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Testing of a Rotary Microfilter to Support Hanford Applications

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SUMMARY

Savannah River National Laboratory (SRNL) researchers are investigating and developing a rotary microfilter for solid-liquid separation applications at the Savannah River Site (SRS). Because of the success of that work, the Hanford Site is evaluating the use of the rotary microfilter for its Supplemental Pretreatment process. The authors performed rotary filter testing with a full-scale, 25-disk unit with 0.5 μ filter media manufactured by Pall Corporation using a Hanford AN-105 simulant at solids loadings of 0.06, 0.29, and 1.29 wt %.

The conclusions from this testing follow.

- The filter flux at 0.06 wt % solids reached a near constant value at an average of 0.26 gpm/ft^2 (6.25 gpm total).
- The filter flux at 0.29 wt % solids reached a near constant value at an average of 0.17 gpm/ft^2 (4 gpm total).
- The filter flux at 1.29 wt % solids reached a near constant value at an average of 0.10 gpm/ft^2 (2.4 gpm total).
- Because of differences in solids loadings, a direct comparison between crossflow filter flux and rotary filter flux is not possible. The data show the rotary filter produces a higher flux than the crossflow filter, but the improvement is not as large as seen in previous testing.
- Filtrate turbidity measured < 4 NTU in all samples collected.
- During production, the filter should be rinsed with filtrate or dilute caustic and drained prior to an extended shutdown to prevent the formation of a layer of settled solids on top of the filter disks.
- Inspection of the seal faces after ~ 140 hours of operation showed an expected amount of initial wear, no passing of process fluid through the seal faces, and very little change in the air channeling grooves on the stationary face.
- Some polishing was observed at the bottom of the shaft bushing. The authors recommend improving the shaft bushing by holding it in place with a locking ring and incorporated grooves to provide additional cooling.
- The authors recommend that CH2MHill Hanford test other pore size media to determine the optimum pore size for Hanford waste.

INTRODUCTION

SRNL researchers identified and tested the rotary microfilter as a technology to increase solid-liquid separation throughput.[1,2,3,4] The testing showed significant improvement in filter flux with the rotary microfilter over the baseline crossflow filter (i.e., 2.5 – 6.5X during the scoping tests, as much as 10X in actual waste tests, and approximately 2X in pilot-scale tests).

SRNL received funding from DOE EM-21, Office of Waste Processing (formerly Office of Cleanup Technologies), to develop the rotary microfilter for high level radioactive service. The work focused on evaluating alternative rotary microfilter vendors, redesigning the equipment for radioactive service, engineering studies to evaluate the risks, determining downstream impacts, assessing costs and benefits of deploying this technology, performing actual waste and pilot-scale testing of the technology, and evaluating alternative filter media. The work led to the decision to design, fabricate and perform testing on a full-scale rotary microfilter for potential SRS Tank Farm applications.

SRNL performed the following work to evaluate the rotary microfilter. They demonstrated flushing of the filter housing and effective removal of soluble and insoluble contaminants. They tested the rotary microfilter performance with simulated small column ion exchange feed and observed ~ 6X improvement in filter flux of a crossflow filter with similar feed. They conducted simulated sludge washing and found the rotary filter unit behaved as a continuous stirred tank reactor. They concentrated the feed to 20 wt % solids, and the filter flux was ~ 6X the flux measured with a crossflow filter at similar solids loadings.[5]

Because of the success of that testing, the Hanford Site is evaluating the use of the rotary microfilter for its Supplemental Pretreatment process.[6] The authors received funding from DOE EM-21 to continue the development of the rotary microfilter and to evaluate its suitability for being the solid-liquid separation technology for Supplemental Pretreatment.[7,8]

The SpinTek high shear rotary filter used in this testing has 25 filter disks covered with 0.5 μ pore size (nominal) sheet membranes (0.007 inch thick) manufactured by Pall Corporation. The filter area of each disk is 0.96 ft^2. The disks are physically mounted on and are hydraulically connected to a common hollow rotating shaft. The entire stack of membrane disks is enclosed within a vessel. Feed is fed into the filter vessel through the inlet on the side of the vessel wall. A pressure is set in the tank by restricting the outlet flow typically using a gate valve on the concentrate piping. This applied pressure forces liquid through the filters on the filter disk. Between each disk is a set of baffles or turbulence promoters. These turbulence promoters cause strong currents and eddies at the surface of the membrane inhibiting the formation of a filter cake. Filtrate flows through the media and along a mesh inside the disk into the hollow shaft. The filtrate then flows through the shaft to the rotary joint which allows the spinning shaft to couple to stationary piping. The concentrated slurry exits the vessel through an outlet on the bottom. Figure 1 illustrates the flow paths across the filter disks during filtration.

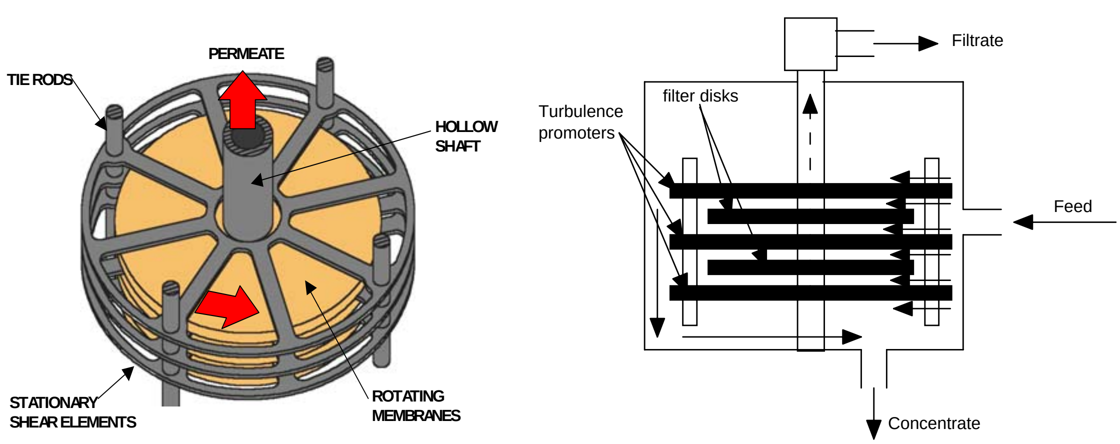

Figure 1. Diagram of Rotary Filter Principle of Operation

The advantage of the rotary microfilter compared to other membrane processes results from the high shear acting on the boundary layer next to the membrane. This shear greatly reduces fouling of the membrane surface and increases fluid flow through the membrane. Pressure is decoupled from the feed flow rate, allowing more control over the driving force pressure and independent control of the shear applied to the filter cake. This feature allows the direct application of shear force with a magnitude significantly greater than that available in conventional membrane systems. The membranes rotate at a tip speed of 60 ft/s in close proximity to the turbulence promoters. For comparison, previous cross-flow filter testing used axial velocities ranging from 3 to 25 ft/s.[1-4]. This creates high speed currents and eddies near the membrane surface. These eddies create a great deal of turbulence at the membrane surface decreasing the buildup of filter cake on the membrane. The SpinTek rotary filter unit uses 11-inch diameter disks and typically operates with a rotational speed of 1170 rpm.

TESTING

The authors performed the rotary filter testing with a full-scale, 25-disk unit that had been used in previous testing to support the small column ion exchange and sludge washing applications for SRS.[5] Figure 2 shows a schematic of the test system.

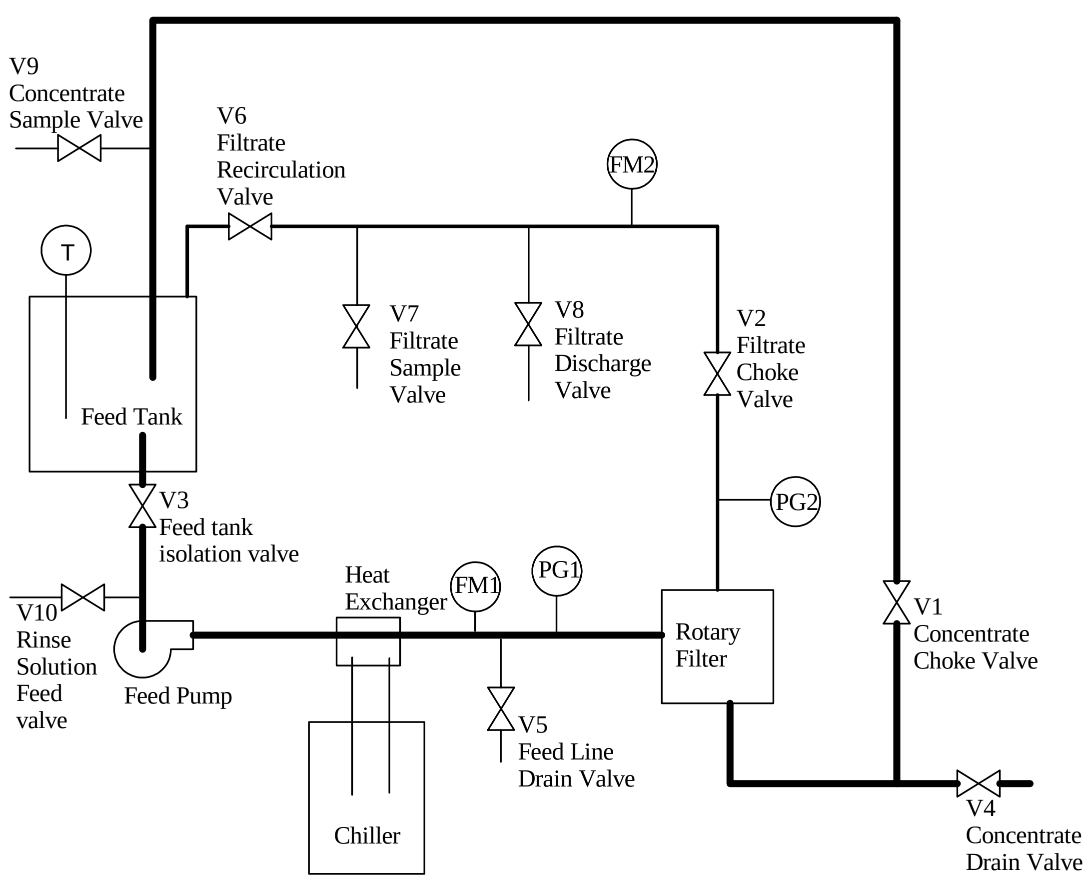

Figure 2. Schematic of Filter Test System

The pump used in testing was a six stage centrifugal booster pump that had been used in previous testing.[5] It produced a flow rate of 18 – 25 gpm with a feed pressure of 60 – 100 psi. The Concentrate and Filtrate Choke valves, V1 and V2 respectively, were PVC gate valves which allowed a fine control of the pressure in the system. All isolation valves, V3 through V9, were PVC ball valves with the exception of V7, the filtrate sample valve, which was stainless steel. Pressure was measured using manual dial pressure gages, which are labeled PG1 and PG2 in Figure 2. Feed and filtrate flow were measured using Fischer Porter Magnetic flow meters and are labeled FM1 and FM2 respectively. The temperature of the process fluid was measured in the feed tank with a Type K thermocouple, indicated in the sketch as "T". All data taken during testing was recorded by hand on data sheets. To minimize the amount of feed slurry needed, the concentrate and filtrate streams are recombined in the feed tank. The feed tank is mixed by recirculation of the concentrate and filtrate streams and by a 1 hp agitator.

Prior to the tests conducted here, the filter unit was modified by replacing the silicon carbide/silicon carbide faced John Crane Type 1 mechanical seal with a John Crane Type 28LD air cooled seal. The material of the bottom shaft bushing was changed from graphite to silicon-carbide. To prevent excessive wear on the shaft, an additional silicon carbide sleeve was added so that the contact wear surfaces at the bottom of the shaft are both silicon carbide.

The filter disks used in testing were a set of 25 un-used disks.

Personnel prepared a simulated Hanford AN-105 feed slurry containing 5 M sodium. The recipe is based on the simulant developed in 2000, but it eliminates trace RCRA metals.[9] Table 1 shows the composition of the supernate and Table 2 shows the solids fractions of the slurry. Personnel prepared 100 gallons of supernate as follows. They added 75.6 kg of de-ionized water to a tank. Next, they added sodium aluminate, sodium hydroxide (50 wt % solution), boric acid, calcium nitrate, cesium nitrate, magnesium nitrate, potassium nitrate, zinc nitrate, sodium chloride, sodium fluoride, sodium sulfate, and potassium molybdate. They mixed the solution until all of the compounds dissolved. Next, they added sodium silicate, sodium acetate, sodium formate, sodium glycolate, sodium oxalate, and sodium phosphate, mixing the solution after the addition of each compound. They added an additional 113.4 kg of de-ionized water, and mixed the solution thoroughly. They added the sodium carbonate, and mixed thoroughly. They added the sodium nitrate and sodium nitrite, and mixed the solution thoroughly. They added an additional 146.7 kg of de-ionized water, and mixed the solution overnight.

Personnel prepared the solids fraction of the slurry as follows. They procured all of the compounds, except for sodium oxalate, with particle size less than 10 μ. The sodium oxalate was not available as less than 10 μ, so SRNL personnel ground the sodium oxalate particles using a Union Process SG-1 Attritor Mill and measured the particle size of the product with a scanning electron microscope. The analysis showed the particles to be less than 10 μ. They mixed the compounds together in the ratios shown in Table 2.

