	30	9	30.5	29.5	0	30	25	0.488	0.488
A-0.07	12:57	10	0.172	0.013	0.077	30	9	30.5	29.5	0	30	25	0.392	0.392
A-0.07	1:07	20	0.173	0.013	0.076	30	9	30.5	29.5	0	30	25	0.389	0.389
A-0.07	1:17	30	0.174	0.013	0.076	30	9	30.5	29.5	0	30	25	0.387	0.387
B-0.07	7:16	0	0.144	0.013	0.092	30	9	31	29	0	30	21	0.466	0.523
B-0.07	7:26	10	0.182	0.013	0.073	30	9	31	29	0	30	22	0.370	0.403
B-0.07	7:36	20	0.194	0.013	0.068	30	9	31	29	0	30	21	0.347	0.389
B-0.07	7:46	30	0.193	0.013	0.069	30	9	31	29	0	30	20	0.349	0.403
B-0.07	7:50	0	0.124	0.013	0.107	40	12	40.5	39.5	0	40	21	0.545	0.611
B-0.07	8:00	10	0.136	0.013	0.097	40	12	40.5	39.5	0	40	22	0.495	0.540
B-0.07	8:10	20	0.134	0.013	0.099	40	12	40.5	39.5	0	40	22	0.502	0.547
B-0.07	8:20	30	0.134	0.013	0.099	40	12	40.5	39.5	0	40	23	0.503	0.532
B-0.07	8:22	0	0.184	0.013	0.072	30	4	31	29	0	30	22	0.366	0.399
B-0.07	8:32	10	0.348	0.013	0.038	30	4	31	29	0	30	20	0.193	0.223
B-0.07	8:42	20	0.366	0.013	0.036	30	4	31	29	0	30	19	0.184	0.219
B-0.07	8:52	30	0.369	0.013	0.036	30	4	31	29	0	30	21	0.183	0.205
B-0.07	8:55	0	0.196	0.013	0.067	15	9	15	15	0	15	21	0.344	0.385
B-0.07	9:05	10	0.217	0.013	0.061	15	9	15	15	0	15	21	0.311	0.348
B-0.07	9:15	20	0.223	0.013	0.059	15	9	15	15	0	15	21	0.302	0.339
B-0.07	9:25	30	0.221	0.013	0.060	15	9	15	15	0	15	21	0.304	0.341
B-0.07	9:27	0	0.147	0.013	0.090	20	12	20.5	19.5	0	20	22	0.458	0.499
B-0.07	9:37	10	0.152	0.013	0.087	20	12	20.5	19.5	0	20	23	0.444	0.470
B-0.07	9:47	20	0.151	0.013	0.087	20	12	20.5	19.5	0	20	23	0.446	0.472
B-0.07	9:57	30	0.150	0.013	0.088	20	12	20.5	19.5	0	20	23	0.450	0.476
B-0.07	10:00	0	0.149	0.013	0.089	30	9	30	30	0	30	23	0.453	0.480
B-0.07	10:10	10	0.171	0.013	0.077	30	9	30	30	0	30	23	0.393	0.416
B-0.07	10:20	20	0.173	0.013	0.076	30	9	30	30	0	30	23	0.388	0.411
B-0.07	10:30	30	0.177	0.013	0.074	30	9	30	30	0	30	23	0.379	0.402
B-0.07	10:32	0	0.133	0.013	0.099	40	6	40.5	39.5	0	40	23	0.505	0.534
B-0.07	10:42	10	0.228	0.013	0.058	40	6	40.5	39.5	0	40	22	0.296	0.322
B-0.07	10:52	20	0.242	0.013	0.055	40	6	40.5	39.5	0	40	22	0.278	0.303
B-0.07	11:02	30	0.244	0.013	0.054	40	6	40.5	39.5	0	40	22	0.276	0.300
B-0.07	11:05	0	0.120	0.013	0.110	45	9	45	45	0	45	22	0.559	0.609
B-0.07	11:15	10	0.174	0.013	0.076	45	9	45	45	0	45	23	0.387	0.409
B-0.07	11:25	20	0.176	0.013	0.075	45	9	45	45	0	45	24	0.383	0.394
B-0.07	11:35	30	0.173	0.013	0.076	45	9	45	45	0	45	24	0.389	0.400
B-0.07	11:40	0	0.110	0.013	0.121	30	14	31	29	0	30	24	0.615	0.632
B-0.07	11:50	10	0.111	0.013	0.120	30	14	31	29	0	30	25	0.609	0.609
B-0.07	12:00	20	0.118	0.013	0.112	30	14	31	29	0	30	24	0.572	0.588
B-0.07	12:10	30	0.117	0.013	0.113	30	14	31	29	0	30	24	0.578	0.594
B-0.07	12:15	0	0.190	0.013	0.070	20	6	20.5	19.5	0	20	24	0.356	0.365
B-0.07	12:25	10	0.275	0.013	0.048	20	6	20.5	19.5	0	20	22	0.245	0.267
B-0.07	12:35	20	0.285	0.013	0.046	20	6	20.5	19.5	0	20	21	0.236	0.264
B-0.07	12:45	30	0.290	0.013	0.046	20	6	20.5	19.5	0	20	21	0.232	0.260
B-0.07	12:50	0	0.160	0.013	0.082	30	9	30	30	0	30	22	0.420	0.457
B-0.07	1:00	10	0.174	0.013	0.076	30	9	30	30	0	30	22	0.386	0.420
B-0.07	1:10	20	0.181	0.013	0.073	30	9	30	30	0	30	22	0.372	0.405
B-0.07	1:20	30	0.184	0.013	0.072	30	9	30	30	0	30	22	0.366	0.399

Table D-1. Strontium Carbonate Flux-Graver 0.07 µm (continued).

C-0.07	6:15	0	0.129	0.013	0.103	30	9	29	31	0	30	21	0.522	0.585
C-0.07	6:25	10	0.187	0.013	0.071	30	9	29	31	0	30	22	0.360	0.392
C-0.07	6:35	20	0.182	0.013	0.073	30	9	29	31	0	30	23	0.370	0.392
C-0.07	6:45	30	0.180	0.013	0.073	30	9	29	31	0	30	23	0.374	0.395
C-0.07	6:50	0	0.107	0.013	0.124	40	12	38.5	41.5	0	40	24	0.632	0.650
C-0.07	7:00	10	0.117	0.013	0.113	40	12	38.5	41.5	0	40	28	0.576	0.530
C-0.07	7:10	20	0.110	0.013	0.120	40	12	38.5	41.5	0	40	30	0.612	0.533
C-0.07	7:20	30	0.106	0.013	0.124	40	12	38.5	41.5	0	40	32	0.634	0.523
C-0.07	7:23	0	0.146	0.013	0.090	30	4	30	30	0	30	31	0.461	0.391
C-0.07	7:33	10	0.287	0.013	0.046	30	4	30	30	0	30	27	0.235	0.222
C-0.07	7:43	20	0.324	0.013	0.041	30	4	30	30	0	30	25	0.208	0.208
C-0.07	7:53	30	0.337	0.013	0.039	30	4	30	30	0	30	24	0.200	0.205
C-0.07	9:50	0	0.184	0.013	0.072	15	9	15.5	14.5	0	15	22	0.366	0.398
C-0.07	10:00	10	0.194	0.013	0.068	15	9	15.5	14.5	0	15	22	0.348	0.379
C-0.07	10:10	20	0.194	0.013	0.068	15	9	15.5	14.5	0	15	21	0.347	0.388
C-0.07	10:20	30	0.193	0.013	0.068	15	9	15.5	14.5	0	15	21	0.348	0.390
C-0.07	10:25	0	0.136	0.013	0.097	20	12	21	19	0	20	22	0.494	0.538
C-0.07	10:35	10	0.136	0.013	0.097	20	12	21	19	0	20	23	0.497	0.526
C-0.07	10:45	20	0.131	0.013	0.101	20	12	21	19	0	20	24	0.512	0.527
C-0.07	10:55	30	0.131	0.013	0.101	20	12	21	19	0	20	24	0.513	0.528
C-0.07	10:58	0	0.129	0.013	0.103	30	9	31	29	0	30	24	0.522	0.537
C-0.07	11:08	10	0.160	0.013	0.083	30	9	31	29	0	30	25	0.422	0.422
C-0.07	11:18	20	0.156	0.013	0.085	30	9	31	29	0	30	25	0.431	0.431
C-0.07	11:28	30	0.155	0.013	0.085	30	9	31	29	0	30	25	0.435	0.435
C-0.07	11:32	0	0.140	0.013	0.094	40	6	41	39	0	40	25	0.480	0.480
C-0.07	11:42	10	0.211	0.013	0.063	40	6	41	39	0	40	25	0.319	0.319
C-0.07	11:52	20	0.216	0.013	0.061	40	6	41	39	0	40	25	0.311	0.311
C-0.07	12:02	30	0.220	0.013	0.060	40	6	41	39	0	40	25	0.307	0.307
C-0.07	12:05	0	0.121	0.013	0.110	45	9	46.5	43.5	0	45	25	0.558	0.558
C-0.07	12:15	10	0.151	0.013	0.088	45	9	46.5	43.5	0	45	27	0.447	0.422
C-0.07	12:25	20	0.149	0.013	0.089	45	9	46.5	43.5	0	45	28	0.452	0.416
C-0.07	12:35	30	0.148	0.013	0.090	45	9	46.5	43.5	0	45	29	0.456	0.408
C-0.07	12:38	0	0.087	0.013	0.151	30	14	32	28	0	30	28	0.771	0.709
C-0.07	12:48	10	0.088	0.013	0.150	30	14	32	28	0	30	30	0.763	0.665
C-0.07	12:58	20	0.087	0.013	0.151	30	14	32	28	0	30	31	0.771	0.653
C-0.07	1:08	30	0.088	0.013	0.150	30	14	32	28	0	30	32	0.762	0.628
C-0.07	1:10	0	0.157	0.013	0.084	20	6	20	20	0	20	31	0.429	0.364
C-0.07	1:20	10	0.221	0.013	0.060	20	6	20	20	0	20	27	0.305	0.288
C-0.07	1:30	20	0.243	0.013	0.054	20	6	20	20	0	20	25	0.277	0.277
C-0.07	1:40	30	0.252	0.013	0.053	20	6	20	20	0	20	24	0.268	0.275
C-0.07	1:43	0	0.132	0.013	0.100	30	9	31	29	0	30	24	0.510	0.525
C-0.07	1:53	10	0.167	0.013	0.079	30	9	31	29	0	30	24	0.403	0.415
C-0.07	2:03	20	0.165	0.013	0.080	30	9	31	29	0	30	24	0.407	0.419
C-0.07	2:13	30	0.167	0.013	0.079	30	9	31	29	0	30	24	0.403	0.415
D-0.07	6:45	0	0.132	0.013	0.100	30	9	31	29	0	30	20	0.509	0.587
D-0.07	6:55	10	0.172	0.013	0.077	30	9	31	29	0	30	24	0.390	0.402
D-0.07	7:05	20	0.169	0.013	0.078	30	9	31	29	0	30	25	0.399	0.399
D-0.07	7:15	30	0.159	0.013	0.083	30	9	31	29	0	30	27	0.425	0.401
D-0.07	7:18	0	0.095	0.013	0.139	40	12	41.5	38.5	0	40	27	0.706	0.667
D-0.07	7:28	10	0.098	0.013	0.135	40	12	41.5	38.5	0	40	33	0.689	0.563
D-0.07	7:38	20	0.093	0.013	0.142	40	12	41.5	38.5	0	40	36	0.722	0.536
D-0.07	7:48	30	0.092	0.013	0.144	40	12	41.5	38.5	0	40	38	0.734	0.517
D-0.07	8:00	0	0.138	0.013	0.096	30	4	30	30	0	30	35	0.488	0.372
D-0.07	8:10	10	0.271	0.013	0.049	30	4	30	30	0	30	31	0.248	0.210
D-0.07	8:20	20	0.289	0.013	0.046	30	4	30	30	0	30	28	0.233	0.214
D-0.07	8:30	30	0.319	0.013	0.041	30	4	30	30	0	30	26	0.211	0.205
D-0.07	8:50	0	0.325	0.013	0.041	15	9	15	15	0	15	25	0.207	0.207
D-0.07	9:00	10	0.233	0.013	0.057	15	9	15	15	0	15	23	0.289	0.305
D-0.07	9:10	20	0.212	0.013	0.062	15	9	15	15	0	15	22	0.317	0.345
D-0.07	9:20	30	0.209	0.013	0.063	15	9	15	15	0	15	22	0.322	0.351
D-0.07	9:25	0	0.156	0.013	0.085	20	12	21	19	0	20	22	0.432	0.470
D-0.07	9:35	10	0.154	0.013	0.086	20	12	21	19	0	20	23	0.438	0.464
D-0.07	9:45	20	0.151	0.013	0.087	20	12	21	19	0	20	24	0.446	0.458
D-0.07	9:55	30	0.150	0.013	0.088	20	12	21	19	0	20	24	0.448	0.461
D-0.07	10:00	0	0.136	0.013	0.097	30	9	29.5	30.5	0	30	24	0.495	0.509
D-0.07	10:10	10	0.155	0.013	0.085	30	9	29.5	30.5	0	30	25	0.435	0.435
D-0.07	10:20	20	0.149	0.013	0.089	30	9	29.5	30.5	0	30	25	0.453	0.453
D-0.07	10:30	30	0.148	0.013	0.089	30	9	29.5	30.5	0	30	25	0.454	0.454
D-0.07	10:34	0	0.143	0.013	0.093	40	6	40.5	39.5	0	40	25	0.472	0.472
D-0.07	10:44	10	0.205	0.013	0.064	40	6	40.5	39.5	0	40	24	0.328	0.338
D-0.07	10:54	20	0.220	0.013	0.060	40	6	40.5	39.5	0	40	24	0.305	0.314
D-0.07	11:04	30	0.223	0.013	0.059	40	6	40.5	39.5	0	40	24	0.302	0.311
D-0.07	11:06	0	0.117	0.013	0.113	45	9	46	44	0	45	24	0.578	0.594
D-0.07	11:16	10	0.142	0.013	0.093	45	9	46	44	0	45	26	0.475	0.462
D-0.07	11:26	20	0.138	0.013	0.095	45	9	46	44	0	45	28	0.486	0.447
D-0.07	11:36	30	0.142	0.013	0.093	45	9	46	44	0	45	28	0.473	0.435
D-0.07	11:39	0	0.099	0.013	0.133	30	14	29	31	0	30	28	0.677	0.623
D-0.07	11:49	10	0.096	0.013	0.138	30	14	29	31	0	30	30	0.701	0.610
D-0.07	11:59	20	0.097	0.013	0.136	30	14	29	31	0	30	31	0.691	0.586
D-0.07	12:09	30	0.098	0.013	0.135	30	14	29	31	0	30	31	0.690	0.585
D-0.07	12:12	0	0.175	0.013	0.076	20	6	20	20	0	20	30	0.385	0.335
D-0.07	12:22	10	0.241	0.013	0.055	20	6	20	20	0	20	27	0.280	0.264
D-0.07	12:32	20	0.262	0.013	0.050	20	6	20	20	0	20	25	0.257	0.257
D-0.07	12:42	30	0.263	0.013	0.050	20	6	20	20	0	20	25	0.256	0.256
D-0.07	12:44	0	0.137	0.013	0.097	30	9	29.5	30.5	0	30	24	0.492	0.507
D-0.07	12:54	10	0.156	0.013	0.084	30	9	29.5	30.5	0	30	24	0.430	0.443
D-0.07	1:04	20	0.157	0.013	0.084	30	9	29.5	30.5	0	30	25	0.429	0.429
D-0.07	1:14	30	0.161	0.013	0.082	30	9	29.5	30.5	0	30	25	0.419	0.419

Table D-1. Strontium Carbonate Flux-Graver 0.07 µm (continued).

E-0.07	10:35	0	0.143	0.013	0.092	30	9	31	29	0	30	22	0.470	0.512
E-0.07	10:45	10	0.209	0.013	0.063	30	9	31	29	0	30	24	0.323	0.332
E-0.07	10:55	20	0.208	0.013	0.064	30	9	31	29	0	30	25	0.324	0.324
E-0.07	11:05	30	0.204	0.013	0.065	30	9	31	29	0	30	26	0.330	0.320
E-0.07	11:10	0	0.108	0.013	0.122	40	12	41	39	0	40	26	0.623	0.606
E-0.07	11:20	10	0.131	0.013	0.101	40	12	41	39	0	40	30	0.514	0.447
E-0.07	11:30	20	0.123	0.013	0.107	40	12	41	39	0	40	32	0.546	0.450
E-0.07	11:40	30	0.117	0.013	0.113	40	12	41	39	0	40	34	0.578	0.452
E-0.07	11:45	0	0.139	0.013	0.095	30	4	30.5	29.5	0	30	33	0.485	0.389
E-0.07	11:55	10	0.311	0.013	0.043	30	4	30.5	29.5	0	30	29	0.217	0.194
E-0.07	12:05	20	0.354	0.013	0.037	30	4	30.5	29.5	0	30	27	0.190	0.180
E-0.07	12:15	30	0.365	0.013	0.036	30	4	30.5	29.5	0	30	26	0.185	0.179
E-0.07	12:20	0	0.216	0.013	0.061	15	9	18	15	0	16.5	26	0.311	0.303
E-0.07	12:30	10	0.213	0.013	0.062	15	9	18	15	0	16.5	25	0.316	0.316
E-0.07	12:40	20	0.215	0.013	0.062	15	9	18	15	0	16.5	25	0.313	0.313
E-0.07	12:50	30	0.218	0.013	0.061	15	9	18	15	0	16.5	25	0.309	0.309
E-0.07	12:55	0	0.146	0.013	0.090	20	12	22	18	0	20	24	0.460	0.473
E-0.07	1:05	10	0.147	0.013	0.090	20	12	22	18	0	20	26	0.459	0.447
E-0.07	1:15	20	0.144	0.013	0.092	20	12	22	18	0	20	27	0.467	0.442
E-0.07	1:25	30	0.148	0.013	0.090	20	12	22	18	0	20	27	0.456	0.431
E-0.07	1:30	0	0.141	0.013	0.094	30	9	32	30	0	31	27	0.479	0.453
E-0.07	1:40	10	0.171	0.013	0.077	30	9	32	30	0	31	27	0.393	0.372
E-0.07	1:50	20	0.172	0.013	0.077	30	9	32	30	0	31	27	0.392	0.370
E-0.07	2:00	30	0.175	0.013	0.076	30	9	32	30	0	31	27	0.385	0.364
E-0.07	2:02	0	0.145	0.013	0.091	40	6	41	39	0	40	27	0.465	0.440
E-0.07	2:12	10	0.220	0.013	0.060	40	6	41	39	0	40	27	0.306	0.290
E-0.07	2:22	20	0.234	0.013	0.056	40	6	41	39	0	40	26	0.287	0.279
E-0.07	2:32	30	0.240	0.013	0.055	40	6	41	39	0	40	26	0.281	0.273
E-0.07	2:35	0	0.125	0.013	0.106	45	9	47	43	0	45	26	0.539	0.524
E-0.07	2:45	10	0.163	0.013	0.081	45	9	47	43	0	45	28	0.413	0.380
E-0.07	2:55	20	0.163	0.013	0.081	45	9	47	43	0	45	29	0.414	0.370
E-0.07	3:05	30	0.160	0.013	0.082	45	9	47	43	0	45	30	0.420	0.365
E-0.07	3:07	0	0.098	0.013	0.135	30	14	32	28	0	30	30	0.688	0.599
E-0.07	3:17	10	0.096	0.013	0.140	30	14	32	28	0	30	33	0.711	0.571
E-0.07	3:27	20	0.093	0.013	0.143	30	14	32	28	0	30	33	0.726	0.583
E-0.07	3:37	30	0.094	0.013	0.141	30	14	32	28	0	30	34	0.718	0.562
E-0.07	3:40	0	0.174	0.013	0.076	20	6	21	19	0	20	33	0.387	0.311
E-0.07	3:50	10	0.228	0.013	0.058	20	6	21	19	0	20	30	0.296	0.257
E-0.07	4:00	20	0.246	0.013	0.054	20	6	21	19	0	20	28	0.274	0.252
E-0.07	4:10	30	0.263	0.013	0.050	20	6	21	19	0	20	27	0.256	0.242
E-0.07	4:12	0	0.158	0.013	0.084	30	9	31	29	0	30	26	0.427	0.415
E-0.07	4:22	10	0.163	0.013	0.081	30	9	31	29	0	30	27	0.412	0.390
E-0.07	4:32	20	0.165	0.013	0.080	30	9	31	29	0	30	27	0.408	0.386
E-0.07	4:42	30	0.165	0.013	0.080	30	9	31	29	0	30	27	0.407	0.385

Table D-2. Strontium Carbonate Flux (Mott 0.1 μm).

$SrCO_3$ Flux Mott 0.1														
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psid)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.1	6:50	0	0.142	0.013	0.093	30	9	31	30	0	30.5	22	0.475	0.517
A-0.1	7:00	10	0.178	0.013	0.074	30	9	31	30	0	30.5	26	0.378	0.368
A-0.1	7:10	20	0.180	0.013	0.073	30	9	31	30	0	30.5	29	0.374	0.334
A-0.1	7:20	30	0.187	0.013	0.071	30	9	31	30	0	30.5	27	0.361	0.341
A-0.1	7:25	0	0.104	0.013	0.127	40	12	41	40	0	40.5	27	0.645	0.610
A-0.1	7:35	10	0.148	0.013	0.090	40	12	41	40	0	40.5	28	0.456	0.420
A-0.1	7:45	20	0.134	0.013	0.099	40	12	41	40	0	40.5	28	0.502	0.462
A-0.1	7:55	30	0.128	0.013	0.103	40	12	41	40	0	40.5	28	0.526	0.484
A-0.1	8:00	0	0.211	0.013	0.063	30	4	30	30	0	30	27	0.319	0.302
A-0.1	8:10	10	0.304	0.013	0.044	30	4	30	30	0	30	25	0.222	0.222
A-0.1	8:20	20	0.322	0.013	0.041	30	4	30	30	0	30	25	0.209	0.209
A-0.1	8:30	30	0.352	0.013	0.038	30	4	30	30	0	30	24	0.191	0.197
A-0.1	8:35	0	0.172	0.013	0.077	15	9	15	15	0	15	24	0.392	0.403
A-0.1	8:45	10	0.199	0.013	0.066	15	9	15	15	0	15	24	0.338	0.348
A-0.1	8:55	20	0.197	0.013	0.067	15	9	15	15	0	15	24	0.342	0.352
A-0.1	9:05	30	0.187	0.013	0.071	15	9	15	15	0	15	24	0.359	0.370
A-0.1	9:10	0	0.128	0.013	0.103	20	12	21	20	0	20.5	25	0.525	0.525
A-0.1	9:20	10	0.138	0.013	0.096	20	12	21	20	0	20.5	25	0.489	0.489
A-0.1	9:30	20	0.131	0.013	0.101	20	12	21	20	0	20.5	26	0.516	0.501
A-0.1	9:40	30	0.130	0.013	0.102	20	12	21	20	0	20.5	26	0.519	0.505
A-0.1	9:45	0	0.128	0.013	0.103	30	9	31	30	0	30.5	26	0.525	0.511
A-0.1	9:55	10	0.158	0.013	0.084	30	9	31	30	0	30.5	26	0.425	0.414
A-0.1	10:05	20	0.169	0.013	0.078	30	9	31	30	0	30.5	26	0.398	0.387
A-0.1	10:15	30	0.166	0.013	0.080	30	9	31	30	0	30.5	26	0.406	0.395
A-0.1	10:20	0	0.109	0.013	0.121	40	6	41	40	0	40.5	26	0.617	0.600
A-0.1	10:30	10	0.213	0.013	0.062	40	6	41	40	0	40.5	25	0.316	0.316
A-0.1	10:40	20	0.221	0.013	0.060	40	6	41	40	0	40.5	25	0.305	0.305
A-0.1	10:50	30	0.227	0.013	0.058	40	6	41	40	0	40.5	25	0.297	0.297
A-0.1	10:55	0	0.124	0.013	0.107	45	9	46	45	0	45.5	26	0.544	0.529
A-0.1	11:05	10	0.156	0.013	0.085	45	9	46	45	0	45.5	27	0.431	0.408
A-0.1	11:15	20	0.162	0.013	0.082	45	9	46	45	0	45.5	27	0.416	0.393
A-0.1	11:25	30	0.162	0.013	0.081	45	9	46	45	0	45.5	27	0.415	0.392
A-0.1	11:30	0	0.101	0.013	0.131	30	14	31.5	30	0	30.75	27	0.668	0.632
A-0.1	11:40	10	0.100	0.013	0.132	30	14	31.5	30	0	30.75	28	0.674	0.620
A-0.1	11:50	20	0.100	0.013	0.133	30	14	31.5	30	0	30.75	28	0.675	0.621
A-0.1	12:00	30	0.095	0.013	0.139	30	14	31.5	30	0	30.75	28	0.706	0.649
A-0.1	12:05	0	0.144	0.013	0.092	20	6	21	20	0	20.5	27	0.467	0.442
A-0.1	12:15	10	0.235	0.013	0.056	20	6	21	20	0	20.5	25	0.287	0.287
A-0.1	12:25	20	0.245	0.013	0.054	20	6	21	20	0	20.5	25	0.274	0.274
A-0.1	12:35	30	0.256	0.013	0.052	20	6	21	20	0	20.5	24	0.263	0.270
A-0.1	12:40	0	0.124	0.013	0.106	30	9	31	30	0	30.5	25	0.541	0.541
A-0.1	12:50	10	0.163	0.013	0.081	30	9	31	30	0	30.5	25	0.412	0.412
A-0.1	1:00	20	0.165	0.013	0.080	30	9	31	30	0	30.5	25	0.407	0.407
A-0.1	1:10	30	0.170	0.013	0.078	30	9	31	30	0	30.5	25	0.397	0.397
B-0.1	5:55	0	0.135	0.013	0.098	30	9	30.5	29.5	0	30	24	0.500	0.514
B-0.1	6:05	10	0.166	0.013	0.080	30	9	30.5	29.5	0	30	24	0.407	0.418
B-0.1	6:15	20	0.171	0.013	0.077	30	9	30.5	29.5	0	30	25	0.394	0.394
B-0.1	6:25	30	0.167	0.013	0.079	30	9	30.5	29.5	0	30	25	0.403	0.403
B-0.1	6:30	0	0.102	0.013	0.130	40	12	41	39	0	40	26	0.663	0.645
B-0.1	6:40	10	0.112	0.013	0.118	40	12	41	39	0	40	27	0.601	0.568
B-0.1	6:50	20	0.112	0.013	0.118	40	12	41	39	0	40	28	0.601	0.553
B-0.1	7:00	30	0.115	0.013	0.115	40	12	41	39	0	40	28	0.586	0.539
B-0.1	7:03	0	0.132	0.013	0.100	30	4	30	30	0	30	27	0.512	0.484
B-0.1	7:13	10	0.266	0.013	0.050	30	4	30	30	0	30	25	0.253	0.253
B-0.1	7:23	20	0.296	0.013	0.045	30	4	30	30	0	30	24	0.227	0.234
B-0.1	7:33	30	0.313	0.013	0.042	30	4	30	30	0	30	24	0.215	0.221
B-0.1	7:36	0	0.152	0.013	0.087	15	9	15	15	0	15	24	0.444	0.456
B-0.1	7:46	10	0.172	0.013	0.077	15	9	15	15	0	15	24	0.390	0.402
B-0.1	7:56	20	0.215	0.013	0.061	15	9	15	15	0	15	24	0.313	0.322
B-0.1	8:06	30	0.189	0.013	0.070	15	9	15	15	0	15	24	0.356	0.366
B-0.1	8:10	0	0.113	0.013	0.117	20	12	20.5	19.5	0	20	25	0.597	0.597
B-0.1	8:20	10	0.127	0.013	0.104	20	12	20.5	19.5	0	20	25	0.531	0.531
B-0.1	8:30	20	0.124	0.013	0.107	20	12	20.5	19.5	0	20	26	0.545	0.530
B-0.1	8:40	30	0.122	0.013	0.108	20	12	20.5	19.5	0	20	26	0.552	0.537
B-0.1	8:45	0	0.105	0.013	0.126	30	9	30.5	29.5	0	30	26	0.644	0.626
B-0.1	8:55	10	0.144	0.013	0.092	30	9	30.5	29.5	0	30	26	0.468	0.455
B-0.1	9:05	20	0.156	0.013	0.085	30	9	30.5	29.5	0	30	26	0.435	0.423
B-0.1	9:15	30	0.155	0.013	0.085	30	9	30.5	29.5	0	30	26	0.435	0.423
B-0.1	9:18	0	0.109	0.013	0.121	40	6	40	40	0	40	25	0.616	0.616
B-0.1	9:28	10	0.197	0.013	0.067	40	6	40	40	0	40	25	0.341	0.341
B-0.1	9:38	20	0.211	0.013	0.063	40	6	40	40	0	40	25	0.320	0.320
B-0.1	9:48	30	0.215	0.013	0.061	40	6	40	40	0	40	25	0.313	0.313
B-0.1	9:50	0	0.109	0.013	0.122	45	9	46	44	0	45	25	0.619	0.619
B-0.1	10:00	10	0.146	0.013	0.091	45	9	46	44	0	45	26	0.463	0.450
B-0.1	10:10	20	0.151	0.013	0.088	45	9	46	44	0	45	27	0.447	0.423
B-0.1	10:20	30	0.153	0.013	0.086	45	9	46	44	0	45	27	0.439	0.415
B-0.1	10:25	0	0.090	0.013	0.147	30	14	31	29	0	30	27	0.749	0.708
B-0.1	10:35	10	0.099	0.013	0.133	30	14	31	29	0	30	27	0.677	0.641
B-0.1	10:45	20	0.103	0.013	0.128	30	14	31	29	0	30	27	0.653	0.618
B-0.1	10:55	30	0.100	0.013	0.132	30	14	31	29	0	30	27	0.671	0.634
B-0.1	11:00	0	0.142	0.013	0.093	20	6	20	20	0	20	27	0.476	0.450
B-0.1	11:10	10	0.217	0.013	0.061	20	6	20	20	0	20	25	0.310	0.310
B-0.1	11:20	20	0.229	0.013	0.058	20	6	20	20	0	20	24	0.293	0.302
B-0.1	11:30	30	0.239	0.013	0.056	20	6	20	20	0	20	24	0.282	0.290
B-0.1	11:35	0	0.112	0.013	0.118	30	9	30.5	29.5	0	30	24	0.603	0.620
B-0.1	11:45	10	0.139	0.013	0.095	30	9	30.5	29.5	0	30	25	0.484	0.484
B-0.1	11:55	20	0.150	0.013	0.088	30	9	30.5	29.5	0	30	25	0.450	0.450
B-0.1	12:05	30	0.149	0.013	0.089	30	9	30.5	29.5	0	30	25	0.451	0.451

Table D-2. Strontium Carbonate Flux-Mott 0.1 µm (continued).

C-0.1	6:55	0	0.118	0.013	0.112	30	9	29.5	30.5	0	30	22	0.573	0.624
C-0.1	7:05	10	0.192	0.013	0.069	30	9	29.5	30.5	0	30	23	0.351	0.371
C-0.1	7:15	20	0.192	0.013	0.069	30	9	29.5	30.5	0	30	23	0.350	0.371
C-0.1	7:25	30	0.195	0.013	0.068	30	9	29.5	30.5	0	30	23	0.346	0.366
C-0.1	7:28	0	0.108	0.013	0.123	40	12	40.5	39.5	0	40	25	0.624	0.624
C-0.1	7:38	10	0.140	0.013	0.094	40	12	40.5	39.5	0	40	24	0.481	0.495
C-0.1	7:48	20	0.139	0.013	0.095	40	12	40.5	39.5	0	40	27	0.485	0.459
C-0.1	7:58	30	0.139	0.013	0.095	40	12	40.5	39.5	0	40	27	0.485	0.458
C-0.1	9:50	0	0.151	0.013	0.088	30	4	30	30	0	30	24	0.447	0.460
C-0.1	10:00	10	0.364	0.013	0.036	30	4	30	30	0	30	24	0.185	0.190
C-0.1	10:10	20	0.380	0.013	0.035	30	4	30	30	0	30	24	0.177	0.182
C-0.1	10:20	30	0.398	0.013	0.033	30	4	30	30	0	30	24	0.169	0.174
C-0.1	10:27	0	0.168	0.013	0.079	15	9	15	15	0	15	24	0.401	0.413
C-0.1	10:37	10	0.222	0.013	0.060	15	9	15	15	0	15	24	0.303	0.312
C-0.1	10:47	20	0.228	0.013	0.058	15	9	15	15	0	15	24	0.296	0.304
C-0.1	10:57	30	0.219	0.013	0.060	15	9	15	15	0	15	24	0.308	0.316
C-0.1	10:59	0	0.142	0.013	0.093	20	12	20.5	19.5	0	20	24	0.475	0.489
C-0.1	11:09	10	0.161	0.013	0.082	20	12	20.5	19.5	0	20	25	0.419	0.419
C-0.1	11:19	20	0.156	0.013	0.085	20	12	20.5	19.5	0	20	25	0.431	0.431
C-0.1	11:29	30	0.154	0.013	0.086	20	12	20.5	19.5	0	20	25	0.437	0.437
C-0.1	11:33	0	0.161	0.013	0.082	30	9	30.5	29.5	0	30	25	0.418	0.418
C-0.1	11:43	10	0.181	0.013	0.073	30	9	30.5	29.5	0	30	25	0.371	0.371
C-0.1	11:53	20	0.442	0.013	0.030	30	9	30.5	29.5	0	30	25	0.152	0.152
C-0.1	12:03	30	0.189	0.013	0.070	30	9	30.5	29.5	0	30	25	0.356	0.356
C-0.1	12:06	0	0.171	0.013	0.077	40	6	40.5	39.5	0	40	25	0.395	0.395
C-0.1	12:16	10	0.231	0.013	0.057	40	6	40.5	39.5	0	40	25	0.292	0.292
C-0.1	12:26	20	0.256	0.013	0.052	40	6	40.5	39.5	0	40	25	0.263	0.263
C-0.1	12:36	30	0.258	0.013	0.051	40	6	40.5	39.5	0	40	25	0.261	0.261
C-0.1	12:43	0	0.127	0.013	0.104	45	9	44.5	45.5	0	45	25	0.530	0.530
C-0.1	12:53	10	0.173	0.013	0.076	45	9	44.5	45.5	0	45	26	0.389	0.378
C-0.1	1:03	20	0.180	0.013	0.073	45	9	44.5	45.5	0	45	26	0.373	0.363
C-0.1	1:13	30	0.193	0.013	0.069	45	9	44.5	45.5	0	45	26	0.349	0.339
C-0.1	1:15	0	0.126	0.013	0.105	30	14	30.5	29.5	0	30	26	0.533	0.518
C-0.1	1:25	10	0.148	0.013	0.089	30	14	30.5	29.5	0	30	27	0.454	0.429
C-0.1	1:35	20	0.145	0.013	0.091	30	14	30.5	29.5	0	30	27	0.466	0.440
C-0.1	1:45	30	0.142	0.013	0.093	30	14	30.5	29.5	0	30	27	0.474	0.449
C-0.1	1:47	0	0.187	0.013	0.071	20	6	20	20	0	20	27	0.360	0.340
C-0.1	1:57	10	0.258	0.013	0.051	20	6	20	20	0	20	25	0.261	0.261
C-0.1	2:07	20	0.289	0.013	0.046	20	6	20	20	0	20	24	0.233	0.240
C-0.1	2:17	30	0.296	0.013	0.045	20	6	20	20	0	20	24	0.228	0.235
C-0.1	2:18	0	0.160	0.013	0.083	30	9	30.5	29.5	0	30	24	0.422	0.434
C-0.1	2:28	10	0.201	0.013	0.066	30	9	30.5	29.5	0	30	25	0.335	0.335
C-0.1	2:38	20	0.208	0.013	0.063	30	9	30.5	29.5	0	30	25	0.323	0.323
C-0.1	2:48	30	0.208	0.013	0.063	30	9	30.5	29.5	0	30	25	0.323	0.323
D-0.1	7:35	0	0.126	0.013	0.105	30	9	30.5	29.5	0	30	23	0.536	0.567
D-0.1	7:45	10	0.197	0.013	0.067	30	9	30.5	29.5	0	30	25	0.341	0.341
D-0.1	7:55	20	0.207	0.013	0.064	30	9	30.5	29.5	0	30	25	0.325	0.325
D-0.1	8:05	30	0.207	0.013	0.064	30	9	30.5	29.5	0	30	25	0.325	0.325
D-0.1	8:09	0	0.106	0.013	0.125	40	12	41	39	0	40	26	0.637	0.619
D-0.1	8:19	10	0.130	0.013	0.102	40	12	41	39	0	40	27	0.518	0.490
D-0.1	8:29	20	0.133	0.013	0.100	40	12	41	39	0	40	28	0.508	0.467
D-0.1	8:39	30	0.130	0.013	0.102	40	12	41	39	0	40	28	0.518	0.477
D-0.1	8:42	0	0.161	0.013	0.082	30	4	30	30	0	30	27	0.418	0.395
D-0.1	8:52	10	0.305	0.013	0.043	30	4	30	30	0	30	25	0.221	0.221
D-0.1	9:02	20	0.347	0.013	0.038	30	4	30	30	0	30	25	0.194	0.194
D-0.1	9:12	30	0.353	0.013	0.037	30	4	30	30	0	30	24	0.191	0.196
D-0.1	9:15	0	0.181	0.013	0.073	15	9	15	15	0	15	24	0.371	0.382
D-0.1	9:25	10	0.187	0.013	0.071	15	9	15	15	0	15	24	0.360	0.371
D-0.1	9:35	20	0.192	0.013	0.069	15	9	15	15	0	15	25	0.351	0.351
D-0.1	9:45	30	0.193	0.013	0.069	15	9	15	15	0	15	25	0.349	0.349
D-0.1	9:48	0	0.152	0.013	0.087	20	12	20.5	19.5	0	20	25	0.443	0.443
D-0.1	9:58	10	0.161	0.013	0.082	20	12	20.5	19.5	0	20	25	0.418	0.418
D-0.1	10:08	20	0.174	0.013	0.076	20	12	20.5	19.5	0	20	26	0.387	0.376
D-0.1	10:18	30	0.157	0.013	0.084	20	12	20.5	19.5	0	20	26	0.430	0.418
D-0.1	10:21	0	0.147	0.013	0.090	30	9	30.5	29.5	0	30	26	0.458	0.445
D-0.1	10:31	10	0.206	0.013	0.064	30	9	30.5	29.5	0	30	26	0.326	0.317
D-0.1	10:41	20	0.209	0.013	0.063	30	9	30.5	29.5	0	30	26	0.323	0.314
D-0.1	10:51	30	0.211	0.013	0.063	30	9	30.5	29.5	0	30	26	0.318	0.310
D-0.1	10:54	0	0.139	0.013	0.095	40	6	40	40	0	40	26	0.485	0.472
D-0.1	11:04	10	0.247	0.013	0.053	40	6	40	40	0	40	26	0.272	0.265
D-0.1	11:14	20	0.258	0.013	0.051	40	6	40	40	0	40	25	0.261	0.261
D-0.1	11:24	30	0.265	0.013	0.050	40	6	40	40	0	40	25	0.254	0.254
D-0.1	11:27	0	0.147	0.013	0.090	45	9	45.5	44.5	0	45	26	0.458	0.446
D-0.1	11:37	10	0.206	0.013	0.064	45	9	45.5	44.5	0	45	27	0.326	0.308
D-0.1	11:47	20	0.212	0.013	0.062	45	9	45.5	44.5	0	45	27	0.317	0.300
D-0.1	11:57	30	0.218	0.013	0.061	45	9	45.5	44.5	0	45	27	0.308	0.292
D-0.1	12:00	0	0.103	0.013	0.128	30	14	31	29	0	30	27	0.651	0.616
D-0.1	12:10	10	0.136	0.013	0.098	30	14	31	29	0	30	27	0.498	0.471
D-0.1	12:20	20	0.131	0.013	0.101	30	14	31	29	0	30	28	0.516	0.474
D-0.1	12:30	30	0.122	0.013	0.108	30	14	31	29	0	30	28	0.551	0.507
D-0.1	12:32	0	0.193	0.013	0.069	20	6	20	20	0	20	26	0.349	0.340
D-0.1	12:42	10	0.240	0.013	0.055	20	6	20	20	0	20	25	0.280	0.280
D-0.1	12:52	20	0.257	0.013	0.051	20	6	20	20	0	20	25	0.262	0.262
D-0.1	1:02	30	0.264	0.013	0.050	20	6	20	20	0	20	24	0.256	0.263
D-0.1	1:05	0	0.118	0.013	0.112	30	9	30.5	29.5	0	30	25	0.569	0.569
D-0.1	1:15	10	0.176	0.013	0.075	30	9	30.5	29.5	0	30	25	0.382	0.382
D-0.1	1:25	20	0.182	0.013	0.072	30	9	30.5	29.5	0	30	26	0.369	0.359
D-0.1	1:35	30	0.190	0.013	0.070	30	9	30.5	29.5	0	30	26	0.354	0.345

Table D-2. Strontium Carbonate Flux-Mott 0.1 µm (continued).

E-0.1	6:25	0	0.167	0.013	0.079	30	9	31	30	0	30.5	23	0.404	0.428
E-0.1	6:35	10	0.263	0.013	0.050	30	9	31	30	0	30.5	23	0.256	0.271
E-0.1	6:45	20	0.268	0.013	0.049	30	9	31	30	0	30.5	24	0.252	0.259
E-0.1	6:55	30	0.279	0.013	0.047	30	9	31	30	0	30.5	25	0.241	0.241
E-0.1	7:00	0	0.111	0.013	0.120	40	12	41.5	40	0	40.75	26	0.609	0.592
E-0.1	7:10	10	0.144	0.013	0.092	40	12	41.5	40	0	40.75	28	0.466	0.429
E-0.1	7:20	20	0.143	0.013	0.093	40	12	41.5	40	0	40.75	28	0.472	0.434
E-0.1	7:30	30	0.143	0.013	0.093	40	12	41.5	40	0	40.75	29	0.472	0.423
E-0.1	7:35	0	0.169	0.013	0.078	30	4	30	30	0	30	28	0.399	0.367
E-0.1	7:45	10	0.352	0.013	0.038	30	4	30	30	0	30	26	0.191	0.186
E-0.1	7:55	20	0.382	0.013	0.035	30	4	30	30	0	30	25	0.176	0.176
E-0.1	8:05	30	0.420	0.013	0.031	30	4	30	30	0	30	25	0.160	0.160
E-0.1	8:20	0	0.186	0.013	0.072	15	9	15	15	0	15	25	0.365	0.365
E-0.1	8:30	10	0.223	0.013	0.059	15	9	15	15	0	15	25	0.302	0.302
E-0.1	8:40	20	0.268	0.013	0.049	15	9	15	15	0	15	25	0.251	0.251
E-0.1	8:50	30	0.273	0.013	0.048	15	9	15	15	0	15	25	0.247	0.247
E-0.1	8:55	0	0.143	0.013	0.093	20	12	21	20	0	20.5	25	0.472	0.472
E-0.1	9:05	10	0.163	0.013	0.081	20	12	21	20	0	20.5	26	0.412	0.401
E-0.1	9:15	20	0.152	0.013	0.087	20	12	21	20	0	20.5	26	0.444	0.432
E-0.1	9:25	30	0.148	0.013	0.089	20	12	21	20	0	20.5	26	0.454	0.442
E-0.1	9:30	0	0.139	0.013	0.095	30	9	31	30	0	30.5	26	0.485	0.471
E-0.1	9:40	10	0.218	0.013	0.061	30	9	31	30	0	30.5	26	0.309	0.300
E-0.1	9:50	20	0.239	0.013	0.055	30	9	31	30	0	30.5	26	0.282	0.274
E-0.1	10:00	30	0.233	0.013	0.057	30	9	31	30	0	30.5	26	0.288	0.280
E-0.1	10:05	0	0.139	0.013	0.095	40	6	41	40	0	40.5	26	0.483	0.470
E-0.1	10:15	10	0.265	0.013	0.050	40	6	41	40	0	40.5	26	0.254	0.247
E-0.1	10:25	20	0.274	0.013	0.048	40	6	41	40	0	40.5	26	0.246	0.239
E-0.1	10:35	30	0.276	0.013	0.048	40	6	41	40	0	40.5	26	0.244	0.237
E-0.1	10:40	0	0.128	0.013	0.103	45	9	46.5	45	0	45.75	26	0.524	0.510
E-0.1	10:50	10	0.173	0.013	0.076	45	9	46.5	45	0	45.75	27	0.388	0.367
E-0.1	11:00	20	0.173	0.013	0.076	45	9	46.5	45	0	45.75	27	0.388	0.367
E-0.1	11:10	30	0.173	0.013	0.077	45	9	46.5	45	0	45.75	27	0.390	0.369
E-0.1	11:15	0	0.103	0.013	0.128	30	14	32	30	0	31	27	0.651	0.616
E-0.1	11:25	10	0.108	0.013	0.123	30	14	32	30	0	31	28	0.624	0.574
E-0.1	11:35	20	0.101	0.013	0.130	30	14	32	30	0	31	29	0.664	0.594
E-0.1	11:45	30	0.101	0.013	0.131	30	14	32	30	0	31	29	0.667	0.597
E-0.1	11:50	0	0.136	0.013	0.097	20	6	21	20	0	20.5	28	0.495	0.456
E-0.1	12:00	10	0.272	0.013	0.049	20	6	21	20	0	20.5	26	0.248	0.241
E-0.1	12:10	20	0.282	0.013	0.047	20	6	21	20	0	20.5	25	0.238	0.238
E-0.1	12:20	30	0.293	0.013	0.045	20	6	21	20	0	20.5	25	0.230	0.230
E-0.1	12:25	0	0.141	0.013	0.094	30	9	31	30	0	30.5	25	0.477	0.477
E-0.1	12:35	10	0.186	0.013	0.071	30	9	31	30	0	30.5	26	0.363	0.353
E-0.1	12:45	20	0.186	0.013	0.071	30	9	31	30	0	30.5	26	0.361	0.351
E-0.1	12:55	30	0.187	0.013	0.071	30	9	31	30	0	30.5	27	0.361	0.341

Table D-3. Strontium Carbonate Flux (Mott 0.5 μm).

$SrCO_3$ Flux															
Mott 0.5															
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.5	6:30	0	0.203	0.013	0.065	30	9	30	30	0	30	20	0.331	0.382
A-0.5	6:40	10	0.253	0.013	0.052	30	9	30	30	0	30	22	0.267	0.290
A-0.5	6:50	20	0.252	0.013	0.052	30	9	30	30	0	30	23	0.267	0.283
A-0.5	7:00	30	0.260	0.013	0.051	30	9	30	30	0	30	24	0.259	0.267
A-0.5	7:03	0	0.155	0.013	0.085	40	12	39.5	40.5	0	40	24	0.434	0.447
A-0.5	7:13	10	0.177	0.013	0.075	40	12	39.5	40.5	0	40	27	0.381	0.360
A-0.5	7:23	20	0.174	0.013	0.076	40	12	39.5	40.5	0	40	28	0.387	0.356
A-0.5	7:33	30	0.174	0.013	0.076	40	12	39.5	40.5	0	40	30	0.386	0.336
A-0.5	7:35	0	0.188	0.013	0.070	30	4	29.5	30.5	0	30	29	0.358	0.320
A-0.5	7:45	10	0.442	0.013	0.030	30	4	29.5	30.5	0	30	27	0.152	0.144
A-0.5	7:55	20	0.483	0.013	0.027	30	4	29.5	30.5	0	30	25	0.139	0.139
A-0.5	8:05	30	0.477	0.013	0.028	30	4	29.5	30.5	0	30	24	0.141	0.145
A-0.5	8:08	0	0.248	0.013	0.053	15	9	14.5	15.5	0	15	24	0.271	0.279
A-0.5	8:18	10	0.278	0.013	0.048	15	9	14.5	15.5	0	15	23	0.243	0.257
A-0.5	8:28	20	0.289	0.013	0.046	15	9	14.5	15.5	0	15	22	0.233	0.253
A-0.5	8:38	30	0.307	0.013	0.043	15	9	14.5	15.5	0	15	22	0.219	0.238
A-0.5	8:45	0	0.181	0.013	0.073	20	12	20	20	0	20	22	0.372	0.405
A-0.5	8:55	10	0.203	0.013	0.065	20	12	20	20	0	20	23	0.332	0.351
A-0.5	9:05	20	0.212	0.013	0.062	20	12	20	20	0	20	24	0.317	0.326
A-0.5	9:15	30	0.219	0.013	0.060	20	12	20	20	0	20	24	0.308	0.317
A-0.5	9:17	0	0.201	0.013	0.066	30	9	30	30	0	30	24	0.335	0.344
A-0.5	9:27	10	0.244	0.013	0.054	30	9	30	30	0	30	25	0.276	0.276
A-0.5	9:37	20	0.253	0.013	0.052	30	9	30	30	0	30	25	0.266	0.266
A-0.5	9:47	30	0.257	0.013	0.051	30	9	30	30	0	30	25	0.262	0.262
A-0.5	9:50	0	0.242	0.013	0.055	40	6	40	40	0	40	25	0.279	0.279
A-0.5	10:00	10	0.351	0.013	0.038	40	6	40	40	0	40	25	0.192	0.192
A-0.5	10:10	20	0.359	0.013	0.037	40	6	40	40	0	40	25	0.188	0.188
A-0.5	10:20	30	0.358	0.013	0.037	40	6	40	40	0	40	25	0.188	0.188
A-0.5	10:24	0	0.206	0.013	0.064	45	9	45	45	0	45	25	0.327	0.327
A-0.5	10:34	10	0.238	0.013	0.056	45	9	45	45	0	45	27	0.283	0.268
A-0.5	10:44	20	0.233	0.013	0.057	45	9	45	45	0	45	29	0.289	0.259
A-0.5	10:54	30	0.241	0.013	0.055	45	9	45	45	0	45	30	0.279	0.243
A-0.5	10:56	0	0.142	0.013	0.093	30	14	30	30	0	30	29	0.474	0.425
A-0.5	11:06	10	0.153	0.013	0.086	30	14	30	30	0	30	30	0.439	0.382
A-0.5	11:16	20	0.162	0.013	0.082	30	14	30	30	0	30	31	0.416	0.353
A-0.5	11:26	30	0.158	0.013	0.084	30	14	30	30	0	30	32	0.427	0.352
A-0.5	11:29	0	0.251	0.013	0.053	20	6	19.5	20.5	0	20	31	0.268	0.227
A-0.5	11:39	10	0.354	0.013	0.037	20	6	19.5	20.5	0	20	28	0.190	0.175
A-0.5	11:49	20	0.355	0.013	0.037	20	6	19.5	20.5	0	20	27	0.190	0.179
A-0.5	11:59	30	0.376	0.013	0.035	20	6	19.5	20.5	0	20	25	0.179	0.179
A-0.5	12:02	0	0.219	0.013	0.060	30	9	30	30	0	30	25	0.307	0.307
A-0.5	12:12	10	0.247	0.013	0.053	30	9	30	30	0	30	26	0.272	0.265
A-0.5	12:22	20	0.262	0.013	0.051	30	9	30	30	0	30	26	0.257	0.250
A-0.5	12:32	30	0.264	0.013	0.050	30	9	30	30	0	30	26	0.256	0.248
B-0.5	6:02	0	0.215	0.013	0.061	30	9	31	29	0	30	20	0.313	0.361
B-0.5	6:12	10	0.235	0.013	0.056	30	9	31	29	0	30	23	0.287	0.303
B-0.5	6:22	20	0.230	0.013	0.058	30	9	31	29	0	30	26	0.293	0.285
B-0.5	6:32	30	0.220	0.013	0.060	30	9	31	29	0	30	28	0.306	0.281
B-0.5	6:35	0	0.138	0.013	0.096	40	12	42	38	0	40	28	0.488	0.449
B-0.5	6:45	10	0.132	0.013	0.100	40	12	42	38	0	40	31	0.510	0.433
B-0.5	6:55	20	0.126	0.013	0.105	40	12	42	38	0	40	33	0.533	0.428
B-0.5	7:05	30	0.129	0.013	0.102	40	12	42	38	0	40	34	0.521	0.407
B-0.5	7:08	0	0.215	0.013	0.061	30	4	29.5	30.5	0	30	32	0.313	0.258
B-0.5	7:18	10	0.399	0.013	0.033	30	4	29.5	30.5	0	30	29	0.169	0.151
B-0.5	7:28	20	0.423	0.013	0.031	30	4	29.5	30.5	0	30	27	0.159	0.150
B-0.5	7:38	30	0.462	0.013	0.029	30	4	29.5	30.5	0	30	25	0.146	0.146
B-0.5	7:42	0	0.213	0.013	0.062	15	9	16	14	0	15	24	0.316	0.325
B-0.5	7:52	10	0.239	0.013	0.055	15	9	16	14	0	15	23	0.282	0.298
B-0.5	8:02	20	0.247	0.013	0.053	15	9	16	14	0	15	23	0.272	0.288
B-0.5	8:12	30	0.251	0.013	0.053	15	9	16	14	0	15	22	0.269	0.293
B-0.5	8:17	0	0.179	0.013	0.074	20	12	22	18	0	20	22	0.376	0.409
B-0.5	8:27	10	0.173	0.013	0.076	20	12	22	18	0	20	24	0.389	0.400
B-0.5	8:37	20	0.172	0.013	0.077	20	12	22	18	0	20	24	0.392	0.403
B-0.5	8:47	30	0.174	0.013	0.076	20	12	22	18	0	20	25	0.386	0.386
B-0.5	8:50	0	0.210	0.013	0.063	30	9	31	29	0	30	25	0.321	0.321
B-0.5	9:00	10	0.245	0.013	0.054	30	9	31	29	0	30	25	0.275	0.275
B-0.5	9:10	20	0.236	0.013	0.056	30	9	31	29	0	30	25	0.286	0.286
B-0.5	9:20	30	0.236	0.013	0.056	30	9	31	29	0	30	26	0.285	0.277
B-0.5	9:23	0	0.251	0.013	0.053	40	6	41	39	0	40	25	0.269	0.269
B-0.5	9:33	10	0.362	0.013	0.037	40	6	41	39	0	40	25	0.186	0.186
B-0.5	9:43	20	0.353	0.013	0.037	40	6	41	39	0	40	25	0.191	0.191
B-0.5	9:53	30	0.362	0.013	0.036	40	6	41	39	0	40	25	0.186	0.186
B-0.5	10:00	0	0.194	0.013	0.068	45	9	47	43	0	45	25	0.347	0.347
B-0.5	10:10	10	0.254	0.013	0.052	45	9	47	43	0	45	27	0.266	0.250
B-0.5	10:20	20	0.243	0.013	0.054	45	9	47	43	0	45	28	0.277	0.255
B-0.5	10:30	30	0.241	0.013	0.055	45	9	47	43	0	45	29	0.280	0.250
B-0.5	10:33	0	0.148	0.013	0.089	30	14	32	28	0	30	29	0.456	0.408
B-0.5	10:43	10	0.146	0.013	0.091	30	14	32	28	0	30	30	0.461	0.402
B-0.5	10:53	20	0.140	0.013	0.094	30	14	32	28	0	30	31	0.480	0.406
B-0.5	11:03	30	0.143	0.013	0.092	30	14	32	28	0	30	31	0.471	0.399
B-0.5	11:06	0	0.276	0.013	0.048	20	6	20.5	19.5	0	20	30	0.245	0.213
B-0.5	11:16	10	0.395	0.013	0.033	20	6	20.5	19.5	0	20	27	0.171	0.161
B-0.5	11:26	20	0.397	0.013	0.033	20	6	20.5	19.5	0	20	25	0.170	0.170
B-0.5	11:36	30	0.419	0.013	0.032	20	6	20.5	19.5	0	20	24	0.161	0.165
B-0.5	11:40	0	0.232	0.013	0.057	30	9	31	29	0	30	24	0.290	0.298
B-0.5	11:50	10	0.263	0.013	0.050	30	9	31	29	0	30	24	0.256	0.263
B-0.5	12:00	20	0.260	0.013	0.051	30	9	31	29	0	30	25	0.259	0.259
B-0.5	12:10	30	0.257	0.013	0.051	30	9	31	29	0	30	25	0.262	0.262

Table D-3. Strontium Carbonate Flux-Mott 0.5 µm (continued).

C-0.5	7:20	0	0.253	0.013	0.052	30	9	31	29	0	30	19	0.266	0.316
C-0.5	7:30	10	0.282	0.013	0.047	30	9	31	29	0	30	21	0.239	0.267
C-0.5	7:40	20	0.273	0.013	0.048	30	9	31	29	0	30	22	0.246	0.268
C-0.5	7:50	30	0.270	0.013	0.049	30	9	31	29	0	30	23	0.249	0.264
C-0.5	7:52	0	0.177	0.013	0.075	40	12	41	39	2	38	23	0.381	0.403
C-0.5	8:02	10	0.173	0.013	0.076	40	12	41	39	2	38	26	0.389	0.378
C-0.5	8:12	20	0.162	0.013	0.081	40	12	41	39	2	38	28	0.415	0.382
C-0.5	8:22	30	0.158	0.013	0.083	40	12	41	39	2	38	29	0.425	0.380
C-0.5	8:24	0	0.312	0.013	0.042	30	4	30.5	29.5	0	30	28	0.216	0.199
C-0.5	8:34	10	0.481	0.013	0.027	30	4	30.5	29.5	0	30	26	0.140	0.136
C-0.5	8:44	20	0.511	0.013	0.026	30	4	30.5	29.5	0	30	24	0.132	0.135
C-0.5	8:54	30	0.537	0.013	0.025	30	4	30.5	29.5	0	30	23	0.125	0.133
C-0.5	8:56	0	0.269	0.013	0.049	15	9	16	14	0	15	23	0.250	0.265
C-0.5	9:06	10	0.277	0.013	0.048	15	9	16	14	0	15	23	0.243	0.257
C-0.5	9:16	20	0.278	0.013	0.048	15	9	16	14	0	15	22	0.242	0.264
C-0.5	9:26	30	0.269	0.013	0.049	15	9	16	14	0	15	22	0.250	0.273
C-0.5	9:28	0	0.190	0.013	0.070	20	12	21	19	0	20	22	0.355	0.386
C-0.5	9:38	10	0.191	0.013	0.069	20	12	21	19	0	20	23	0.353	0.374
C-0.5	9:48	20	0.191	0.013	0.069	20	12	21	19	0	20	24	0.353	0.363
C-0.5	9:58	30	0.192	0.013	0.069	20	12	21	19	0	20	25	0.351	0.351
C-0.5	10:00	0	0.236	0.013	0.056	30	9	31	29	0	30	25	0.285	0.285
C-0.5	10:10	10	0.265	0.013	0.050	30	9	31	29	0	30	25	0.254	0.254
C-0.5	10:20	20	0.258	0.013	0.051	30	9	31	29	0	30	25	0.261	0.261
C-0.5	10:30	30	0.257	0.013	0.051	30	9	31	29	0	30	26	0.262	0.255
C-0.5	10:32	0	0.311	0.013	0.042	40	6	41	39	0	40	25	0.216	0.216
C-0.5	10:42	10	0.375	0.013	0.035	40	6	41	39	0	40	25	0.179	0.179
C-0.5	10:52	20	0.381	0.013	0.035	40	6	41	39	0	40	25	0.177	0.177
C-0.5	11:02	30	0.378	0.013	0.035	40	6	41	39	0	40	25	0.178	0.178
C-0.5	11:05	0	0.230	0.013	0.058	45	9	47	43	0	45	26	0.293	0.285
C-0.5	11:15	10	0.243	0.013	0.054	45	9	47	43	0	45	28	0.277	0.255
C-0.5	11:25	20	0.235	0.013	0.056	45	9	47	43	0	45	29	0.287	0.256
C-0.5	11:35	30	0.234	0.013	0.056	45	9	47	43	0	45	29	0.287	0.257
C-0.5	11:40	0	0.144	0.013	0.092	30	14	31	29	0	30	29	0.466	0.417
C-0.5	11:50	10	0.152	0.013	0.087	30	14	31	29	0	30	30	0.444	0.386
C-0.5	12:00	20	0.154	0.013	0.086	30	14	31	29	0	30	31	0.437	0.371
C-0.5	12:10	30	0.155	0.013	0.085	30	14	31	29	0	30	31	0.434	0.368
C-0.5	12:12	0	0.306	0.013	0.043	20	6	20.5	19.5	0	20	31	0.220	0.186
C-0.5	12:22	10	0.400	0.013	0.033	20	6	20.5	19.5	0	20	28	0.168	0.155
C-0.5	12:32	20	0.399	0.013	0.033	20	6	20.5	19.5	0	20	26	0.169	0.164
C-0.5	12:42	30	0.421	0.013	0.031	20	6	20.5	19.5	0	20	25	0.160	0.160
C-0.5	12:45	0	0.248	0.013	0.053	30	9	31	29	0	30	24	0.272	0.279
C-0.5	12:55	10	0.254	0.013	0.052	30	9	31	29	0	30	25	0.265	0.265
C-0.5	1:05	20	0.254	0.013	0.052	30	9	31	29	0	30	26	0.265	0.258
C-0.5	1:15	30	0.249	0.013	0.053	30	9	31	29	0	30	26	0.270	0.263
D-0.5	6:15	0	0.205	0.013	0.064	30	9	30	30	0	30	20	0.328	0.378
D-0.5	6:25	10	0.268	0.013	0.049	30	9	30	30	0	30	22	0.251	0.273
D-0.5	6:35	20	0.265	0.013	0.050	30	9	30	30	0	30	23	0.254	0.269
D-0.5	6:45	30	0.269	0.013	0.049	30	9	30	30	0	30	23	0.250	0.265
D-0.5	6:49	0	0.156	0.013	0.085	40	12	39.5	40.5	0	40	24	0.432	0.444
D-0.5	6:59	10	0.167	0.013	0.079	40	12	39.5	40.5	0	40	27	0.403	0.381
D-0.5	7:09	20	0.166	0.013	0.080	40	12	39.5	40.5	0	40	29	0.405	0.363
D-0.5	7:19	30	0.170	0.013	0.078	40	12	39.5	40.5	0	40	30	0.396	0.345
D-0.5	7:22	0	0.236	0.013	0.056	30	4	30	30	0	30	29	0.287	0.257
D-0.5	7:32	10	0.536	0.013	0.025	30	4	30	30	0	30	27	0.126	0.119
D-0.5	7:42	20	0.547	0.013	0.024	30	4	30	30	0	30	25	0.123	0.123
D-0.5	7:52	30	0.592	0.013	0.022	30	4	30	30	0	30	24	0.114	0.117
D-0.5	7:55	0	0.272	0.013	0.049	15	9	14.5	15.5	0	15	24	0.248	0.255
D-0.5	8:05	10	0.283	0.013	0.047	15	9	14.5	15.5	0	15	23	0.238	0.252
D-0.5	8:15	20	0.298	0.013	0.044	15	9	14.5	15.5	0	15	22	0.226	0.246
D-0.5	8:25	30	0.306	0.013	0.043	15	9	14.5	15.5	0	15	22	0.220	0.239
D-0.5	8:28	0	0.221	0.013	0.060	20	12	20	20	0	20	22	0.305	0.332
D-0.5	8:38	10	0.247	0.013	0.054	20	12	20	20	0	20	23	0.273	0.289
D-0.5	8:48	20	0.257	0.013	0.051	20	12	20	20	0	20	23	0.262	0.277
D-0.5	8:58	30	0.258	0.013	0.051	20	12	20	20	0	20	24	0.261	0.269
D-0.5	9:00	0	0.181	0.013	0.073	30	9	30	30	0	30	24	0.372	0.383
D-0.5	9:10	10	0.257	0.013	0.051	30	9	30	30	0	30	24	0.262	0.269
D-0.5	9:20	20	0.257	0.013	0.051	30	9	30	30	0	30	24	0.262	0.269
D-0.5	9:30	30	0.257	0.013	0.051	30	9	30	30	0	30	25	0.262	0.262
D-0.5	9:33	0	0.274	0.013	0.048	40	6	39.5	40.5	0	40	25	0.246	0.246
D-0.5	9:43	10	0.377	0.013	0.035	40	6	39.5	40.5	0	40	25	0.179	0.179
D-0.5	9:53	20	0.384	0.013	0.034	40	6	39.5	40.5	0	40	25	0.175	0.175
D-0.5	10:03	30	0.389	0.013	0.034	40	6	39.5	40.5	0	40	25	0.173	0.173
D-0.5	10:06	0	0.210	0.013	0.063	45	9	45	45	0	45	25	0.321	0.321
D-0.5	10:16	10	0.245	0.013	0.054	45	9	45	45	0	45	26	0.276	0.267
D-0.5	10:26	20	0.243	0.013	0.054	45	9	45	45	0	45	28	0.277	0.255
D-0.5	10:36	30	0.242	0.013	0.055	45	9	45	45	0	45	29	0.278	0.249
D-0.5	10:39	0	0.155	0.013	0.085	30	14	29.5	30.5	0	30	28	0.434	0.399
D-0.5	10:49	10	0.168	0.013	0.079	30	14	29.5	30.5	0	30	30	0.401	0.349
D-0.5	10:59	20	0.176	0.013	0.075	30	14	29.5	30.5	0	30	30	0.382	0.333
D-0.5	11:09	30	0.180	0.013	0.073	30	14	29.5	30.5	0	30	31	0.374	0.317
D-0.5	11:12	0	0.289	0.013	0.046	20	6	19.5	20.5	0	20	30	0.233	0.203
D-0.5	11:22	10	0.401	0.013	0.033	20	6	19.5	20.5	0	20	27	0.168	0.159
D-0.5	11:32	20	0.416	0.013	0.032	20	6	19.5	20.5	0	20	25	0.162	0.162
D-0.5	11:42	30	0.431	0.013	0.031	20	6	19.5	20.5	0	20	24	0.156	0.161
D-0.5	11:45	0	0.236	0.013	0.056	30	9	30	30	0	30	24	0.286	0.294
D-0.5	11:55	10	0.258	0.013	0.051	30	9	30	30	0	30	24	0.261	0.269
D-0.5	12:05	20	0.256	0.013	0.052	30	9	30	30	0	30	25	0.263	0.263
D-0.5	12:15	30	0.259	0.013	0.051	30	9	30	30	0	30	25	0.260	0.260

Table D-3. Strontium Carbonate Flux-Mott 0.5 µm (continued).