Table 1. Hanford AN-105 Supernate

Compound	Target Concentration (g/L)
$NaAlO_2$	56.661
NaOH	64.461
H_3BO_3	0.137
$Ca(NO3)_2.4H_2O$	0.111
$CsNO_3$	0.114
$Mg(NO_3)_2.6H_2O$	0.027
KNO_3	9.030
$Zn(NO_3)_2.6H_2O$	0.022
NaCl	7.039
NaF	0.197
Na_2SO_4	0.536
K_2MoO_4	0.096
$Na_2SiO_3.9H_2O$	1.003
$NaCH_3COO.3H_2O$	2.241
HCOONa	2.044
$HOCH_2COONa$	0.706
Na_2C_2O4	0.436
$Na_3PO_4.12H_2O$	1.072
Na_2CO_3	10.405
$NaNO_3$	98.500
$NaNO_2$	78.211

Table 2. Hanford AN-105 Solids

Compound	Solids Fraction (%)
Al_2O_3	9.2
CaOxalate	5.0
Cr_2O_3	26.0
Fe_2O_3	1.1
MnO_2	0.3
NaOxalate	52.5
NiO	0.5
SiO_2	5.4

Personnel prepared the slurry as follows. They added 80 gallons of supernate and 226.04 g of solids to the filter feed tank to produce a 0.06 wt % solids slurry. They fed the slurry to the filter at a feed flow rate of ~25 gpm, a feed pressure of ~70 psi, and a feed temperature of ~35 °C. The filtrate pressure was ~30 psi, producing a transmembrane pressure of ~40 psi. They set the rotor speed to 1170 rpm. The filter operated for ~40 hours on day shift (i.e., ~ 8 hours per day, 5 times per week), and personnel recorded the operating parameters and filtrate flow rate during the test. The operating parameters recorded were feed flow rate, filtrate flow rate, feed pressure, concentrate pressure, filtrate pressure, temperature, and rotor speed. Motor current and output power, along with the surface temperatures of the rotary joint and mechanical seal housing were measured at random intervals. Appendix A contains the data. They collected filtrate samples twice each day of operation to measure turbidity.

After operating for 40 hours, they added an additional 866.5 g of solids to the feed tank to produce a 0.29 wt % solids slurry. They fed the slurry to the filter at a feed flow rate of ~25 gpm, a feed pressure of ~70 psi, and a feed temperature of ~35 °C. The filtrate pressure was ~30 psi, producing a transmembrane pressure of ~40 psi. They set the rotor speed to 1170 rpm. The filter operated for ~40 hours on day shift, and personnel recorded the operating parameters and filtrate flow rate during the test. They collected filtrate samples daily to measure turbidity.

After operating for 40 hours, they added an additional 3767.38 g of solids to the feed tank to produce a 1.29 wt % solids slurry. They fed the slurry to the filter at a feed flow rate of ~25 gpm, a feed pressure of ~70 psi, and a feed temperature of ~35 °C. The filtrate pressure was ~30 psi, producing a transmembrane pressure of ~40 psi. They set the rotor speed to 1170 rpm. The filter operated for ~40 hours on day shift, and personnel recorded the operating parameters and filtrate flow rate during the test. They collected filtrate samples daily to measure turbidity.

RESULTS

Mechanical Performance and Flux

Figure 3 shows the flux with the 0.06 wt % slurry. After reaching near constant value, the filter flux averaged 0.26 gpm/ft^2 (6.25 gpm total). The filter reached near constant value in approximately 10 hours.

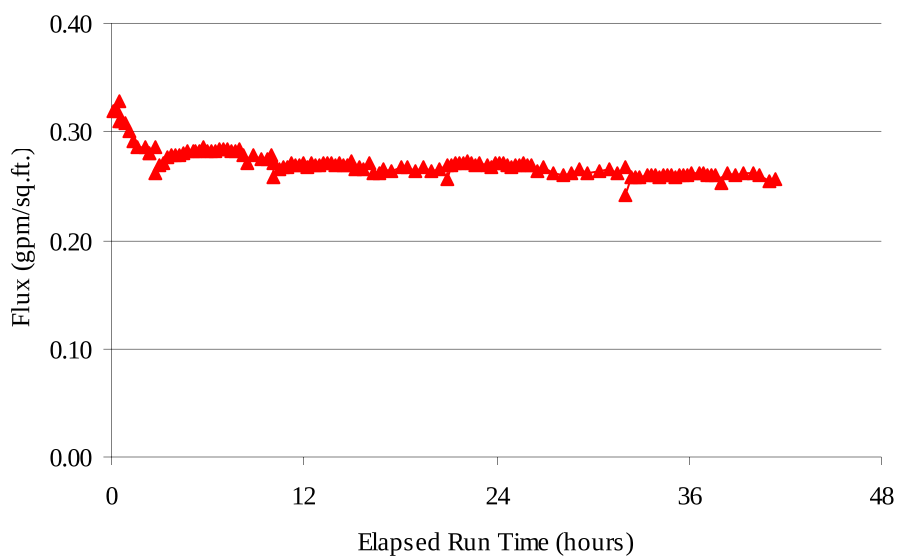

Figure 3 Flux for 0.06 wt% Insoluble Solids at TMP of 40 psi

Additional solids were added to the feed to raise the insoluble solids concentration to 0.29 wt %. **Figure 4** shows the flux with the 0.29 wt % slurry. After reaching a near constant value, the filter flux averaged 0.17 gpm/ft^2 (4 gpm total). The filter reached a near constant value after approximately 15 hours.

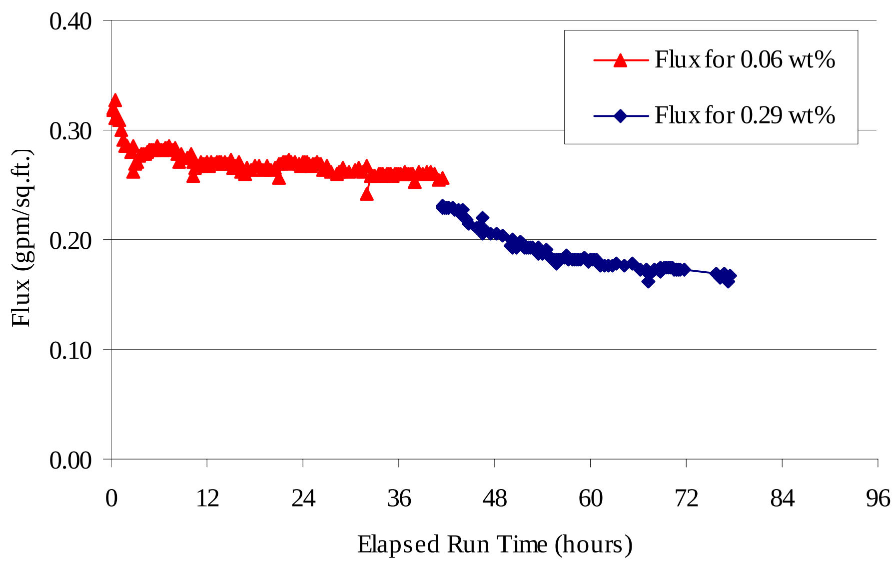

Figure 4 Flux for 0.06 wt % and 0.29 wt % Insoluble Solids at TMP of 40 psi

Figure 5 shows the flux with the 1.29 wt % slurry added. After reaching a near constant value, the filter flux averaged approximately 0.10 gpm/ft^2 (2.4 gpm total). The filter flux reached a near constant value after approximately 25 hours.

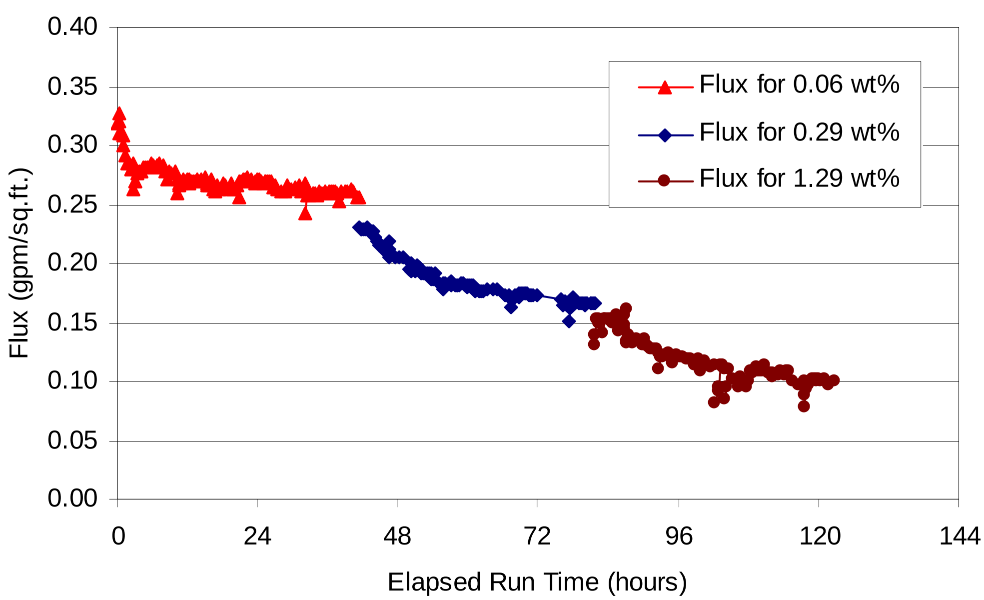

Figure 5 Flux for 0.06 wt %, 0.29 wt % and 1.29 wt % Insoluble Solids at TMP of 40 psi

Figure 6 compares the flux of the AN-105 simulant to the flux measured during a prior test with simulated SRS sludge. The comparison is made since both sludges contain similar compounds (e.g., metal oxides) and have relatively similar particle size (mean 1 – 5 μ). At the start of the testing with 0.06 wt % solids, the AN-105 simulant had a higher flux than the SRS sludge simulant. When we increased the solids loading to 0.29 wt %, the flux with the AN-105 simulant was initially higher. By the end of that test, the flux was approximately the same for both feed slurries. When we increased the solids loading to 1.29 wt %, the flux with SRS simulant remained approximately the same, while the flux with AN-105 decreased further.

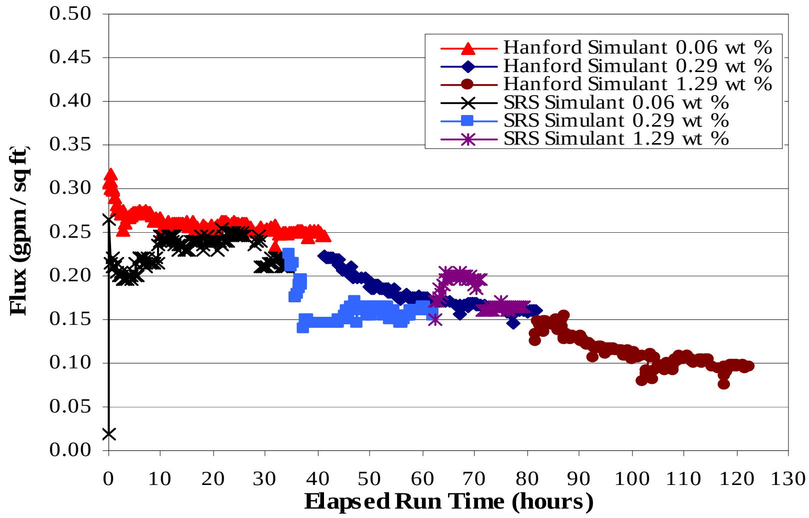

Figure 6 Comparison of SRS and Hanford Simulant Flux Rates

Figure 7 shows a comparison of the 0.06 wt % insoluble solids loadings for the Hanford simulant and the SRS simulant.[5]

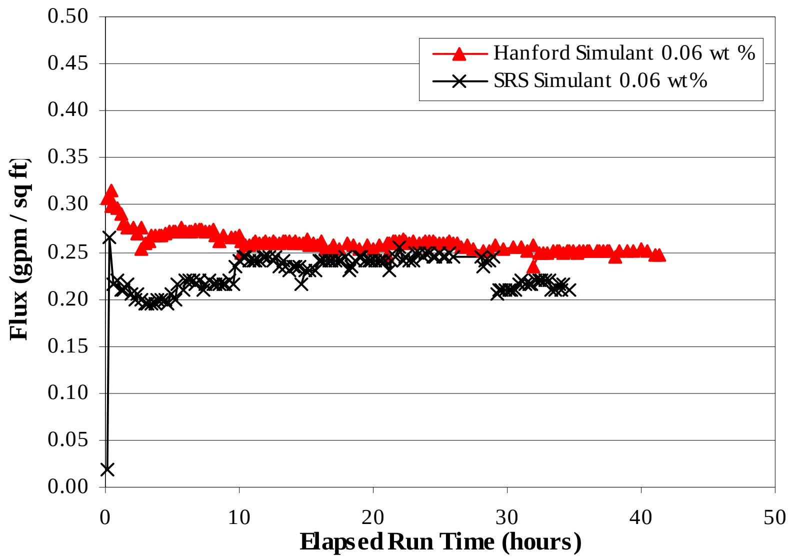

Figure 7 Comparison of Hanford and SRS Simulant Flux Rates at 0.06 wt % Insoluble Solids

Figure 8 compares the testing with the AN-105 simulant with the SRS simulant at 0.29 wt % insoluble solids.[5] Over the course of testing both simulants reached approximately the same state-state flux of approximately 0.17 gpm per square foot of media. Total filtration rate for the filter unit was approximately 4 gpm at this solids loading.

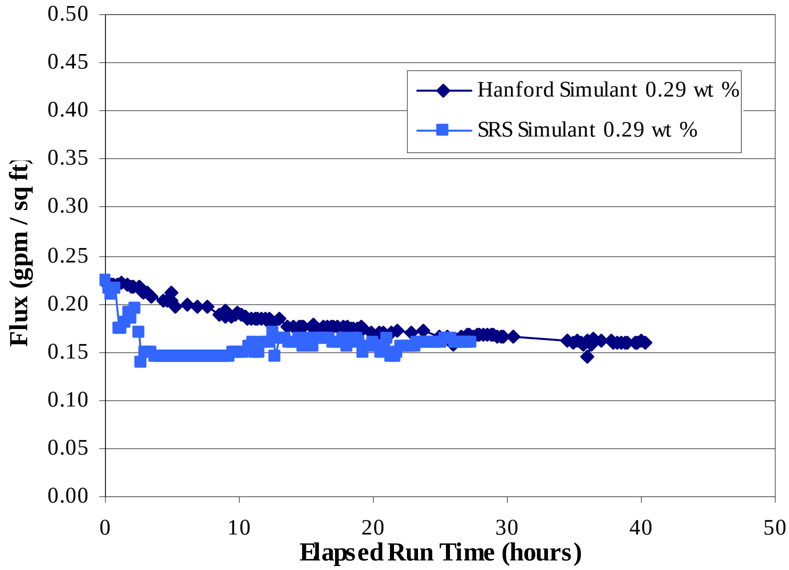

Figure 8 Comparison of Hanford and SRS Simulant Flux Rates at 0.29 wt % Insoluble Solids

Figure 9 compares the flux of the AN-105 simulant with the SRS simulant at 1.29 wt % insoluble solids.[5] Both simulants had approximately the same starting flux of 0.15 gpm per square foot. The flux with the AN-105 simulant continued to decay until reaching approximately 0.10 gpm per disk or 2.4 gpm of filtrate for the entire unit.

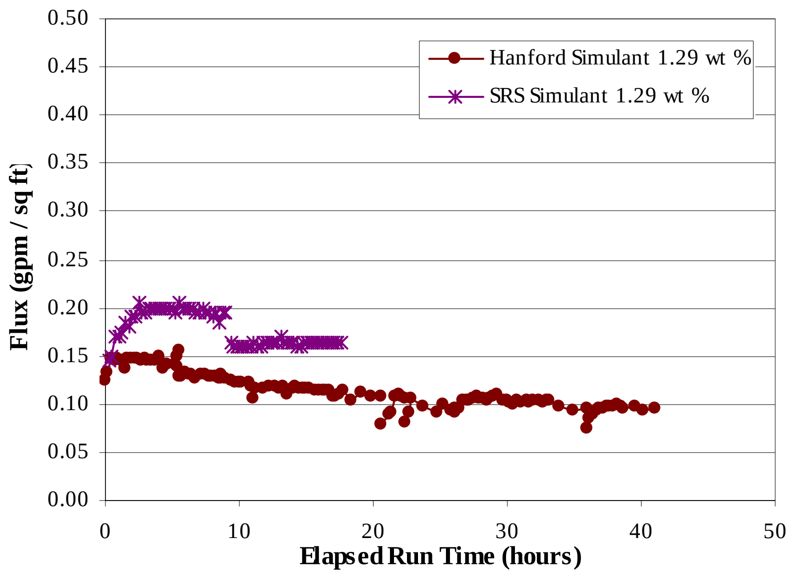

Figure 9 Comparison of Hanford and SRS Simulant Flux Rates at 1.29 wt % Insoluble Solids

Figure 10 compares the flux in this test with the flux measured during a crossflow filter test with an AN-105 simulant.[10] Because the tests used different solids loadings, different filter pore size, and differences in simulant recipe, a direct comparison is not available. Comparing the rotary filter flux at 0.06 wt % solids with the crossflow filter flux at 0.5 wt % solids shows the rotary filter flux is 1.8 – 3.0 X higher. Comparing the rotary filter flux at 0.29 wt % solids with the crossflow filter flux at 0.5 wt % solids shows the rotary filter flux is 1.15 – 2.0 X higher. Comparing the rotary filter flux at 1.29 wt % solids with the crossflow filter flux at 0.5 wt % solids shows the rotary filter flux is 0.7 – 1.25 X of the flux with a crossflow filter.

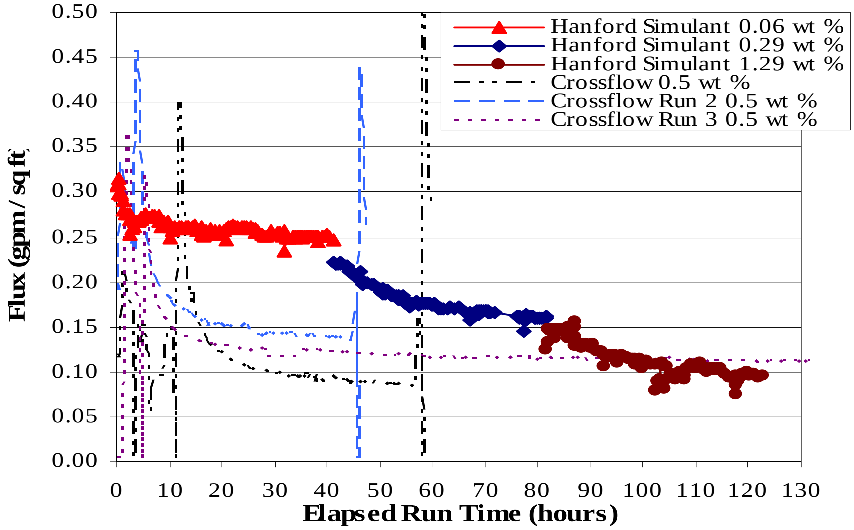

Figure 10 Comparison of Flux with Rotary Filter and Crossflow Filter

Figure 11 shows the particle size distribution of the solids in the current test and in the rotary filter test using SRS sludge. Particle size was measured with a Microtrac SRA-150. The carrier fluid for the measurement was simulated salt solution (SRS salt solution for SRS sludge and AN-105 salt solution for AN-105 solids). The median particle size of the AN-105 solids was 1.49 μ. The median particle size of the SRS solids was 3.32 μ. In addition, the AN-105 solids had a larger fraction of particles less than 1 μ. According to different filtration theories, filter flux increases with increasing particle size. The relationship is described by equation [1]

$$J = K\, d_p^{\,n} \qquad [1]$$

where J is filter flux, K is a constant, d_p is particle size, and n is an exponent. Various filtration models have n equal to 4/3, 2, and 3.[11] In addition, the increase in fine particles (<1 μ) would provide more particles that could penetrate the filter membrane to foul the filter pores.

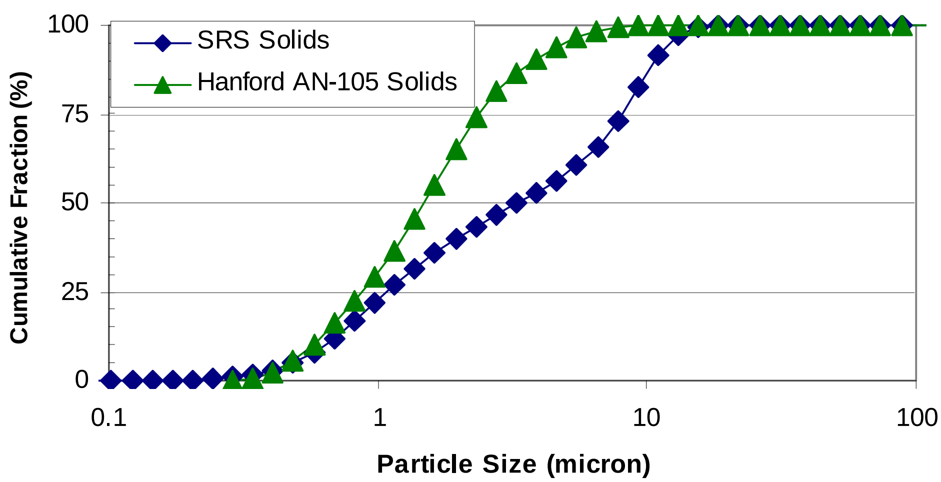

Figure 11. Comparison of Particle Size Data for Hanford and SRS Simulants

Figure 12 shows the particle size of the AN-105 solids from the rotary filter test and the crossflow filter test. The median particle size of the AN-105 solids in the rotary filter test was 1.49 μ. The median particle size of the solids during the crossflow filter tests was 2.32 and 2.59 μ. As described above, this larger particle size would produce higher filter flux, and may explain why the rotary filter did not show as big of an improvement in filter flux as has been observed in other rotary filter versus crossflow filter tests. In addition, the feed for the rotary filter test had a larger fraction of particles less than 1 μ than the feed for the crossflow filter tests.

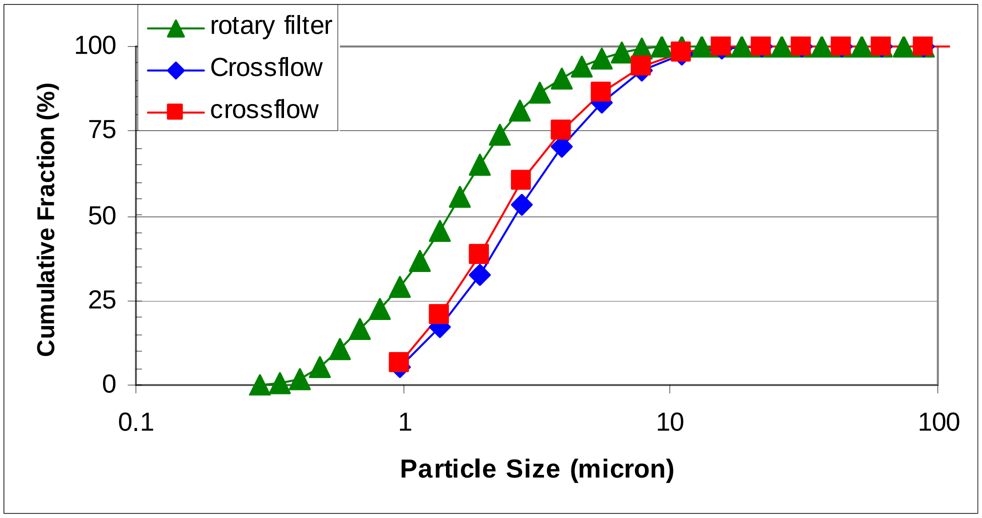

Figure 12. Particle Size Comparison of Hanford Simulant used in Rotary and Crossflow Filters

Filtrate Clarity

Figure 13 shows the turbidity of the filtrate samples collected. All filtrate samples had turbidity less than 4 NTU.

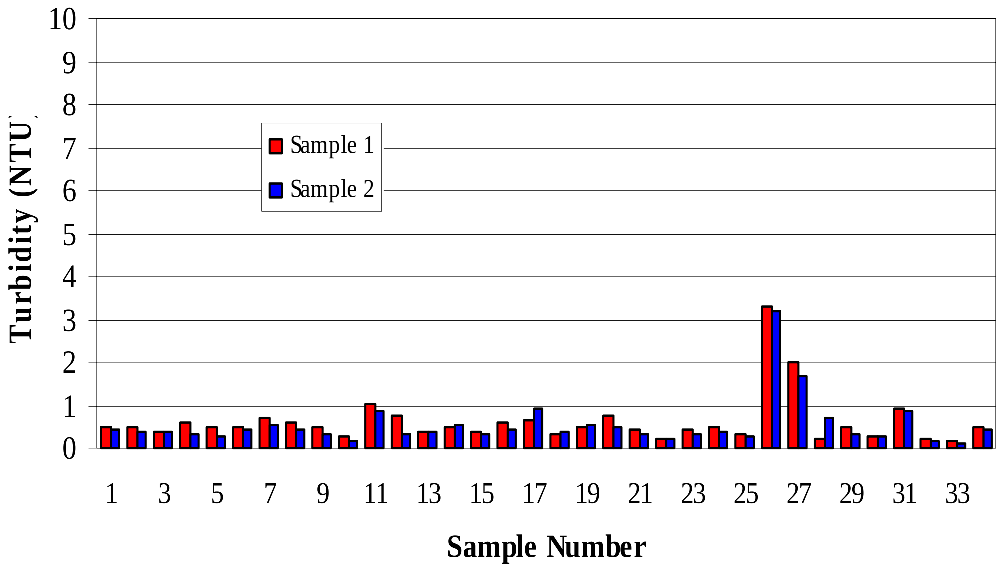

Figure 13. Filtrate Turbidity from Rotary Filter Testing of Hanford Simulant

Disassembly and Inspection

After completion of the operational testing, personnel disassembled the filter disk stack. The disk stack was not flushed because the feed pump failed due to the packing of large (up to 2 cm) solids in the suction side of the pump (see Appendix B). A significant difference in the filter cake between the top side of the disks and the bottom side was observed. Figure 14 shows the top of a representative filter disk and Figure 15 shows the bottom side of the same filter disk (third from the bottom in the stack). The filter-cake buildup on the top side of the disk is due to the settling of the feed material when operation is complete. During testing, the filter was simply shut down at the end of the day. No draining or flushing was done. Additionally, no attempt was made to clean in the disk in-situ by dropping the TMP while maintaining the rotor speed. In previous testing, this approach was shown to improve filter flux by a small amount. The condition of the filter disks is consistent with previous observations with the top side of the disks showing a greater buildup of solids. This leads to the conclusion that the filter is better at preventing the buildup of filter cake than breaking up a filter cake that has already formed. To prevent the buildup of similar filter-cake in deployment, it is recommended that the filter be drained and flushed with filtrate or dilute caustic after shutdown.