E-0.5	6:28	0	0.130	0.013	0.101	30	9	30	30	0	30	20	0.517	0.597
E-0.5	6:38	10	0.230	0.013	0.057	30	9	30	30	0	30	21	0.293	0.328
E-0.5	6:48	20	0.237	0.013	0.056	30	9	30	30	0	30	22	0.284	0.309
E-0.5	6:58	30	0.245	0.013	0.054	30	9	30	30	0	30	23	0.274	0.290
E-0.5	7:02	0	0.122	0.013	0.108	40	12	39.5	40.5	0	40	23	0.550	0.582
E-0.5	7:12	10	0.177	0.013	0.075	40	12	39.5	40.5	0	40	26	0.380	0.370
E-0.5	7:22	20	0.180	0.013	0.073	40	12	39.5	40.5	0	40	28	0.374	0.344
E-0.5	7:32	30	0.178	0.013	0.074	40	12	39.5	40.5	0	40	29	0.379	0.339
E-0.5	7:35	0	0.180	0.013	0.074	30	4	30	30	0	30	29	0.375	0.335
E-0.5	7:45	10	0.438	0.013	0.030	30	4	30	30	0	30	27	0.154	0.145
E-0.5	7:55	20	0.488	0.013	0.027	30	4	30	30	0	30	25	0.138	0.138
E-0.5	8:05	30	0.485	0.013	0.027	30	4	30	30	0	30	24	0.139	0.143
E-0.5	8:10	0	0.231	0.013	0.057	15	9	15	15	0	15	24	0.291	0.299
E-0.5	8:20	10	0.267	0.013	0.050	15	9	15	15	0	15	23	0.252	0.267
E-0.5	8:30	20	0.288	0.013	0.046	15	9	15	15	0	15	22	0.234	0.255
E-0.5	8:40	30	0.294	0.013	0.045	15	9	15	15	0	15	22	0.229	0.249
E-0.5	8:43	0	0.217	0.013	0.061	20	12	20	20	0	20	22	0.311	0.339
E-0.5	8:53	10	0.245	0.013	0.054	20	12	20	20	0	20	23	0.275	0.291
E-0.5	9:03	20	0.251	0.013	0.053	20	12	20	20	0	20	24	0.268	0.275
E-0.5	9:13	30	0.262	0.013	0.050	20	12	20	20	0	20	24	0.257	0.264
E-0.5	9:25	0	0.207	0.013	0.064	30	9	30	30	0	30	24	0.325	0.334
E-0.5	9:35	10	0.236	0.013	0.056	30	9	30	30	0	30	24	0.285	0.294
E-0.5	9:45	20	0.244	0.013	0.054	30	9	30	30	0	30	25	0.276	0.276
E-0.5	9:55	30	0.249	0.013	0.053	30	9	30	30	0	30	25	0.271	0.271
E-0.5	9:58	0	0.231	0.013	0.057	40	6	39.5	40.5	0	40	25	0.292	0.292
E-0.5	10:08	10	0.347	0.013	0.038	40	6	39.5	40.5	0	40	25	0.194	0.194
E-0.5	10:18	20	0.348	0.013	0.038	40	6	39.5	40.5	0	40	24	0.194	0.199
E-0.5	10:28	30	0.357	0.013	0.037	40	6	39.5	40.5	0	40	24	0.189	0.194
E-0.5	10:30	0	0.189	0.013	0.070	45	9	45	45	0	45	24	0.357	0.367
E-0.5	10:40	10	0.227	0.013	0.058	45	9	45	45	0	45	26	0.296	0.288
E-0.5	10:50	20	0.225	0.013	0.059	45	9	45	45	0	45	27	0.299	0.283
E-0.5	11:00	30	0.223	0.013	0.059	45	9	45	45	0	45	28	0.302	0.278
E-0.5	11:04	0	0.127	0.013	0.104	30	14	30	30	0	30	28	0.529	0.487
E-0.5	11:14	10	0.160	0.013	0.083	30	14	30	30	0	30	29	0.422	0.378
E-0.5	11:24	20	0.163	0.013	0.081	30	14	30	30	0	30	30	0.412	0.359
E-0.5	11:34	30	0.166	0.013	0.079	30	14	30	30	0	30	30	0.405	0.353
E-0.5	11:37	0	0.250	0.013	0.053	20	6	19.5	20.5	0	20	30	0.270	0.235
E-0.5	11:47	10	0.375	0.013	0.035	20	6	19.5	20.5	0	20	27	0.179	0.170
E-0.5	11:57	20	0.391	0.013	0.034	20	6	19.5	20.5	0	20	25	0.172	0.172
E-0.5	12:07	30	0.434	0.013	0.030	20	6	19.5	20.5	0	20	24	0.155	0.160
E-0.5	12:10	0	0.187	0.013	0.071	30	9	30	30	0	30	24	0.360	0.371
E-0.5	12:20	10	0.256	0.013	0.052	30	9	30	30	0	30	24	0.263	0.271
E-0.5	12:30	20	0.261	0.013	0.051	30	9	30	30	0	30	25	0.258	0.258
E-0.5	12:40	30	0.264	0.013	0.050	30	9	30	30	0	30	25	0.255	0.255

Table D-4. Strontium Carbonate Flux (Pall 0.1 μm).

$SrCO_3$ Flux Pall 0.1															
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.1	5:50	0	0.174	0.013	0.076	30	9	30	30	0	30	19	0.353	0.419
A-0.1	6:00	10	0.238	0.013	0.056	30	9	30	30	0	30	21	0.259	0.290
A-0.1	6:10	20	0.230	0.013	0.057	30	9	30	30	0	30	22	0.267	0.291
A-0.1	6:20	30	0.234	0.013	0.056	30	9	30	30	0	30	23	0.263	0.279
A-0.1	6:26	0	0.138	0.013	0.096	40	12	40	40	0	40	23	0.446	0.472
A-0.1	6:36	10	0.162	0.013	0.082	40	12	40	40	0	40	25	0.380	0.380
A-0.1	6:46	20	0.164	0.013	0.081	40	12	40	40	0	40	26	0.375	0.365
A-0.1	6:56	30	0.165	0.013	0.080	40	12	40	40	0	40	26	0.374	0.363
A-0.1	7:02	0	0.248	0.013	0.053	30	4	29.5	30.5	0	30	24	0.248	0.256
A-0.1	7:12	10	0.491	0.013	0.027	30	4	29.5	30.5	0	30	23	0.125	0.133
A-0.1	7:22	20	0.489	0.013	0.027	30	4	29.5	30.5	0	30	22	0.126	0.137
A-0.1	7:32	30	0.498	0.013	0.027	30	4	29.5	30.5	0	30	22	0.123	0.134
A-0.1	7:37	0	0.241	0.013	0.055	15	9	15	15	0	15	21	0.256	0.286
A-0.1	7:47	10	0.267	0.013	0.050	15	9	15	15	0	15	22	0.231	0.251
A-0.1	7:57	20	0.271	0.013	0.049	15	9	15	15	0	15	22	0.227	0.248
A-0.1	8:07	30	0.275	0.013	0.048	15	9	15	15	0	15	22	0.224	0.244
A-0.1	8:12	0	0.172	0.013	0.077	20	12	20	20	0	20	22	0.357	0.389
A-0.1	8:22	10	0.182	0.013	0.073	20	12	20	20	0	20	23	0.339	0.358
A-0.1	8:32	20	0.191	0.013	0.069	20	12	20	20	0	20	24	0.323	0.332
A-0.1	8:42	30	0.193	0.013	0.069	20	12	20	20	0	20	24	0.319	0.329
A-0.1	8:45	0	0.173	0.013	0.077	30	9	30	30	0	30	23	0.357	0.378
A-0.1	8:55	10	0.229	0.013	0.058	30	9	30	30	0	30	23	0.269	0.285
A-0.1	9:05	20	0.233	0.013	0.057	30	9	30	30	0	30	23	0.266	0.280
A-0.1	9:15	30	0.236	0.013	0.056	30	9	30	30	0	30	23	0.261	0.277
A-0.1	9:20	0	0.162	0.013	0.082	40	6	39.5	40.5	0	40	23	0.381	0.403
A-0.1	9:30	10	0.351	0.013	0.038	40	6	39.5	40.5	0	40	23	0.175	0.186
A-0.1	9:40	20	0.361	0.013	0.037	40	6	39.5	40.5	0	40	23	0.171	0.181
A-0.1	9:50	30	0.357	0.013	0.037	40	6	39.5	40.5	0	40	23	0.173	0.183
A-0.1	9:55	0	0.152	0.013	0.087	45	9	45	45	0	45	23	0.404	0.428
A-0.1	10:05	10	0.226	0.013	0.058	45	9	45	45	0	45	24	0.272	0.280
A-0.1	10:15	20	0.229	0.013	0.058	45	9	45	45	0	45	24	0.269	0.276
A-0.1	10:25	30	0.230	0.013	0.057	45	9	45	45	0	45	25	0.267	0.267
A-0.1	10:29	0	0.134	0.013	0.098	30	14	30.5	29.5	0	30	25	0.459	0.459
A-0.1	10:39	10	0.147	0.013	0.090	30	14	30.5	29.5	0	30	26	0.420	0.408
A-0.1	10:49	20	0.151	0.013	0.087	30	14	30.5	29.5	0	30	26	0.407	0.395
A-0.1	10:59	30	0.154	0.013	0.086	30	14	30.5	29.5	0	30	26	0.401	0.390
A-0.1	11:05	0	0.267	0.013	0.050	20	6	19.5	20.5	0	20	24	0.231	0.238
A-0.1	11:15	10	0.399	0.013	0.033	20	6	19.5	20.5	0	20	23	0.154	0.163
A-0.1	11:25	20	0.409	0.013	0.032	20	6	19.5	20.5	0	20	21	0.151	0.169
A-0.1	11:35	30	0.418	0.013	0.032	20	6	19.5	20.5	0	20	21	0.147	0.165
A-0.1	11:43	0	0.193	0.013	0.069	30	9	30.5	29.5	0	30	21	0.319	0.358
A-0.1	11:53	10	0.252	0.013	0.052	30	9	30.5	29.5	0	30	22	0.244	0.266
A-0.1	12:03	20	0.256	0.013	0.052	30	9	30.5	29.5	0	30	23	0.241	0.255
A-0.1	12:13	30	0.251	0.013	0.053	30	9	30.5	29.5	0	30	23	0.246	0.259
B-0.1	5:45	0	0.196	0.013	0.067	30	9	32	28	0	30	19	0.313	0.372
B-0.1	5:55	10	0.224	0.013	0.059	30	9	32	28	0	30	22	0.274	0.299
B-0.1	6:05	20	0.222	0.013	0.060	30	9	32	28	0	30	23	0.277	0.294
B-0.1	6:15	30	0.218	0.013	0.061	30	9	32	28	0	30	23	0.283	0.299
B-0.1	6:19	0	0.137	0.013	0.096	40	12	42	38	0	40	23	0.448	0.474
B-0.1	6:29	10	0.148	0.013	0.089	40	12	42	38	0	40	25	0.417	0.417
B-0.1	6:39	20	0.145	0.013	0.091	40	12	42	38	0	40	26	0.424	0.412
B-0.1	6:49	30	0.147	0.013	0.090	40	12	42	38	0	40	26	0.419	0.407
B-0.1	6:53	0	0.244	0.013	0.054	30	4	31.5	28.5	0	30	25	0.252	0.252
B-0.1	7:03	10	0.588	0.013	0.022	30	4	31.5	28.5	0	30	23	0.105	0.111
B-0.1	7:13	20	0.594	0.013	0.022	30	4	31.5	28.5	0	30	22	0.104	0.113
B-0.1	7:23	30	0.598	0.013	0.022	30	4	31.5	28.5	0	30	22	0.103	0.112
B-0.1	7:28	0	0.274	0.013	0.048	15	9	17	13	0	15	22	0.225	0.245
B-0.1	7:38	10	0.272	0.013	0.049	15	9	17	13	0	15	22	0.226	0.246
B-0.1	7:48	20	0.274	0.013	0.048	15	9	17	13	0	15	22	0.225	0.245
B-0.1	7:58	30	0.271	0.013	0.049	15	9	17	13	0	15	22	0.227	0.247
B-0.1	8:02	0	0.190	0.013	0.070	20	12	22	18	0	20	22	0.324	0.353
B-0.1	8:12	10	0.190	0.013	0.069	20	12	22	18	0	20	23	0.324	0.342
B-0.1	8:22	20	0.189	0.013	0.070	20	12	22	18	0	20	23	0.326	0.345
B-0.1	8:32	30	0.193	0.013	0.068	20	12	22	18	0	20	23	0.319	0.337
B-0.1	8:36	0	0.187	0.013	0.071	30	9	32	28	0	30	23	0.330	0.349
B-0.1	8:46	10	0.228	0.013	0.058	30	9	32	28	0	30	23	0.270	0.286
B-0.1	8:56	20	0.228	0.013	0.058	30	9	32	28	0	30	23	0.270	0.285
B-0.1	9:06	30	0.225	0.013	0.059	30	9	32	28	0	30	23	0.274	0.290
B-0.1	9:10	0	0.184	0.013	0.072	40	6	42	38	0	40	23	0.335	0.355
B-0.1	9:20	10	0.366	0.013	0.036	40	6	42	38	0	40	23	0.168	0.178
B-0.1	9:30	20	0.360	0.013	0.037	40	6	42	38	0	40	23	0.171	0.181
B-0.1	9:40	30	0.360	0.013	0.037	40	6	42	38	0	40	23	0.171	0.181
B-0.1	9:45	0	0.165	0.013	0.080	45	9	47	43	0	45	23	0.374	0.395
B-0.1	9:55	10	0.225	0.013	0.059	45	9	47	43	0	45	24	0.274	0.282
B-0.1	10:05	20	0.221	0.013	0.060	45	9	47	43	0	45	25	0.279	0.279
B-0.1	10:15	30	0.223	0.013	0.059	45	9	47	43	0	45	25	0.276	0.276
B-0.1	10:19	0	0.134	0.013	0.099	30	14	32	28	0	30	24	0.460	0.473
B-0.1	10:29	10	0.133	0.013	0.099	30	14	32	28	0	30	25	0.462	0.462
B-0.1	10:39	20	0.128	0.013	0.103	30	14	32	28	0	30	26	0.482	0.469
B-0.1	10:49	30	0.133	0.013	0.099	30	14	32	28	0	30	26	0.462	0.449
B-0.1	10:54	0	0.297	0.013	0.044	20	6	21	19	0	20	25	0.207	0.207
B-0.1	11:04	10	0.391	0.013	0.034	20	6	21	19	0	20	22	0.158	0.172
B-0.1	11:14	20	0.401	0.013	0.033	20	6	21	19	0	20	22	0.154	0.167
B-0.1	11:24	30	0.402	0.013	0.033	20	6	21	19	0	20	21	0.153	0.172
B-0.1	11:29	0	0.218	0.013	0.061	30	9	32	28	0	30	21	0.283	0.317
B-0.1	11:39	10	0.238	0.013	0.056	30	9	32	28	0	30	23	0.259	0.274
B-0.1	11:49	20	0.239	0.013	0.055	30	9	32	28	0	30	23	0.258	0.273
B-0.1	11:59	30	0.233	0.013	0.057	30	9	32	28	0	30	23	0.264	0.280

Table D-4. Strontium Carbonate Flux-Pall 0.1 µm (continued).

C-0.1	6:05	0	0.171	0.013	0.077	30	9	30	30	0	30	19	0.360	0.428
C-0.1	6:15	10	0.247	0.013	0.053	30	9	30	30	0	30	22	0.249	0.271
C-0.1	6:25	20	0.244	0.013	0.054	30	9	30	30	0	30	23	0.253	0.267
C-0.1	6:35	30	0.240	0.013	0.055	30	9	30	30	0	30	23	0.257	0.272
C-0.1	6:39	0	0.135	0.013	0.098	40	12	41	39	0	40	23	0.455	0.482
C-0.1	6:49	10	0.160	0.013	0.083	40	12	41	39	0	40	25	0.385	0.385
C-0.1	6:59	20	0.157	0.013	0.084	40	12	41	39	0	40	26	0.391	0.390
C-0.1	7:09	30	0.156	0.013	0.085	40	12	41	39	0	40	26	0.394	0.384
C-0.1	7:13	0	0.206	0.013	0.064	30	4	29	31	0	30	25	0.298	0.298
C-0.1	7:23	10	0.568	0.013	0.023	30	4	29	31	0	30	23	0.108	0.115
C-0.1	7:33	20	0.576	0.013	0.023	30	4	29	31	0	30	22	0.107	0.116
C-0.1	7:43	30	0.572	0.013	0.023	30	4	29	31	0	30	22	0.108	0.117
C-0.1	7:48	0	0.265	0.013	0.050	15	9	15	15	0	15	21	0.232	0.260
C-0.1	7:58	10	0.273	0.013	0.048	15	9	15	15	0	15	22	0.225	0.245
C-0.1	8:08	20	0.271	0.013	0.049	15	9	15	15	0	15	22	0.227	0.247
C-0.1	8:18	30	0.271	0.013	0.049	15	9	15	15	0	15	22	0.227	0.247
C-0.1	8:22	0	0.188	0.013	0.070	20	12	21	19	0	20	22	0.328	0.357
C-0.1	8:32	10	0.190	0.013	0.070	20	12	21	19	0	20	23	0.324	0.343
C-0.1	8:42	20	0.187	0.013	0.071	20	12	21	19	0	20	24	0.330	0.339
C-0.1	9:52	30	0.187	0.013	0.071	20	12	21	19	0	20	24	0.329	0.338
C-0.1	8:56	0	0.187	0.013	0.071	30	9	30	30	0	30	23	0.329	0.348
C-0.1	9:06	10	0.240	0.013	0.055	30	9	30	30	0	30	23	0.256	0.271
C-0.1	9:16	20	0.235	0.013	0.056	30	9	30	30	0	30	24	0.262	0.269
C-0.1	9:26	30	0.236	0.013	0.056	30	9	30	30	0	30	24	0.261	0.269
C-0.1	9:30	0	0.195	0.013	0.068	40	6	39.5	40.5	0	40	23	0.315	0.334
C-0.1	9:40	10	0.361	0.013	0.037	40	6	40	40	0	40	23	0.170	0.180
C-0.1	9:50	20	0.363	0.013	0.036	40	6	40	40	0	40	23	0.170	0.180
C-0.1	10:00	30	0.362	0.013	0.037	40	6	40	40	0	40	23	0.170	0.180
C-0.1	10:06	0	0.156	0.013	0.085	45	9	45	45	0	45	22	0.395	0.431
C-0.1	10:16	10	0.237	0.013	0.056	45	9	45	45	0	45	24	0.260	0.267
C-0.1	10:26	20	0.237	0.013	0.056	45	9	45	45	0	45	24	0.260	0.267
C-0.1	10:36	30	0.236	0.013	0.056	45	9	45	45	0	45	26	0.260	0.253
C-0.1	10:41	0	0.134	0.013	0.099	30	14	31	29	0	30	24	0.459	0.472
C-0.1	10:51	10	0.135	0.013	0.098	30	14	31	29	0	30	25	0.457	0.457
C-0.1	11:01	20	0.137	0.013	0.096	30	14	31	29	0	30	26	0.449	0.436
C-0.1	11:11	30	0.143	0.013	0.092	30	14	31	29	0	30	26	0.430	0.418
C-0.1	11:16	0	0.259	0.013	0.051	20	6	19.5	20.5	0	20	25	0.238	0.238
C-0.1	11:26	10	0.402	0.013	0.033	20	6	19.5	20.5	0	20	22	0.153	0.167
C-0.1	11:36	20	0.410	0.013	0.032	20	6	19.5	20.5	0	20	22	0.150	0.163
C-0.1	11:46	30	0.415	0.013	0.032	20	6	19.5	20.5	0	20	22	0.148	0.161
C-0.1	11:53	0	0.200	0.013	0.066	30	9	30	30	0	30	22	0.308	0.336
C-0.1	12:03	10	0.245	0.013	0.054	30	9	30	30	0	30	23	0.251	0.266
C-0.1	12:13	20	0.242	0.013	0.055	30	9	30	30	0	30	23	0.256	0.269
C-0.1	12:23	30	0.245	0.013	0.054	30	9	30	0	0	15	23	0.251	0.266
D-0.1	6:00	0	0.204	0.013	0.065	30	9	31.5	28.5	0	30	20	0.301	0.348
D-0.1	6:10	10	0.250	0.013	0.053	30	9	31.5	28.5	0	30	21	0.246	0.276
D-0.1	6:20	20	0.251	0.013	0.053	30	9	31.5	28.5	0	30	22	0.245	0.267
D-0.1	6:30	30	0.254	0.013	0.052	30	9	31.5	28.5	0	30	22	0.242	0.264
D-0.1	6:36	0	0.146	0.013	0.090	40	12	42	38	0	40	23	0.421	0.446
D-0.1	6:46	10	0.162	0.013	0.082	40	12	42	38	0	40	25	0.381	0.381
D-0.1	6:56	20	0.158	0.013	0.084	40	12	42	38	0	40	26	0.391	0.380
D-0.1	7:06	30	0.157	0.013	0.084	40	12	42	38	0	40	26	0.393	0.382
D-0.1	7:10	0	0.237	0.013	0.056	30	4	31.5	28.5	0	30	25	0.259	0.259
D-0.1	7:20	10	0.587	0.013	0.023	30	4	31.5	28.5	0	30	22	0.105	0.114
D-0.1	7:30	20	0.594	0.013	0.022	30	4	31.5	28.5	0	30	22	0.104	0.113
D-0.1	7:40	30	0.587	0.013	0.023	30	4	31.5	28.5	0	30	22	0.105	0.114
D-0.1	7:46	0	0.249	0.013	0.053	15	9	16.5	13.5	0	15	22	0.247	0.270
D-0.1	7:56	10	0.261	0.013	0.051	15	9	16.5	13.5	0	15	22	0.236	0.257
D-0.1	8:06	20	0.261	0.013	0.051	15	9	16.5	13.5	0	15	22	0.236	0.257
D-0.1	8:16	30	0.268	0.013	0.049	15	9	16.5	13.5	0	15	22	0.229	0.250
D-0.1	8:20	0	0.180	0.013	0.074	20	12	22	18	0	20	22	0.343	0.373
D-0.1	8:30	10	0.177	0.013	0.075	20	12	22	18	0	20	23	0.349	0.369
D-0.1	8:40	20	0.178	0.013	0.074	20	12	22	18	0	20	23	0.346	0.366
D-0.1	8:50	30	0.178	0.013	0.074	20	12	22	18	0	20	23	0.346	0.367
D-0.1	8:53	0	0.190	0.013	0.070	30	9	31.5	28.5	0	30	23	0.325	0.344
D-0.1	9:03	10	0.239	0.013	0.055	30	9	31.5	28.5	0	30	23	0.257	0.272
D-0.1	9:13	20	0.234	0.013	0.057	30	9	31.5	28.5	0	30	23	0.264	0.279
D-0.1	9:23	30	0.232	0.013	0.057	30	9	31.5	28.5	0	30	23	0.265	0.280
D-0.1	9:27	0	0.198	0.013	0.067	40	6	42	38	0	40	23	0.311	0.329
D-0.1	9:37	10	0.377	0.013	0.035	40	6	42	38	0	40	23	0.163	0.173
D-0.1	9:47	20	0.381	0.013	0.035	40	6	42	38	0	40	23	0.161	0.171
D-0.1	9:57	30	0.376	0.013	0.035	40	6	42	38	0	40	23	0.164	0.173
D-0.1	10:03	0	0.183	0.013	0.072	45	9	47	43	0	45	23	0.336	0.355
D-0.1	10:13	10	0.236	0.013	0.056	45	9	47	43	0	45	24	0.260	0.268
D-0.1	10:23	20	0.235	0.013	0.056	45	9	47	43	0	45	25	0.262	0.262
D-0.1	10:33	30	0.229	0.013	0.058	45	9	47	43	0	45	25	0.269	0.269
D-0.1	10:38	0	0.137	0.013	0.096	30	14	32	28	0	30	24	0.449	0.462
D-0.1	10:48	10	0.189	0.013	0.070	30	14	32	28	0	30	25	0.326	0.326
D-0.1	10:58	20	0.184	0.013	0.072	30	14	32	28	0	30	25	0.335	0.335
D-0.1	11:08	30	0.186	0.013	0.071	30	14	32	28	0	30	25	0.330	0.330
D-0.1	11:12	0	0.287	0.013	0.046	20	6	21	19	0	20	24	0.214	0.220
D-0.1	11:22	10	0.423	0.013	0.031	20	6	21	19	0	20	22	0.146	0.159
D-0.1	11:32	20	0.518	0.013	0.026	20	6	21	19	0	20	21	0.119	0.133
D-0.1	11:42	30	0.424	0.013	0.031	20	6	21	19	0	20	22	0.146	0.158
D-0.1	11:47	0	0.211	0.013	0.063	30	9	31.5	28.5	0	30	21	0.292	0.327
D-0.1	11:57	10	0.250	0.013	0.053	30	9	31.5	28.5	0	30	21	0.246	0.276
D-0.1	12:07	20	0.243	0.013	0.054	30	9	31.5	28.5	0	30	23	0.253	0.268
D-0.1	12:17	30	0.244	0.013	0.054	30	9	31.5	28.5	0	30	23	0.252	0.267

Table D-4. Strontium Carbonate Flux-Pall 0.1 µm (continued).

E-0.1	6:15	0	0.158	0.013	0.084	30	9	30	30	0	30	20	0.389	0.449
E-0.1	6:25	10	0.188	0.013	0.070	30	9	30	30	0	30	23	0.327	0.346
E-0.1	6:35	20	0.194	0.013	0.068	30	9	30	30	0	30	23	0.317	0.335
E-0.1	6:45	30	0.204	0.013	0.065	30	9	30	30	0	30	23	0.301	0.319
E-0.1	6:49	0	0.124	0.013	0.107	40	12	40	40	0	40	23	0.497	0.526
E-0.1	6:59	10	0.148	0.013	0.089	40	12	40	40	0	40	25	0.416	0.416
E-0.1	7:09	20	0.155	0.013	0.086	40	12	40	40	0	40	26	0.398	0.387
E-0.1	7:19	30	0.162	0.013	0.082	40	12	40	40	0	40	26	0.381	0.370
E-0.1	7:23	0	0.184	0.013	0.072	30	4	29	31	0	30	24	0.336	0.345
E-0.1	7:33	10	0.377	0.013	0.035	30	4	29	31	0	30	22	0.163	0.178
E-0.1	7:43	20	0.397	0.013	0.033	30	4	29	31	0	30	22	0.155	0.169
E-0.1	7:53	30	0.412	0.013	0.032	30	4	29	31	0	30	21	0.149	0.168
E-0.1	7:58	0	0.265	0.013	0.050	15	9	15	15	0	15	21	0.232	0.260
E-0.1	8:08	10	0.283	0.013	0.047	15	9	15	15	0	15	21	0.217	0.244
E-0.1	8:18	20	0.294	0.013	0.045	15	9	15	15	0	15	21	0.209	0.234
E-0.1	8:28	30	0.294	0.013	0.045	15	9	15	15	0	15	21	0.209	0.235
E-0.1	8:33	0	0.197	0.013	0.067	20	12	20	20	0	20	22	0.313	0.340
E-0.1	8:43	10	0.250	0.013	0.053	20	12	20	20	0	20	23	0.246	0.261
E-0.1	8:53	20	0.270	0.013	0.049	20	12	20	20	0	20	23	0.228	0.242
E-0.1	9:03	30	0.281	0.013	0.047	20	12	20	20	0	20	23	0.219	0.232
E-0.1	9:07	0	0.166	0.013	0.080	30	9	30	30	0	30	22	0.372	0.405
E-0.1	9:17	10	0.218	0.013	0.061	30	9	30	30	0	30	23	0.282	0.299
E-0.1	9:27	20	0.234	0.013	0.057	30	9	30	30	0	30	23	0.264	0.279
E-0.1	9:37	30	0.237	0.013	0.056	30	9	30	30	0	30	23	0.260	0.275
E-0.1	9:41	0	0.164	0.013	0.081	40	6	39.5	40.5	0	40	22	0.376	0.409
E-0.1	9:51	10	0.311	0.013	0.042	40	6	39.5	40.5	0	40	23	0.198	0.209
E-0.1	10:01	20	0.316	0.013	0.042	40	6	39.5	40.5	0	40	23	0.195	0.206
E-0.1	10:11	30	0.321	0.013	0.041	40	6	39.5	40.5	0	40	23	0.192	0.203
E-0.1	10:15	0	0.155	0.013	0.085	45	9	45	45	0	45	23	0.397	0.420
E-0.1	10:25	10	0.217	0.013	0.061	45	9	45	45	0	45	24	0.283	0.291
E-0.1	10:35	20	0.216	0.013	0.061	45	9	45	45	0	45	25	0.285	0.285
E-0.1	10:45	30	0.221	0.013	0.060	45	9	45	45	0	45	25	0.278	0.278
E-0.1	10:49	0	0.135	0.013	0.098	30	14	30.5	29.5	0	30	25	0.457	0.457
E-0.1	10:59	10	0.149	0.013	0.088	30	14	30.5	29.5	0	30	26	0.412	0.401
E-0.1	11:09	20	0.156	0.013	0.085	30	14	30.5	29.5	0	30	26	0.394	0.383
E-0.1	11:19	30	0.160	0.013	0.083	30	14	30.5	29.5	0	30	26	0.385	0.374
E-0.1	11:23	0	0.243	0.013	0.054	20	6	19.5	20.5	0	20	25	0.253	0.253
E-0.1	11:33	10	0.378	0.013	0.035	20	6	19.5	20.5	0	20	23	0.163	0.172
E-0.1	11:43	20	0.388	0.013	0.034	20	6	19.5	20.5	0	20	22	0.159	0.173
E-0.1	11:53	30	0.391	0.013	0.034	20	6	19.5	20.5	0	20	22	0.158	0.172
E-0.1	11:57	0	0.184	0.013	0.072	30	9	30	30	0	30	21	0.336	0.375
E-0.1	12:07	10	0.238	0.013	0.055	30	9	30	30	0	30	22	0.258	0.281
E-0.1	12:17	20	0.243	0.013	0.054	30	9	30	30	0	30	23	0.254	0.269
E-0.1	12:27	30	0.247	0.013	0.054	30	9	30	30	0	30	23	0.249	0.264

Table D-5. Strontium Carbonate Flux (Pall 0.8 µm).