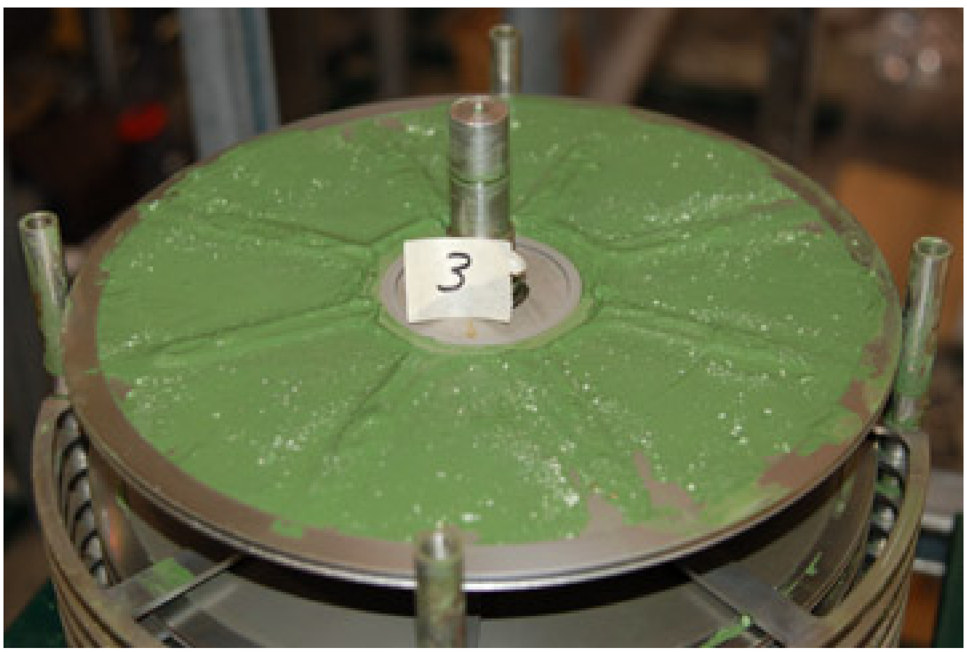

Figure 14 Top Side of Filter Disk

Figure 15 Bottom Side of Filter Disk

Seal Wear Inspection

After disassembly was completed, the shaft seal was removed and inspected. There was no indication that any of the process fluid passed the seal. Figure 16 shows the seal rotor after the first 20 hours and 44 minutes (i.e., left photo) of operation and then after 143 hours and 28 minutes (i.e., right photo) of operation

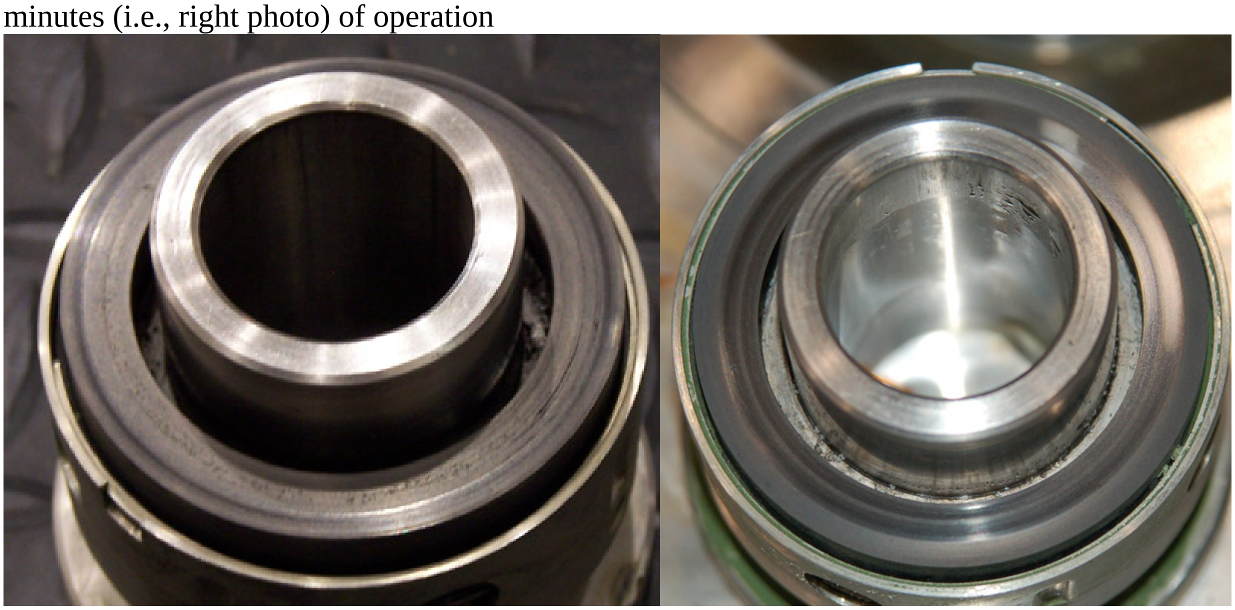

Figure 16 Rotor Portion of Air Seal after 20 ¾ Hours (left photo) and 143 ½ hours (right photo) of Operation

Figure 17 shows the stationary part of the seal after the first 20 hours and 44 minutes of operation and then after 143 hours and 28 minutes of operation.

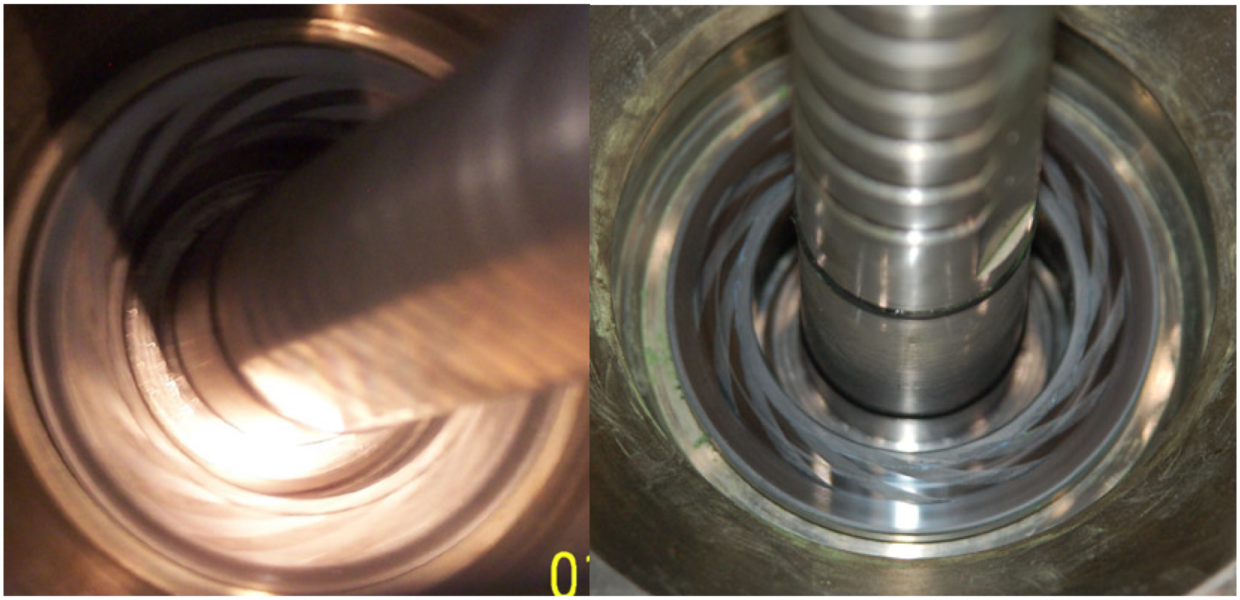

Figure 17 Stationary Portion of Air Seal after 20 ¾ hours (left photo) and 143 ½ hours (right photo) of Operation

The carbon face of the rotor is showing polishing in the area indicative of initial wear. This polishing is due to contact of the seal faces, primarily at startup and shutdown, when there is not enough velocity to cause liftoff for the faces. No evidence of the passing of process fluid was observed. Very little change to the air channeling grooves on the stationary was observed, though no depth measurements were obtained since these measurements would have required the removal of the seal stationary.

Figure 18 and Figure 19 show the condition of the bushing set at the bottom of the filter after 143 hours and 28 minutes of operation. Some polishing can be observed on the bottom of the shaft bushing as well as the receiver bushing. The shaft bushing is not supported and is held in place by a sealant. This sealant was compromised by the process fluid allowing the shaft bushing to contact the bottom of the receiver bushing. It is recommended that the shaft bushing be updated to allow it to be held in place by a retaining ring as well as incorporated grooves to allow for additional cooling flow.

Figure 18. Shaft Bushing after 143 ½ hours of Operation

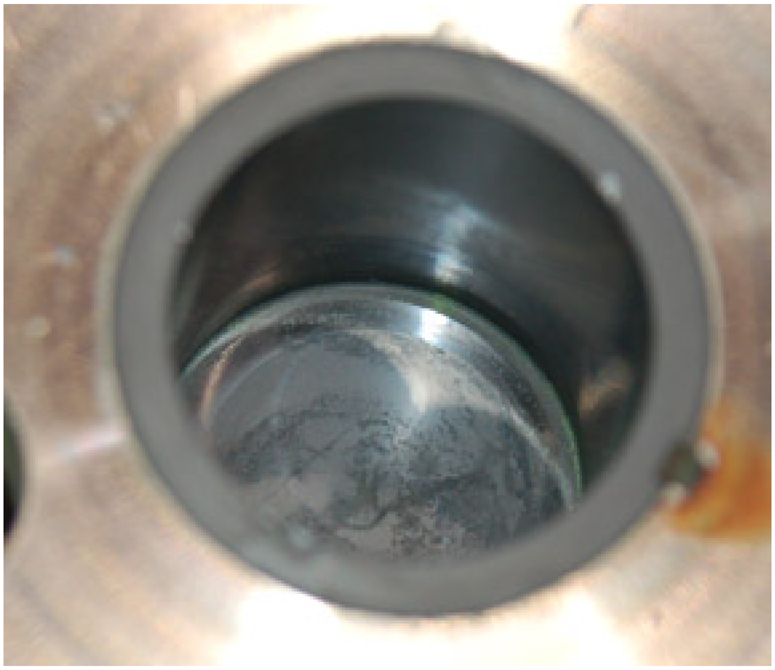

Figure 19. Receiver Bushing after 143 ½ hours of Operation

Figure 20 shows the current and power draw by the filter motor during operation.

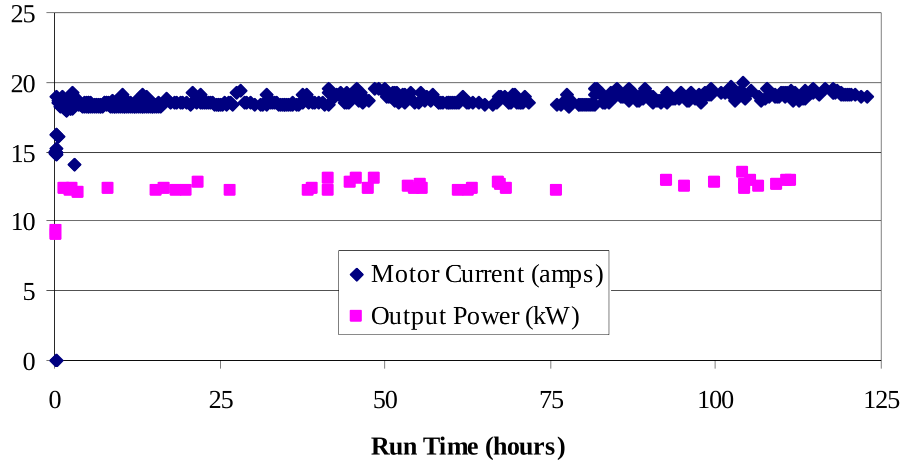

Figure 20. Filter Motor Power and Current Draw

The maximum current rating on the motor is 24.1 amps at 460 volts. No dramatic power or current increases were required as the insoluble solids loadings were increased in the process fluid.

CONCLUSIONS

The conclusions from this testing follow.

- The filter flux at 0.06 wt % solids reached a near constant value at an average of 0.26 gpm/ft^2 (6.25 gpm total).
- The filter flux at 0.29 wt % solids reached a near constant value at an average of 0.17 gpm/ft^2 (4 gpm total).
- The filter flux at 1.29 wt % solids reached a near constant value at an average of 0.10 gpm/ft^2 (2.4 gpm total).
- Because of differences in solids loadings, a direct comparison between crossflow filter flux and rotary filter flux is not possible. The data show the rotary filter produces a higher flux than the crossflow filter, but the improvement is not as large as seen in previous testing.
- Filtrate turbidity measured < 4 NTU in all samples collected.
- During production, the filter should be rinsed with filtrate or dilute caustic and drained prior to an extended shutdown to prevent the formation of a layer of settled solids on top of the filter disks.
- Inspection of the seal faces after ~ 140 hours of operation showed an expected amount of initial wear, no passing of process fluid through the seal faces, and very little change in the air channeling grooves on the stationary face.
- Some polishing was observed at the bottom of the shaft bushing. The authors recommend improving the shaft bushing by holding it in place with a locking ring and incorporated grooves to provide additional cooling.
- The authors recommend that CH2MHill Hanford test other pore size media to determine the optimum pore size for Hanford waste.