$SrCO_3$ Flux, Pall 0.8														
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.8	6:35	0	0.213	0.013	0.062	30	9	30	30	0	30	21	0.349	0.391
A-0.8	6:45	10	0.290	0.013	0.046	30	9	30	30	0	30	23	0.256	0.271
A-0.8	6:55	20	0.289	0.013	0.046	30	9	30	30	0	30	24	0.257	0.265
A-0.8	7:05	30	0.302	0.013	0.044	30	9	30	30	0	30	24	0.246	0.253
A-0.8	7:08	0	0.132	0.013	0.100	40	12	40	40	0	40	24	0.564	0.580
A-0.8	7:18	10	0.210	0.013	0.063	40	12	40	40	0	40	26	0.353	0.344
A-0.8	7:28	20	0.217	0.013	0.061	40	12	40	40	0	40	26	0.342	0.332
A-0.8	7:38	30	0.220	0.013	0.060	40	12	40	40	0	40	27	0.337	0.319
A-0.8	8:16	0	0.219	0.013	0.060	30	4	29	31	0	30	24	0.339	0.349
A-0.8	8:26	10	0.556	0.013	0.024	30	4	29	31	0	30	24	0.134	0.137
A-0.8	8:36	20	0.526	0.013	0.025	30	4	29	31	0	30	24	0.141	0.145
A-0.8	8:46	30	0.560	0.013	0.024	30	4	29	31	0	30	24	0.132	0.136
A-0.8	8:48	0	0.279	0.013	0.047	15	9	15	15	0	15	24	0.266	0.274
A-0.8	8:58	10	0.333	0.013	0.040	15	9	15	15	0	15	24	0.223	0.229
A-0.8	9:08	20	0.337	0.013	0.039	15	9	15	15	0	15	24	0.220	0.227
A-0.8	9:18	30	0.355	0.013	0.037	15	9	15	15	0	15	24	0.209	0.215
A-0.8	9:20	0	0.195	0.013	0.068	20	12	20	20	0	20	24	0.381	0.391
A-0.8	9:30	10	0.224	0.013	0.059	20	12	20	20	0	20	25	0.331	0.331
A-0.8	9:40	20	0.234	0.013	0.056	20	12	20	20	0	20	25	0.317	0.317
A-0.8	9:50	30	0.240	0.013	0.055	20	12	20	20	0	20	25	0.309	0.309
A-0.8	9:52	0	0.219	0.013	0.060	30	9	30	30	0	30	25	0.339	0.339
A-0.8	10:02	10	0.289	0.013	0.046	30	9	30	30	0	30	25	0.257	0.257
A-0.8	10:12	20	0.294	0.013	0.045	30	9	30	30	0	30	25	0.252	0.252
A-0.8	10:22	30	0.301	0.013	0.044	30	9	30	30	0	30	25	0.247	0.247
A-0.8	10:26	0	0.255	0.013	0.052	40	6	40	40	0	40	25	0.291	0.291
A-0.8	10:36	10	0.420	0.013	0.031	40	6	40	40	0	40	25	0.177	0.177
A-0.8	10:46	20	0.418	0.013	0.032	40	6	40	40	0	40	25	0.178	0.178
A-0.8	10:56	30	0.420	0.013	0.031	40	6	40	40	0	40	25	0.177	0.177
A-0.8	11:00	0	0.189	0.013	0.070	45	9	45	45	0	45	25	0.393	0.393
A-0.8	11:10	10	0.278	0.013	0.047	45	9	45	45	0	45	26	0.267	0.259
A-0.8	11:20	20	0.288	0.013	0.046	45	9	45	45	0	45	26	0.257	0.250
A-0.8	11:30	30	0.290	0.013	0.046	45	9	45	45	0	45	26	0.256	0.249
A-0.8	11:33	0	0.164	0.013	0.081	30	14	29.5	30.5	0	30	26	0.454	0.441
A-0.8	11:43	10	0.184	0.013	0.072	30	14	29.5	30.5	0	30	27	0.404	0.382
A-0.8	11:53	20	0.192	0.013	0.069	30	14	29.5	30.5	0	30	27	0.386	0.365
A-0.8	12:03	30	0.199	0.013	0.066	30	14	29.5	30.5	0	30	27	0.373	0.353
A-0.8	12:05	0	0.303	0.013	0.044	20	6	20	20	0	20	26	0.245	0.238
A-0.8	12:15	10	0.458	0.013	0.029	20	6	20	20	0	20	25	0.162	0.162
A-0.8	12:25	20	0.478	0.013	0.028	20	6	20	20	0	20	24	0.155	0.160
A-0.8	12:35	30	0.481	0.013	0.027	20	6	20	20	0	20	24	0.154	0.159
A-0.8	12:38	0	0.245	0.013	0.054	30	9	30	30	0	30	24	0.303	0.312
A-0.8	12:48	10	0.302	0.013	0.044	30	9	30	30	0	30	25	0.246	0.246
A-0.8	12:58	20	0.304	0.013	0.044	30	9	30	30	0	30	25	0.244	0.244
A-0.8	1:08	30	0.309	0.013	0.043	30	9	30	30	0	30	25	0.240	0.240
B-0.8	5:55	0	0.254	0.013	0.052	30	9	30	30	0	30	19	0.292	0.347
B-0.8	6:05	10	0.311	0.013	0.043	30	9	30	30	0	30	21	0.239	0.268
B-0.8	6:15	20	0.295	0.013	0.045	30	9	30	30	0	30	23	0.251	0.266
B-0.8	6:25	30	0.290	0.013	0.046	30	9	30	30	0	30	24	0.256	0.263
B-0.8	6:28	0	0.173	0.013	0.076	40	12	40	0	0	20	24	0.428	0.440
B-0.8	6:38	10	0.195	0.013	0.068	40	12	40	0	0	20	26	0.381	0.370
B-0.8	6:48	20	0.195	0.013	0.068	40	12	40	0	0	20	26	0.380	0.369
B-0.8	6:58	30	0.192	0.013	0.069	40	12	40	0	0	20	27	0.386	0.365
B-0.8	7:01	0	0.270	0.013	0.049	30	4	29	31	0	30	26	0.275	0.267
B-0.8	7:11	10	0.629	0.013	0.021	30	4	29	31	0	30	25	0.118	0.118
B-0.8	7:21	20	0.643	0.013	0.021	30	4	29	31	0	30	24	0.115	0.119
B-0.8	7:31	30	0.643	0.013	0.021	30	4	29	31	0	30	24	0.115	0.119
B-0.8	7:35	0	0.230	0.013	0.058	15	9	15	15	0	15	24	0.323	0.333
B-0.8	7:45	10	0.298	0.013	0.044	15	9	15	15	0	15	24	0.249	0.256
B-0.8	7:55	20	0.299	0.013	0.044	15	9	15	15	0	15	24	0.248	0.255
B-0.8	8:05	30	0.298	0.013	0.044	15	9	15	15	0	15	24	0.249	0.256
B-0.8	8:08	0	0.197	0.013	0.067	20	12	21	19	0	20	24	0.377	0.387
B-0.8	8:18	10	0.206	0.013	0.064	20	12	21	19	0	20	25	0.361	0.361
B-0.8	8:28	20	0.202	0.013	0.066	20	12	21	19	0	20	25	0.368	0.368
B-0.8	8:38	30	0.201	0.013	0.066	20	12	21	19	0	20	25	0.369	0.369
B-0.8	8:41	0	0.238	0.013	0.056	30	9	30	30	0	30	25	0.312	0.312
B-0.8	8:51	10	0.293	0.013	0.045	30	9	30	30	0	30	25	0.254	0.254
B-0.8	9:01	20	0.289	0.013	0.046	30	9	30	30	0	30	25	0.257	0.257
B-0.8	9:11	30	0.289	0.013	0.046	30	9	30	30	0	30	25	0.257	0.257
B-0.8	9:13	0	0.267	0.013	0.049	40	6	39.5	40.5	0	40	25	0.278	0.278
B-0.8	9:23	10	0.413	0.013	0.032	40	6	39.5	40.5	0	40	25	0.180	0.180
B-0.8	9:33	20	0.423	0.013	0.031	40	6	39.5	40.5	0	40	25	0.176	0.176
B-0.8	9:43	30	0.417	0.013	0.032	40	6	39.5	40.5	0	40	25	0.178	0.178
B-0.8	9:47	0	0.228	0.013	0.058	45	9	45	45	0	45	25	0.325	0.325
B-0.8	9:57	10	0.285	0.013	0.046	45	9	45	45	0	45	26	0.261	0.253
B-0.8	10:07	20	0.289	0.013	0.046	45	9	45	45	0	45	26	0.257	0.250
B-0.8	10:17	30	0.288	0.013	0.046	45	9	45	45	0	45	26	0.258	0.251
B-0.8	10:20	0	0.159	0.013	0.083	30	14	30.5	29.5	0	30	26	0.467	0.454
B-0.8	10:30	10	0.160	0.013	0.083	30	14	30.5	29.5	0	30	26	0.465	0.452
B-0.8	10:40	20	0.161	0.013	0.082	30	14	30.5	29.5	0	30	27	0.461	0.436
B-0.8	10:50	30	0.164	0.013	0.081	30	14	30.5	29.5	0	30	27	0.454	0.429
B-0.8	10:52	0	0.333	0.013	0.040	20	6	20	20	0	20	26	0.223	0.217
B-0.8	11:02	10	0.475	0.013	0.028	20	6	20	20	0	20	24	0.156	0.161
B-0.8	11:12	20	0.468	0.013	0.028	20	6	20	20	0	20	24	0.159	0.163
B-0.8	11:22	30	0.472	0.013	0.028	20	6	20	20	0	20	24	0.157	0.162
B-0.8	11:25	0	0.263	0.013	0.050	30	9	30	30	0	30	24	0.283	0.291
B-0.8	11:35	10	0.297	0.013	0.045	30	9	30	30	0	30	24	0.250	0.257
B-0.8	11:45	20	0.298	0.013	0.044	30	9	30	30	0	30	25	0.249	0.249
B-0.8	11:55	30	0.296	0.013	0.045	30	9	30	30	0	30	25	0.251	0.251

Table D-5. Strontium Carbonate Flux-Pall 0.8 µm (continued).

C-0.8	7:23	0	0.296	0.013	0.045	30	9	30	30	0	30	19	0.251	0.298
C-0.8	7:33	10	0.295	0.013	0.045	30	9	30	30	0	30	22	0.252	0.274
C-0.8	7:43	20	0.285	0.013	0.046	30	9	30	30	0	30	24	0.260	0.268
C-0.8	7:53	30	0.281	0.013	0.047	30	9	30	30	0	30	24	0.264	0.271
C-0.8	7:55	0	0.184	0.013	0.072	40	12	40	40	0	40	25	0.403	0.403
C-0.8	8:05	10	0.184	0.013	0.072	40	12	40	40	0	40	26	0.404	0.393
C-0.8	8:15	20	0.183	0.013	0.072	40	12	40	40	0	40	27	0.405	0.383
C-0.8	8:25	30	0.183	0.013	0.072	40	12	40	40	0	40	27	0.405	0.383
C-0.8	8:28	0	0.373	0.013	0.036	30	4	29	31	0	30	26	0.199	0.194
C-0.8	8:38	10	0.674	0.013	0.020	30	4	29	31	0	30	25	0.110	0.110
C-0.8	8:48	20	0.646	0.013	0.020	30	4	29	31	0	30	24	0.115	0.118
C-0.8	8:58	30	0.644	0.013	0.021	30	4	29	31	0	30	24	0.115	0.119
C-0.8	9:00	0	0.236	0.013	0.056	15	9	15	15	0	15	24	0.314	0.323
C-0.8	9:10	10	0.250	0.013	0.053	15	9	15	15	0	15	24	0.296	0.305
C-0.8	9:20	20	0.296	0.013	0.045	15	9	15	15	0	15	24	0.251	0.258
C-0.8	9:30	30	0.293	0.013	0.046	15	9	15	15	0	15	24	0.253	0.260
C-0.8	9:32	0	0.195	0.013	0.068	20	12	20	20	0	20	24	0.380	0.391
C-0.8	9:42	10	0.195	0.013	0.068	20	12	20	20	0	20	25	0.381	0.381
C-0.8	9:52	20	0.193	0.013	0.069	20	12	20	20	0	20	25	0.385	0.385
C-0.8	10:02	30	0.192	0.013	0.069	20	12	20	20	0	20	25	0.387	0.387
C-0.8	10:04	0	0.250	0.013	0.053	30	9	30	30	0	30	25	0.297	0.297
C-0.8	10:14	10	0.280	0.013	0.047	30	9	30	30	0	30	25	0.265	0.265
C-0.8	10:24	20	0.273	0.013	0.048	30	9	30	30	0	30	25	0.272	0.272
C-0.8	10:34	30	0.273	0.013	0.048	30	9	30	30	0	30	25	0.272	0.272
C-0.8	10:37	0	0.317	0.013	0.042	40	6	40.5	39.5	0	40	25	0.234	0.234
C-0.8	10:47	10	0.388	0.013	0.034	40	6	40.5	39.5	0	40	26	0.191	0.186
C-0.8	10:57	20	0.393	0.013	0.034	40	6	40.5	39.5	0	40	26	0.189	0.184
C-0.8	11:07	30	0.406	0.013	0.033	40	6	40.5	39.5	0	40	24	0.183	0.188
C-0.8	11:10	0	0.253	0.013	0.052	45	9	45	45	0	45	24	0.293	0.302
C-0.8	11:20	10	0.289	0.013	0.046	45	9	45	45	0	45	25	0.257	0.257
C-0.8	11:30	20	0.298	0.013	0.044	45	9	45	45	0	45	25	0.249	0.249
C-0.8	11:40	30	0.298	0.013	0.044	45	9	45	45	0	45	25	0.249	0.249
C-0.8	11:42	0	0.164	0.013	0.081	30	14	30.5	29.5	0	30	25	0.453	0.453
C-0.8	11:52	10	0.170	0.013	0.078	30	14	30.5	29.5	0	30	24	0.438	0.460
C-0.8	12:02	20	0.172	0.013	0.077	30	14	30.5	29.5	0	30	24	0.432	0.445
C-0.8	12:12	30	0.171	0.013	0.077	30	14	30.5	29.5	0	30	24	0.434	0.446
C-0.8	12:15	0	0.416	0.013	0.032	20	6	20	20	0	20	24	0.178	0.183
C-0.8	12:25	10	0.506	0.013	0.026	20	6	20	20	0	20	22	0.147	0.160
C-0.8	12:35	20	0.513	0.013	0.026	20	6	20	20	0	20	22	0.145	0.158
C-0.8	12:45	30	0.521	0.013	0.025	20	6	20	20	0	20	22	0.142	0.155
C-0.8	12:50	0	0.296	0.013	0.045	30	9	30	30	0	30	22	0.251	0.273
C-0.8	1:00	10	0.316	0.013	0.042	30	9	30	30	0	30	22	0.235	0.256
C-0.8	1:10	20	0.312	0.013	0.042	30	9	30	30	0	30	23	0.238	0.252
C-0.8	1:20	30	0.313	0.013	0.042	30	9	30	30	0	30	23	0.237	0.251
D-0.8	6:18	0	0.275	0.013	0.048	30	9	30	30	0	30	21	0.270	0.302
D-0.8	6:28	10	0.296	0.013	0.045	30	9	30	30	0	30	23	0.251	0.266
D-0.8	6:38	20	0.292	0.013	0.045	30	9	30	30	0	30	24	0.254	0.261
D-0.8	6:48	30	0.294	0.013	0.045	30	9	30	30	0	30	24	0.253	0.260
D-0.8	6:51	0	0.181	0.013	0.073	40	12	39.5	40.5	0	40	25	0.411	0.411
D-0.8	7:01	10	0.208	0.013	0.063	40	12	39.5	40.5	0	40	26	0.356	0.347
D-0.8	7:11	20	0.213	0.013	0.062	40	12	39.5	40.5	0	40	28	0.348	0.320
D-0.8	7:21	30	0.220	0.013	0.060	40	12	39.5	40.5	0	40	27	0.338	0.319
D-0.8	7:23	0	0.300	0.013	0.044	30	4	29.5	30.5	0	30	26	0.248	0.241
D-0.8	7:33	10	0.705	0.013	0.019	30	4	29.5	30.5	0	30	25	0.105	0.105
D-0.8	7:43	20	0.670	0.013	0.020	30	4	29.5	30.5	0	30	24	0.111	0.114
D-0.8	7:53	30	0.723	0.013	0.018	30	4	29.5	30.5	0	30	24	0.103	0.106
D-0.8	7:58	0	0.278	0.013	0.047	15	9	15	15	0	15	24	0.267	0.274
D-0.8	8:08	10	0.328	0.013	0.040	15	9	15	15	0	15	24	0.226	0.233
D-0.8	8:18	20	0.342	0.013	0.039	15	9	15	15	0	15	24	0.217	0.223
D-0.8	8:28	30	0.345	0.013	0.038	15	9	15	15	0	15	24	0.216	0.221
D-0.8	8:30	0	0.204	0.013	0.065	20	12	19.5	20.5	0	20	24	0.364	0.375
D-0.8	8:40	10	0.223	0.013	0.059	20	12	19.5	20.5	0	20	25	0.333	0.333
D-0.8	8:50	20	0.231	0.013	0.057	20	12	19.5	20.5	0	20	25	0.322	0.322
D-0.8	9:00	30	0.236	0.013	0.056	20	12	19.5	20.5	0	20	25	0.314	0.314
D-0.8	9:03	0	0.225	0.013	0.059	30	9	30	30	0	30	25	0.330	0.330
D-0.8	9:13	10	0.299	0.013	0.044	30	9	30	30	0	30	25	0.248	0.248
D-0.8	9:23	20	0.303	0.013	0.044	30	9	30	30	0	30	25	0.245	0.245
D-0.8	9:33	30	0.308	0.013	0.043	30	9	30	30	0	30	25	0.241	0.241
D-0.8	9:36	0	0.279	0.013	0.047	40	6	39.5	40.5	0	40	25	0.266	0.266
D-0.8	9:46	10	0.422	0.013	0.031	40	6	39.5	40.5	0	40	25	0.176	0.176
D-0.8	9:56	20	0.427	0.013	0.031	40	6	39.5	40.5	0	40	25	0.174	0.174
D-0.8	10:06	30	0.426	0.013	0.031	40	6	39.5	40.5	0	40	25	0.174	0.174
D-0.8	10:09	0	0.229	0.013	0.058	45	9	45	45	0	45	25	0.325	0.325
D-0.8	10:19	10	0.302	0.013	0.044	45	9	45	45	0	45	26	0.246	0.239
D-0.8	10:29	20	0.297	0.013	0.044	45	9	45	45	0	45	27	0.250	0.236
D-0.8	10:39	30	0.298	0.013	0.044	45	9	45	45	0	45	27	0.249	0.236
D-0.8	10:42	0	0.168	0.013	0.079	30	14	29.5	30.5	0	30	27	0.441	0.417
D-0.8	10:52	10	0.183	0.013	0.072	30	14	29.5	30.5	0	30	27	0.405	0.383
D-0.8	11:02	20	0.190	0.013	0.070	30	14	29.5	30.5	0	30	27	0.392	0.370
D-0.8	11:12	30	0.195	0.013	0.068	30	14	29.5	30.5	0	30	27	0.380	0.359
D-0.8	11:15	0	0.381	0.013	0.036	20	6	19.5	20.5	0	20	26	0.196	0.189
D-0.8	11:25	10	0.516	0.013	0.026	20	6	19.5	20.5	0	20	25	0.144	0.144
D-0.8	11:35	20	0.511	0.013	0.026	20	6	19.5	20.5	0	20	24	0.145	0.149
D-0.8	11:45	30	0.512	0.013	0.026	20	6	19.5	20.5	0	20	24	0.146	0.149
D-0.8	11:48	0	0.267	0.013	0.049	30	9	30	30	0	30	24	0.270	0.286
D-0.8	11:58	10	0.308	0.013	0.043	30	9	30	30	0	30	25	0.241	0.241
D-0.8	12:08	20	0.310	0.013	0.043	30	9	30	30	0	30	25	0.240	0.240
D-0.8	12:18	30	0.307	0.013	0.043	30	9	30	30	0	30	25	0.242	0.242

Table D-5. Strontium Carbonate Flux-Pall 0.8 µm (continued).

E-0.8	8:33	0	0.103	0.013	0.128	30	9	30	30	0	30	22	0.720	0.785
E-0.8	8:43	10	0.205	0.013	0.064	30	9	30	30	0	30	24	0.362	0.373
E-0.8	8:53	20	0.223	0.013	0.059	30	9	30	30	0	30	24	0.332	0.342
E-0.8	9:03	30	0.236	0.013	0.056	30	9	30	30	0	30	24	0.315	0.324
E-0.8	9:05	0	0.096	0.013	0.138	40	12	39.5	40.5	0	40	24	0.776	0.798
E-0.8	9:15	10	0.171	0.013	0.077	40	12	39.5	40.5	0	40	26	0.433	0.421
E-0.8	9:25	20	0.193	0.013	0.068	40	12	39.5	40.5	0	40	26	0.384	0.373
E-0.8	9:35	30	0.208	0.013	0.064	40	12	39.5	40.5	0	40	26	0.358	0.348
E-0.8	9:40	0	0.202	0.013	0.065	30	4	30	30	0	30	26	0.367	0.357
E-0.8	9:50	10	0.446	0.013	0.030	30	4	30	30	0	30	25	0.166	0.166
E-0.8	10:00	20	0.480	0.013	0.028	30	4	30	30	0	30	24	0.155	0.159
E-0.8	10:10	30	0.460	0.013	0.029	30	4	30	30	0	30	24	0.161	0.166
E-0.8	10:12	0	0.220	0.013	0.060	15	9	15	15	0	15	24	0.337	0.347
E-0.8	10:22	10	0.290	0.013	0.045	15	9	15	15	0	15	24	0.256	0.263
E-0.8	10:32	20	0.303	0.013	0.044	15	9	15	15	0	15	24	0.245	0.252
E-0.8	10:42	30	0.311	0.013	0.042	15	9	15	15	0	15	24	0.238	0.245
E-0.8	10:44	0	0.172	0.013	0.077	20	12	20	20	0	20	24	0.433	0.445
E-0.8	10:54	10	0.221	0.013	0.060	20	12	20	20	0	20	24	0.336	0.346
E-0.8	11:04	20	0.239	0.013	0.055	20	12	20	20	0	20	24	0.311	0.320
E-0.8	11:14	30	0.255	0.013	0.052	20	12	20	20	0	20	25	0.291	0.291
E-0.8	11:16	0	0.168	0.013	0.078	30	9	30	30	0	30	24	0.441	0.453
E-0.8	11:26	10	0.269	0.013	0.049	30	9	30	30	0	30	25	0.276	0.276
E-0.8	11:36	20	0.276	0.013	0.048	30	9	30	30	0	30	25	0.269	0.269
E-0.8	11:46	30	0.295	0.013	0.045	30	9	30	30	0	30	25	0.251	0.251
E-0.8	11:49	0	0.156	0.013	0.084	40	6	40	40	0	40	25	0.475	0.475
E-0.8	11:59	10	0.347	0.013	0.038	40	6	40	40	0	40	25	0.214	0.214
E-0.8	12:09	20	0.358	0.013	0.037	40	6	40	40	0	40	25	0.207	0.207
E-0.8	12:19	30	0.370	0.013	0.036	40	6	40	40	0	40	25	0.200	0.200
E-0.8	12:22	0	0.146	0.013	0.090	45	9	45	45	0	45	25	0.507	0.507
E-0.8	12:32	10	0.256	0.013	0.052	45	9	45	45	0	45	26	0.290	0.282
E-0.8	12:42	20	0.260	0.013	0.051	45	9	45	45	0	45	26	0.285	0.277
E-0.8	12:52	30	0.270	0.013	0.049	45	9	45	45	0	45	26	0.274	0.267
E-0.8	12:55	0	0.156	0.013	0.085	30	14	30	30	0	30	26	0.476	0.463
E-0.8	1:05	10	0.193	0.013	0.069	30	14	30	30	0	30	26	0.385	0.375
E-0.8	1:15	20	0.198	0.013	0.067	30	14	30	30	0	30	26	0.375	0.364
E-0.8	1:25	30	0.212	0.013	0.062	30	14	30	30	0	30	26	0.350	0.341
E-0.8	1:28	0	0.251	0.013	0.053	20	6	19.5	20.5	0	20	25	0.295	0.295
E-0.8	1:38	10	0.433	0.013	0.031	20	6	19.5	20.5	0	20	24	0.172	0.176
E-0.8	1:48	20	0.429	0.013	0.031	20	6	19.5	20.5	0	20	24	0.173	0.178
E-0.8	1:58	30	0.437	0.013	0.030	20	6	19.5	20.5	0	20	24	0.170	0.175
E-0.8	2:03	0	0.220	0.013	0.060	30	9	30	30	0	30	24	0.337	0.347
E-0.8	2:13	10	0.294	0.013	0.045	30	9	30	30	0	30	24	0.252	0.260
E-0.8	2:23	20	0.298	0.013	0.044	30	9	30	30	0	30	24	0.249	0.256
E-0.8	2:33	30	0.303	0.013	0.044	30	9	30	30	0	30	25	0.245	0.245

Table D-6. Strontium Carbonate Flux (GKN 0.1 μm).

$SrCO_3$ Flux															
GKN 0.1															
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
A-0.1	6:08	0	0.255	0.013	0.052	30	9	30.5	29.5	0	30	20	0.264	0.304
A-0.1	6:18	10	0.281	0.013	0.047	30	9	30.5	29.5	0	30	22	0.239	0.261
A-0.1	6:28	20	0.276	0.013	0.048	30	9	30.5	29.5	0	30	23	0.244	0.258
A-0.1	6:38	30	0.285	0.013	0.046	30	9	30.5	29.5	0	30	23	0.236	0.250
A-0.1	6:43	0	0.163	0.013	0.081	40	12	41	39	0	40	23	0.412	0.436
A-0.1	6:53	10	0.184	0.013	0.072	40	12	41	39	0	40	25	0.365	0.365
A-0.1	7:03	20	0.183	0.013	0.072	40	12	41	39	0	40	27	0.368	0.348
A-0.1	7:13	30	0.176	0.013	0.075	40	12	41	39	0	40	29	0.383	0.343
A-0.1	7:16	0	0.252	0.013	0.053	30	4	30	30	0	30	28	0.268	0.246
A-0.1	7:26	10	0.543	0.013	0.024	30	4	30	30	0	30	25	0.124	0.124
A-0.1	7:36	20	0.572	0.013	0.023	30	4	30	30	0	30	24	0.118	0.121
A-0.1	7:46	30	0.587	0.013	0.022	30	4	30	30	0	30	23	0.115	0.121
A-0.1	7:51	0	0.252	0.013	0.052	15	9	15.5	14.5	0	15	22	0.267	0.291
A-0.1	8:01	10	0.289	0.013	0.046	15	9	15.5	14.5	0	15	22	0.233	0.253
A-0.1	8:11	20	0.293	0.013	0.045	15	9	15.5	14.5	0	15	22	0.229	0.250
A-0.1	8:21	30	0.306	0.013	0.043	15	9	15.5	14.5	0	15	21	0.221	0.247
A-0.1	8:25	0	0.205	0.013	0.064	20	12	20.5	19.5	0	20	21	0.328	0.368
A-0.1	8:35	10	0.203	0.013	0.065	20	12	20.5	19.5	0	20	22	0.332	0.361
A-0.1	8:45	20	0.207	0.013	0.064	20	12	20.5	19.5	0	20	23	0.325	0.344
A-0.1	8:55	30	0.211	0.013	0.063	20	12	20.5	19.5	0	20	24	0.319	0.328
A-0.1	9:00	0	0.203	0.013	0.065	30	9	30.5	29.5	0	30	24	0.332	0.342
A-0.1	9:10	10	0.269	0.013	0.049	30	9	30.5	29.5	0	30	24	0.250	0.257
A-0.1	9:20	20	0.271	0.013	0.049	30	9	30.5	29.5	0	30	24	0.249	0.256
A-0.1	9:30	30	0.273	0.013	0.048	30	9	30.5	29.5	0	30	25	0.247	0.247
A-0.1	9:57	0	0.226	0.013	0.058	40	6	40.5	39.5	0	40	25	0.298	0.298
A-0.1	10:07	10	0.422	0.013	0.031	40	6	40.5	39.5	0	40	25	0.159	0.159
A-0.1	10:17	20	0.419	0.013	0.032	40	6	40.5	39.5	0	40	25	0.161	0.161
A-0.1	10:27	30	0.424	0.013	0.031	40	6	40.5	39.5	0	40	25	0.159	0.159
A-0.1	10:33	0	0.192	0.013	0.069	45	9	45.5	44.5	0	45	25	0.350	0.350
A-0.1	10:43	10	0.272	0.013	0.049	45	9	45.5	44.5	0	45	26	0.248	0.241
A-0.1	10:53	20	0.267	0.013	0.049	45	9	45.5	44.5	0	45	28	0.252	0.232
A-0.1	11:03	30	0.292	0.013	0.045	45	9	45.5	44.5	0	45	28	0.231	0.212
A-0.1	11:08	0	0.138	0.013	0.096	30	14	31	29	0	30	28	0.488	0.449
A-0.1	11:18	10	0.149	0.013	0.089	30	14	31	29	0	30	30	0.453	0.394
A-0.1	11:28	20	0.150	0.013	0.088	30	14	31	29	0	30	31	0.448	0.380
A-0.1	11:38	30	0.152	0.013	0.087	30	14	31	29	0	30	31	0.444	0.376
A-0.1	11:41	0	0.272	0.013	0.049	20	6	20	20	0	20	31	0.247	0.209
A-0.1	11:51	10	0.381	0.013	0.035	20	6	20	20	0	20	28	0.177	0.163
A-0.1	12:01	20	0.409	0.013	0.032	20	6	20	20	0	20	25	0.165	0.165
A-0.1	12:11	30	0.430	0.013	0.031	20	6	20	20	0	20	24	0.156	0.161
A-0.1	12:15	0	0.240	0.013	0.055	30	9	30.5	29.5	0	30	24	0.281	0.289
A-0.1	12:25	10	0.284	0.013	0.046	30	9	30.5	29.5	0	30	24	0.237	0.244
A-0.1	12:35	20	0.280	0.013	0.047	30	9	30.5	29.5	0	30	24	0.240	0.247
A-0.1	12:45	30	0.294	0.013	0.045	30	9	30.5	29.5	0	30	24	0.229	0.235
B-0.1	5:08	0	0.235	0.013	0.056	30	9	30.5	29.5	0	30	19	0.287	0.341
B-0.1	5:18	10	0.296	0.013	0.045	30	9	30.5	29.5	0	30	22	0.227	0.247
B-0.1	5:28	20	0.283	0.013	0.047	30	9	30.5	29.5	0	30	24	0.238	0.245
B-0.1	5:38	30	0.279	0.013	0.047	30	9	30.5	29.5	0	30	24	0.241	0.248
B-0.1	5:41	0	0.165	0.013	0.080	40	12	41	39	0	40	24	0.409	0.421
B-0.1	5:51	10	0.184	0.013	0.072	40	12	41	39	0	40	26	0.366	0.355
B-0.1	6:01	20	0.175	0.013	0.076	40	12	41	39	0	40	28	0.385	0.354
B-0.1	6:11	30	0.172	0.013	0.077	40	12	41	39	0	40	29	0.391	0.350
B-0.1	6:14	0	0.248	0.013	0.053	30	4	30	30	0	30	28	0.272	0.250
B-0.1	6:24	10	0.646	0.013	0.020	30	4	30	30	0	30	24	0.104	0.107
B-0.1	6:34	20	0.687	0.013	0.019	30	4	30	30	0	30	23	0.098	0.104
B-0.1	6:44	30	0.713	0.013	0.019	30	4	30	30	0	30	22	0.094	0.103
B-0.1	6:48	0	0.285	0.013	0.046	15	9	15.5	14.5	0	15	22	0.236	0.257
B-0.1	6:58	10	0.321	0.013	0.041	15	9	15.5	14.5	0	15	21	0.210	0.235
B-0.1	7:08	20	0.320	0.013	0.041	15	9	15.5	14.5	0	15	21	0.210	0.236
B-0.1	7:18	30	0.309	0.013	0.043	15	9	15.5	14.5	0	15	21	0.218	0.244
B-0.1	7:22	0	0.199	0.013	0.066	20	12	21	19	0	20	21	0.339	0.380
B-0.1	7:32	10	0.205	0.013	0.064	20	12	21	19	0	20	22	0.328	0.357
B-0.1	7:42	20	0.201	0.013	0.066	20	12	21	19	0	20	23	0.335	0.355
B-0.1	7:52	30	0.200	0.013	0.066	20	12	21	19	0	20	23	0.336	0.356
B-0.1	7:55	0	0.200	0.013	0.066	30	9	30.5	29.5	0	30	23	0.337	0.357
B-0.1	8:05	10	0.281	0.013	0.047	30	9	30.5	29.5	0	30	23	0.239	0.253
B-0.1	8:15	20	0.278	0.013	0.047	30	9	30.5	29.5	0	30	24	0.242	0.249
B-0.1	8:25	30	0.278	0.013	0.048	30	9	30.5	29.5	0	30	24	0.242	0.249
B-0.1	8:28	0	0.305	0.013	0.043	40	6	40.5	39.5	0	40	24	0.220	0.227
B-0.1	8:38	10	0.416	0.013	0.032	40	6	40.5	39.5	0	40	24	0.162	0.166
B-0.1	8:48	20	0.422	0.013	0.031	40	6	40.5	39.5	0	40	24	0.159	0.164
B-0.1	8:58	30	0.424	0.013	0.031	40	6	40.5	39.5	0	40	24	0.159	0.163
B-0.1	9:02	0	0.253	0.013	0.052	45	9	46	44	0	45	24	0.267	0.274
B-0.1	9:12	10	0.284	0.013	0.047	45	9	46	44	0	45	26	0.237	0.231
B-0.1	9:22	20	0.272	0.013	0.049	45	9	46	44	0	45	27	0.248	0.234
B-0.1	9:32	30	0.268	0.013	0.049	45	9	46	44	0	45	28	0.251	0.231
B-0.1	9:35	0	0.140	0.013	0.094	30	14	31	29	0	30	27	0.481	0.455
B-0.1	9:45	10	0.141	0.013	0.094	30	14	31	29	0	30	28	0.478	0.440
B-0.1	9:55	20	0.140	0.013	0.095	30	14	31	29	0	30	29	0.482	0.432
B-0.1	10:05	30	0.137	0.013	0.097	30	14	31	29	0	30	30	0.493	0.429
B-0.1	10:08	0	0.264	0.013	0.050	20	6	20	20	0	20	29	0.256	0.228
B-0.1	10:18	10	0.432	0.013	0.031	20	6	20	20	0	20	26	0.156	0.151
B-0.1	10:28	20	0.451	0.013	0.029	20	6	20	20	0	20	24	0.149	0.154
B-0.1	10:38	30	0.479	0.013	0.028	20	6	20	20	0	20	23	0.140	0.149
B-0.1	10:42	0	0.232	0.013	0.057	30	9	30.5	29.5	0	30	23	0.290	0.307
B-0.1	10:52	10	0.313	0.013	0.042	30	9	30.5	29.5	0	30	23	0.215	0.228
B-0.1	11:02	20	0.303	0.013	0.044	30	9	30.5	29.5	0	30	24	0.222	0.228
B-0.1	11:12	30	0.303	0.013	0.044	30	9	30.5	29.5	0	30	24	0.222	0.229

Table D-6. Strontium Carbonate Flux-GKN 0.1 μm (continued).