REFERENCES

1. M. R. Poirier, “Evaluation of Solid-Liquid Separation Technologies to Remove Sludge and Monosodium Titanate from SRS High Level Waste”, WSRC-TR-2000-00288, Rev. 0, August 16, 2000.
2. M. R. Poirier, “Filtration Systems, Inc., Report for SRS SpinTek Rotary Microfilter Testing”, WSRC-TR-2001-00214, Rev. 0, May 4, 2001.
3. D. T. Herman, M. R. Poirier, and S. D. Fink, “Testing of the SpinTek Rotary Microfilter Using Actual Waste”, WSRC-TR-2003-00030, Rev. 1, December 2003.
4. M. R. Poirier, D. T. Herman, S. D. Fink, R. Haggard, T. Deal, C. Stork, and V. Van Brunt, “Pilot-Scale Testing of a SpinTek Rotary Microfilter with SRS Simulated High Level Waste”, WSRC-TR-2003-00071, February 3, 2003.
5. D. T. Herman, M. R. Poirier, and S. D. Fink, “Testing and Evaluation of the Modified Design of the 25-Disk Rotary Microfilter”, WSRC-STI-2006-00073, Rev. 0, August 2006.
6. M.G. Thien, M.E. Johnson, D.W. Reberger, R.D. Williamson, C.M. Musick, and M.D. Roupe, “Evaluation of Starting the Waste Treatment and Immobilization Plant(WTP) Low Activity Waste LAW) Facility First”, RPP-29981, Rev. 0, July 2006, CH2MHill Hanford Group, Inc., Richland , WA, June 2006.
7. K. Gerdes, “Rotary Microfilter for Hanford Tank Waste”, TTP SR-07-1101, March 18, 2008.
8. M. R. Poirier, D. T. Herman, D. B. Stefanko, S. D. Fink, “Task Technical and Quality Assurance Plan for the Testing of the Rotary Microfilter to Support Hanford Applications”, WSRC-RP-2007-00794, Rev 0, September 6, 2007.
9. R. E. Eibling and C. A. Nash, “Hanford Waste Simulants Created to Support the Research and Development on the River Protection Project – Waste Treatment Plant”, WSRC-TR-2000-00338, February 2001.
10. M. R. Duignan, “Final Report: Pilot-scale Cross-flow Ultrafiltration Test Using a Hanford Site Tank 241-AN-105 Waste Simulant – Envelope A + Entrained Solids”, BNF-003-98-0221, Rev. 0, February 23, 2000.
11. R. A. Peterson, C. A. Nash, and D. J. McCabe, “Correlation of Filtrate Flow Rate for Irradiated and Unirradiated Tetraphenylborate Slurries”, WSRC-MS-95-0448.

Appendix A: Test Data

Rotary Microfilter Data Sheet

Date: 10/24/07

Time (hh:mm)	Tank Level (gal)	Temp (°F)	Conc. Press (psi)	Filtrate Press (psi)	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed (Hz)	Insol Solids (wt %)	Comments	Observer
9:50	28	90	46	26	9.50	6.4	60	[illegible]	12.3 amp torque current	DKH
10:00	"	96.7	46	15	9.51	7.2	60	"	12.0 amp	
10:10	"	96.0	47	15	9.71	7.15	60	"	12.0 amp	
10:20	"	99.8	48	17	9.65	7.05	60	"	11.9 amp	

Run time @ 130.1 hours on VFD

Rotary Microfilter Data Sheet

Date: 10/31/07

Time (hh:mm)	Tank Level (gal)	Temp (°F)	Conc. Press (psi)	Filtrate Press (psi)	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed (Hz)	Insol Solids (wt %)	Comments at full current	Observer
11:20	30	77.2	45	23	10.82	5.78	60	water	15.1 amps 9.4 kW output power Torque [illegible]	current 12
11:30	"	80.1	55	15	11.5	7.67	60	"	15.0 amps 9.3 kW output power Torque I=	8.9 amp
11:40	"	87.8	59	19	11.3	7.3	60	"	14.9 amps 9.2 kW output power Torque I = 119	[illegible]
11:50	"	91.2	60	19	11.2	7.25	"	"	14.9 amps 9.1 kW output power Torque I 11.7	
12:00	"	83.8	60	20	11.2	7.1	"	"	14.8 amps 9.1 kW output power Torque I [illegible]	[illegible]

[illegible] temp 82°F [illegible] 77°F

Rotary Microfilter Data Sheet

Date: 12/10/07

PG-1 PG-2

Time (hh:mm)	Tank Level (gal)	Temp (°F)	Conc. Press (psi)	Filtrate Press (psi)	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed (Hz)	Insol Solids (wt %)	Comments	Observer
10:05	30	80.2	49	22	12.30	3.61	60.0	water	Rotor Joint 87.3°F	
10:16	30	99.2	43	22	12.37	3.40	60.0	water	Seal - 95.5°F	
									(10:16) Seal - 96.5 Joint - 97.3	
									STOPPED	
11:32	30	98.0	41.3	20.1	12.53	3.04	60.0	water	Joint - 93.0 Seal - 92.0	
11:51	30	85.6	61.0	29.0	12.03	6.07	60.0	water	Amps - 15.3 Joint - 83.0 Seal - 92.5	
									STOPPED	
15:07	30	91.8	38.0	15.5	10.16	5.23	60.0	water	99.3°F temp @ Rotor Joint	MP
15:30	30	98.1	50.0	19.5	11.95	6.30	60.0	water	95°F temp @ Seal	
									96°F Rotor Joint 119°F Mech	MP
12-11 10:50	30	80.0	50.0	20.0	11.91	5.82	60.0	water	Rotor Joint 79°F Mech 79.5	MP
									15.1 Amps	
11:07	30.0	101.3	50.0	18.0	11.92	6.47	60.0	water	Joint 96.5 Mech 92.5	MP
11:15	30.0	92.0	70.0	35.0	11.69	6.22	60.0	water	Joint 91.5 Mech 94.5	MP
11:39	30.0	92.6	70.0	33.0	11.60	6.40	60.0	water	Joint 96.0 Seal 91.5	[illegible]
12:04	30.0	94.9	70.0	33.0	11.60	6.21	49.6	water	Joint 96.0 Seal 89.3	
	30.0		63.0	31.0	11.30	6.0	60.0			

Rotary Microfilter Data Sheet

Date: 12-12-07 P1 P2

Time (hh:mm)	Tank Level (gal)	Temp (°F)	Conc. Press (psi)	Filtrate Press (psi)	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed (Hz)	Insol Solids (wt %)	Comments	Observer
2:34	30.0	83.3	60	30	12.2	6.1	60.0	Water	Joint - 82.5 Seal - 76.5	
2:49	30.0	89.4	60	30	12.1	6.1	60.0	Water	Joint - 88.0 Seal - 89.5	
3:08	30.0	89.2	53	24	12.1	5.8	60.0	Water	Joint 87.0 Seal - 90.0	
12-13-07										
1518	30.0	81.1	61.0	30.0	12.03	5.83	60.0	water	Joint 78.5 Neck - 73.5	MP
1537	30.0	93.1	70.0	25.0	11.69	6.92	60.0	water	Joint 88.0 Neck 82.0	MP
1547	30.0	92.1	71.0	30.0	11.56	6.84	60.0	water	Joint 87.5 Neck 89.0	MP
1600	30.0	90.4	70.0	31.0	11.56	6.76	60.0	water	Joint 90.0 Neck 90.0	MP
1610	30.0	92.5	70.0	40.0	11.66	5.60	60.0	water	Joint 90.0 Neck 91.0	MP

Rotary Microfilter Data Sheet

Date: 12/18

Time (hh:mm)	Tank Level (gal)	Temp (°F)	Conc. Press (psi) P1	Filtrate Press (psi) P2	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed (Hz)	Insol Solids (wt %)	Comments	Observer
13:36	30	80.9	72.0	28.0	11.55	6.72	60	water	Neck 69.5 Joint 74.5	mrl
13:44	30.0	89.1	77.0	33.0	11.30	6.61	60	water	Neck 76.5 Joint 81.5 Amp. 15.0	mP

25 Disk Rotary Filter Data Sheet

Date 12-19-07

Time hh:mm	Tank Level (gal)	Solids Loading (wt %)	Temp (F)	Conc. Press PG-1 (PSI)	Filtrate Press PG-2 (psi)	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed (hz)	Seal Temp (F)	Rotary Joint Temp (F)	Motor Current (amps)	Comments	Recorded by
1310	70	0.06	81.6	70	30	11.8	4.71	60.0	69.5	73.0	19.5	Feed tank loaded w/ 80 gal. [illegible]	MAP
1325	70	0.06	93.2	70	32	11.73	4.90	60.0	92.0	91.5	19.0		[illegible]
1340	70	0.06	94.9	71	31	11.85	5.03	60.0	113.5	93.0	18.7		MAP
13:40	↓	↓										Pulled [illegible] samples	
13:50	↓	↓		72	54	11.90	4.30	60	—	—	18.5	checked filtrate [illegible] to [illegible] disks	DHY
1400	↓	↓	99.6	72	58	11.74	4.30	60	119.5	105	18.5		
14:03	↓	↓	93.6	70	23	11.78	5.34	60	[illegible]	102.5	18.3		
14:15	70	0.06	98.5	71	29	11.82	5.45		108.5	100.5	18.3	Hand timing 1.807 gpm filtrate	[illegible]
14:34	↓	↓	104.3	72	30	11.76	5.31	60	100.5	99.0	18.1		[illegible]
14:55	70	0.06	99.2	72	30	11.80	5.52		100.5	97.0	18.0		MAP
1507	70	↓	99.9	70	31	11.82	5.32	60	101.0	100.0	18.0	Shut Down	[illegible]
Restart													
1830	70	0.06	92.4	70	30	11.52	5.48	60	—	—	18.4	[illegible] measurements	DHY
18 48	70	↓	93.7	70	30	11.49	5.47	60	—	—	18.3		DHY
1850	↓	↓	—	70	30	11.88	5.32	60	94	95	18.1	rpm = 1181 [illegible]	DHY
1907	↓	↓	95.6	70	30	11.71	5.44	60	—	—	18.1		↓
1910	↓	↓	95.4	70	30	11.76	5.47	55	—	—	—	rpm dropped to 1084	↓
1912	↓	↓	—	71	32	11.55	5.70	50	—	—	—	rpm drop	↓
1914	↓	↓	95.1	71	32	11.73	5.59	45	—	—	—	rpm drop	↓
1917	↓	↓	94.1	70	30	11.82	5.83	60	—	—	18.1	back to 1187 rpm 11.94 kW [illegible]	↓
1930	↓	↓	95.5	70	31	11.86	5.41	60	94.5	92	14.1		DH

Shutdown

25 Disk Rotary Filter Data Sheet

Date: 12-20-07

Time hh:mm	Tank Level (gal)	Solids Loading (wt %)	Temp (F)	Conc. Press PG-1 (PSI)	Filtrate Press PG-2 (psi)	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed (hz)	Seal Temp (F)	Rotary Joint Temp (F)	Motor Current (amps)	Comments	Recorded by
0800	70.0	0.06	81.1	70.0	30.0	12.02	5.20	60.0	79.5	83.0	18.7	Mixer speed = 40	MAP
0810	Pulled Filtrate Sample												
0815	70.0	0.06	91.1	70.0	30.0	11.83	5.42	60.0	86.5	92.5	18.4		MAP
0830	↓	↓	93.0	70.0	30.0	11.75	5.47	60.0	92.0	95.0	17.4	Filtrate appears to have entrained air	[illegible]
0845	↓	↓	94.4	70.0	30.0	11.91	5.47	60.0	95.0	96.0	18.3		[illegible]
0900	70.0	0.06	94.5	70.0	30.0	11.82	5.41	60.0	95.5	96.5	18.2	output power 12 kw	[illegible]
0915	↓	↓	96.2	70.0	30.0	11.83	5.43	60.0	97.0	97.0	18.3		[illegible]
0930	↓	↓	95.9	70.0	30.0	11.82	5.49	60.0	93.3	96.0	18.2		[illegible]
0945	↓	↓	95.4	70.0	30.0	12.02	5.45	60.0	93.5	96.5	18.2		MAP
10:00	↓	↓	95.2	69.0	29.0	11.83	5.34	60.0	93.0	96.3	18.3		[illegible]
10:15	↓	↓	94.9	70.0	30.0	12.01	5.36	60.0	97.0	95.5	18.3		MAP
10:30	↓	↓	95.2	70.0	30.0	11.87	5.42	60.0	93.5	96.5	18.3		MAP
10:45	70	0.06	95.2	70.0	30.0	12.01	5.45	60.0	97.5	96.0	18.4		MAP
11:00	70	0.06	95.3	70.0	30.0	11.99	5.41	60.0	93.0	96.5	18.3		MAP
11:13	Pulled Filtrate Sample												[illegible]
11:15	70	0.06	95.2	70	30	12.03	5.49	60	96.5	95.0	18.4		MAP