C-0.1	5:30	0	0.194	0.013	0.068	30	9	30.5	29.5	0	30	19	0.347	0.412
C-0.1	5:40	10	0.299	0.013	0.044	30	9	30.5	29.5	0	30	22	0.225	0.245
C-0.1	5:50	20	0.286	0.013	0.046	30	9	30.5	29.5	0	30	23	0.235	0.249
C-0.1	6:00	30	0.279	0.013	0.047	30	9	30.5	29.5	0	30	23	0.241	0.255
C-0.1	6:04	0	0.169	0.013	0.078	40	12	41	39	0	40	23	0.398	0.421
C-0.1	6:14	10	0.178	0.013	0.074	40	12	41	39	0	40	26	0.378	0.367
C-0.1	6:24	20	0.171	0.013	0.077	40	12	41	39	0	40	28	0.395	0.363
C-0.1	6:34	30	0.169	0.013	0.078	40	12	41	39	0	40	29	0.399	0.357
C-0.1	6:37	0	0.238	0.013	0.056	30	4	30	30	0	30	28	0.283	0.260
C-0.1	6:47	10	0.584	0.013	0.023	30	4	30	30	0	30	26	0.115	0.112
C-0.1	6:57	20	0.602	0.013	0.022	30	4	30	30	0	30	24	0.112	0.115
C-0.1	7:07	30	0.656	0.013	0.020	30	4	30	30	0	30	23	0.103	0.109
C-0.1	7:13	0	0.213	0.013	0.062	15	9	15.5	14.5	0	15	22	0.316	0.344
C-0.1	7:23	10	0.293	0.013	0.045	15	9	15.5	14.5	0	15	22	0.229	0.250
C-0.1	7:33	20	0.296	0.013	0.045	15	9	15.5	14.5	0	15	21	0.228	0.255
C-0.1	7:43	30	0.296	0.013	0.045	15	9	15.5	14.5	0	15	21	0.228	0.255
C-0.1	7:46	0	0.198	0.013	0.067	20	12	21	19	0	20	21	0.339	0.380
C-0.1	7:56	10	0.195	0.013	0.068	20	12	21	19	0	20	22	0.345	0.375
C-0.1	8:06	20	0.194	0.013	0.068	20	12	21	19	0	20	23	0.346	0.366
C-0.1	8:16	30	0.191	0.013	0.069	20	12	21	19	0	20	24	0.353	0.363
C-0.1	8:20	0	0.221	0.013	0.060	30	9	30.5	29.5	0	30	24	0.304	0.313
C-0.1	8:30	10	0.279	0.013	0.047	30	9	30.5	29.5	0	30	24	0.241	0.248
C-0.1	8:40	20	0.282	0.013	0.047	30	9	30.5	29.5	0	30	24	0.238	0.245
C-0.1	8:50	30	0.281	0.013	0.047	30	9	30.5	29.5	0	30	24	0.239	0.246
C-0.1	8:53	0	0.228	0.013	0.058	40	6	40.5	39.5	0	40	24	0.295	0.304
C-0.1	9:03	10	0.418	0.013	0.032	40	6	40.5	39.5	0	40	24	0.161	0.166
C-0.1	9:13	20	0.414	0.013	0.032	40	6	40.5	39.5	0	40	24	0.163	0.167
C-0.1	9:23	30	0.425	0.013	0.031	40	6	40.5	39.5	0	40	24	0.158	0.163
C-0.1	9:26	0	0.241	0.013	0.055	45	9	46	44	0	45	24	0.280	0.288
C-0.1	9:36	10	0.278	0.013	0.048	45	9	46	44	0	45	26	0.242	0.236
C-0.1	9:46	20	0.270	0.013	0.049	45	9	46	44	0	45	27	0.250	0.236
C-0.1	9:56	30	0.268	0.013	0.049	45	9	46	44	0	45	28	0.251	0.231
C-0.1	9:59	0	0.134	0.013	0.099	30	14	31.5	28.5	0	30	28	0.503	0.462
C-0.1	10:09	10	0.133	0.013	0.100	30	14	31.5	28.5	0	30	29	0.507	0.454
C-0.1	10:19	20	0.136	0.013	0.097	30	14	31.5	28.5	0	30	30	0.496	0.432
C-0.1	10:29	30	0.139	0.013	0.095	30	14	31.5	28.5	0	30	31	0.484	0.410
C-0.1	10:32	0	0.283	0.013	0.047	20	6	20	20	0	20	30	0.238	0.207
C-0.1	10:42	10	0.444	0.013	0.030	20	6	20	20	0	20	26	0.151	0.147
C-0.1	10:52	20	0.446	0.013	0.030	20	6	20	20	0	20	25	0.151	0.151
C-0.1	11:02	30	0.460	0.013	0.029	20	6	20	20	0	20	23	0.150	0.158
C-0.1	11:06	0	0.229	0.013	0.058	30	9	30.5	29.5	0	30	23	0.294	0.311
C-0.1	11:16	10	0.281	0.013	0.047	30	9	30.5	29.5	0	30	24	0.240	0.247
C-0.1	11:26	20	0.280	0.013	0.047	30	9	30.5	29.5	0	30	24	0.241	0.248
C-0.1	11:36	30	0.279	0.013	0.047	30	9	30.5	29.5	0	30	24	0.241	0.248
D-0.1	5:38	0	0.241	0.013	0.055	30	9	30.5	29.5	0	30	17	0.279	0.351
D-0.1	5:48	10	0.313	0.013	0.042	30	9	30.5	29.5	0	30	20	0.216	0.248
D-0.1	5:58	20	0.308	0.013	0.043	30	9	30.5	29.5	0	30	21	0.218	0.245
D-0.1	6:08	30	0.308	0.013	0.043	30	9	30.5	29.5	0	30	22	0.218	0.238
D-0.1	6:11	0	0.171	0.013	0.077	40	12	41	39	0	40	22	0.394	0.429
D-0.1	6:21	10	0.198	0.013	0.067	40	12	41	39	0	40	25	0.341	0.341
D-0.1	6:31	20	0.187	0.013	0.071	40	12	41	39	0	40	27	0.361	0.341
D-0.1	6:41	30	0.180	0.013	0.074	40	12	41	39	0	40	28	0.375	0.345
D-0.1	6:45	0	0.248	0.013	0.053	30	4	30.5	29.5	0	30	27	0.272	0.257
D-0.1	6:55	10	0.666	0.013	0.020	30	4	30.5	29.5	0	30	24	0.101	0.104
D-0.1	7:05	20	0.734	0.013	0.018	30	4	30.5	29.5	0	30	23	0.092	0.097
D-0.1	7:15	30	0.713	0.013	0.019	30	4	30.5	29.5	0	30	22	0.094	0.103
D-0.1	7:19	0	0.273	0.013	0.048	15	9	15.5	14.5	0	15	21	0.247	0.276
D-0.1	7:29	10	0.307	0.013	0.043	15	9	15.5	14.5	0	15	21	0.219	0.246
D-0.1	7:39	20	0.305	0.013	0.043	15	9	15.5	14.5	0	15	20	0.221	0.255
D-0.1	7:49	30	0.306	0.013	0.043	15	9	15.5	14.5	0	15	20	0.221	0.255
D-0.1	7:52	0	0.196	0.013	0.067	20	12	21	19	0	20	20	0.343	0.396
D-0.1	8:02	10	0.206	0.013	0.064	20	12	21	19	0	20	21	0.327	0.366
D-0.1	8:12	20	0.201	0.013	0.066	20	12	21	19	0	20	22	0.335	0.365
D-0.1	8:22	30	0.203	0.013	0.065	20	12	21	19	0	20	23	0.332	0.351
D-0.1	8:26	0	0.215	0.013	0.061	30	9	30.5	29.5	0	30	22	0.313	0.341
D-0.1	8:36	10	0.296	0.013	0.045	30	9	30.5	29.5	0	30	23	0.227	0.241
D-0.1	8:46	20	0.301	0.013	0.044	30	9	30.5	29.5	0	30	23	0.223	0.236
D-0.1	8:56	30	0.306	0.013	0.043	30	9	30.5	29.5	0	30	23	0.220	0.233
D-0.1	9:00	0	0.243	0.013	0.054	40	6	40.5	39.5	0	40	23	0.277	0.293
D-0.1	9:10	10	0.439	0.013	0.030	40	6	40.5	39.5	0	40	23	0.153	0.162
D-0.1	9:20	20	0.444	0.013	0.030	40	6	40.5	39.5	0	40	23	0.152	0.160
D-0.1	9:30	30	0.444	0.013	0.030	40	6	40.5	39.5	0	40	23	0.152	0.160
D-0.1	9:32	0	0.209	0.013	0.063	45	9	46	44	0	45	23	0.323	0.341
D-0.1	9:42	10	0.281	0.013	0.047	45	9	46	44	0	45	25	0.240	0.240
D-0.1	9:52	20	0.277	0.013	0.048	45	9	46	44	0	45	26	0.243	0.236
D-0.1	10:02	30	0.267	0.013	0.049	45	9	46	44	0	45	27	0.252	0.238
D-0.1	10:04	0	0.142	0.013	0.093	30	14	31.5	28.5	0	30	27	0.474	0.449
D-0.1	10:14	10	0.145	0.013	0.091	30	14	31.5	28.5	0	30	28	0.464	0.426
D-0.1	10:24	20	0.143	0.013	0.092	30	14	31.5	28.5	0	30	29	0.471	0.422
D-0.1	10:34	30	0.139	0.013	0.095	30	14	31.5	28.5	0	30	29	0.483	0.432
D-0.1	10:37	0	0.267	0.013	0.049	20	6	20.5	19.5	0	20	28	0.252	0.232
D-0.1	10:47	10	0.459	0.013	0.029	20	6	20.5	19.5	0	20	25	0.147	0.147
D-0.1	10:57	20	0.461	0.013	0.029	20	6	20.5	19.5	0	20	24	0.146	0.150
D-0.1	11:07	30	0.466	0.013	0.028	20	6	20.5	19.5	0	20	23	0.144	0.153
D-0.1	11:10	0	0.240	0.013	0.053	30	9	30.5	29.5	0	30	22	0.271	0.295
D-0.1	11:20	10	0.302	0.013	0.044	30	9	30.5	29.5	0	30	23	0.223	0.236
D-0.1	11:30	20	0.308	0.013	0.043	30	9	30.5	29.5	0	30	23	0.219	0.232
D-0.1	11:40	30	0.308	0.013	0.043	30	9	30.5	29.5	0	30	24	0.219	0.225

Table D-6. Strontium Carbonate Flux-GKN 0.1 μm (continued).

E-0.1	6:10	0	0.156	0.013	0.085	30	9	31	29	0	30	19	0.431	0.512
E-0.1	6:20	10	0.249	0.013	0.053	30	9	31	29	0	30	22	0.271	0.295
E-0.1	6:30	20	0.247	0.013	0.053	30	9	31	29	0	30	23	0.272	0.288
E-0.1	6:40	30	0.252	0.013	0.052	30	9	31	29	0	30	24	0.267	0.274
E-0.1	6:44	0	0.135	0.013	0.098	40	12	41	39	0	40	24	0.500	0.514
E-0.1	6:54	10	0.181	0.013	0.073	40	12	41	39	0	40	26	0.371	0.361
E-0.1	7:04	20	0.185	0.013	0.071	40	12	41	39	0	40	28	0.363	0.334
E-0.1	7:14	30	0.179	0.013	0.074	40	12	41	39	0	40	29	0.376	0.336
E-0.1	7:19	0	0.199	0.013	0.066	30	4	30	30	0	30	29	0.338	0.303
E-0.1	7:29	10	0.473	0.013	0.028	30	4	30	30	0	30	26	0.142	0.138
E-0.1	7:39	20	0.480	0.013	0.028	30	4	30	30	0	30	24	0.140	0.144
E-0.1	7:49	30	0.531	0.013	0.025	30	4	30	30	0	30	23	0.127	0.134
E-0.1	7:53	0	0.219	0.013	0.060	15	9	15.5	14.5	0	15	22	0.307	0.334
E-0.1	8:03	10	0.275	0.013	0.048	15	9	15.5	14.5	0	15	22	0.245	0.267
E-0.1	8:13	20	0.286	0.013	0.046	15	9	15.5	14.5	0	15	21	0.235	0.264
E-0.1	8:23	30	0.294	0.013	0.045	15	9	15.5	14.5	0	15	21	0.229	0.257
E-0.1	8:25	0	0.181	0.013	0.073	20	12	21	19	0	20	21	0.372	0.417
E-0.1	8:35	10	0.203	0.013	0.065	20	12	21	19	0	20	22	0.331	0.360
E-0.1	8:45	20	0.208	0.013	0.063	20	12	21	19	0	20	23	0.323	0.342
E-0.1	8:55	30	0.213	0.013	0.062	20	12	21	19	0	20	24	0.316	0.325
E-0.1	8:58	0	0.173	0.013	0.076	30	9	31	29	0	30	24	0.388	0.399
E-0.1	9:08	10	0.260	0.013	0.051	30	9	31	29	0	30	24	0.259	0.267
E-0.1	9:18	20	0.264	0.013	0.050	30	9	31	29	0	30	24	0.255	0.263
E-0.1	9:28	30	0.264	0.013	0.050	30	9	31	29	0	30	24	0.256	0.262
E-0.1	9:32	0	0.177	0.013	0.074	40	6	40.5	39.5	0	40	24	0.379	0.390
E-0.1	9:42	10	0.368	0.013	0.036	40	6	40.5	39.5	0	40	24	0.183	0.188
E-0.1	9:52	20	0.366	0.013	0.036	40	6	40.5	39.5	0	40	24	0.184	0.189
E-0.1	10:02	30	0.374	0.013	0.035	40	6	40.5	39.5	0	40	24	0.180	0.185
E-0.1	10:08	0	0.165	0.013	0.080	45	9	46	44	0	45	24	0.409	0.421
E-0.1	10:18	10	0.257	0.013	0.051	45	9	46	44	0	45	25	0.262	0.262
E-0.1	10:28	20	0.254	0.013	0.052	45	9	46	44	0	45	26	0.265	0.258
E-0.1	10:38	30	0.254	0.013	0.052	45	9	46	44	0	45	27	0.265	0.251
E-0.1	10:42	0	0.127	0.013	0.104	30	14	31.5	28.5	0	30	27	0.531	0.502
E-0.1	10:52	10	0.150	0.013	0.088	30	14	31.5	28.5	0	30	28	0.448	0.412
E-0.1	11:02	20	0.153	0.013	0.086	30	14	31.5	28.5	0	30	29	0.440	0.394
E-0.1	11:12	30	0.156	0.013	0.084	30	14	31.5	28.5	0	30	30	0.430	0.375
E-0.1	11:15	0	0.246	0.013	0.054	20	6	20	20	0	20	30	0.273	0.238
E-0.1	11:25	10	0.368	0.013	0.036	20	6	20	20	0	20	27	0.183	0.173
E-0.1	11:35	20	0.386	0.013	0.034	20	6	20	20	0	20	25	0.174	0.174
E-0.1	11:45	30	0.393	0.013	0.034	20	6	20	20	0	20	24	0.171	0.176
E-0.1	11:48	0	0.238	0.013	0.056	30	9	31	29	0	30	23	0.283	0.300
E-0.1	11:58	10	0.260	0.013	0.051	30	9	31	29	0	30	22	0.258	0.282
E-0.1	12:08	20	0.263	0.013	0.050	30	9	31	29	0	30	25	0.256	0.256
E-0.1	12:18	30	0.261	0.013	0.051	30	9	31	29	0	30	25	0.258	0.258

Appendix E

SRS Simulant 0.29 wt%

Appendix E

SRS Simulant 0.29 wt%

Table E-1. SRS Simulant 0.29 wt% (Graver 0.07 µm).

SRS Surrogate 0.29 wt%															
Mott 0.1 (B)															
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)	Turbidity (NTU)
B-0.1	7:40	0	0.526	0.013	0.025	30	9	31.5	28.5	0	30	18	0.128	0.157	
B-0.1	7:50	10	0.945	0.013	0.014	30	9	31.5	28.5	0	30	20	0.071	0.082	
B-0.1	8:00	20	0.918	0.013	0.014	30	9	31.5	28.5	0	30	21	0.073	0.082	
B-0.1	8:10	30	1.013	0.013	0.013	30	9	31.5	28.5	0	30	21	0.066	0.074	4.65 ± 0.35
B-0.1	8:16	0	0.476	0.013	0.028	40	12	38	42	0	40	24	0.141	0.145	
B-0.1	8:26	10	0.782	0.013	0.017	40	12	38	42	0	40	22	0.086	0.094	
B-0.1	8:36	20	0.835	0.013	0.016	40	12	38	42	0	40	23	0.081	0.085	
B-0.1	8:46	30	0.878	0.013	0.015	40	12	38	42	0	40	23	0.077	0.081	
B-0.1	8:51	0	0.657	0.013	0.020	30	4	31.5	28.5	0	30	22	0.102	0.112	
B-0.1	9:01	10	1.456	0.013	0.009	30	4	31.5	28.5	0	30	21	0.046	0.052	
B-0.1	9:12	20	1.968	0.013	0.007	30	4	31.5	28.5	0	30	20	0.034	0.040	
B-0.1	9:22	30	2.158	0.013	0.006	30	4	31.5	28.5	0	30	20	0.031	0.036	
B-0.1	9:32	0	1.255	0.013	0.011	15	9	17	13	0	15	20	0.054	0.062	
B-0.1	9:42	10	1.484	0.013	0.009	15	9	17	13	0	15	20	0.045	0.052	
B-0.1	9:52	20	1.640	0.013	0.008	15	9	17	13	0	15	20	0.041	0.047	
B-0.1	10:02	30	1.713	0.013	0.008	15	9	17	13	0	15	20	0.039	0.045	
B-0.1	10:11	0	1.061	0.013	0.012	20	12	22	18	0	20	20	0.063	0.073	
B-0.1	10:21	10	1.185	0.013	0.011	20	12	22	18	0	20	21	0.057	0.064	
B-0.1	10:31	20	1.248	0.013	0.011	20	12	22	18	0	20	21	0.054	0.060	
B-0.1	10:41	30	1.241	0.013	0.011	20	12	22	18	0	20	21	0.054	0.061	
B-0.1	10:47	0	0.698	0.013	0.019	30	9	31.5	28.5	0	30	21	0.096	0.108	
B-0.1	10:57	10	1.240	0.013	0.011	30	9	31.5	28.5	0	30	21	0.054	0.061	
B-0.1	11:07	20	1.399	0.013	0.009	30	9	31.5	28.5	0	30	21	0.048	0.054	
B-0.1	11:17	30	1.438	0.013	0.009	30	9	31.5	28.5	0	30	21	0.047	0.052	2.52 ± 0.21
B-0.1	11:23	0	0.673	0.013	0.020	40	6	41.5	38.5	0	40	21	0.100	0.112	
B-0.1	11:33	10	1.513	0.013	0.009	40	6	41.5	38.5	0	40	21	0.044	0.050	
B-0.1	11:43	20	1.767	0.013	0.007	40	6	41.5	38.5	0	40	21	0.038	0.043	
B-0.1	11:53	30	1.952	0.013	0.007	40	6	41.5	38.5	0	40	21	0.034	0.039	
B-0.1	11:58	0	0.609	0.013	0.022	45	9	47	43	0	45	21	0.110	0.124	
B-0.1	12:08	10	1.233	0.013	0.011	45	9	47	43	0	45	22	0.055	0.059	
B-0.1	12:18	20	1.398	0.013	0.009	45	9	47	43	0	45	23	0.048	0.051	
B-0.1	12:28	30	1.484	0.013	0.009	45	9	47	43	0	45	23	0.045	0.048	
B-0.1	12:35	0	0.949	0.013	0.014	30	14	33	27	0	30	23	0.071	0.075	
B-0.1	12:45	10	1.105	0.013	0.012	30	14	33	27	0	30	24	0.061	0.063	
B-0.1	12:55	20	1.154	0.013	0.011	30	14	33	27	0	30	24	0.058	0.060	
B-0.1	1:05	30	1.152	0.013	0.011	30	14	33	27	0	30	24	0.058	0.060	
B-0.1	1:11	0	1.244	0.013	0.011	20	6	21.5	18.5	0	20	23	0.054	0.057	
B-0.1	1:21	10	2.020	0.013	0.007	20	6	21.5	18.5	0	20	21	0.033	0.037	
B-0.1	1:31	20	2.388	0.013	0.006	20	6	21.5	18.5	0	20	21	0.028	0.032	
B-0.1	1:41	30	2.492	0.013	0.005	20	6	21.5	18.5	0	20	20	0.027	0.031	
B-0.1	1:48	0	1.015	0.013	0.013	30	9	31.5	28.5	0	30	21	0.066	0.074	
B-0.1	1:58	10	1.472	0.013	0.009	30	9	31.5	28.5	0	30	22	0.046	0.050	
B-0.1	2:08	20	1.669	0.013	0.008	30	9	31.5	28.5	0	30	22	0.040	0.044	
B-0.1	2:18	30	1.721	0.013	0.008	30	9	31.5	28.5	0	30	22	0.039	0.043	1.22 ± 0.06

Table E-2. SRS Simulant 0.29 wt% (Mott 0.1 µm).

SRS Surrogate 0.29 wt%															
Graver 0.07 (B)															
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)	Turbidity (NTU)
B-0.07	7:27	0	0.440	0.013	0.030	30	9	29	31	0	30	17	0.153	0.193	
B-0.07	7:37	10	1.102	0.013	0.012	30	9	29	31	0	30	20	0.061	0.070	
B-0.07	7:47	20	1.082	0.013	0.012	30	9	29	31	0	30	20	0.062	0.072	
B-0.07	7:57	30	0.961	0.013	0.014	30	9	28.5	31.5	0	30	21	0.070	0.079	4.05 ± 0.26
B-0.07	8:03	0	0.409	0.013	0.032	40	12	42	38	0	40	21	0.165	0.184	
B-0.07	8:13	10	0.624	0.013	0.021	40	12	42	38	0	40	23	0.108	0.114	
B-0.07	8:23	20	0.659	0.013	0.020	40	12	42	38	0	40	25	0.102	0.102	
B-0.07	8:33	30	0.674	0.013	0.020	40	12	42	38	0	40	26	0.100	0.097	
B-0.07	8:38	0	0.542	0.013	0.024	30	4	30.5	29.5	0	30	24	0.124	0.128	
B-0.07	8:48	10	1.524	0.013	0.009	30	4	30.5	29.5	0	30	22	0.044	0.048	
B-0.07	8:58	20	1.755	0.013	0.008	30	4	30.5	29.5	0	30	20	0.038	0.044	
B-0.07	9:08	30	1.839	0.013	0.007	30	4	30.5	29.5	0	30	19	0.037	0.043	
B-0.07	9:17	0	1.013	0.013	0.013	15	9	16	14	0	15	19	0.066	0.079	
B-0.07	9:27	10	1.241	0.013	0.011	15	9	16	14	0	15	19	0.054	0.064	
B-0.07	9:37	20	1.313	0.013	0.010	15	9	16	14	0	15	18	0.051	0.063	
B-0.07	9:47	30	1.360	0.013	0.010	15	9	16	14	0	15	18	0.049	0.061	
B-0.07	9:53	0	0.780	0.013	0.017	20	12	22	18	0	20	18	0.086	0.106	
B-0.07	10:03	10	0.950	0.013	0.014	20	12	22	18	0	20	20	0.071	0.082	
B-0.07	10:13	20	0.957	0.013	0.014	20	12	22	18	0	20	21	0.070	0.079	
B-0.07	10:23	30	0.968	0.013	0.014	20	12	22	18	0	20	22	0.070	0.076	
B-0.07	10:29	0	0.589	0.013	0.022	30	9	31.5	28.5	0	30	22	0.114	0.124	
B-0.07	10:39	10	1.067	0.013	0.012	30	9	31.5	28.5	0	30	22	0.063	0.069	
B-0.07	10:49	20	1.155	0.013	0.011	30	9	31.5	28.5	0	30	22	0.058	0.063	
B-0.07	10:59	30	1.194	0.013	0.011	30	9	31.5	28.5	0	30	22	0.056	0.061	2.27 ± 0.14
B-0.07	11:04	0	0.535	0.013	0.025	40	6	41	39	0	40	21	0.126	0.141	
B-0.07	11:14	10	1.392	0.013	0.009	40	6	41	39	0	40	21	0.048	0.054	
B-0.07	11:24	20	1.512	0.013	0.009	40	6	41	39	0	40	21	0.044	0.050	
B-0.07	11:34	30	1.637	0.013	0.008	40	6	41	39	0	40	21	0.041	0.046	
B-0.07	11:40	0	0.493	0.013	0.027	45	9	46	44	0	45	21	0.137	0.153	
B-0.07	11:50	10	1.195	0.013	0.011	45	9	46	44	0	45	23	0.056	0.060	
B-0.07	12:00	20	1.225	0.013	0.011	45	9	46	44	0	45	25	0.055	0.055	
B-0.07	12:10	30	1.262	0.013	0.010	45	9	46	44	0	45	25	0.053	0.053	
B-0.07	12:17	0	0.601	0.013	0.022	30	14	33	27	0	30	25	0.112	0.112	
B-0.07	12:27	10	0.784	0.013	0.017	30	14	33	27	0	30	27	0.086	0.081	
B-0.07	12:37	20	0.807	0.013	0.016	30	14	33	27	0	30	28	0.083	0.077	
B-0.07	12:47	30	0.836	0.013	0.016	30	14	33	27	0	30	29	0.081	0.072	
B-0.07	12:52	0	0.872	0.013	0.015	20	6	21	19	0	20	28	0.077	0.071	
B-0.07	1:02	10	1.493	0.013	0.009	20	6	21	19	0	20	24	0.045	0.046	
B-0.07	1:12	20	1.789	0.013	0.007	20	6	21	19	0	20	23	0.038	0.040	
B-0.07	1:22	30	2.002	0.013	0.007	20	6	21	19	0	20	21	0.034	0.038	
B-0.07	1:30	0	0.752	0.013	0.018	30	9	31	29	0	30	21	0.089	0.100	
B-0.07	1:40	10	1.304	0.013	0.010	30	9	31	29	0	30	22	0.052	0.056	
B-0.07	1:50	20	1.468	0.013	0.009	30	9	31	29	0	30	22	0.046	0.050	
B-0.07	2:00	30	1.494	0.013	0.009	30	9	31	29	0	30	23	0.045	0.048	0.99 ± 0.24

Table E-3. SRS Simulant 0.29 wt% (Mott 0.5 µm).

SRS Surrogate 0.29 wt%																
Pall 0.1 (C)																
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 25 C)	Turbidity (NTU)
C-0.1	7:12	0	0.383	0.013	0.034	30	9	31.5	28.5	0	30	19	0.161	0.191	
C-0.1	7:22	10	0.616	0.013	0.021	30	9	31.5	28.5	0	30	21	0.100	0.112	
C-0.1	7:32	20	0.665	0.013	0.020	30	9	31.5	28.5	0	30	22	0.093	0.101	
C-0.1	7:42	30	0.707	0.013	0.019	30	9	31.5	28.5	0	30	23	0.087	0.092	1.07 ± 0.02
C-0.1	7:46	0	0.305	0.013	0.043	40	12	37.5	42.5	0	40	21	0.202	0.227	
C-0.1	7:56	10	0.490	0.013	0.027	40	12	37.5	42.5	0	40	27	0.126	0.119	
C-0.1	8:06	20	0.513	0.013	0.026	40	12	37.5	42.5	0	40	29	0.120	0.107	
C-0.1	8:16	30	0.533	0.013	0.025	40	12	37.5	42.5	0	40	30	0.116	0.101	
C-0.1	8:21	0	0.374	0.013	0.035	30	4	30.5	29.5	0	30	28	0.164	0.151	
C-0.1	8:31	10	1.250	0.013	0.011	30	4	30.5	29.5	0	30	24	0.049	0.051	
C-0.1	8:41	20	1.495	0.013	0.009	30	4	30.5	29.5	0	30	22	0.041	0.045	
C-0.1	8:51	30	1.812	0.013	0.007	30	4	30.5	29.5	0	30	20	0.034	0.039	
C-0.1	8:57	0	0.802	0.013	0.016	15	9	17	13	0	15	20	0.077	0.089	
C-0.1	9:07	10	1.105	0.013	0.012	15	9	17	13	0	15	20	0.056	0.064	
C-0.1	9:17	20	1.164	0.013	0.011	15	9	17	13	0	15	20	0.053	0.061	
C-0.1	9:27	30	1.240	0.013	0.011	15	9	17	13	0	15	20	0.050	0.057	
C-0.1	9:32	0	0.640	0.013	0.021	20	12	23	17	0	20	20	0.096	0.111	
C-0.1	9:42	10	0.828	0.013	0.016	20	12	23	17	0	20	23	0.074	0.079	
C-0.1	9:52	20	0.875	0.013	0.015	20	12	23	17	0	20	24	0.070	0.072	
C-0.1	10:02	30	0.897	0.013	0.015	20	12	23	17	0	20	24	0.069	0.071	
C-0.1	10:07	0	0.444	0.013	0.030	30	9	32	28	0	30	24	0.139	0.143	
C-0.1	10:17	10	0.921	0.013	0.014	30	9	32	28	0	30	24	0.067	0.069	
C-0.1	10:27	20	1.016	0.013	0.013	30	9	32	28	0	30	24	0.061	0.062	
C-0.1	10:37	30	1.076	0.013	0.012	30	9	32	28	0	30	24	0.057	0.059	1.03 ± 0.09
C-0.1	10:42	0	0.430	0.013	0.031	40	6	41	39	0	40	23	0.143	0.152	
C-0.1	10:52	10	1.383	0.013	0.010	40	6	41	39	0	40	23	0.044	0.047	
C-0.1	11:02	20	1.527	0.013	0.009	40	6	41	39	0	40	23	0.040	0.043	
C-0.1	11:12	30	1.631	0.013	0.008	40	6	41	39	0	40	23	0.038	0.040	
C-0.1	11:18	0	0.402	0.013	0.033	45	9	47	43	0	45	22	0.153	0.167	
C-0.1	11:28	10	0.968	0.013	0.014	45	9	47	43	0	45	26	0.064	0.062	
C-0.1	11:38	20	1.028	0.013	0.013	45	9	47	43	0	45	27	0.060	0.057	
C-0.1	11:48	30	1.082	0.013	0.012	45	9	47	43	0	45	28	0.057	0.052	
C-0.1	11:54	0	0.434	0.013	0.030	30	14	34	26	0	30	28	0.142	0.130	
C-0.1	12:04	10	0.649	0.013	0.020	30	14	34	26	0	30	33	0.095	0.076	
C-0.1	12:14	20	0.632	0.013	0.021	30	14	34	26	0	30	37	0.097	0.070	
C-0.1	12:24	30	0.645	0.013	0.020	30	14	34	26	0	30	38	0.095	0.067	
C-0.1	12:28	0	0.548	0.013	0.024	20	6	21	19	0	20	36	0.112	0.083	
C-0.1	12:38	10	1.193	0.013	0.011	20	6	21	19	0	20	32	0.052	0.043	
C-0.1	12:48	20	1.384	0.013	0.010	20	6	21	19	0	20	29	0.044	0.040	
C-0.1	12:58	30	1.526	0.013	0.009	20	6	21	19	0	20	27	0.040	0.038	
C-0.1	1:03	0	0.435	0.013	0.030	30	9	32	28	0	30	26	0.142	0.138	
C-0.1	1:13	10	1.013	0.013	0.013	30	9	32	28	0	30	28	0.061	0.056	
C-0.1	1:23	20	1.150	0.013	0.011	30	9	32	28	0	30	28	0.054	0.049	
C-0.1	1:33	30	1.128	0.013	0.012	30	9	32	28	0	30	28	0.055	0.050	0.66 ± 0.03

Table E-4. SRS Simulant 0.29 wt% (Pall 0.1 µm).

SRS Surrogate 0.29 wt%															
Mott 0.5 (B)															
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 25 C)	Turbidity NTU
B-0.5	7:15	0	0.369	0.013	0.036	30	9	30	30	0	30	18	0.182	0.223	
B-0.5	7:25	10	0.903	0.013	0.015	30	9	30	30	0	30	19	0.075	0.089	
B-0.5	7:35	20	0.985	0.013	0.013	30	9	30	30	0	30	19	0.068	0.081	
B-0.5	7:45	30	1.023	0.013	0.013	30	9	30	30	0	30	20	0.066	0.076	1.01 ± 0.01
B-0.5	7:50	0	0.507	0.013	0.026	40	12	40.5	39.5	0	40	20	0.133	0.153	
B-0.5	8:00	10	0.804	0.013	0.016	40	12	40.5	39.5	0	40	22	0.084	0.091	
B-0.5	8:10	20	0.874	0.013	0.015	40	12	40.5	39.5	0	40	23	0.077	0.082	
B-0.5	8:20	30	0.893	0.013	0.015	40	12	40.5	39.5	0	40	23	0.075	0.080	
B-0.5	8:24	0	0.630	0.013	0.021	30	4	29	31	0	30	23	0.107	0.113	
B-0.5	8:34	10	1.511	0.013	0.009	30	4	29	31	0	30	20	0.045	0.051	
B-0.5	8:44	20	1.999	0.013	0.007	30	4	29	31	0	30	20	0.034	0.039	
B-0.5	8:54	30	2.284	0.013	0.006	30	4	29	31	0	30	19	0.029	0.035	
B-0.5	9:02	0	1.424	0.013	0.009	15	9	15	15	0	15	19	0.047	0.056	
B-0.5	9:12	10	1.648	0.013	0.008	15	9	15	15	0	15	19	0.041	0.049	
B-0.5	9:22	20	1.775	0.013	0.007	15	9	15	15	0	15	19	0.038	0.045	
B-0.5	9:32	30	1.800	0.013	0.007	15	9	15	15	0	15	19	0.037	0.044	
B-0.5	9:40	0	1.354	0.013	0.010	20	12	20.5	19.5	0	20	19	0.050	0.059	
B-0.5	9:50	10	1.483	0.013	0.009	20	12	20.5	19.5	0	20	20	0.045	0.052	
B-0.5	10:00	20	1.498	0.013	0.009	20	12	20.5	19.5	0	20	20	0.045	0.052	
B-0.5	10:10	30	1.539	0.013	0.009	20	12	20.5	19.5	0	20	20	0.044	0.050	
B-0.5	10:18	0	0.966	0.013	0.014	30	9	30	30	0	30	21	0.070	0.078	
B-0.5	10:28	10	1.317	0.013	0.010	30	9	30	30	0	30	21	0.051	0.057	1.84 ± 0.12
B-0.5	10:38	20	1.414	0.013	0.009	30	9	30	30	0	30	21	0.048	0.053	
B-0.5	10:48	30	1.471	0.013	0.009	30	9	30	30	0	30	21	0.046	0.051	
B-0.5	10:55	0	0.841	0.013	0.016	40	6	39.5	40.5	0	40	20	0.080	0.092	
B-0.5	11:05	10	1.586	0.013	0.008	40	6	39.5	40.5	0	40	20	0.042	0.049	
B-0.5	11:15	20	1.764	0.013	0.007	40	6	39.5	40.5	0	40	20	0.038	0.044	
B-0.5	11:25	30	1.937	0.013	0.007	40	6	39.5	40.5	0	40	20	0.035	0.040	
B-0.5	11:32	0	0.857	0.013	0.015	45	9	45	45	0	45	20	0.079	0.091	
B-0.5	11:42	10	1.303	0.013	0.010	45	9	45	45	0	45	22	0.052	0.056	
B-0.5	11:52	20	1.374	0.013	0.010	45	9	45	45	0	45	22	0.049	0.053	
B-0.5	12:02	30	1.431	0.013	0.009	45	9	45	45	0	45	23	0.047	0.050	
B-0.5	12:07	0	1.258	0.013	0.011	30	14	31	29	0	30	23	0.053	0.057	
B-0.5	12:17	10	1.392	0.013	0.009	30	14	31	29	0	30	24	0.048	0.050	
B-0.5	12:27	20	1.408	0.013	0.009	30	14	31	29	0	30	25	0.048	0.048	
B-0.5	12:37	30	1.440	0.013	0.009	30	14	31	29	0	30	25	0.047	0.047	
B-0.5	12:43	0	1.302	0.013	0.010	20	6	20	20	0	20	24	0.052	0.053	2.90 ± 0.18
B-0.5	12:53	10	1.855	0.013	0.007	20	6	20	20	0	20	22	0.036	0.040	
B-0.5	1:03	20	2.100	0.013	0.006	20	6	20	20	0	20	21	0.032	0.036	
B-0.5	1:13	30	2.325	0.013	0.006	20	6	20	20	0	20	20	0.029	0.033	
B-0.5	1:25	0	1.328	0.013	0.010	30	9	30	30	0	30	20	0.051	0.058	2.50 ± 0.04
B-0.5	1:35	10	1.528	0.013	0.009	30	9	30	30	0	30	21	0.044	0.049	
B-0.5	1:45	20	1.632	0.013	0.008	30	9	30	30	0	30	21	0.041	0.046	
B-0.5	1:55	30	1.665	0.013	0.008	30	9	30	30	0	30	21	0.040	0.045	0.50 ± 0.13

Table E-5. SRS Simulant 0.29 wt% (Pall 0.8 μm).

SRS Surrogate 0.29 wt% GKN 0.1 (C)																
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 25 C)	Turbidity NTU
C-0.1	7:07	0	0.325	0.013	0.041	30	9	31	29	0	30	18	0.207	0.253	
C-0.1	7:17	10	0.818	0.013	0.016	30	9	31	29	0	30	18	0.082	0.101	
C-0.1	7:27	20	0.909	0.013	0.015	30	9	31	29	0	30	18	0.074	0.091	
C-0.1	7:37	30	0.983	0.013	0.013	30	9	31	29	0	30	18	0.068	0.084	0.61 ± 0.02
C-0.1	7:42	0	0.254	0.013	0.052	40	12	42	38	0	40	18	0.265	0.325	
C-0.1	7:52	10	0.741	0.013	0.018	40	12	42	38	0	40	20	0.091	0.105	
C-0.1	8:02	20	0.789	0.013	0.017	40	12	42	38	0	40	21	0.085	0.096	
C-0.1	8:12	30	0.833	0.013	0.016	40	12	42	38	0	40	22	0.081	0.088	
C-0.1	8:15	0	0.369	0.013	0.036	30	4	30.5	29.5	0	30	21	0.183	0.205	
C-0.1	8:25	10	1.341	0.013	0.010	30	4	30.5	29.5	0	30	19	0.050	0.060	
C-0.1	8:35	20	1.807	0.013	0.007	30	4	30.5	29.5	0	30	17	0.037	0.047	
C-0.1	8:45	30	2.228	0.015	0.007	30	4	30.5	29.5	0	30	17	0.033	0.042	
C-0.1	8:52	0	0.708	0.013	0.019	15	9	14.5	15.5	0	15	16	0.095	0.124	
C-0.1	9:02	10	1.319	0.013	0.010	15	9	14.5	15.5	0	15	16	0.051	0.066	
C-0.1	9:12	20	1.454	0.013	0.009	15	9	14.5	15.5	0	15	16	0.046	0.060	
C-0.1	9:22	30	1.513	0.013	0.009	15	9	14.5	15.5	0	15	16	0.044	0.058	
C-0.1	9:28	0	0.616	0.013	0.021	20	12	21.5	18.5	0	20	16	0.109	0.142	
C-0.1	9:38	10	1.060	0.013	0.012	20	12	21.5	18.5	0	20	18	0.063	0.078	
C-0.1	9:48	20	1.131	0.013	0.012	20	12	21.5	18.5	0	20	18	0.059	0.073	
C-0.1	9:58	30	1.186	0.013	0.011	20	12	21.5	18.5	0	20	18	0.057	0.069	
C-0.1	10:04	0	0.456	0.013	0.029	30	9	31	29	0	30	18	0.148	0.181	
C-0.1	10:14	10	1.216	0.013	0.011	30	9	31	29	0	30	18	0.055	0.068	1.31 ± 0.17
C-0.1	10:24	20	1.355	0.013	0.010	30	9	31	29	0	30	19	0.050	0.059	
C-0.1	10:34	30	1.461	0.013	0.009	30	9	31	29	0	30	19	0.046	0.055	
C-0.1	10:43	0	0.400	0.013	0.033	40	6	40.5	39.5	0	40	18	0.168	0.206	
C-0.1	10:53	10	1.468	0.013	0.009	40	6	40.5	39.5	0	40	18	0.046	0.056	
C-0.1	11:03	20	1.779	0.013	0.007	40	6	40.5	39.5	0	40	18	0.038	0.046	
C-0.1	11:13	30	1.908	0.013	0.007	40	6	40.5	39.5	0	40	18	0.035	0.043	
C-0.1	11:18	0	0.379	0.013	0.036	45	9	46	44	0	45	18	0.181	0.222	
C-0.1	11:28	10	1.202	0.013	0.011	45	9	46	44	0	45	20	0.056	0.065	
C-0.1	11:38	20	1.335	0.013	0.010	45	9	46	44	0	45	21	0.050	0.057	
C-0.1	11:48	30	1.430	0.013	0.009	45	9	46	44	0	45	21	0.047	0.053	
C-0.1	11:53	0	0.617	0.013	0.021	30	14	32	28	0	30	21	0.109	0.122	
C-0.1	12:03	10	0.969	0.013	0.014	30	14	32	28	0	30	22	0.069	0.076	
C-0.1	12:13	20	1.019	0.013	0.013	30	14	32	28	0	30	22	0.066	0.072	
C-0.1	12:23	30	1.101	0.013	0.012	30	14	32	28	0	30	22	0.061	0.067	
C-0.1	12:28	0	0.743	0.013	0.018	20	6	20	20	0	20	21	0.091	0.102	3.70 ± 0.04
C-0.1	12:38	10	1.852	0.013	0.007	20	6	20	20	0	20	19	0.036	0.043	
C-0.1	12:48	20	2.418	0.013	0.005	20	6	20	20	0	20	18	0.028	0.034	
C-0.1	12:58	30	2.497	0.013	0.005	20	6	20	20	0	20	17	0.027	0.034	
C-0.1	1:08	0	0.775	0.013	0.017	30	9	31	29	0	30	17	0.087	0.109	
C-0.1	1:18	10	1.565	0.013	0.008	30	9	31	29	0	30	18	0.043	0.053	
C-0.1	1:28	20	1.843	0.015	0.008	30	9	31	29	0	30	18	0.040	0.049	
C-0.1	1:38	30	1.715	0.013	0.008	30	9	31	29	0	30	19	0.039	0.047	

Table E-6. SRS Simulant 0.29 wt% (GKN 0.1 μm).

SRS Surrogate 0.29 wt% Pall 0.8 (B)															
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 25 C)	Turbidity NTU
B-0.8	7:18	0	0.447	0.013	0.030	30	9	32	28	0	30	19	0.166	0.197	
B-0.8	7:28	10	0.829	0.013	0.016	30	9	32	28	0	30	20	0.090	0.103	
B-0.8	7:38	20	0.967	0.013	0.014	30	9	32	28	0	30	20	0.077	0.089	
B-0.8	7:48	30	1.020	0.013	0.013	30	9	32	28	0	30	21	0.073	0.082	0.27 ± 0.05
B-0.8	7:53	0	0.426	0.013	0.031	40	12	42.5	37.5	0	40	21	0.174	0.195	
B-0.8	8:03	10	0.774	0.013	0.017	40	12	42.5	37.5	0	40	22	0.096	0.104	
B-0.8	8:13	20	0.806	0.013	0.016	40	12	42.5	37.5	0	40	22	0.092	0.100	
B-0.8	8:23	30	0.837	0.013	0.016	40	12	42.5	37.5	0	40	23	0.089	0.094	
B-0.8	8:28	0	0.542	0.013	0.024	30	4	31.5	28.5	0	30	22	0.137	0.149	
B-0.8	8:38	10	1.581	0.013	0.008	30	4	31.5	28.5	0	30	21	0.047	0.053	
B-0.8	8:48	20	2.016	0.013	0.007	30	4	31.5	28.5	0	30	20	0.037	0.042	
B-0.8	8:58	30	2.206	0.013	0.006	30	4	31.5	28.5	0	30	20	0.034	0.039	
B-0.8	9:06	0	1.058	0.013	0.012	15	9	17	13	0	15	20	0.070	0.081	
B-0.8	9:16	10	1.379	0.013	0.010	15	9	17	13	0	15	20	0.054	0.062	
B-0.8	9:26	20	1.480	0.013	0.009	15	9	17	13	0	15	20	0.050	0.058	
B-0.8	9:36	30	1.477	0.013	0.009	15	9	17	13	0	15	20	0.050	0.058	
B-0.8	9:43	0	0.887	0.013	0.015	20	12	22	18	0	20	20	0.084	0.097	
B-0.8	9:53	10	1.124	0.013	0.012	20	12	22	18	0	20	21	0.066	0.074	
B-0.8	10:03	20	1.180	0.013	0.011	20	12	22	18	0	20	21	0.063	0.070	
B-0.8	10:13	30	1.183	0.013	0.011	20	12	22	18	0	20	21	0.063	0.070	
B-0.8	10:18	0	0.658	0.013	0.020	30	9	32	28	0	30	21	0.113	0.126	
B-0.8	10:28	10	1.160	0.013	0.011	30	9	32	28	0	30	21	0.064	0.072	
B-0.8	10:38	20	1.298	0.013	0.010	30	9	32	28	0	30	21	0.057	0.064	
B-0.8	10:48	30	1.420	0.013	0.009	30	9	32	28	0	21	21	0.052	0.059	0.24 ± 0.07
B-0.8	10:53	0	0.590	0.013	0.022	40	6	42	38	0	40	21	0.126	0.141	
B-0.8	11:03	10	1.387	0.013	0.010	40	6	42	38	0	40	21	0.054	0.060	
B-0.8	11:13	20	1.708	0.013	0.008	40	6	42	38	0	40	21	0.043	0.049	
B-0.8	11:23	30	1.817	0.013	0.007	40	6	42	38	0	40	21	0.041	0.046	
B-0.8	11:30	0	0.574	0.013	0.023	45	9	47	43	0	45	21	0.129	0.145	
B-0.8	11:40	10	1.280	0.013	0.010	45	9	47	43	0	45	22	0.058	0.063	
B-0.8	11:50	20	1.409	0.013	0.009	45	9	47	43	0	45	22	0.053	0.057	
B-0.8	12:00	30	1.523	0.013	0.009	45	9	47	43	0	45	22	0.049	0.053	
B-0.8	12:07	0	0.789	0.013	0.017	30	14	33	27	0	30	22	0.094	0.102	
B-0.8	12:17	10	1.078	0.013	0.012	30	14	33	27	0	30	23	0.069	0.073	
B-0.8	12:27	20	1.052	0.013	0.013	30	14	33	27	0	30	23	0.071	0.075	
B-0.8	12:37	30	1.165	0.013	0.011	30	14	33	27	0	30	23	0.064	0.067	
B-0.8	12:42	0	1.022	0.013	0.013	20	6	21	19	0	20	22	0.073	0.079	
B-0.8	12:52	10	2.083	0.013	0.006	20	6	21	19	0	20	21	0.036	0.040	
B-0.8	1:02	20	2.677	0.013	0.005	20	6	21	19	0	20	20	0.028	0.032	
B-0.8	1:12	30	2.561	0.013	0.005	20	6	21	19	0	20	20	0.029	0.033	
B-0.8	1:26	0	0.907	0.013	0.015	30	9	31.5	28.5	0	30	21	0.082	0.092	
B-0.8	1:36	10	1.426	0.013	0.009	30	9	31.5	28.5	0	30	21	0.052	0.058	
B-0.8	1:46	20	1.630	0.013	0.008	30	9	31.5	28.5	0	30	21	0.046	0.051	
B-0.8	1:56	30	1.767	0.013	0.007	30	9	31.5	28.5	0	30	21	0.042	0.047	0.38 ± 0.04

Appendix F

SRS Simulant 4.5 wt%

Appendix F

SRS Simulant 4.5 wt%

Table F-1. SRS Simulant 4.5 wt% (Graver 0.07 μm).

SRS Surrogate 4.5 wt% Graver 0.07 (B)																
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 25 C)	Turbidity (NTU)
B-0.07	7:20	0	0.887	0.013	0.015	30	9	32	28	0	30	18	0.076	0.093	
B-0.07	7:30	10	1.230	0.013	0.011	30	9	32	28	0	30	21	0.055	0.061	
B-0.07	7:40	20	1.248	0.013	0.011	30	9	32	28	0	30	23	0.054	0.057	
B-0.07	7:50	30	1.276	0.013	0.010	30	9	32	28	0	30	23	0.053	0.056	0.43 ± 0.05
B-0.07	7:55	0	0.744	0.013	0.018	40	12	42	38	0	40	23	0.090	0.096	
B-0.07	8:05	10	1.056	0.013	0.013	40	12	42	38	0	40	26	0.064	0.062	
B-0.07	8:15	20	1.214	0.016	0.013	40	12	42	38	0	40	27	0.067	0.063	
B-0.07	8:25	30	1.021	0.013	0.013	40	12	42	38	0	40	28	0.066	0.061	
B-0.07	8:29	0	1.752	0.013	0.008	30	4	31	29	0	30	27	0.038	0.036	
B-0.07	8:39	10	1.913	0.008	0.004	30	4	31	29	0	30	25	0.021	0.021	
B-0.07	8:49	20	2.409	0.008	0.003	30	4	31	29	0	30	22	0.017	0.018	
B-0.07	8:59	30	2.473	0.008	0.003	30	4	31	29	0	30	21	0.016	0.018	
B-0.07	9:05	0	1.589	0.013	0.008	15	9	16	14	0	15	21	0.042	0.047	
B-0.07	9:15	10	1.277	0.008	0.006	15	9	16	14	0	15	21	0.032	0.035	
B-0.07	9:25	20	1.283	0.008	0.006	15	9	16	14	0	15	20	0.031	0.036	
B-0.07	9:35	30	1.931	0.011	0.005	15	9	16	14	0	15	20	0.028	0.032	
B-0.07	9:41	0	1.228	0.013	0.011	20	12	22	18	0	20	20	0.055	0.063	
B-0.07	9:51	10	1.273	0.013	0.010	20	12	22	18	0	20	22	0.053	0.058	
B-0.07	10:01	20	1.508	0.013	0.009	20	12	22	18	0	20	22	0.045	0.049	
B-0.07	10:11	30	1.469	0.013	0.009	20	12	22	18	0	20	22	0.046	0.050	
B-0.07	10:16	0	1.442	0.013	0.009	30	9	31.5	28.5	0	30	24	0.047	0.048	
B-0.07	10:26	10	1.258	0.008	0.006	30	9	31.5	28.5	0	30	24	0.032	0.033	
B-0.07	10:36	20	2.082	0.013	0.006	30	9	31.5	28.5	0	30	24	0.032	0.033	
B-0.07	10:46	30	1.235	0.008	0.006	30	9	31.5	28.5	0	30	24	0.033	0.034	0.64 ± 0.02
B-0.07	10:51	0	1.682	0.013	0.008	40	6	41	39	0	40	24	0.040	0.041	
B-0.07	11:01	10	1.812	0.008	0.004	40	6	41	39	0	40	24	0.022	0.023	
B-0.07	11:11	20	1.836	0.008	0.004	40	6	41	39	0	40	24	0.022	0.023	
B-0.07	11:21	30	1.823	0.008	0.004	40	6	41	39	0	40	23	0.022	0.023	
B-0.07	11:26	0	1.381	0.013	0.010	45	9	47	43	0	45	23	0.049	0.052	
B-0.07	11:36	10	1.235	0.008	0.006	45	9	47	43	0	45	25	0.033	0.033	
B-0.07	11:46	20	1.199	0.008	0.007	45	9	47	43	0	45	26	0.034	0.033	
B-0.07	11:56	30	1.131	0.008	0.007	45	9	47	43	0	45	27	0.036	0.034	
B-0.07	12:00	0	0.986	0.013	0.013	30	14	33	27	0	30	28	0.068	0.063	
B-0.07	12:10	10	1.036	0.013	0.013	30	14	33	27	0	30	29	0.065	0.058	
B-0.07	12:20	20	1.029	0.013	0.013	30	14	33	27	0	30	30	0.065	0.057	
B-0.07	12:30	30	1.009	0.013	0.013	30	14	33	27	0	30	30	0.067	0.058	
B-0.07	12:35	0	2.061	0.013	0.006	20	6	21	19	0	20	29	0.033	0.029	
B-0.07	12:45	10	2.344	0.008	0.003	20	6	21	19	0	20	25	0.017	0.017	
B-0.07	12:55	20	2.605	0.008	0.003	20	6	21	19	0	20	23	0.015	0.016	
B-0.07	1:05	30	2.563	0.008	0.003	20	6	21	19	0	20	22	0.016	0.017	
B-0.07	1:13	0	2.038	0.013	0.006	30	9	31.5	28.5	0	30	22	0.033	0.036	
B-0.07	1:23	10	2.755	0.011	0.004	30	9	31.5	28.5	0	30	23	0.020	0.021	
B-0.07	1:33	20	1.878	0.008	0.004	30	9	31.5	28.5	0	30	24	0.021	0.022	
B-0.07	1:43	30	1.829	0.008	0.004	30	9	31.5	28.5	0	30	24	0.022	0.023	0.64 ± 0.04

Table F-2. SRS Simulant 4.5 wt% (Mott 0.1 μm).

SRS Surrogate 4.5 wt% Mott 0.1 (B)															
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 25 C)	Turbidity (NTU)
B-0.1	7:28	0	1.220	0.013	0.011	30	9	32	28	0	30	19	0.055	0.066	
B-0.1	7:38	10	1.471	0.013	0.009	30	9	32	28	0	30	21	0.046	0.051	
B-0.1	7:48	20	1.597	0.013	0.008	30	9	32	28	0	30	22	0.042	0.046	
B-0.1	7:58	30	1.627	0.013	0.008	30	9	32	28	0	30	22	0.041	0.045	1.36 ± 0.07
B-0.1	8:05	0	1.104	0.013	0.012	40	12	42	38	0	40	22	0.061	0.066	
B-0.1	8:16	10	1.224	0.013	0.011	40	12	42	38	0	40	24	0.055	0.057	
B-0.1	8:26	20	1.210	0.013	0.011	40	12	42	38	0	40	24	0.056	0.057	
B-0.1	8:36	30	1.214	0.013	0.011	40	12	42	38	0	40	24	0.055	0.057	
B-0.1	8:43	0	2.771	0.013	0.005	30	4	31	29	0	30	23	0.024	0.026	
B-0.1	8:53	10	2.796	0.008	0.003	30	4	31	29	0	30	22	0.014	0.016	
B-0.1	9:03	20	2.842	0.008	0.003	30	4	31	29	0	30	22	0.014	0.015	
B-0.1	9:13	30	3.514	0.008	0.002	30	4	31	29	0	30	22	0.011	0.013	
B-0.1	9:24	0	2.190	0.013	0.006	15	9	16.5	13.5	0	15	21	0.031	0.034	
B-0.1	9:34	10	1.463	0.008	0.005	15	9	16.5	13.5	0	15	21	0.028	0.031	
B-0.1	9:44	20	1.428	0.008	0.006	15	9	16.5	13.5	0	15	21	0.028	0.032	
B-0.1	9:54	30	1.285	0.008	0.006	15	9	16.5	13.5	0	15	21	0.031	0.035	
B-0.1	9:59	0	1.425	0.013	0.009	20	12	22	18	0	20	21	0.047	0.053	
B-0.1	10:09	10	1.978	0.013	0.007	20	12	22	18	0	20	22	0.034	0.037	
B-0.1	10:19	20	1.929	0.013	0.007	20	12	22	18	0	20	22	0.035	0.038	
B-0.1	10:29	30	1.945	0.013	0.007	20	12	22	18	0	20	22	0.035	0.038	
B-0.1	10:37	0	2.132	0.013	0.006	30	9	31	29	0	30	22	0.032	0.034	
B-0.1	10:47	10	1.354	0.008	0.006	30	9	31	29	0	30	22	0.030	0.032	
B-0.1	10:57	20	1.387	0.008	0.006	30	9	31	29	0	30	22	0.029	0.032	
B-0.1	11:07	30	1.362	0.008	0.006	30	9	31	29	0	30	22	0.030	0.032	0.39 ± 0.06
B-0.1	11:14	0	1.803	0.008	0.004	40	6	41.5	38.5	0	40	22	0.022	0.024	
B-0.1	11:24	10	2.168	0.008	0.004	40	6	41.5	38.5	0	40	22	0.019	0.020	
B-0.1	11:34	20	2.203	0.008	0.004	40	6	41.5	38.5	0	40	22	0.018	0.020	
B-0.1	11:44	30	2.137	0.008	0.004	40	6	41.5	38.5	0	40	22	0.019	0.021	
B-0.1	11:52	0	2.270	0.013	0.006	45	9	47	43	0	45	23	0.030	0.031	
B-0.1	12:02	10	1.498	0.008	0.005	45	9	47	43	0	45	24	0.027	0.028	
B-0.1	12:12	20	1.509	0.008	0.005	45	9	47	43	0	45	24	0.027	0.028	
B-0.1	12:22	30	1.539	0.008	0.005	45	9	47	43	0	45	24	0.026	0.027	
B-0.1	12:30	0	1.325	0.013	0.010	30	14	32.5	27.5	0	30	24	0.051	0.052	
B-0.1	12:40	10	0.844	0.008	0.009	30	14	32.5	27.5	0	30	24	0.048	0.049	
B-0.1	12:50	20	0.889	0.008	0.009	30	14	32.5	27.5	0	30	24	0.045	0.047	
B-0.1	1:00	30	0.834	0.008	0.010	30	14	32.5	27.5	0	30	24	0.048	0.050	
B-0.1	1:08	0	0.820	0.003	0.003	20	6	21	19	0	20	23	0.016	0.017	
B-0.1	1:18	10	0.955	0.003	0.003	20	6	21	19	0	20	22	0.014	0.015	
B-0.1	1:28	20	0.959	0.003	0.003	20	6	21	19	0	20	21	0.014	0.016	
B-0.1	1:38	30	0.931	0.003	0.003	20	6	21	19	0	20	21	0.014	0.016	
B-0.1	1:48	0	1.669	0.008	0.005	30	9	31	29	0	30	22	0.024	0.026	
B-0.1	1:58	10	1.700	0.008	0.005	30	9	31	29	0	30	22	0.024	0.026	
B-0.1	2:08	20	1.750	0.008	0.005	30	9	31	29	0	30	23	0.023	0.024	
B-0.1	2:18	30	1.760	0.008	0.005	30	9	31	29	0	30	23	0.023	0.024	0.24 ± 0.03

Table F-3. SRS Simulant 4.5 wt% (Mott 0.5 μm).

SRS Surrogate 4.5 wt% Mott 0.5 (B)															
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 25 C)	Turbidity (NTU)
B-0.5	7:26	0	1.199	0.013	0.011	30	9	30	30	0	30	19	0.056	0.067	
B-0.5	7:36	10	1.444	0.013	0.009	30	9	30	30	0	30	19	0.047	0.055	
B-0.5	7:46	20	1.499	0.013	0.009	30	9	30	30	0	30	20	0.045	0.052	
B-0.5	7:56	30	1.487	0.013	0.009	30	9	30	30	0	30	20	0.045	0.052	0.63 ± 0.02
B-0.5	8:02	0	1.145	0.013	0.012	40	12	41	39	0	40	20	0.059	0.068	
B-0.5	8:12	10	1.250	0.013	0.011	40	12	41	39	0	40	22	0.054	0.059	
B-0.5	8:22	20	1.228	0.013	0.011	40	12	41	39	0	40	23	0.055	0.058	
B-0.5	8:32	30	1.224	0.013	0.011	40	12	41	39	0	40	23	0.055	0.058	
B-0.5	8:41	0	1.938	0.008	0.004	30	4	29.5	30.5	0	30	22	0.021	0.023	
B-0.5	8:51	10	2.624	0.008	0.003	30	4	29.5	30.5	0	30	21	0.015	0.017	
B-0.5	9:01	20	2.925	0.008	0.003	30	4	29.5	30.5	0	30	20	0.014	0.016	
B-0.5	9:11	30	2.968	0.008	0.003	30	4	29.5	30.5	0	30	20	0.014	0.016	
B-0.5	9:26	0	1.270	0.008	0.006	15	9	15	15	0	15	19	0.032	0.038	
B-0.5	9:36	10	1.312	0.008	0.006	15	9	15	15	0	15	19	0.031	0.037	
B-0.5	9:46	20	1.364	0.008	0.006	15	9	15	15	0	15	19	0.030	0.035	
B-0.5	9:56	30	1.460	0.008	0.005	15	9	15	15	0	15	19	0.028	0.033	
B-0.5	10:03	0	0.856	0.008	0.009	20	12	20	20	0	20	19	0.047	0.056	
B-0.5	10:13	10	1.000	0.008	0.008	20	12	20	20	0	20	20	0.040	0.047	
B-0.5	10:23	20	0.959	0.008	0.008	20	12	20	20	0	20	20	0.042	0.049	
B-0.5	10:33	30	0.973	0.008	0.008	20	12	20	20	0	20	21	0.042	0.047	
B-0.5	10:37	0	1.224	0.008	0.006	30	9	31	29	0	30	20	0.033	0.038	
B-0.5	10:47	10	1.370	0.008	0.006	30	9	31	29	0	30	21	0.029	0.033	
B-0.5	10:57	20	1.352	0.008	0.006	30	9	31	29	0	30	21	0.030	0.033	
B-0.5	11:07	30	1.391	0.008	0.006	30	9	31	29	0	30	21	0.029	0.033	0.43 ± 0.01
B-0.5	11:14	0	1.734	0.008	0.005	40	6	40.5	39.5	0	40	21	0.023	0.026	
B-0.5	11:24	10	2.211	0.008	0.004	40	6	40.5	39.5	0	40	20	0.018	0.021	
B-0.5	11:34	20	2.270	0.008	0.003	40	6	40.5	39.5	0	40	20	0.018	0.021	
B-0.5	11:44	30	2.265	0.008	0.003	40	6	40.5	39.5	0	40	20	0.018	0.021	
B-0.5	11:53	0	1.320	0.008	0.006	45	9	44.5	45.5	0	45	21	0.031	0.034	
B-0.5	12:03	10	1.447	0.008	0.005	45	9	44.5	45.5	0	45	22	0.028	0.030	
B-0.5	12:13	20	1.471	0.008	0.005	45	9	44.5	45.5	0	45	23	0.027	0.029	
B-0.5	12:23	30	1.418	0.008	0.006	45	9	44.5	45.5	0	45	23	0.028	0.030	
B-0.5	12:29	0	0.775	0.008	0.010	30	14	31.5	28.5	0	30	23	0.052	0.055	
B-0.5	12:39	10	0.735	0.008	0.011	30	14	31.5	28.5	0	30	24	0.055	0.057	
B-0.5	12:49	20	0.732	0.008	0.011	30	14	31.5	28.5	0	30	24	0.055	0.057	
B-0.5	12:59	30	0.741	0.008	0.011	30	14	31.5	28.5	0	30	24	0.054	0.056	
B-0.5	1:05	0	2.137	0.008	0.004	20	6	19.5	20.5	0	20	22	0.019	0.021	
B-0.5	1:15	10	2.475	0.008	0.003	20	6	19.5	20.5	0	20	21	0.016	0.018	
B-0.5	1:25	20	2.612	0.008	0.003	20	6	19.5	20.5	0	20	20	0.015	0.018	
B-0.5	1:35	30	2.665	0.008	0.003	20	6	19.5	20.5	0	20	19	0.015	0.018	
B-0.5	1:47	0	1.585	0.008	0.005	30	9	30	30	0	30	19	0.025	0.030	
B-0.5	1:57	10	1.648	0.008	0.005	30	9	30	30	0	30	20	0.025	0.028	
B-0.5	2:07	20	1.632	0.008	0.005	30	9	30	30	0	30	21	0.025	0.028	
B-0.5	2:17	30	1.623	0.008	0.005	30	9	30	30	0	30	21	0.025	0.028	0.26 ± 0.03

Table F-4. SRS Simulant 4.5 wt% (Pall 0.1 μm).

SRS Surrogate 4.5 wt% Pall 0.1 (C)															
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 25 C)	Turbidity (NTU)
C-0.1	7:35	0	0.958	0.013	0.014	30	9	31	29	0	30	20	0.064	0.074	
C-0.1	7:45	10	1.282	0.013	0.010	30	9	31	29	0	30	23	0.048	0.051	
C-0.1	7:55	20	1.289	0.013	0.010	30	9	31	29	0	30	24	0.048	0.049	
C-0.1	8:05	30	1.273	0.013	0.010	30	9	31	29	0	30	25	0.048	0.048	0.62 ± 0.01
C-0.1	8:09	0	0.591	0.013	0.022	40	12	42	38	0	40	25	0.104	0.104	
C-0.1	8:19	10	0.737	0.013	0.018	40	12	42	38	0	40	28	0.084	0.077	
C-0.1	8:29	20	0.969	0.013	0.014	40	12	42	38	0	40	27	0.063	0.060	
C-0.1	8:39	30	0.981	0.013	0.013	40	12	42	38	0	40	27	0.063	0.059	
C-0.1	8:44	0	1.094	0.013	0.012	30	4	30.5	29.5	0	30	25	0.056	0.056	
C-0.1	8:54	10	2.171	0.008	0.004	30	4	30.5	29.5	0	30	22	0.017	0.019	
C-0.1	9:04	20	2.491	0.008	0.003	30	4	30.5	29.5	0	30	20	0.015	0.017	
C-0.1	9:14	30	3.093	0.008	0.003	30	4	30.5	29.5	0	30	19	0.012	0.014	
C-0.1	9:27	0	0.938	0.008	0.008	15	9	17	13	0	15	18	0.039	0.048	
C-0.1	9:37	10	1.081	0.008	0.007	15	9	17	13	0	15	18	0.034	0.042	
C-0.1	9:47	20	1.081	0.008	0.007	15	9	17	13	0	15	18	0.034	0.042	
C-0.1	9:57	30	1.055	0.008	0.008	15	9	17	13	0	15	18	0.035	0.043	
C-0.1	10:03	0	1.186	0.013	0.011	20	12	23	17	0	20	18	0.052	0.063	
C-0.1	10:13	10	1.209	0.013	0.011	20	12	23	17	0	20	20	0.051	0.059	
C-0.1	10:23	20	1.124	0.013	0.012	20	12	23	17	0	20	21	0.055	0.061	
C-0.1	10:33	30	1.130	0.013	0.012	20	12	23	17	0	20	22	0.054	0.059	
C-0.1	10:41	0	1.148	0.013	0.012	30	9	32	28	0	30	21	0.054	0.060	
C-0.1	10:51	10	1.624	0.013	0.008	30	9	32	28	0	30	22	0.038	0.041	
C-0.1	11:01	20	1.226	0.008	0.006	30	9	32	28	0	30	22	0.030	0.033	
C-0.1	11:11	30	1.237	0.008	0.006	30	9	32	28	0	30	22	0.030	0.033	0.65 ± 0.05
C-0.1	11:19	0	1.779	0.013	0.007	40	6	41.5	38.5	0	40	21	0.035	0.039	
C-0.1	11:29	10	1.646	0.008	0.005	40	6	41.5	38.5	0	40	21	0.022	0.025	
C-0.1	11:39	20	1.694	0.008	0.005	40	6	41.5	38.5	0	40	21	0.022	0.024	
C-0.1	11:49	30	1.733	0.008	0.005	40	6	41.5	38.5	0	40	21	0.021	0.024	
C-0.1	11:59	0	1.002	0.008	0.008	45	9	47.5	42.5	0	45	21	0.037	0.041	
C-0.1	12:09	10	1.038	0.008	0.008	45	9	47.5	42.5	0	45	23	0.036	0.038	
C-0.1	12:19	20	1.034	0.008	0.008	45	9	47.5	42.5	0	45	24	0.036	0.037	
C-0.1	12:29	30	1.018	0.008	0.008	45	9	47.5	42.5	0	45	25	0.036	0.036	
C-0.1	12:34	0	0.847	0.013	0.016	30	14	33.5	26.5	0	30	25	0.073	0.073	
C-0.1	12:44	10	0.515	0.008	0.015	30	14	33.5	26.5	0	30	27	0.072	0.068	
C-0.1	12:54	20	0.488	0.008	0.016	30	14	33.5	26.5	0	30	28	0.076	0.070	
C-0.1	1:04	30	0.487	0.008	0.016	30	14	33.5	26.5	0	30	29	0.076	0.068	
C-0.1	1:07	0	0.961	0.008	0.008	20	6	21	19	0	20	27	0.038	0.036	
C-0.1	1:17	10	2.353	0.009	0.004	20	6	21	19	0	20	22	0.018	0.020	
C-0.1	1:27	20	2.147	0.008	0.004	20	6	21	19	0	20	20	0.017	0.020	
C-0.1	1:37	30	2.265	0.008	0.003	20	6	21	19	0	20	19	0.016	0.019	
C-0.1	1:45	0	1.316	0.013	0.010	30	9	32	28	0	30	19	0.047	0.056	
C-0.1	1:55	10	1.369	0.008	0.006	30	9	32	28	0	30	20	0.027	0.031	
C-0.1	2:05	20	1.367	0.008	0.006	30	9	32	28	0	30	21	0.027	0.030	
C-0.1	2:15	30	1.754	0.011	0.006	30	9	32	28	0	30	22	0.028	0.031	0.61 ± 0.03

Table F-5. SRS Simulant 4.5 wt% (Pall 0.8 μm).