25 Disk Rotary Filter Data Sheet

Date: 1-2-08

Time hh:mm	Tank Level (gal)	Solids Loading (wt %)	Temp (F)	Conc. Press PG-1 (PSI)	Filtrate Press PG-2 (psi)	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed (hz)	Seal Temp (F)	Rotary Joint Temp (F)	Motor Current (amps)	Comments	Recorded by
11:25	700	0.06	67.7	68	30	11.58	4.92	60	67.0	71.0	19.7	Mixer Speed 40	[illegible]
11:35	—	—	—	—	—	—	—	—	—	—	—	pulled Sample (Silicate	[illegible]
11:40	700	.006	80.3	70	30	11.61	5.42	60	84	84.5	19.3		[illegible]
12:00	70.0	0.06	91.2	70	30	11.78	5.41	60.0	92.5	92.0	19.4		mAP
12:15	70.0	0.06	92.6	70	30	11.81	5.34	60.0	92.5	92.5	19.4		mAP
12:30	70	.06		72	30	11.81	5.35	60.0	95.5	95.0	19.4		mAP
12:45	70	.006	94.5	70	30	11.82	5.41	60.0	93.5	94.3	19.2		[illegible]
1300	70	.006	94.3	70	30	11.79	5.41	60.0	93.5	94.3	19.2		[illegible]
1315	70	.006	95.0	71	30	11.72	5.42	60.0	95.0	95.0	19.2		[illegible]
1330	70	.06	95.1	70	30	11.73	5.41	60.0	95.0	95.0	19.2		[illegible]
1:45	70	.06	94.5	70	30	11.72	5.25	60.0	95.5	95.5	19.3		mAP
14:00	70	.06	94.9	71	31	11.73	5.34	60.0	94.5	93.5	19.2		[illegible]
14:15	70	.06	94.5	70	30	11.98	5.25	60.0	96.5	95.5	19.2		mAP
1430	70	.06	95.1	70	30	11.76	5.32	60.0	96.0	96.0	19.2		[illegible]
14:45	70	.06	94.9	70	30	11.82	5.41	60.0	95.0	97.0	19.2		mAP
1500	70	.06	94.8	71	32	11.84	5.42	60.0	96.5	96.5	19.2	15:05 filtrate sample pulled	[illegible]
1520	70	.006	94.6	71	30	11.86	5.41	60.0	96.0	96.0	19.2		[illegible]
1532	70	.06	94.8	71	30	11.90	5.54	60.0	97.0	98.5	18.3		mAP
1547	70	.06	95.0	71	31	11.93	5.46	60.0	96.0	97.5	18.3		mAP
16:01	70	.06	95.1	71	31	11.74	5.29	60.0	92.5	96.5	18.4		mAP

25 Disk Rotary Filter Data Sheet

Date: 1-3-08

Time hh:mm	Tank Level (gal)	Solids Loading (wt %)	Temp (F)	Conc. Press PG-1 (PSI)	Filtrate Press PG-2 (psi)	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed (hz)	Seal Temp (F)	Rotary Joint Temp (F)	Motor Current (amps)	Comments	Recorded by
7:35	70	0.06	79.6	70	30	12.01	3.24	60.0	79.5	80.5	15.8		[illegible]
7:45	70	0.06	90.6	71	33	11.84	3.24	60.0	86.0	93.5	15.5	HY@ 67°F	[illegible]
8:00	70	0.06	91.9	71	31	11.85	5.32	60.0	93.5	94.5	15.4		[illegible]
8:15	70	0.06	93.3	71	31	11.81	5.41	60.0	94.5	94.0	15.4		[illegible]
8:30	70	0.06	94.2	71	31	11.86	5.32	60.0	95.5	95.5	15.3		[illegible]
8:45	70	0.06	93.4	72	31	11.81	5.33	60.0	95.0	98.0	15.2		[illegible]
9:00	70	0.06	95.3	72	31	11.83	5.38	60.0	95.5	98.5	15.2		[illegible]
9:15	70	0.06	95.2	70	30	11.84	5.44	60.0	97.8	92.5	15.2	Pulled filtrate sample	[illegible]
9:30	70	0.06	92.9	70	30	11.83	5.38	60.0	95.8	93.0	15.2		[illegible]
9:45	70	0.06	94.8	70	30	11.85	5.44	60.0	96.5	96.0	15.0		[illegible]
10:00	70	0.06	95.0	70	30	11.96	5.49	60.0	95.5	96.5	15.2		[illegible]
10:15	70	0.06	95.0	70	30	11.87	5.40	60.0	96.5	97.5	15.2		[illegible]
10:30	70	0.06	95.0	70	30	11.88	5.41	60.0	96.5	96.0	15.2		[illegible]
10:45	70	0.06	95.0	70	30	11.83	5.50	60.0	94.0	95.5	15.2		[illegible]
11:00	70	0.06	95.0	70	30	11.71	5.35	60.0	94.5	96.0	15.2		[illegible]
11:15	70	0.06	95.0	71	30	11.82	5.43	60.0	95.4	95.0	15.2		[illegible]
11:30	70	0.06	95.0	72	30	11.81	5.47	60.0	92.3	96.5	15.2		[illegible]
11:45	70	0.06	95.0	70	30	11.85	5.41	60.0	96.5	96.0	15.3		[illegible]
12:00	70	0.06	95.0	71	31	11.87	5.34	60.0	91.0	96.0	15.2		[illegible]
12:15	70	0.06	95.0	70	30	11.89	5.32	60.0	92.3	96.0	15.2		[illegible]
12:30	70	0.06	95.0	70	30	11.81	5.39	60.0	96.5	95.0	15.3		[illegible]
12:45	70	0.06	95.0	70	30	11.83	5.07	60.0	95.5	97.0	15.3		[illegible]
13:00	70	0.06	95.0	70	30	11.82	5.04	60.0	95.5	97.0	15.2		[illegible]
13:15	70	0.06	95.0	70	30	11.83	5.29	60.0	95.5	97.5	15.3		[illegible]
13:30	70	0.06	95.0	71	30	11.88	5.24	60.0	97	97.5	15.2		[illegible]
13:45	70	0.06	95.0	70	30	11.86	5.22	60.0	96.5	98.5	15.2		[illegible]
14:00	70	0.06	95.0	70	30	11.94	5.26	60.0	92.5	96.0	15.2		[illegible]
14:15	70	0.06	95.0	70	30	11.94	5.31	60.0	98.5	97.5	15.2		[illegible]
14:30	70	0.06	95.0	70	30	11.97	5.32	60.0	96.8	95.5	15.2		[illegible]
14:45	70	0.06	95.0	71	45	11.91	4.94	60.0	98.5	98.0	15.3		[illegible]
15:00	70	0.06	95.0	71	45	11.93	4.82	60.0	97.0	98.0	15.3	changed TMP to ~25psi	[illegible]
15:15	70	0.06	95.0	70	30	11.81	5.41	60.0	97.5	96.5	15.3	Sample taken filtrate (1800)	[illegible]
15:30	70	0.06	95.0	70	30	11.93	5.20	60.0	95.5	99.5	15.2		[illegible]
15:45	70	0.06	95.0	70	30	11.87	5.52	60.0	98.5	96.5	15.2		[illegible]
16:00	70	0.06	95.0	70	30	11.94	5.36	60.0	95.5	96.5	15.2		[illegible]

25 Disk Rotary Filter Data Sheet

Date: 1 25 08

Time hh:mm	Tank Level (gal)	Solids Loading (wt %)	Temp (F)	Conc. Press PG-1 (PSI)	Filtrate Press PG-2 (psi)	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed (hz)	Seal Temp (F)	Rotary Joint Temp (F)	Motor Current (amps)	Comments	Recorded by
AM 10:32	68	0.06	84	63	22	12.10	10.04	-55.6	53.5	85.5	16.5		
10:42	68	0.06	87	66	24	12.11	10.14	54.[illegible]	87.0	90.0	16.3		
10:52	68	0.06	95	67	24	12.12	10.16	54.48	92.5	96.0	16.2		
11:02	67	0.06	99	68	25	12.14	10.32	54.98	96.5	100	16.1	STOPPED RUN	
1430	69	0.06	95	62	20	12.21	9.79	60	81.5	94.5	13.6		
1446	68	0.06	96	67	21	12.22	9.70	60	95.5	94.0	19.3	Elapsed Run Time 155?	DW
1500	69	0.06	94	68	29	12.19	9.95	60	100	94.0	19.3		
1515	69	0.06	93	67	21	12.10	9.79	60	100.5	94.0	18.7		
1530	68	0.06	93	71	30	11.8	9.62	60	103.5	98.5	19.0		
1546	↓	↓	93	71	30	11.7	9.5	60	98.5	95.0	18.7	Power 12.4 kW torque current 15.8 amp	DT4
1612	↓	↓	94	70	30	11.94	9.5	60	97.5	95.5	18.7		DT4
1630	↓	↓	95	70	30	11.9	9.4	60	96	96.5	18.6		DT4
								60	95	98	18.5	Power 12.5 kW	DT4
1740	↓	↓	92	70	30	11.9	9.4	60	92	91.5	18.8	adjusted to .010"	
1800	↓	↓	93	71	31	11.9	9.5	60	95.5	94	16.6	12.32 kW	DT4

25 Disk Rotary Filter Data Sheet

Date: 1-28-2005

Time hh:mm	Tank Level (gal)	Solids Loading (wt %)	Temp (F)	Conc. Press PG-1 (PSI)	Filtrate Press PG-2 (psi)	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed (hz)	Seal Temp (F)	Rotary Joint Temp (F)	Motor Current (amps)	Comments	Recorded by
07:30	68	0.06	94	70	30	11.96	9.15	60	92.5	92.5	19.2		[illegible]
0745	69	0.06	93	70	31	11.94	9.20	60	93.5	92.5	13.6	Start UP	[illegible]
0800	68	0.06	93	70	30	11.92	9.21	60	91.5	93.0	18.5		[illegible]
0815	68	0.06	94	70	30	11.93	9.34	60	93.5	93.5	18.5		[illegible]
0830	69	0.06	95	70	30	11.90	9.35	60	94.5	93.5	17.5	added brace for vibration R.H.W	DTH
0845	69	0.06	95	71	30	11.90	9.37	60	96.0	94.5	17.9	Pulled Filtrate Sample	[illegible]
0900	68	0.06	93	70	30	11.89	9.37	60	99.0	93.5	17.4		[illegible]
0915	67	0.06	95	70	30	11.89	[illegible]	60	96.0	93.5	17.4		[illegible]
0930	69	0.06	95	71	30	11.89	9.41	60	96.0	94.0	19.3		[illegible]
0945	69	0.06	95	70	30	11.96	9.44	60	92.0	94.0	19.3		[illegible]
1000	68	0.06	95	70	30	11.89	9.43	60	99.0	96.5	18.5		[illegible]
1015	68	0.06	95	70	30	11.89	9.49	60	95.3	93.0	17.5		[illegible]
1030	69	0.06	95	70	30	11.59	9.44	60	96.0	93.5	17.5		[illegible]
1045	68	0.06	95	70	30	11.59	9.50	60	96.0	94.0	18.4		[illegible]
11:00	69	0.06	93	70	30	11.59	9.43	60	96.0	94.0	18.4		[illegible]
11:15	69	0.06	95	70	30	11.53	9.45	60	92.0	95.4	18.4		[illegible]
11:30	69	0.06	93	70	30	11.55	9.44	60	93.0	93.0	18.4		[illegible]
11:45	68	0.06	95	70	30	11.56	9.47	60	92.5	93.5	18.4		[illegible]
1200	69	0.06	93	70	30	11.50	9.47	60	95.0	96.0	18.4		[illegible]
12:15	68	0.06	96	70	30	11.58	9.49	60	93.0	98.5	18.4		[illegible]
12:30	[illegible]	0.06	96	70	30	11.56	9.49	60	96.5	94.5	18.3		[illegible]
1245	68	0.06	96	70	30	11.53	9.44	60	96.0	94.3	18.5		[illegible]
1300	68	0.06	95	71	30	11.53	9.46	60	96.0	94.5	18.6		[illegible]
13:18	65	0.06	95	70	30	11.75	9.37	60	96.0	98	18.6	[illegible] current 15.7 amp 12.38 kW	DTH
13:38	68	0.06	96	70	30	11.70	9.24	60	96	97	18.6		DTH
1409	68	0.06	95	70	30	11.93	9.35	60	97.5	96.5	18.7		DTH
1431	68	6.06	95	70	30	11.70	9.31	60	96.5	96.0	18.7		DTH
1445	68	0.06	95	70	30	11.76	9.31	60	97	97	18.6	filtrate sample feed sample	DTH
			96	70	30	11.60	9.32	60	98	97.5	18.5	shut down	
1835	65	0.06	91	70	30	11.85	9.35	60	87	91	18.8		DTH
1845	68	6.06	92	71	31	11.83	9.24	60	92.5	94.5	18.7	restart added lower bore clamp on tank re-aligned	DTH

25 Disk Rotary Filter Data Sheet

Date: 1-29-08

Time hh:mm	Tank Level (gal)	Solids Loading (wt %)	Temp (F)	Conc. Press PG-1 (PSI)	Filtrate Press PG-2 (psi)	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed (hz)	Seal Temp (F)	Rotary Joint Temp (F)	Motor Current (amps)	Comments	Recorded by
0740	63	0.06	73	70	30	11.94	5.99	60	69	73.5	19.1	Start UP	[illegible]
0800	63	0.06	93	70	30	11.57	9.13	60	93.5	92	19.2		[illegible]
0815	63	0.06	94	70	30	11.71	9.16	60	96.0	92.5	19.2		[illegible]
0830	63	0.06	94	71	31	11.53	9.17	60	92.5	92.5	19.6		[illegible]
0845	63	0.06	94	71	31	11.52	9.23	60	93.5	92.5	19.6	Pulled Filtrate Sample	[illegible]
0900	69	0.06	93	70	30	11.56	9.19	60	92.5	94.5	19.3		[illegible]
0915	69	0.06	93	70	30	11.56	9.13	60	94.5	93.5	19.4		[illegible]
0930	63	0.06	93	70	30	11.49	9.22	60	94.5	93.0	19.4		[illegible]
0945	63	0.06	93	70	30	11.59	9.17	60	94.0	93.0	19.5		[illegible]
1000	63	0.06	93	70	30	11.59	9.22	60	94.5	93.9	19.4		[illegible]
10:15	63	0.06	93	70	30	11.59	9.20	60	94.5	93.5	19.4		[illegible]
1030	63	0.06	93	70	30	11.91	9.20	60	96.0	94.5	19.0		[illegible]
1045	63	0.06	93	70	30	11.79	9.21	60	94.0	93.0	19.1		[illegible]
1100	63	0.06	93	70	30	11.42	9.21	60	92.5	94.5	19.3		[illegible]
1115	63	0.06	96	71	31	11.90	9.22	60	93.5	95.5	18.5		[illegible]
1130	69	0.06	96	70	30	11.36	9.20	60	93.5	95.0	19.1		[illegible]
1145	69	0.06	96	70	30	11.58	9.22	60	94.0	94.0	18.5	Pulled Filtrate Sample	[illegible]
1200	68	0.06	96	70	30	11.56	9.17	60	96.5	93.5	19.6		[illegible]
12:15	65	0.06	95	70	30	11.81	9.19	60	97.5	96.5	18.6		[illegible]
12:32	66	0.06	95	70	30	11.71	9.26	60	98	98.5	18.4		[illegible]
12:45	↓	↓	95	70	30	11.84	9.13	60	96.5	96.5	18.4		[illegible]
1300			95	70	30	11.82	9.17	60	96.0	95.0	18.1		[illegible]
1317			95	70	30	11.80	9.13	60	96.5	95.5	18.5	12.16 KW 170.0 lbs [illegible]	[illegible]
1334			95	70	30	11.55	9.24	60	96.5	94.0	18.4		[illegible]
1352			95	70	30	11.53	9.05	60	96	96	18.4		[illegible]
1416			95	70	30	11.88	9.03	60	98	97	18.5		[illegible]
1432			96	70	30	11.75	9.13	60	96.5	95.5	18.8	12.34 KW	[illegible]
1500			95	70	30	11.66	9.07	60	97.5	97.5	18.5		[illegible]
1534			95	70	30	11.75	9.12	60	97.5	96.5	18.5		[illegible]
1600			95	70	30	11.76	9.14	60	97	97.5	18.5		[illegible]
1631			95	70	30	11.94	9.08	60	96.5	97.5	18.5	12.26 KW	[illegible]
1701			95	70	30	11.83	9.16	60	97	98	18.5		[illegible]
1730			95	70	30	11.83	9.02	60	97.5	96	18.5		[illegible]
1800			96	70	30	11.76	9.13	60	96	95.5	18.4	12.33 KW 175.4 lbs [illegible]	[illegible]
1831	↓	↓	96	70	30	11.57	9.18	60	96.5	97.5	18.3	shutdown	[illegible]

25 Disk Rotary Filter Data Sheet

Date: 1/30/08

Time hh:mm	Tank Level (gal)	Solids Loading (wt %)	Temp (F)	Conc. Press PG-1 (PSI)	Filtrate Press PG-2 (psi)	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed (hz)	Seal Temp (F)	Rotary Joint Temp (F)	Motor Current (amps)	Comments	Recorded by
07:33	68	0.06	80	70	30	11.56	8.94	60	72	75.5	17.2		DHF
0748	↓	↓	93	70	30	11.57	9.19	↓	86.5	95.5	18.7		Sam
0800			102	70	30	11.50	9.21		96.5	97.5	18.5		DHF
815			97	70	30	11.86	9.24		97	96.5	18.9	12,79 KW	DHF
830			96	70	30	11.97	9.24		97	94.5	17.7		Sam
845			96	70	30	11.95	9.25		97.0	94.0	19.5	Pulled Filtrate Sample	Sam
0900			96	70	30	11.85	9.21		96	94.5	19.5		Sam
0915			93	70	30	11.85	9.20		95	93.5	19.3		Sam
0930			93	70	30	11.86	9.22		95.5	94.0	19.5		Sam
1000			96	70	30	11.77	9.20		95.5	94.0	19.3		Sam
1015			93	70	30	11.78	9.17		96.0	94.3	19.5		Sam
1030			96	70	30	11.75	9.23		96	94	19.5		Sam
1045			93	70	30	11.74	9.22		96.0	94.0	19.4		Sam
1100			96	70	30	11.84	9.21		95.5	94.0	19.4		Sam
1115			96	70	30	11.82	9.17		96.0	93.5	19.4		Sam
11:30			93	70	30	11.83	9.17		97.0	93.5	19.4		Sam
1145			96	70	30	11.76	9.19		96.0	95.0	19.4		Sam
1200			95	71	30	11.72	9.20		96.0	93.5	19.4		Sam
1215			95	70	30	11.74	9.21		97.5	95.0	19.5		Sam
1230			96	70	30	11.91	9.22		96.0	94.0	19.4		Sam
1245			95	70	30	11.86	9.19		93.0	93.5	19.5		Sam
1305			95	70	30	11.74	9.09		96.5	95.0	18.5		Sam
1330			93	70	30	11.81	9.14		97.5	96.0	18.4	12.22 KW	DHF
1403			95	70	30	11.79	9.06		98	94.5	19.3		DHF
1445			95	70	30	11.74	9.02		98.5	95.5	19.4	12.91 KW	DHF
15:10			95	70	30	11.73	9.04		96.5	97	18.5		DHF
15:40			95	70	30	11.72	9.13		96.5	96.5	18.6	ran at reduced TMP prior to data point	DHF
1615			95	70	30	11.81	9.05		97	96	18.5		DHF
1658			95	70	30	11.79	9.09		97.5	98	18.4		DHF
1739			95	70	30	11.74	9.12		97	98.5	18.4		DHF
1806			95	70	30	11.73	9.04		97.5	97.5	18.4		DHF
1833			95	71	30	11.72	9.15		97.5	97.0	18.4	Filtrate sample 18:20	DHF

25 Disk Rotary Filter Data Sheet

Date: 1-31-08

Time hh:mm	Tank Level (gal)	Solids Loading (wt %)	Temp (F)	Conc. Press PG-1 (PSI)	Filtrate Press PG-2 (psi)	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed (hz)	Seal Temp (F)	Rotary Joint Temp (F)	Motor Current (amps)	Comments	Recorded by
0735	68	0.06	77	70	30	11.90	8.67	60	62.5	72.3	19.1	Started Run	[illegible]
0800			91	70	30	11.90	8.97		93.5	93.0	18.7		[illegible]
0815			93	70	30	11.90	8.97		93.5	94.0	18.6		[illegible]
0830			94	70	30	11.90	8.97		93.0	94.0	18.6	Pulled Filtrate Sample	[illegible]
0900			95	70	30	11.86	9.00		93.5	94.0	18.6		[illegible]
0915			93	70	30	11.91	9.00		96.0	94.5	18.5		[illegible]
0930			96	70	30	11.90	9.01		96.0	94.3	18.4		[illegible]
0945			95	70	30	11.91	8.97		94.0	93.5	18.4		[illegible]
1000			96	70	30	11.94	9.02		95.5	93.5	18.4		[illegible]
10:15			93	70	30	11.84	9.01		95.0	93.0	18.4		[illegible]
1030			93	70	30	11.91	9.01		97.0	96.0	18.4		[illegible]
1045			96	70	30	11.86	8.99		96.0	94.0	18.4		[illegible]
1100			95	70	30	11.91	9.01		97.0	95.3	18.4		[illegible]
1115			93	70	30	11.92	9.02		97.5	95.3	18.4		[illegible]
1130			96	70	30	11.90	9.01		97.0	94.9	18.5		[illegible]
1145			96	70	30	11.92	9.03		97.5	95.3	18.4		[illegible]
1215			96	70	30	11.57	9.04		97.0	95.0	18.4		[illegible]
1230			93	70	30	11.91	9.03		97.5	96.0	18.4		[illegible]
1245			93	70	30	11.91	9.02		99.0	96.0	18.5		[illegible]
1300			96	70	30	11.94	9.01		98.5	95.3	18.5		[illegible]
1315			96	70	30	11.90	9.01		99.5	96.5	19.1		[illegible]
1337			96	70	30	11.95	8.88		102	95	18.1		[illegible]
1400			96	70	30	11.95	9.04		97	97	18.5	12.22 KW	[illegible]
1430			96	70	30	12.00	9.02		97	97.5	18.5	12.30 KW	[illegible]
1500			96	70	30	11.92	9.04		95.5	96	18.5	chiller to 66	[illegible]
1535			95	70	30	11.79	9.06		92	97	18.5		[illegible]
16:00			94	70	30	11.80	9.02		97	97	18.5		[illegible]
1635			95	70	30	11.83	8.92		93	98	18.4	chiller to 66.5 filtrate sample	[illegible]
1700			95	70	30	11.86	8.13		98	97	18.4	12.16 KW	[illegible]

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25 Disk Rotary Filter Data Sheet

Date: 2/4/08

Time hh:mm	Tank Level (gal)	Solids Loading (wt %)	Temp (F)	Conc. Press PG-1 (PSI)	Filtrate Press PG-2 (psi)	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed (hz)	Seal Temp (F)	Rotary Joint Temp (F)	Motor Current (amps)	Comments	Recorded by
0836	68	0.29	73	70	30	11.91	8.45	60	71.5	73.5	19.6	13.11 KW	[illegible]
0845			81	71	31	11.91	8.42		77.5	82.5	19.3	Added solids to 0.29 wt%	[illegible]
0908			87	70	30	11.90	8.41		86.5	88.0	19.2		[illegible]
0915			90	69	29	11.92	8.41		91.5	91.0	19.1		[illegible]
0930			93	70	30	11.90	8.41		95.0	93.5	19.9		[illegible]
952			94	72	31	11.82	8.43		98	97.5	19.1	Pulled Filtrate Sample	[illegible]
1015			95	70	29	11.90	9.38		93.5	94.5	19.1	Vibration measurements being taken 1132	[illegible]
1034			96	70	30	11.91	8.37		101.0	95	19.2		[illegible]
1048			95	70	30	11.89	8.36		99.8	94.5	19.0		[illegible]
11:07			93	71	30	11.92	8.37		96.0	93.5	19.5		[illegible]
1115			93	70	29	11.73	8.27		92.5	99.0	19.0		[illegible]
1130			93	70	30	11.91	8.23		99.0	99.5	19.2		[illegible]
1145			96	72	32	11.92	8.23		100.0	95.0	19.6	Pulled Filtrate and Feed	[illegible]
1201			95	70	30	11.76	8.14		85.5	85.0	19.1	12.84 KW	[illegible]
1258			95	70	30	11.8	8.06		101	95.5	19.6	13.08 KW	[illegible]
1315			98	70	30	11.58	8.07		99.5	100	19.7		[illegible]
1335			96	70	30	11.93	8.08		102	100.5	19.3	shutdown	[illegible]
1427			93	70	30	11.54	9.23		96	97.5	19.1	Restart	[illegible]
1500				70	30	11.54	7.95		102.5	103	18.6		[illegible]
1558			95	70	30	11.53	7.97		98	103.5	16.7	12.36 KW	[illegible]
1640			96	71	30	11.54	7.95		102.5	103	11.5	13.08 KW	[illegible]
1725			96	70	30	11.78	7.94		103.5	106	19.6		[illegible]
1820			96	70	30	11.86	7.32		103	102	19.6		[illegible]
1844			96	70	30	11.76	7.35		104.5	102.5	19.1	shutdown	[illegible]

25 Disk Rotary Filter Data Sheet

Date: 2-5-08

Time hh:mm	Tank Level (gal)	Solids Loading (wt %)	Temp (F)	Conc. Press PG-1 (PSI)	Filtrate Press PG-2 (psi)	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed (hz)	Seal Temp (F)	Rotary Joint Temp (F)	Motor Current (amps)	Comments	Recorded by
0746	68	0.29	93	70	30	11.92	7.72	60	96	93.5	18.9	Started run	[illegible]
0800			92	70	30	11.93	7.80		92.6	92.5	19.0		[illegible]
0815			93	70	30	11.51	7.72		93.5	93.6	19.0		[illegible]
0830			94	70	30	11.51	7.79		95.5	93.5	19.3		[illegible]
0844			95	70	30	11.52	7.51		97.5	94.0	19.2	Pulled Filtrate Sample	[illegible]
0900			95	70	30	11.53	7.79		96.0	94.0	18.7		[illegible]
0915			93	70	30	11.52	7.72		97.6	94.0	19.3		[illegible]
0930			95	71	30	11.57	7.71		98.0	95.5	18.6		[illegible]
0945			93	70	30	11.52	7.71		99.0	95.0	19.3		[illegible]
1000			96	70	30	11.57	7.71		99.5	94.0	19.1		[illegible]
1015			96	70	30	11.59	7.71		100	95.0	19.1		[illegible]
1030			96	70	30	11.52	7.70		99.5	94.0	18.6		[illegible]
1045			93	70	30	11.53	7.70		99.8	94.5	19.0		[illegible]
1100			93	70	30	11.52	7.71		100.5	96.0	19.0	STOPPED RUN	[illegible]
1525			90	70	30	11.85	7.61		90.5	90.5	18.8	12.56 KW	[illegible]
[illegible]			93	70	30	11.77	7.61		97.5	95	15.2		[illegible]
1615			95	72	31	11.71	7.69		99	98.5	18.6	12.39 KW	[illegible]
1650			96	70	30	11.63	7.54		99.5	102	18.5		[illegible]
1720			95	70	30	11.72	7.51		100	100.5	19.2	12.63 KW	[illegible]
1740			95	70	30	11.56	7.52		99	100.5	18.8	12.38 KW	[illegible]