SRS Surrogate 4.5 wt%															
Pall 0.8 (B)															
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)	Turbidity (NTU)
B-0.8	7:43	0	1.244	0.013	0.011	30	9	31.5	28.5	0	30	18	0.060	0.073	
B-0.8	7:53	10	1.904	0.008	0.004	30	9	31.5	28.5	0	30	16	0.023	0.030	
B-0.8	8:03	20	1.880	0.008	0.004	30	9	31.5	28.5	0	30	15	0.024	0.032	
B-0.8	8:13	30	1.885	0.008	0.004	30	9	31.5	28.5	0	30	16	0.024	0.031	0.35 ± 0.01
B-0.8	8:21	0	0.800	0.008	0.010	40	12	42.5	37.5	0	40	16	0.056	0.072	
B-0.8	8:31	10	0.774	0.008	0.010	40	12	42.5	37.5	0	40	21	0.057	0.064	
B-0.8	8:41	20	0.715	0.008	0.011	40	12	42.5	37.5	0	40	24	0.062	0.064	
B-0.8	8:51	30	0.736	0.008	0.011	40	12	42.5	37.5	0	40	23	0.060	0.064	
B-0.8	8:57	0	1.597	0.008	0.005	30	4	31.5	28.5	0	30	22	0.028	0.030	
B-0.8	9:07	10	3.022	0.008	0.003	30	4	31.5	28.5	0	30	21	0.015	0.017	
B-0.8	9:17	20	3.124	0.008	0.003	30	4	31.5	28.5	0	30	21	0.014	0.016	
B-0.8	9:27	30	3.073	0.008	0.003	30	4	31.5	28.5	0	30	20	0.014	0.017	
B-0.8	9:40	0	1.304	0.008	0.006	15	9	17	13	0	15	20	0.034	0.039	
B-0.8	9:50	10	1.272	0.008	0.006	15	9	17	13	0	15	20	0.035	0.040	
B-0.8	10:00	20	1.494	0.008	0.005	15	9	17	13	0	15	19	0.030	0.035	
B-0.8	10:10	30	1.425	0.008	0.006	15	9	17	13	0	15	19	0.031	0.037	
B-0.8	10:16	0	0.884	0.008	0.009	20	12	22	18	0	20	19	0.050	0.060	
B-0.8	10:26	10	1.238	0.011	0.009	20	12	22	18	0	20	20	0.048	0.055	
B-0.8	10:36	20	0.889	0.008	0.009	20	12	22	18	0	20	20	0.050	0.058	
B-0.8	10:46	30	0.856	0.008	0.009	20	12	22	18	0	20	21	0.052	0.058	
B-0.8	10:53	0	1.200	0.008	0.007	30	9	32	28	0	30	21	0.037	0.042	
B-0.8	11:03	10	1.671	0.008	0.005	30	9	32	28	0	30	21	0.027	0.030	
B-0.8	11:13	20	1.590	0.008	0.005	30	9	32	28	0	30	21	0.028	0.031	
B-0.8	11:23	30	1.704	0.008	0.005	30	9	32	28	0	30	21	0.026	0.029	0.53 ± 0.05
B-0.8	11:35	0	1.701	0.008	0.005	40	6	42	38	0	40	21	0.026	0.029	
B-0.8	11:45	10	2.085	0.008	0.004	40	6	42	38	0	40	21	0.021	0.024	
B-0.8	11:55	20	1.980	0.008	0.004	40	6	42	38	0	40	21	0.022	0.025	
B-0.8	12:05	30	2.434	0.008	0.003	40	6	42	38	0	40	21	0.018	0.021	
B-0.8	12:16	0	1.278	0.008	0.006	45	9	47	43	0	45	22	0.035	0.038	
B-0.8	12:26	10	1.416	0.008	0.006	45	9	47	43	0	45	23	0.031	0.033	
B-0.8	12:36	20	1.516	0.008	0.005	45	9	47	43	0	45	23	0.029	0.031	
B-0.8	12:46	30	1.410	0.008	0.006	45	9	47	43	0	45	23	0.032	0.033	
B-0.8	12:52	0	1.194	0.013	0.011	30	14	33	27	0	30	23	0.062	0.066	
B-0.8	1:02	10	0.724	0.008	0.011	30	14	33	27	0	30	24	0.062	0.063	
B-0.8	1:12	20	0.703	0.008	0.011	30	14	33	27	0	30	24	0.063	0.065	
B-0.8	1:22	30	0.722	0.008	0.011	30	14	33	27	0	30	24	0.062	0.063	
B-0.8	1:31	0	2.021	0.008	0.004	20	6	21	19	0	20	23	0.022	0.023	
B-0.8	1:41	10	2.462	0.008	0.003	20	6	21	19	0	20	22	0.018	0.020	
B-0.8	1:51	20	2.836	0.008	0.003	20	6	21	19	0	20	21	0.016	0.018	
B-0.8	2:01	30	2.898	0.008	0.003	20	6	21	19	0	20	20	0.015	0.018	
B-0.8	2:14	0	1.501	0.008	0.005	30	9	32	28	0	30	21	0.030	0.033	
B-0.8	2:24	10	1.536	0.008	0.005	30	9	32	28	0	30	21	0.029	0.032	
B-0.8	2:34	20	1.542	0.008	0.005	30	9	32	28	0	30	21	0.029	0.032	
B-0.8	2:44	30	1.597	0.008	0.005	30	9	32	28	0	30	21	0.028	0.031	0.36 ± 0.02

Table F-6. SRS Simulant 4.5 wt% (GKN 0.1 μm).

SRS Surrogate 4.5 wt%															
GKN 0.1 (C)															
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)	Turbidity (NTU)
C-0.1	7:18	0	0.917	0.013	0.014	30	9	31	29	0	30	19	0.073	0.087	
C-0.1	7:28	10	1.379	0.013	0.010	30	9	31	29	0	30	19	0.049	0.058	
C-0.1	7:38	20	1.581	0.013	0.008	30	9	31	29	0	30	19	0.043	0.051	
C-0.1	7:48	30	1.700	0.013	0.008	30	9	31	29	0	30	19	0.040	0.047	1.08 ± 0.05
C-0.1	7:56	0	1.149	0.013	0.012	40	12	41.5	38.5	0	40	19	0.059	0.070	
C-0.1	8:06	10	1.396	0.013	0.009	40	12	41.5	38.5	0	40	21	0.048	0.054	
C-0.1	8:16	20	1.798	0.017	0.010	40	12	41.5	38.5	0	40	21	0.049	0.055	
C-0.1	8:26	30	1.379	0.013	0.010	40	12	41.5	38.5	0	40	22	0.049	0.053	
C-0.1	8:37	0	1.855	0.008	0.004	30	4	30.5	29.5	0	30	20	0.022	0.025	
C-0.1	8:47	10	2.665	0.008	0.003	30	4	30.5	29.5	0	30	18	0.015	0.019	
C-0.1	8:57	20	3.703	0.009	0.002	30	4	30.5	29.5	0	30	17	0.013	0.016	
C-0.1	9:07	30	3.391	0.008	0.002	30	4	30.5	29.5	0	30	17	0.012	0.015	
C-0.1	9:23	0	1.496	0.008	0.005	15	9	16	14	0	15	16	0.027	0.035	
C-0.1	9:33	10	1.499	0.008	0.005	15	9	16	14	0	15	16	0.027	0.035	
C-0.1	9:43	20	1.602	0.008	0.005	15	9	16	14	0	15	16	0.025	0.033	
C-0.1	9:53	30	1.589	0.008	0.005	15	9	16	14	0	15	16	0.025	0.033	
C-0.1	10:02	0	1.039	0.008	0.008	20	12	21	19	0	20	17	0.039	0.049	
C-0.1	10:12	10	1.159	0.008	0.007	20	12	21	19	0	20	18	0.035	0.043	
C-0.1	10:22	20	1.197	0.008	0.007	20	12	21	19	0	20	18	0.034	0.041	
C-0.1	10:32	30	1.195	0.008	0.007	20	12	21	19	0	20	19	0.034	0.040	
C-0.1	10:39	0	1.369	0.008	0.006	30	9	31	29	0	30	18	0.030	0.036	
C-0.1	10:49	10	1.512	0.008	0.005	30	9	31	29	0	30	19	0.027	0.032	
C-0.1	10:59	20	1.507	0.008	0.005	30	9	31	29	0	30	19	0.027	0.032	
C-0.1	11:09	30	1.562	0.008	0.005	30	9	31	29	0	30	19	0.026	0.031	1.02 ± 0.03
C-0.1	11:17	0	1.961	0.008	0.004	40	6	41	39	0	40	18	0.021	0.025	
C-0.1	11:27	10	2.497	0.008	0.003	40	6	41	39	0	40	18	0.016	0.020	
C-0.1	11:37	20	2.567	0.008	0.003	40	6	41	39	0	40	18	0.016	0.019	
C-0.1	11:47	30	2.627	0.008	0.003	40	6	41	39	0	40	18	0.015	0.019	
C-0.1	11:57	0	1.468	0.008	0.005	45	9	46	44	0	45	19	0.028	0.033	
C-0.1	12:07	10	1.548	0.008	0.005	45	9	46	44	0	45	20	0.026	0.030	
C-0.1	12:17	20	1.587	0.008	0.005	45	9	46	44	0	45	21	0.025	0.029	
C-0.1	12:27	30	1.591	0.008	0.005	45	9	46	44	0	45	21	0.025	0.028	
C-0.1	12:35	0	0.855	0.008	0.009	30	14	31	29	0	30	21	0.047	0.053	
C-0.1	12:45	10	0.864	0.008	0.009	30	14	31	29	0	30	22	0.047	0.051	
C-0.1	12:55	20	0.882	0.008	0.009	30	14	31	29	0	30	22	0.046	0.050	
C-0.1	1:05	30	0.877	0.008	0.009	30	14	31	29	0	30	22	0.046	0.050	
C-0.1	1:13	0	2.358	0.008	0.003	20	6	19.5	20.5	0	20	20	0.017	0.020	
C-0.1	1:23	10	2.024	0.005	0.003	20	6	19.5	20.5	0	20	18	0.013	0.016	
C-0.1	1:33	20	1.993	0.005	0.003	20	6	19.5	20.5	0	20	17	0.014	0.017	
C-0.1	1:43	30	2.621	0.005	0.002	20	6	19.5	20.5	0	20	17	0.010	0.013	
C-0.1	1:57	0	1.854	0.008	0.004	30	9	31	29	0	30	18	0.022	0.027	
C-0.1	2:07	10	2.008	0.008	0.004	30	9	31	29	0	30	18	0.020	0.025	
C-0.1	2:17	20	2.017	0.008	0.004	30	9	31	29	0	30	19	0.020	0.024	
C-0.1	2:27	30	1.929	0.008	0.004	30	9	31	29	0	30	19	0.021	0.025	1.04 ± 0.02

Appendix G

SRS Simulant 4.5 wt%

Repeat

Appendix G
SRS Simulant 4.5 wt%
Repeat

Table G-1. SRS Simulant 4.5 wt% Repeat (GKN 0.1 μm).

Repeat														
SRS Surrogate 4.5 wt%														
GKN 0.1 (C)														
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
B-0.1	7:08	0	1.024	0.013	0.013	30	9	31	29	0	30	20	0.066	0.076
B-0.1	7:18	10	1.232	0.013	0.011	30	9	31	29	0	30	23	0.055	0.058
B-0.1	7:28	20	1.174	0.013	0.011	30	9	31	29	0	30	25	0.057	0.057
B-0.1	7:38	30	1.164	0.013	0.011	30	9	31	29	0	30	26	0.058	0.056
B-0.1	7:44	0	0.781	0.013	0.017	40	12	41.5	38.5	0	40	27	0.086	0.082
B-0.1	7:54	10	0.896	0.013	0.015	40	12	41.5	38.5	0	40	29	0.075	0.067
B-0.1	8:04	20	0.883	0.013	0.015	40	12	41.5	38.5	0	40	30	0.076	0.066
B-0.1	8:14	30	0.896	0.013	0.015	40	12	41.5	38.5	0	40	30	0.075	0.065
B-0.1	8:20	0	2.082	0.013	0.006	30	4	30	30	0	30	27	0.032	0.031
B-0.1	8:30	10	2.535	0.008	0.003	30	4	30	30	0	30	23	0.016	0.017
B-0.1	8:40	20	2.702	0.008	0.003	30	4	30	30	0	30	21	0.015	0.017
B-0.1	8:50	30	2.818	0.008	0.003	30	4	30	30	0	30	20	0.014	0.017
B-0.1	9:01	0	1.937	0.013	0.007	15	9	16	14	0	15	19	0.035	0.041
B-0.1	9:11	10	2.471	0.013	0.005	15	9	16	14	0	15	19	0.027	0.032
B-0.1	9:21	20	2.388	0.013	0.006	15	9	16	14	0	15	19	0.028	0.033
B-0.1	9:31	30	2.464	0.013	0.005	15	9	16	14	0	15	18	0.027	0.033
B-0.1	9:41	0	1.429	0.013	0.009	20	12	21.5	18.5	0	20	19	0.047	0.056
B-0.1	9:51	10	1.610	0.013	0.008	20	12	21.5	18.5	0	20	20	0.042	0.048
B-0.1	10:01	20	1.630	0.013	0.008	20	12	21.5	18.5	0	20	20	0.041	0.048
B-0.1	10:11	30	1.631	0.013	0.008	20	12	21.5	18.5	0	20	20	0.041	0.048
B-0.1	10:19	0	1.960	0.013	0.007	30	9	31	29	0	30	20	0.035	0.040
B-0.1	10:29	10	2.088	0.013	0.006	30	9	31	29	0	30	20	0.032	0.037
B-0.1	10:39	20	2.126	0.013	0.006	30	9	31	29	0	30	20	0.032	0.037
B-0.1	10:49	30	2.285	0.013	0.006	30	9	31	29	0	30	20	0.029	0.034
B-0.1	10:58	0	1.630	0.008	0.005	40	6	40.5	39.5	0	40	20	0.025	0.029
B-0.1	11:08	10	2.186	0.008	0.004	40	6	40.5	39.5	0	40	20	0.018	0.021
B-0.1	11:18	20	2.215	0.008	0.004	40	6	40.5	39.5	0	40	20	0.018	0.021
B-0.1	11:28	30	2.237	0.008	0.004	40	6	40.5	39.5	0	40	20	0.018	0.021
B-0.1	11:40	0	2.086	0.013	0.006	45	9	46	44	0	45	21	0.032	0.036
B-0.1	11:50	10	2.212	0.013	0.006	45	9	46	44	0	45	22	0.030	0.033
B-0.1	12:00	20	2.192	0.013	0.006	45	9	46	44	0	45	22	0.031	0.033
B-0.1	12:10	30	2.256	0.013	0.006	45	9	46	44	0	45	22	0.030	0.032
B-0.1	12:19	0	1.147	0.013	0.012	30	14	32	28	0	30	23	0.059	0.062
B-0.1	12:29	10	1.243	0.013	0.011	30	14	32	28	0	30	23	0.054	0.057
B-0.1	12:39	20	1.219	0.013	0.011	30	14	32	28	0	30	24	0.055	0.057
B-0.1	12:49	30	1.241	0.013	0.011	30	14	32	28	0	30	24	0.054	0.056
B-0.1	12:55	0	2.021	0.008	0.004	20	6	20.5	19.5	0	20	22	0.020	0.022
B-0.1	1:05	10	2.520	0.008	0.003	20	6	20.5	19.5	0	20	20	0.016	0.018
B-0.1	1:15	20	3.609	0.011	0.003	20	6	20.5	19.5	0	20	19	0.015	0.018
B-0.1	1:25	30	2.774	0.008	0.003	20	6	20.5	19.5	0	20	18	0.015	0.018
B-0.1	1:38	0	1.546	0.008	0.005	30	9	31	29	0	30	19	0.026	0.031
B-0.1	1:48	10	1.735	0.008	0.005	30	9	31	29	0	30	20	0.023	0.027
B-0.1	1:58	20	1.751	0.008	0.005	30	9	31	29	0	30	20	0.023	0.027
B-0.1	2:08	30	1.844	0.008	0.004	30	9	31	29	0	30	20	0.022	0.025

Table G-2. SRS Simulant 4.5 wt% Repeat (Mott 0.5 μm).

Repeat														
SRS Surrogate 4.5 wt%														
Mott 0.5 (B)														
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 25 C)
B-0.5	7:21	0	1.192	0.013	0.011	30	9	30	30	0	30	20	0.056	0.065
B-0.5	7:31	10	1.753	0.013	0.008	30	9	30	30	0	30	21	0.038	0.043
B-0.5	7:41	20	1.527	0.013	0.009	30	9	30	30	0	30	22	0.044	0.048
B-0.5	7:51	30	1.703	0.013	0.008	30	9	30	30	0	30	22	0.040	0.043
B-0.5	7:58	0	1.043	0.013	0.013	40	12	41	39	0	40	22	0.065	0.070
B-0.5	8:08	10	1.729	0.017	0.010	40	12	41	39	0	40	23	0.051	0.054
B-0.5	8:18	20	1.523	0.013	0.009	40	12	41	39	0	40	24	0.044	0.045
B-0.5	8:28	30	1.508	0.013	0.009	40	12	41	39	0	40	24	0.045	0.046
B-0.5	8:37	0	1.853	0.008	0.004	30	4	30	30	0	30	23	0.022	0.023
B-0.5	8:47	10	2.547	0.008	0.003	30	4	30	30	0	30	21	0.016	0.018
B-0.5	8:57	20	3.045	0.008	0.003	30	4	30	30	0	30	20	0.013	0.015
B-0.5	9:07	30	3.103	0.008	0.003	30	4	30	30	0	30	20	0.013	0.015
B-0.5	9:21	0	2.081	0.013	0.006	15	9	15	15	0	15	19	0.032	0.038
B-0.5	9:31	10	2.315	0.013	0.006	15	9	15	15	0	15	19	0.029	0.035
B-0.5	9:41	20	1.475	0.008	0.005	15	9	15	15	0	15	18	0.027	0.033
B-0.5	9:51	30	1.400	0.008	0.006	15	9	15	15	0	15	18	0.029	0.035
B-0.5	9:59	0	1.689	0.013	0.008	20	12	20.5	19.5	0	20	19	0.042	0.050
B-0.5	10:09	10	1.154	0.008	0.007	20	12	20.5	19.5	0	20	19	0.035	0.042
B-0.5	10:19	20	1.152	0.008	0.007	20	12	20.5	19.5	0	20	20	0.035	0.040
B-0.5	10:29	30	1.076	0.008	0.007	20	12	20.5	19.5	0	20	20	0.038	0.043
B-0.5	10:35	0	1.319	0.008	0.006	30	9	30	30	0	30	20	0.031	0.035
B-0.5	10:45	10	1.356	0.008	0.006	30	9	30	30	0	30	20	0.030	0.034
B-0.5	10:55	20	1.447	0.008	0.005	30	9	30	30	0	30	19	0.028	0.033
B-0.5	11:05	30	1.459	0.008	0.005	30	9	30	30	0	30	19	0.028	0.033
B-0.5	11:11	0	1.750	0.008	0.005	40	6	40.5	39.5	0	40	19	0.023	0.027
B-0.5	11:21	10	2.521	0.009	0.004	40	6	40.5	39.5	0	40	19	0.019	0.022
B-0.5	11:31	20	2.466	0.008	0.003	40	6	40.5	39.5	0	40	19	0.016	0.019
B-0.5	11:41	30	2.477	0.008	0.003	40	6	40.5	39.5	0	40	19	0.016	0.019
B-0.5	11:50	0	1.337	0.008	0.006	45	9	45.5	44.5	0	45	20	0.030	0.035
B-0.5	12:00	10	1.487	0.008	0.005	45	9	45.5	44.5	0	45	21	0.027	0.030
B-0.5	12:10	20	1.497	0.008	0.005	45	9	45.5	44.5	0	45	22	0.027	0.029
B-0.5	12:20	30	1.484	0.008	0.005	45	9	45.5	44.5	0	45	22	0.027	0.030
B-0.5	12:26	0	0.780	0.008	0.010	30	14	31	29	0	30	22	0.052	0.056
B-0.5	12:36	10	0.845	0.008	0.009	30	14	31	29	0	30	23	0.048	0.051
B-0.5	12:45	20	0.789	0.008	0.010	30	14	31	29	0	30	23	0.051	0.054
B-0.5	12:55	30	0.831	0.008	0.010	30	14	31	29	0	30	24	0.049	0.050
B-0.5	1:03	0	2.175	0.008	0.004	20	6	20	20	0	20	22	0.019	0.020
B-0.5	1:13	10	3.279	0.009	0.003	20	6	20	20	0	20	20	0.014	0.017
B-0.5	1:23	20	4.552	0.012	0.003	20	6	20	20	0	20	19	0.013	0.016
B-0.5	1:33	30	2.920	0.008	0.003	20	6	20	20	0	20	18	0.014	0.017
B-0.5	1:44	0	1.615	0.008	0.005	30	9	30	30	0	30	19	0.025	0.030
B-0.5	1:54	10	1.704	0.008	0.005	30	9	30	30	0	30	19	0.024	0.028
B-0.5	2:04	20	1.720	0.008	0.005	30	9	30	30	0	30	20	0.023	0.027
B-0.5	2:14	30	1.726	0.008	0.005	30	9	30	30	0	30	20	0.023	0.027

Table G-3. SRS Simulant 4.5 wt% Repeat (Graver 0.07 μm).

Repeat SRS Surrogate 4.5 wt% Graver 0.07 (B)														
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 35 C)
B-0.07	7:44	0	0.463	0.013	0.029	30	9	31.5	28.5	0	30	30	0.145	0.166
B-0.07	7:54	10	0.767	0.013	0.017	30	9	31.5	28.5	0	30	34	0.088	0.090
B-0.07	8:04	20	0.856	0.013	0.015	30	9	31.5	28.5	0	30	36	0.079	0.077
B-0.07	8:14	30	0.885	0.013	0.015	30	9	31.5	28.5	0	30	35	0.076	0.076
B-0.07	8:17	0	0.665	0.013	0.020	30	9	31.5	28.5	0	30	35	0.101	0.101
B-0.07	8:27	10	0.866	0.013	0.015	30	9	31.5	28.5	0	30	35	0.078	0.078
B-0.07	8:37	20	0.865	0.013	0.015	30	9	31.5	28.5	0	30	35	0.078	0.078
B-0.07	8:47	30	0.869	0.013	0.015	30	9	31.5	28.5	0	30	35	0.077	0.077
B-0.07	8:52	0	0.561	0.013	0.024	40	12	42	38	0	40	35	0.120	0.120
B-0.07	9:02	10	0.684	0.013	0.019	40	12	42	38	0	40	36	0.098	0.096
B-0.07	9:12	20	0.681	0.013	0.019	40	12	42	38	0	40	37	0.099	0.094
B-0.07	9:22	30	0.674	0.013	0.020	40	12	42	38	0	40	37	0.100	0.095
B-0.07	9:25	0	1.172	0.013	0.011	30	4	30.5	29.5	0	30	36	0.057	0.056
B-0.07	9:35	10	1.618	0.008	0.005	30	4	30.5	29.5	0	30	33	0.025	0.026
B-0.07	9:45	20	1.667	0.008	0.005	30	4	30.5	29.5	0	30	33	0.024	0.026
B-0.07	9:55	30	1.611	0.008	0.005	30	4	30.5	29.5	0	30	33	0.025	0.026
B-0.07	10:01	0	0.998	0.013	0.013	15	9	16.5	13.5	0	15	33	0.067	0.071
B-0.07	10:11	10	1.612	0.013	0.008	15	9	16.5	13.5	0	15	33	0.042	0.044
B-0.07	10:21	20	1.583	0.013	0.008	15	9	16.5	13.5	0	15	33	0.043	0.045
B-0.07	10:31	30	1.537	0.013	0.009	15	9	16.5	13.5	0	15	34	0.044	0.045
B-0.07	10:36	0	0.667	0.013	0.020	20	12	22.5	17.5	0	20	34	0.101	0.104
B-0.07	10:46	10	0.856	0.013	0.015	20	12	22.5	17.5	0	20	36	0.079	0.077
B-0.07	10:56	20	0.806	0.013	0.016	20	12	22.5	17.5	0	20	37	0.083	0.079
B-0.07	11:06	30	0.806	0.013	0.016	20	12	22.5	17.5	0	20	35	0.084	0.084
B-0.07	11:10	0	0.888	0.013	0.015	30	9	31.5	28.5	0	30	35	0.076	0.076
B-0.07	11:20	10	1.105	0.013	0.012	30	9	31.5	28.5	0	30	34	0.061	0.063
B-0.07	11:30	20	1.123	0.013	0.012	30	9	31.5	28.5	0	30	34	0.060	0.062
B-0.07	11:40	30	1.133	0.013	0.012	30	9	31.5	28.5	0	30	34	0.059	0.061
B-0.07	11:45	0	1.079	0.013	0.012	40	6	41	39	0	40	33	0.062	0.066
B-0.07	11:55	10	1.162	0.013	0.011	40	6	41	39	0	40	35	0.058	0.058
B-0.07	12:05	20	1.288	0.008	0.006	40	6	41	39	0	40	35	0.031	0.031
B-0.07	12:15	30	1.276	0.008	0.006	40	6	41	39	0	40	36	0.032	0.031
B-0.07	12:21	0	0.843	0.013	0.016	45	9	47	43	0	45	36	0.080	0.078
B-0.07	12:31	10	1.270	0.013	0.010	45	9	47	43	0	45	38	0.053	0.049
B-0.07	12:41	20	1.273	0.013	0.010	45	9	47	43	0	45	37	0.053	0.050
B-0.07	12:51	30	1.276	0.013	0.010	45	9	47	43	0	45	36	0.053	0.051
B-0.07	12:56	0	0.602	0.013	0.022	30	14	33	27	0	30	36	0.112	0.109
B-0.07	1:06	10	0.673	0.013	0.020	30	14	33	27	0	30	36	0.100	0.097
B-0.07	1:16	20	0.663	0.013	0.020	30	14	33	27	0	30	37	0.101	0.096
B-0.07	1:26	30	0.641	0.013	0.021	30	14	33	27	0	30	37	0.105	0.100
B-0.07	1:30	0	0.783	0.008	0.010	20	6	21	19	0	20	36	0.052	0.050
B-0.07	1:40	10	1.092	0.008	0.007	20	6	21	19	0	20	35	0.037	0.037
B-0.07	1:50	20	1.115	0.008	0.007	20	6	21	19	0	20	35	0.036	0.036
B-0.07	2:00	30	1.245	0.008	0.006	20	6	21	19	0	20	34	0.032	0.033
B-0.07	2:06	0	1.032	0.013	0.013	30	9	31.5	28.5	0	30	34	0.065	0.067
B-0.07	2:16	10	1.311	0.013	0.010	30	9	31.5	28.5	0	30	36	0.051	0.050
B-0.07	2:26	20	1.290	0.013	0.010	30	9	31.5	28.5	0	30	36	0.052	0.051
B-0.07	2:36	30	1.263	0.013	0.010	30	9	31.5	28.5	0	30	36	0.053	0.052

Table G-4. SRS Simulant 4.5 wt% Repeat (Mott 0.1 μm).

Repeat SRS Surrogate 4.5 wt% Mott 0.1 (B)														
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 35 C)
B-0.1	7:50	0	0.72	0.013	0.018	30	9	30	30	0	30	30	0.094	0.108
B-0.1	8:00	10	0.95	0.013	0.014	30	9	30	30	0	30	32	0.071	0.077
B-0.1	8:10	20	0.90	0.013	0.015	30	9	30	30	0	30	34	0.075	0.077
B-0.1	8:20	30	0.92	0.013	0.014	30	9	30	30	0	30	35	0.073	0.073
B-0.1	8:25	0	0.88	0.013	0.015	30	9	30	30	0	30	35	0.076	0.076
B-0.1	8:35	10	1.01	0.013	0.013	30	9	30	30	0	30	35	0.067	0.067
B-0.1	8:45	20	0.99	0.013	0.013	30	9	30	30	0	30	35	0.068	0.068
B-0.1	8:55	30	1.01	0.013	0.013	30	9	30	30	0	30	36	0.067	0.065
B-0.1	9:00	0	0.66	0.013	0.020	40	12	39.5	40.5	0	40	36	0.101	0.099
B-0.1	9:10	10	0.71	0.013	0.019	40	12	39.5	40.5	0	40	37	0.096	0.090
B-0.1	9:20	20	0.92	0.013	0.014	40	12	39.5	40.5	0	40	36	0.074	0.072
B-0.1	9:30	30	0.94	0.013	0.014	40	12	39.5	40.5	0	40	36	0.072	0.070
B-0.1	9:36	0	2.16	0.013	0.006	30	4	29.5	30.5	0	30	34	0.031	0.032
B-0.1	9:46	10	3.51	0.011	0.003	30	4	29.5	30.5	0	30	33	0.015	0.016
B-0.1	9:56	20	2.69	0.008	0.003	30	4	29.5	30.5	0	30	33	0.015	0.016
B-0.1	10:06	30	2.64	0.008	0.003	30	4	29.5	30.5	0	30	33	0.015	0.016
B-0.1	10:16	0	1.23	0.013	0.011	15	9	15	15	0	15	34	0.055	0.056
B-0.1	10:26	10	0.78	0.008	0.010	15	9	15	15	0	15	34	0.052	0.053
B-0.1	10:36	20	1.34	0.013	0.010	15	9	15	15	0	15	34	0.050	0.052
B-0.1	10:46	30	0.80	0.008	0.010	15	9	15	15	0	15	35	0.050	0.050
B-0.1	10:52	0	0.79	0.013	0.017	20	12	19.5	20.5	0	20	35	0.085	0.085
B-0.1	11:02	10	0.52	0.008	0.015	20	12	19.5	20.5	0	20	35	0.077	0.077
B-0.1	11:12	20	0.54	0.008	0.015	20	12	19.5	20.5	0	20	35	0.075	0.075
B-0.1	11:22	30	0.93	0.013	0.014	20	12	19.5	20.5	0	20	35	0.073	0.073
B-0.1	11:28	0	0.68	0.008	0.012	30	9	30	30	0	30	35	0.059	0.059
B-0.1	11:38	10	0.78	0.008	0.010	30	9	30	30	0	30	35	0.052	0.052
B-0.1	11:48	20	0.80	0.008	0.010	30	9	30	30	0	30	35	0.050	0.050
B-0.1	11:58	30	0.81	0.008	0.010	30	9	30	30	0	30	35	0.050	0.050
B-0.1	12:06	0	1.02	0.008	0.008	40	6	40	40	0	40	35	0.040	0.040
B-0.1	12:16	10	1.26	0.008	0.006	40	6	40	40	0	40	34	0.032	0.033
B-0.1	12:26	20	1.27	0.008	0.006	40	6	40	40	0	40	34	0.032	0.033
B-0.1	12:36	30	1.31	0.008	0.006	40	6	40	40	0	40	34	0.031	0.032
B-0.1	12:43	0	0.76	0.008	0.010	45	9	45	45	0	45	33	0.053	0.056
B-0.1	12:53	10	0.94	0.008	0.008	45	9	45	45	0	45	34	0.043	0.044
B-0.1	1:03	20	0.94	0.008	0.008	45	9	45	45	0	45	34	0.043	0.044
B-0.1	1:13	30	0.86	0.008	0.009	45	9	45	45	0	45	34	0.047	0.048
B-0.1	1:18	0	0.44	0.008	0.018	30	14	29	31	0	30	34	0.092	0.094
B-0.1	1:28	10	0.45	0.008	0.018	30	14	29	31	0	30	35	0.090	0.090
B-0.1	1:38	20	0.47	0.008	0.017	30	14	29	31	0	30	35	0.087	0.087
B-0.1	1:48	30	0.46	0.008	0.017	30	14	29	31	0	30	36	0.088	0.085
B-0.1	1:55	0	1.30	0.008	0.006	20	6	19.5	20.5	0	20	34	0.031	0.032
B-0.1	2:05	10	1.52	0.008	0.005	20	6	19.5	20.5	0	20	33	0.027	0.028
B-0.1	2:15	20	1.56	0.008	0.005	20	6	19.5	20.5	0	20	33	0.026	0.027
B-0.1	2:25	30	1.56	0.008	0.005	20	6	19.5	20.5	0	20	33	0.026	0.027
B-0.1	2:33	0	0.83	0.008	0.010	30	9	30	30	0	30	33	0.048	0.051
B-0.1	2:43	10	0.83	0.008	0.010	30	9	30	30	0	30	34	0.049	0.050
B-0.1	2:53	20	0.82	0.008	0.010	30	9	30	30	0	30	35	0.049	0.049
B-0.1	3:03	30	0.84	0.008	0.009	30	9	30	30	0	30	35	0.048	0.048

Table G-5. SRS Simulant 4.5 wt% Repeat (Pall 0.1 μm).

Repeat SRS Surrogate 4.5 wt% Pall 0.1 (C)															
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 35 C)
C-0.1	8:05	0	0.486	0.013	0.027	30	9	31.5	28.5	0	30	30	0.127	0.145
C-0.1	8:15	10	0.676	0.013	0.020	30	9	31.5	28.5	0	30	34	0.091	0.094
C-0.1	8:25	20	0.640	0.013	0.021	30	9	31.5	28.5	0	30	37	0.096	0.091
C-0.1	8:35	30	0.709	0.013	0.019	30	9	31.5	28.5	0	30	36	0.087	0.085
C-0.1	8:40	0	0.604	0.013	0.022	30	9	31.5	28.5	0	30	35	0.102	0.102
C-0.1	8:50	10	0.745	0.013	0.018	30	9	31.5	28.5	0	30	35	0.083	0.083
C-0.1	9:00	20	0.764	0.013	0.017	30	9	31.5	28.5	0	30	35	0.081	0.081
C-0.1	9:10	30	0.764	0.013	0.017	30	9	31.5	28.5	0	30	35	0.081	0.081
C-0.1	9:13	0	0.492	0.013	0.027	40	12	43	37	0	40	35	0.125	0.125
C-0.1	9:23	10	0.589	0.013	0.022	40	12	43	37	0	40	36	0.105	0.102
C-0.1	9:33	20	0.578	0.013	0.023	40	12	43	37	0	40	36	0.107	0.104
C-0.1	9:43	30	0.595	0.013	0.022	40	12	43	37	0	40	35	0.104	0.104
C-0.1	9:48	0	1.495	0.013	0.009	30	4	30.5	29.5	0	30	34	0.041	0.042
C-0.1	9:58	10	1.503	0.008	0.005	30	4	30.5	29.5	0	30	34	0.025	0.025
C-0.1	10:08	20	1.472	0.008	0.005	30	4	30.5	29.5	0	30	34	0.025	0.026
C-0.1	10:18	30	1.481	0.008	0.005	30	4	30.5	29.5	0	30	34	0.025	0.026
C-0.1	10:24	0	0.821	0.013	0.016	15	9	17	13	0	15	35	0.075	0.075
C-0.1	10:34	10	0.850	0.013	0.016	15	9	17	13	0	15	36	0.072	0.071
C-0.1	10:44	20	0.855	0.013	0.015	15	9	17	13	0	15	36	0.072	0.070
C-0.1	10:54	30	0.871	0.013	0.015	15	9	17	13	0	15	35	0.071	0.071
C-0.1	11:01	0	0.543	0.013	0.024	20	12	23	17	0	20	35	0.113	0.113
C-0.1	11:11	10	0.618	0.013	0.021	20	12	23	17	0	20	35	0.100	0.100
C-0.1	11:21	20	0.601	0.013	0.022	20	12	23	17	0	20	35	0.102	0.102
C-0.1	11:31	30	0.592	0.013	0.022	20	12	23	17	0	20	35	0.104	0.104
C-0.1	11:35	0	0.826	0.013	0.016	30	9	32	28	0	30	35	0.074	0.074
C-0.1	11:45	10	0.889	0.013	0.015	30	9	32	28	0	30	36	0.069	0.067
C-0.1	11:55	20	1.082	0.013	0.012	30	9	32	28	0	30	35	0.057	0.057
C-0.1	12:05	30	1.102	0.013	0.012	30	9	32	28	0	30	35	0.056	0.056
C-0.1	12:11	0	1.193	0.013	0.011	40	6	41	39	0	40	34	0.052	0.053
C-0.1	12:21	10	1.002	0.008	0.008	40	6	41	39	0	40	35	0.037	0.037
C-0.1	12:31	20	1.018	0.008	0.008	40	6	41	39	0	40	36	0.036	0.035
C-0.1	12:41	30	1.029	0.008	0.008	40	6	41	39	0	40	35	0.036	0.036
C-0.1	12:47	0	0.862	0.013	0.015	45	9	47	43	0	45	35	0.071	0.071
C-0.1	12:57	10	1.060	0.015	0.014	45	9	47	43	0	45	36	0.064	0.062
C-0.1	1:07	20	0.988	0.013	0.013	45	9	47	43	0	45	36	0.062	0.061
C-0.1	1:17	30	0.963	0.013	0.014	45	9	47	43	0	45	37	0.064	0.061
C-0.1	1:21	0	0.530	0.013	0.025	30	13.6	34	26	0	30	36	0.116	0.113
C-0.1	1:31	10	0.610	0.013	0.022	30	13	34	26	0	30	35	0.101	0.101
C-0.1	1:41	20	0.635	0.013	0.021	30	13	34	26	0	30	33	0.097	0.102
C-0.1	1:51	30	0.627	0.013	0.021	30	13	34	26	0	30	35	0.098	0.098
C-0.1	1:57	0	0.840	0.008	0.009	20	6	21.5	18.5	0	20	34	0.044	0.045
C-0.1	2:07	10	0.974	0.008	0.008	20	6	21.5	18.5	0	20	34	0.038	0.039
C-0.1	2:17	20	0.958	0.008	0.008	20	6	21.5	18.5	0	20	34	0.039	0.040
C-0.1	2:27	30	0.966	0.008	0.008	20	6	21.5	18.5	0	20	34	0.038	0.039
C-0.1	2:31	0	0.914	0.013	0.014	30	9	32	28	0	30	35	0.067	0.067
C-0.1	2:41	10	0.957	0.013	0.014	30	9	32	28	0	30	37	0.064	0.061
C-0.1	2:51	20	0.976	0.013	0.014	30	9	32	28	0	30	36	0.063	0.061
C-0.1	3:01	30	0.987	0.013	0.013	30	9	32	28	0	30	36	0.062	0.061

Appendix H

SRS Simulant 0.06 wt%

Appendix H

SRS Simulant 0.06 wt%

Table H-1. SRS Simulant 0.06 wt% (Graver 0.07 μm).

Repeat															
SRS Surrogate 0.06 wt%															
Graver 0.07 (B)															
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 35 C)
B-0.07	7:31	0	0.345	0.013	0.038	30	9	31.5	28.5	0	30	30	0.195	0.223
B-0.07	7:41	10	0.407	0.013	0.032	30	9	31.5	28.5	0	30	34	0.165	0.170
B-0.07	7:51	20	0.439	0.013	0.030	30	9	31.5	28.5	0	30	36	0.153	0.149
B-0.07	8:01	30	0.469	0.013	0.028	30	9	31.5	28.5	0	30	36	0.144	0.140
B-0.07	8:04	0	0.301	0.013	0.044	30	9	31.5	28.5	0	30	35	0.224	0.224
B-0.07	8:14	10	0.472	0.013	0.028	30	9	31.5	28.5	0	30	35	0.143	0.143
B-0.07	8:24	20	0.498	0.013	0.027	30	9	31.5	28.5	0	30	34	0.136	0.139
B-0.07	8:34	30	0.541	0.013	0.024	30	9	31.5	28.5	0	30	34	0.124	0.128
B-0.07	8:37	0	0.235	0.013	0.056	40	12	42.5	37.5	0	40	34	0.286	0.294
B-0.07	8:47	10	0.359	0.013	0.037	40	12	42.5	37.5	0	40	36	0.187	0.182
B-0.07	8:57	20	0.409	0.013	0.032	40	12	42.5	37.5	0	40	37	0.165	0.156
B-0.07	9:07	30	0.456	0.013	0.029	40	12	42.5	37.5	0	40	38	0.148	0.137
B-0.07	9:10	0	0.312	0.013	0.042	30	4	30.5	29.5	0	30	37	0.215	0.204
B-0.07	9:20	10	0.473	0.013	0.028	30	4	30.5	29.5	0	30	35	0.142	0.142
B-0.07	9:30	20	0.578	0.013	0.023	30	4	30.5	29.5	0	30	35	0.117	0.117
B-0.07	9:40	30	0.626	0.013	0.021	30	4	30.5	29.5	0	30	35	0.108	0.108
B-0.07	9:44	0	0.688	0.013	0.022	15	9	17	13	0	15	35	0.115	0.115
B-0.07	9:54	10	0.698	0.013	0.022	15	9	17	13	0	15	35	0.113	0.113
B-0.07	10:04	20	0.671	0.013	0.020	15	9	17	13	0	15	35	0.100	0.100
B-0.07	10:14	30	0.710	0.013	0.019	15	9	17	13	0	15	35	0.095	0.095
B-0.07	10:17	0	0.436	0.013	0.030	20	12	22	18	0	20	35	0.154	0.154
B-0.07	10:27	10	0.481	0.013	0.027	20	12	22	18	0	20	35	0.140	0.140
B-0.07	10:37	20	0.548	0.013	0.024	20	12	22	18	0	20	36	0.123	0.120
B-0.07	10:47	30	0.598	0.013	0.022	20	12	22	18	0	20	35	0.112	0.112
B-0.07	10:51	0	0.319	0.013	0.041	30	9	31.5	28.5	0	30	35	0.211	0.211
B-0.07	11:01	10	0.487	0.013	0.027	30	9	31.5	28.5	0	30	34	0.138	0.142
B-0.07	11:11	20	0.530	0.013	0.025	30	9	31.5	28.5	0	30	35	0.127	0.127
B-0.07	11:21	30	0.584	0.013	0.023	30	9	31.5	28.5	0	30	35	0.115	0.115
B-0.07	11:24	0	0.248	0.013	0.053	40	6	41	39	0	40	35	0.271	0.271
B-0.07	11:34	10	0.439	0.013	0.030	40	6	41	39	0	40	36	0.153	0.149
B-0.07	11:44	20	0.533	0.013	0.025	40	6	41	39	0	40	36	0.126	0.123
B-0.07	11:54	30	0.667	0.015	0.022	40	6	41	39	0	40	35	0.111	0.111
B-0.07	11:57	0	0.216	0.013	0.061	45	9	47	43	0	45	35	0.311	0.311
B-0.07	12:07	10	0.450	0.013	0.029	45	9	47	43	0	45	35	0.150	0.150
B-0.07	12:17	20	0.522	0.013	0.025	45	9	47	43	0	45	35	0.129	0.129
B-0.07	12:27	30	0.575	0.013	0.023	45	9	47	43	0	45	35	0.117	0.117
B-0.07	12:31	0	0.312	0.013	0.042	30	14	33	27	0	30	35	0.215	0.215
B-0.07	12:41	10	0.452	0.013	0.029	30	14	33	27	0	30	36	0.149	0.145
B-0.07	12:51	20	0.528	0.013	0.025	30	14	33	27	0	30	36	0.127	0.124
B-0.07	1:01	30	0.573	0.013	0.023	30	14	33	27	0	30	37	0.118	0.112
B-0.07	1:05	0	0.454	0.013	0.029	20	6	21	19	0	20	36	0.148	0.144
B-0.07	1:15	10	0.609	0.013	0.022	20	6	21	19	0	20	33	0.111	0.117
B-0.07	1:25	20	0.768	0.013	0.017	20	6	21	19	0	20	34	0.088	0.090
B-0.07	1:35	30	0.828	0.013	0.016	20	6	21	19	0	20	35	0.081	0.081
B-0.07	1:40	0	0.346	0.013	0.038	30	9	31.5	28.5	0	30	35	0.196	0.195
B-0.07	1:50	10	0.515	0.013	0.026	30	9	31.5	28.5	0	30	36	0.131	0.127
B-0.07	2:00	20	0.589	0.013	0.022	30	9	31.5	28.5	0	30	36	0.114	0.111
B-0.07	2:10	30	0.638	0.013	0.021	30	9	31.5	28.5	0	30	36	0.106	0.103

Table H-2. SRS Simulant 0.06 wt% (Mott 0.1 μm).

Repeat															
SRS Simulant 0.06 wt%															
Mott 0.1 (B)															
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp C	Filtrate Flux (gpm/ft²)	Temp Adjusted Flux (Adjusted to 35 C)
B-0.1	7:34	0	0.201	0.013	0.066	30	9	30	30	0	30	30	0.335	0.383
B-0.1	7:44	10	0.422	0.013	0.031	30	9	30	30	0	30	33	0.160	0.168
B-0.1	7:54	20	0.471	0.013	0.028	30	9	30	30	0	30	35	0.143	0.143
B-0.1	8:04	30	0.505	0.013	0.026	30	9	30	30	0	30	36	0.133	0.130
B-0.1	8:07	0	0.184	0.013	0.072	30	9	30	30	0	30	36	0.366	0.357
B-0.1	8:17	10	0.444	0.013	0.030	30	9	30	30	0	30	36	0.152	0.148
B-0.1	8:27	20	0.549	0.013	0.024	30	9	30	30	0	30	35	0.123	0.123
B-0.1	8:37	30	0.587	0.013	0.023	30	9	30	30	0	30	35	0.115	0.115
B-0.1	8:41	0	0.199	0.013	0.067	40	12	40	40	0	40	35	0.339	0.339
B-0.1	8:51	10	0.428	0.013	0.031	40	12	40	40	0	40	37	0.157	0.149
B-0.1	9:01	20	0.508	0.013	0.026	40	12	40	40	0	40	36	0.133	0.129
B-0.1	9:11	30	0.548	0.013	0.024	40	12	40	40	0	40	36	0.123	0.120
B-0.1	9:15	0	0.207	0.013	0.064	30	4	30	30	0	30	35	0.325	0.325
B-0.1	9:25	10	0.517	0.013	0.026	30	4	30	30	0	30	33	0.130	0.137
B-0.1	9:35	20	0.658	0.013	0.020	30	4	30	30	0	30	33	0.102	0.108
B-0.1	9:45	30	0.718	0.013	0.018	30	4	30	30	0	30	34	0.094	0.096
B-0.1	9:48	0	0.501	0.013	0.026	15	9	15	15	0	15	34	0.134	0.138
B-0.1	9:58	10	0.543	0.013	0.024	15	9	15	15	0	15	35	0.124	0.124
B-0.1	10:08	20	0.796	0.013	0.017	15	9	15	15	0	15	35	0.085	0.085
B-0.1	10:18	30	0.812	0.013	0.016	15	9	15	15	0	15	35	0.083	0.083
B-0.1	10:22	0	0.462	0.013	0.029	20	12	20	20	0	20	35	0.146	0.146
B-0.1	10:32	10	0.601	0.013	0.022	20	12	20	20	0	20	35	0.112	0.112
B-0.1	10:42	20	0.661	0.013	0.020	20	12	20	20	0	20	36	0.102	0.099
B-0.1	10:52	30	0.768	0.013	0.017	20	12	20	20	0	20	35	0.088	0.088
B-0.1	10:55	0	0.284	0.013	0.047	30	9	30	30	0	30	35	0.237	0.237
B-0.1	11:05	10	0.554	0.013	0.024	30	9	30	30	0	30	35	0.121	0.121
B-0.1	11:15	20	0.610	0.013	0.022	30	9	30	30	0	30	35	0.110	0.110
B-0.1	11:25	30	0.642	0.013	0.021	30	9	30	30	0	30	35	0.105	0.105
B-0.1	11:27	0	0.169	0.013	0.078	40	6	39.5	40.5	0	40	35	0.398	0.398
B-0.1	11:37	10	0.513	0.013	0.026	40	6	39.5	40.5	0	40	35	0.131	0.131
B-0.1	11:47	20	0.590	0.013	0.022	40	6	39.5	40.5	0	40	35	0.114	0.114
B-0.1	11:57	30	0.663	0.013	0.020	40	6	39.5	40.5	0	40	35	0.102	0.102
B-0.1	11:59	0	0.216	0.013	0.061	45	9	44.5	45.5	0	45	35	0.312	0.312
B-0.1	12:09	10	0.496	0.013	0.027	45	9	44.5	45.5	0	45	35	0.136	0.136
B-0.1	12:19	20	0.615	0.013	0.021	45	9	44.5	45.5	0	45	34	0.109	0.112
B-0.1	12:29	30	0.679	0.013	0.019	45	9	44.5	45.5	0	45	34	0.099	0.102
B-0.1	12:32	0	0.382	0.013	0.035	30	14	31	29	0	30	34	0.176	0.181
B-0.1	12:42	10	0.598	0.013	0.022	30	14	31	29	0	30	35	0.112	0.112
B-0.1	12:52	20	0.684	0.013	0.019	30	14	31	29	0	30	35	0.098	0.098
B-0.1	1:02	30	0.745	0.013	0.018	30	14	31	29	0	30	35	0.090	0.090
B-0.1	1:07	0	0.417	0.013	0.032	20	6	19.5	20.5	0	20	34	0.161	0.166
B-0.1	1:17	10	0.683	0.013	0.019	20	6	19.5	20.5	0	20	34	0.099	0.101
B-0.1	1:27	20	0.813	0.013	0.016	20	6	19.5	20.5	0	20	34	0.083	0.085
B-0.1	1:37	30	0.889	0.013	0.015	20	6	19.5	20.5	0	20	34	0.076	0.078
B-0.1	1:40	0	0.364	0.013	0.036	30	9	30	30	0	30	34	0.185	0.190
B-0.1	1:50	10	0.573	0.013	0.023	30	9	30	30	0	30	35	0.117	0.117
B-0.1	2:00	20	0.685	0.013	0.019	30	9	30	30	0	30	35	0.098	0.098
B-0.1	2:10	30	0.735	0.013	0.018	30	9	30	30	0	30	35	0.092	0.092

Table H-3. SRS Simulant 0.06 wt% (Pall 0.1 μm).

Repeat SRS Simulant 0.06 wt% Pall 0.1 (C)														
Membrane Number	Clock Time	Cumulative Time (minutes)	Time (minutes)	Permeate Volume (gallons)	Permeate Flowrate (gpm)	TMP (psig)	AV (ft/sec)	Inlet Pressure (psig)	Outlet Pressure (psig)	Permeate Pressure (psig)	Delta P (psid)	Temp C	Filtrate Flux (gpm/ft^2)	Temp Adjusted Flux (Adjusted to 35 C)
C-0.1	7:40	0	0.269	0.013	0.049	30	9	31.5	28.5	0	30	32	0.228	0.247
C-0.1	7:50	10	0.360	0.013	0.037	30	9	31.5	28.5	0	30	34	0.171	0.175
C-0.1	8:00	20	0.419	0.013	0.032	30	9	31.5	28.5	0	30	35	0.147	0.147
C-0.1	8:10	30	0.442	0.013	0.030	30	9	31.5	28.5	0	30	35	0.139	0.139
C-0.1	8:14	0	0.236	0.013	0.056	30	9	31.5	28.5	0	30	35	0.261	0.261
C-0.1	8:24	10	0.393	0.013	0.034	30	9	31.5	28.5	0	30	35	0.156	0.156
C-0.1	8:34	20	0.439	0.013	0.030	30	9	31.5	28.5	0	30	36	0.140	0.137
C-0.1	8:44	30	0.497	0.013	0.027	30	9	31.5	28.5	0	30	34	0.124	0.127
C-0.1	8:48	0	0.189	0.013	0.070	40	12	43	37	0	40	34	0.325	0.334
C-0.1	8:58	10	0.337	0.013	0.039	40	12	43	37	0	40	35	0.183	0.183
C-0.1	9:08	20	0.390	0.013	0.034	40	12	43	37	0	40	36	0.158	0.154
C-0.1	9:18	30	0.428	0.013	0.031	40	12	43	37	0	40	36	0.144	0.140
C-0.1	9:21	0	0.235	0.013	0.056	30	4	31	29	0	30	35	0.262	0.262
C-0.1	9:31	10	0.506	0.013	0.026	30	4	31	29	0	30	33	0.122	0.128
C-0.1	9:41	20	0.566	0.013	0.023	30	4	31	29	0	30	34	0.109	0.112
C-0.1	9:51	30	0.614	0.013	0.022	30	4	31	29	0	30	35	0.100	0.100
C-0.1	9:54	0	0.427	0.013	0.031	15	9	16.5	13.5	0	15	35	0.144	0.144
C-0.1	10:04	10	0.579	0.013	0.023	15	9	16.5	13.5	0	15	34	0.106	0.109
C-0.1	10:14	20	0.642	0.013	0.021	15	9	16.5	13.5	0	15	33	0.096	0.101
C-0.1	10:24	30	0.677	0.013	0.020	15	9	16.5	13.5	0	15	34	0.091	0.093
C-0.1	10:28	0	0.318	0.013	0.042	20	12	22.5	17.5	0	20	34	0.194	0.199
C-0.1	10:38	10	0.419	0.013	0.032	20	12	22.5	17.5	0	20	36	0.147	0.143
C-0.1	10:48	20	0.491	0.013	0.027	20	12	22.5	17.5	0	20	36	0.125	0.122
C-0.1	10:58	30	0.553	0.013	0.024	20	12	22.5	17.5	0	20	34	0.111	0.114
C-0.1	11:01	0	0.245	0.013	0.054	30	9	31.5	28.5	0	30	34	0.252	0.258
C-0.1	11:11	10	0.434	0.013	0.030	30	9	31.5	28.5	0	30	34	0.142	0.146
C-0.1	11:21	20	0.489	0.013	0.027	30	9	31.5	28.5	0	30	36	0.126	0.122
C-0.1	11:31	30	0.533	0.013	0.025	30	9	31.5	28.5	0	30	36	0.115	0.112
C-0.1	11:34	0	0.186	0.013	0.071	40	6	41	39	0	40	35	0.331	0.331
C-0.1	11:44	10	0.415	0.013	0.032	40	6	41	39	0	40	36	0.148	0.144
C-0.1	11:54	20	0.502	0.013	0.026	40	6	41	39	0	40	36	0.123	0.119
C-0.1	12:04	30	0.573	0.013	0.023	40	6	41	39	0	40	35	0.107	0.107
C-0.1	12:08	0	0.174	0.013	0.076	45	9	47	43	0	45	35	0.354	0.354
C-0.1	12:18	10	0.397	0.013	0.033	45	9	47	43	0	45	35	0.155	0.155
C-0.1	12:28	20	0.487	0.013	0.027	45	9	47	43	0	45	35	0.126	0.126
C-0.1	12:38	30	0.571	0.013	0.023	45	9	47	43	0	45	35	0.108	0.108
C-0.1	12:42	0	0.223	0.013	0.059	30	13.2	34	26	0	30	34	0.276	0.283
C-0.1	12:52	10	0.428	0.013	0.031	30	13.2	34	26	0	30	35	0.144	0.144
C-0.1	1:02	20	0.507	0.013	0.026	30	13.2	34	26	0	30	35	0.121	0.121
C-0.1	1:12	30	0.548	0.013	0.024	30	13.2	34	26	0	30	35	0.112	0.112
C-0.1	1:14	0	0.350	0.013	0.038	20	6	21.5	18.5	0	20	34	0.176	0.181
C-0.1	1:24	10	0.570	0.013	0.023	20	6	21.5	18.5	0	20	33	0.108	0.114
C-0.1	1:34	20	0.727	0.013	0.018	20	6	21.5	18.5	0	20	33	0.085	0.089
C-0.1	1:44	30	0.750	0.013	0.018	20	6	21.5	18.5	0	20	34	0.082	0.084
C-0.1	1:47	0	0.247	0.013	0.053	30	9	31.5	28.5	0	30	34	0.249	0.256
C-0.1	1:57	10	0.454	0.013	0.029	30	9	31.5	28.5	0	30	36	0.136	0.132
C-0.1	2:07	20	0.545	0.013	0.024	30	9	31.5	28.5	0	30	36	0.113	0.110
C-0.1	2:17	30	0.621	0.013	0.021	30	9	31.5	28.5		30	35	0.099	0.099

Appendix I

Budgetary Quotes

Appendix I

Budgetary Quotes

Table I-1. Budgetary quote for Pall membranes.

BUDGETARY PRICE SHEET

WSRC Ultrafilter Retrofit Vessel and Filter Assembly

Customer: Westinghouse Savannah River
Date: May 20, 2004

Item 1: (280) 96” AccuSep® Zirconia coated (0.1µ micron) membranes welded directly into the tubesheet comprising a combined filtration area of 231 ft^2.

Item 2: 96” AccuSep® (1.0µ micron) membranes welded directly into the tubesheet.

Price

[Item 1] Pall will complete the work as proposed for the budgetary price of **$100,000.00**

[Item 2] Pall will complete the work as proposed for the budgetary price of **$140,000.00**

Validity

Pricing is valid for a period of 90-days from noted date. If a formal purchase order or executed contract is not received within the 90-day period, both the pricing and delivery schedule are subject to review and adjustment.

Delivery

16 Weeks ARAD

Taxes and Duties

Taxes are not included in the pricing. Any taxes, duties, tariffs of any type are for the account of the Purchaser.

Terms of Payment

50% Upon Receipt of Order
50% Delivery

Table I-2. Budgetary quote for GKN membrane.

May 20, 2004
KemTEK, Inc.
21 Colonial Ave.

Haddonfield, NJ 08033

Attn.: Mr. Carl Gakeler
Subject: **SRS BUDGET QUOTE---**
Ref.: INEEL ---(1)FILTER 18" HyPULSE LSX Vessel
Refer to our ----DCF ref.#040502----
Carl:

With reference to your request for a budgetary price for subject 18" Filter Vessel:
DCF price to design and build with reference to **DOE SRS 200S AREA** drawing (Defense Waste Processing Facility, Late Wash Facility) for Cross Flow Filter Modifications, Plan and Sections S511-205-030-00-F, as well as, referred to reference drawing #D7020346:
Price for one vessel as follows:

DCF design/manufacturing engineering -----------------------	optional---------	$200,000.
DCF vessel and GKN supplied tubes ---		$275,000.
	Total	$475,000.

Ref. Drawing #D7020346 please note the following:
Notes 1,2, & 3 ----Vessel to be designed, built, and stamped to ASME SECTION VIII, DIV I in accordance with NQA-1 requirements.

Note #4----Final assembly --Westinghouse SRS Engineering Stds ---not applicable.

Note #5----Welding to be in accordance ASME CODE SECT VIII, DIV I, as applicable. (Welding procedures, welders & welder operators qualified (prior to fabrication) in accordance with SECT IX of ASME CODE. Reference to Westinghouse SRS Engineering Stds--- not applicable).

Tubes to be furnished by GKN—tubes to be manufactured and welded in accordance with DIN and GKN MFG STDS.
Note #12---Shipping is for a domestic box.
Notes #16, 22 & 23---Not applicable.
Price excludes tube design engineering costs (by KemTEK/GKN)
Price is exclusive of sales, use and all other taxes

Price is good for a period of 30 days from date of quotation.

Delivery: to be determined at time of order placement, subject to material availability lead times and DCF production scheduling.

FOB Florence, NJ (Freight costs by others)
Terms: To be determined, mutually agreed upon.

Should you have any questions or comments please do not hesitate to contact me.

Sincerely,

Robert Sarraiocco

Business Development Manager

DC Fabricators Inc.

Carl Gakeler
21 Colonial Avenue
Haddonfield NJ 08033

Phone: 856-428-9332
Fax: 856-428-9206

www.kemteknj.com
carl@kemteknj.com

KemTEK

Fax

To: NICK MANN

From: *Carl Gakeler*

Company: INEEL

Date: MAY 20, 2004

Fax: ~~208-526-3499~~
208-526-...

Pages: 3

Phone: 208-526-8644

Cc: KSI FAX 208-221-7250

Re: CROSS FLOW ULTRA FILTER 18" DIAMETER

NICK:

BUDGET PRICE IS ATTACHED.

TO BE SAFE, I HAVE INCLUDED SPECIFICATIONS OF ASME CODE AND NQA-1. THIS PRICE IS SIMILAR THE HANFORD FILTERS EXCEPT THE ENGINEERING COST IS NOT APPORTIONED OVER SIX (6) FILTERS. IN THE EVENT MULTIPLE FILTERS WOULD BE REQUIRED, THE ENGINEERING COST OF $200,000.00 WOULD BE APPORTIONED.

I COULD NOT PREDICT THE WESTINGHOUSE STANDARDS THEREFORE HAVE TAKEN EXCEPTION TO THEM, BUT HOPEFULLY HAVE THEM COVERED TO SOME EXTENT.

THE QUOTE IS TO DRAWING 7020346 REV D WHILE THE OVERALL DIMESIONS AND LAYOUT ARE TO S511-205-030-00-F.

NICK, I HOPE THIS PRESENTATION AND QUOTE WILL BE SUFFICIENT TO YOUR CURRENT NEEDS.THE TUBES ARE GKN AS TYPE TUBES.

BEST REGARDS,

Carl

Table I-3. Budgetary quote for Graver membranes.

Graver Technologies

Graver Technologies, Inc.
200 Lake Drive
Glasgow, DE 19702•3319
Toll Free: 800•249•1990
Tel: 302•731•1700
Fax: 302•731•1707

Budget QUOTATION

DATE: May 24, 2004 **QUOTATION # C6034**

PREPARED FOR:
INEEL

Idaho Falls, ID. 83415

SUBMITTED FROM:
Graver Technologies Inc.
200 Lake Drive
Glasgow, DE 19702 USA

Attn: Mr. Nick Mann - AST; Re: SCEPTER® MF Module for Savannah River

Your interest in Graver Technologies products is appreciated and we propose to furnish you:

ITEM #	QTY	DESCRIPTION	Price Each	TOTAL
1A	1	Graver Technologies Scepter microfiltration membrane module model no. **12C-750A-10P2**. This is a **two-pass**, 10 foot (3-meter) porous tube length module designed for horizontal mounting. Provides approximately 237.5 sq.ft. (**22 m^2**) of membrane area rated at 0.1 microns. Contains quantity 126 (63/pass) tubular membranes having a nominal inner diameter of **0.72 inches** (18.3 mm). Module shell material of construction is 316L. Tubes are 316L with TiO membrane. ASME code designed and stamped for 200 psig (13.8 bar) at 400°F (204°C). Process connections to be standard pipe size weld stubs (or other as mutually agreed). Sizes, quantity, and orientations to be determined. All welded construction. A circulation flowrate of **479 to 718 gpm** would provide a crossflow velocity of 6 to 9 ft/sec.	$45,600.00	$45,600.00
1B	1	Graver Technologies Scepter microfiltration membrane module model no. **10C-375A-10P**. This is a **one-pass**, 10 foot (3-meter) porous tube length module designed for horizontal mounting. Provides approximately 312 sq.ft. (**29 m^2**) of membrane area rated at 0.1 microns. Contains 312 tubular membranes having a nominal inner diameter of **0.38 inches** (9.65 mm). Module shell material of construction is 316L. Tubes are 316L with TiO membrane. ASME code designed and stamped for 200 psig (13.8 bar) at 400°F (204°C). Process connections to be standard pipe size weld stubs. Sizes, quantity, and orientations to be determined. All welded construction. A circulation flowrate of **659 to 998 gpm** would provide a crossflow velocity of 6 to 9 ft/sec.	$58,800.00	$58,800.00

1C	1	Graver Technologies Scepter microfiltration membrane module model no. **12C-750A-10P**. This is a **one-pass**, 10 foot (3-meter) porous tube length module designed for horizontal mounting. Provides approximately 262 sq.ft. (**24.3 m^2**) of membrane area rated at 0.1 microns. Contains 139 tubular membranes having a nominal inner diameter of **0.72 inch** (18.3 mm). Module shell material of construction is 316L. Tubes are 316L with TiO membrane. ASME code designed and stamped for 200 psig (13.8 bar) at 400^oF (204^oC). Process connections to be standard pipe size weld stubs. Sizes, quantity, and orientations to be determined. All welded construction. A circulation flowrate of **1056 to 1585 gpm** would provide a crossflow velocity of 6 to 9 ft/sec.	$44,000.00	$44,000.00

-- An approval drawing will be provided for your review and comments prior to manufacture. --

Terms: Twenty-five percent on drawing approval; Balance Net 30 days after shipment with approved credit. Approval drawing within 10 days of order.
FOB: Shipping Point – Robbinsville, NJ.
Freight: PP and add, or Collect. By dedicated air-ride flat bed truck.
Shipment: 10 - 12 weeks after drawing approval, but dependent on shop load at time of order.
Validity: This quotation is valid for purchase for 60 days.

To place an order call Scott Wittwer at (302) 731 - 3539.

Subject to enclosed terms unless otherwise stated above or in any documents attached.

PREPARED BY
__*Scott Wittwer*________
Scott Wittwer
Product Manager

Table I-4. Budgetary quote for the Mott 0.1 μm membrane (personal email, 06-23-04).

Michael,

The actual quote for the 0.1 Mott filter was $255,000 + $15,000 for QA related documentation and inspections for a total cost of $270,000. This quote was effective in January 2004. We expect to see an escalation of the cost based on rising costs for stainless steel.

The $27,300 for modification of the factory supplied filter to add elbows, Hanford nozzles, balance it, etc. should be a COMMON cost for any vendor's filter we purchase. However, keep in mind that the facility was designed specifically around a Mott filter with certain length tubes. I would expect the modification costs to be higher for any vendor's filter that was different in size, etc (e.g. different length standard tubes resulting in a fatter or longer tube bundle to get the same filter area.). The existing jumpers in the Cell are designed to fit the exact geometry of the Mott filter. If we use a different vendor and the nozzle locations are different by any dimensional amount, then at least 4 or more jumpers will have to modified at considerable cost ($100,000 or more).

The estimate of $30,000 for 512S operational costs to install the filter would also be a common cost for any vendor's filter.

Please call me Michael and we can discuss how you intend to use this information in your comparisons of Filter Vendors. I want to make sure we are not talking apples and oranges when the filter vendors are compared. The cost numbers I saw for the "other vendors" seemed too low for a complete filter vessel.

----- Forwarded by E Seufert/WSRC/Srs on 06/23/2004 08:44 AM -----

James Lovekamp/BSRI/Srs

06/23/2004 08:14 AM