25 Disk Rotary Filter Data Sheet

Date: 2-06-08

Time hh:mm	Tank Level (gal)	Solids Loading (wt %)	Temp (F)	Conc. Press PG-1 (PSI)	Filtrate Press PG-2 (psi)	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed (hz)	Seal Temp (F)	Rotary Joint Temp (F)	Motor Current (amps)	Comments	Recorded by
0706	68	0.29	95	70	30	11.92	7.45	60	79.5	92.0	18.8	Started Run	[illegible]
0715			92	70	30	11.93	7.51		84.5	93.0	18.7		[illegible]
0730			95	70	30	11.91	7.52		94.5	94.0	19.0		[illegible]
0800			95	70	30	11.83	7.53		96.5	94.0	18.8		[illegible]
0815			95	70	30	11.59	7.59		99.0	96.5	18.9	Pulled filtrate sample	[illegible]
0830			95	70	30	11.50	7.56		100.5	96.0	19.1		[illegible]
0900			95	70	30	11.93	7.51		99.5	95.0	19.7		[illegible]
0915			96	70	30	11.32	7.51		98.5	95.5	18.5		[illegible]
0930			95	70	35	11.96	7.51		96.5	94.3	18.6		[illegible]
0945			95	70	30	11.81	7.51		97.5	90.0	18.5		[illegible]
1000			96	70	30	11.30	7.52		92.0	95.5	18.5		[illegible]
1030			96	70	30	11.33	7.53		92.5	95.0	18.3		[illegible]
1049			95	70	30	11.92	7.51		95.5	93.5	18.3		[illegible]
1100			95	70	30	11.91	7.43		96.5	95.0	18.5		[illegible]
1115			95	70	30	11.50	7.50		97.0	95.0	18.5		[illegible]
1130			95	70	30	11.83	7.50		96.0	94.5	18.5		[illegible]
1145			96	70	30	11.82	7.51		95.5	94.0	18.5		[illegible]
1200			95	70	30	11.92	7.50		96.5	94.5	18.5		[illegible]
1230			95	70	30	11.81	7.41		96.5	97.5	18.5	12.25 KW	[illegible]
1304			95	70	30	11.82	7.41		95.5	98.5	18.0		[illegible]
1330			95	70	30	11.86	7.41		99	101.5	18.5		[illegible]
1400			95	70	30	11.73	7.40		98	98	18.5	12.25 KW	[illegible]
1430			95	70	30	11.71	7.43		96	102	18.5	12.30 KW	[illegible]
1530			95	70	30	11.77	7.42		97.5	100	18.5		[illegible]
1625			95	70	30	11.73	7.43		96	98.5	18.7		[illegible]
1734			95	70	30	11.79	7.33		95.5	97.5	18.3		[illegible]
1825			95	70	30	11.72	7.32		95	100.5	18.5	12.31 KW 222840	[illegible]
1835			95	70	30	11.74	7.28		97	97.5	18.8		[illegible]

25 Disk Rotary Filter Data Sheet

Date: 2/7/05

Time hh:mm	Tank Level (gal)	Solids Loading (wt %)	Temp (F)	Conc. Press PG-1 (PSI)	Filtrate Press PG-2 (psi)	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed (hz)	Seal Temp (F)	Rotary Joint Temp (F)	Motor Current (amps)	Comments	Recorded by
7:50	68	0.75	82	70	30	11.96	7.19	60	77	82.5	19.0	12.77 KW	[illegible]
8:05	↓	↓	94	70	30	11.96	7.28	↓	91	93.5	19.0	12.53 KW	[illegible]
8:32			95	70	30	11.81	7.34		99	99.5	19.0		[illegible]
8:58			96	70	30	11.72	7.35		100	101	18.8	12.32 KW	[illegible]
9:20			95	70	30	11.67	7.30		97	97	18.5		[illegible]
~~1000~~												Shut down	[illegible]
1000			93	70	30	11.84	7.37		92.0	95.0	19.5	Started run	[illegible]
1015			96	70	30	11.85	7.33		97.5	96.0	19.6		[illegible]
1030			95	70	30	11.85	7.36		99.0	96.0	19.7		[illegible]
1049			95	70	30	11.86	7.36		99.3	96.0	19.1		[illegible]
1100			96	70	30	11.78	7.35		101.0	96.0	19.1		[illegible]
1115			96	70	30	11.83	7.37		99.0	96.0	19.5	~~Pulled Filtrate Sample~~	[illegible]
1130			95	70	30	11.86	7.37		95.5	93.5	19.5	Pulled Filtrate Sample	[illegible]
1145			96	70	30	11.86	7.35		96.0	94.0	19.5		[illegible]
1200			96	70	30	11.81	7.33		99.0	96.5	19.5		[illegible]
1215			95	70	30	11.81	7.32		101.0	99.5	19.6		[illegible]
1230			96	70	30	11.81	7.32		99.0	95.5	19.0		[illegible]
1310			97	70	30	11.86	7.32		94.5	100.5	18.5		[illegible]
1713			95	70	30	11.73	7.26		94	96	18.4	12.24	[illegible]
1738			95	70	30	11.91	7.18					Filtrate Sample pulled 17:25	[illegible]
1800			96	70	30	11.83	7.25		96	99.5 (~~98.5~~)	18.4		[illegible]
1815			95	70	30	11.75	7.18		99	101.5	18.5		[illegible]
1830			95	70	30	11.81	7.14		98.5	100.5	18.5	12.29 KW	[illegible]
1845			95	70	30	11.81	7.22		96.5	99	18.5	12.29 KW	[illegible]
~~0800~~			2-8-05										
0900			84	70	30	11.57	6.90		93.0	93.5	19.1	Started Run	[illegible]
0919			101	70	30	11.75	7.13		94.5	101.0	15.3		[illegible]
0830			99	70	30	11.58	7.30		97.5	95.5	15.3		[illegible]
0900	↓	↓	97	70	30	11.62	7.22	↓	95.0	96.0	19.5	Pulled Filtrate Sample	[illegible]
~~0930~~													[illegible]
0943			96	70	30	11.92	7.22		98.5	98.5	19.4		[illegible]
1000			96	70	30	11.93	7.21		97.3	98.3	18.4	Pulled Feed Sample	[illegible]

25 Disk Rotary Filter Data Sheet

Date: 2-7-08

Time hh:mm	Tank Level (gal)	Solids Loading (wt %)	Temp (F)	Conc. Press PG-1 (PSI)	Filtrate Press PG-2 (psi)	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed (hz)	Seal Temp (F)	Rotary Joint Temp (F)	Motor Current (amps)	Comments	Recorded by
1015	68	0.29	96	20	30	11.78	2.21	60	96.0	94.5	18.4		[illegible]
1030			96	20	30	11.81	2.20		95.0	94.5	18.4		[illegible]
1046			96	20	30	11.81	2.19		95.5	94.3	18.4		[illegible]
1100			95	20	30	11.82	2.20		95.5	94.0	18.4		[illegible]
1130			96	20	30	11.81	2.20		95.5	94.3	18.4		[illegible]
1145			96	20	30	11.80	2.21		95.0	94.0	18.4		[illegible]
1200			96	20	30	11.81	2.22		96.0	94.5	18.4		[illegible]
1215			95	20	30	11.81	2.21		95.5	94.5	18.4		[illegible]

25 Disk Rotary Filter Data Sheet

Date: 2-11-08

Time hh:mm	Tank Level (gal)	Solids Loading (wt %)	Temp (F)	Conc. Press PG-1 (PSI)	Filtrate Press PG-2 (psi)	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed (hz)	Seal Temp (F)	Rotary Joint Temp (F)	Motor Current (amps)	Comments	Recorded by
0718	65	1.29	72	70	30	11.93	6.51	60	67.0	72.0	19.6	Started run	[illegible]
0831			83	70	30	11.91	6.69		80.8	89.5	19.1		[illegible]
0845			87	70	30	11.96	6.95		90.5	92.5	19.5	12.52 KW	[illegible]
0900			91	70	30	11.95	6.89		93	95	19.2		[illegible]
0915			93	70	30	11.89	6.93		96.0	93.5	19.2		[illegible]
0930			93	70	30	11.91	6.92		96.0	94.5	19.6	Pulled Filtrate Sample	[illegible]
0945			95	70	30	11.93	6.73		95.5	94.0	19.5	Pulled Feed Sample	[illegible]
1000			95	70	30	11.90	6.96		96.2	94.5	19.6		[illegible]
1015			93	70	30	11.92	6.96		96.5	95.0	19.7		[illegible]
1030			96	70	30	11.93	6.99		97.0	95.5	19.6		[illegible]
1045			95	70	30	11.91	6.94		97.5	95.0	19.7		[illegible]
1100			95	70	30	11.92	6.92		101.3	96.3	19.2		[illegible]
1115			96	70	30	11.92	6.93		101.5	96.5	19.2		[illegible]
1130			96	70	30	11.90	6.89		102.5	96.5	19.0		[illegible]
1145			96	70	30	11.90	6.90		102.5	96.5	19.5		[illegible]
1200			96	70	30	11.90	6.91		102.5	97.0	19.7		[illegible]
1218			97	70	30	11.86	6.93		100.5	95.0	19.1	STOPPED RUN	[illegible]
1529			91	70	30	11.95	7.00		80	90.5	19.0	restart 17.71 KW	[illegible]
1547			9_	70	30	11.86	6.75		55.5	58.5	18.9		[illegible]
1605			95	70	30	11.98	6.84		55.5	58.0	18.9	Vibration measurements	[illegible]
1640			96	70	30	11.85	6.84				19.6	" chiller to 66.0	[illegible]
1647			95	70	30	11.74	6.77				19.4	shutdown	
1836			93	70	30	11.54	7.00				18.7		
1845			95	62	35	11.43	7.10						

25 Disk Rotary Filter Data Sheet

Date: 2-12-08

Time hh:mm	Tank Level (gal)	Solids Loading (wt %)	Temp (F)	Conc. Press PG-1 (PSI)	Filtrate Press PG-2 (psi)	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed (hz)	Seal Temp (F)	Rotary Joint Temp (F)	Motor Current (amps)	Comments	Recorded by
0930	65	1.29	80	70	30	11.92	6.36	60	72	79	19.1	Started run	[illegible]
0945			90	70	30	11.99	6.57		87.5	90.5	19.0		[illegible]
0900			92	70	30	11.94	6.67		91.5	92.5	19.2		[illegible]
0915			94	70	30	11.94	6.60		93.3	93.0	17.9		[illegible]
0930			94	70	30	11.91	6.60		95.0	93.5	18.7	Pulled Filtrate Sample	[illegible]
0945			93	70	30	11.93	6.59		95.0	94.0	18.7		[illegible]
1015			93	70	30	11.91	6.63		99.5	97.0	17.8		[illegible]
1030			95	70	30	11.94	6.60		100.5	99.5	19.2		[illegible]
1045			95	70	30	11.89	6.59		100.0	97.5	19.5		[illegible]
1100			95	70	30	11.94	6.54		100.5	96.0	19.6		[illegible]
1115			95	70	30	11.90	6.59		100.5	97.5	17.9		[illegible]
1130			95	70	30	11.91	6.53		100.5	96.5	18.7		[illegible]
1145			95	70	30	11.96	6.52		100.5	95.5	19.7	Shut down	[illegible]
1300			94	70	30	11.90	6.63		93.0	94.5	18.6	Started run	[illegible]
1315			95	70	30	11.91	6.53		97.5	96.5	19.9		[illegible]
1345			96	70	30	11.97	6.48		97.5	99.5	19.2		[illegible]
1400			96	70	30	11.97	6.46		96.5	94.5	18.7	Pulled Filtrate Sample	[illegible]
1415			95	70	30	11.91	6.44		96.5	94.5	18.7		[illegible]
1430			96	70	30	11.90	6.46		96.5	94.5	18.6		[illegible]
1500			95	70	30	11.92	6.44		96.5	94.5	18.7		[illegible]
1515			93	70	30	11.84	6.34		96.0	94.5	18.6	~~Shut down~~	[illegible]
1520						Shut down							[illegible]

25 Disk Rotary Filter Data Sheet

Date: 2/13/08

Time hh:mm	Tank Level (gal)	Solids Loading (wt %)	Temp (F)	Conc. Press PG-1 (PSI)	Filtrate Press PG-2 (psi)	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed (hz)	Seal Temp (F)	Rotary Joint Temp (F)	Motor Current (amps)	Comments	Recorded by
8:48	65	1.77	80	70	30	11.73	6.14	60	79.5	80.5	15.3	checked coupling alignment 12.96 KW	[illegible]
902			90	70	30	11.73	6.34		86	93	18.6		[illegible]
9:30			93	70	30	11.81	6.34		94	98.5	18.8		[illegible]
1000			94	70	30	11.80	6.37		96.0	99.0	19.8		[illegible]
1030			95	70	30	11.79	6.38		100.5	96.0	19.8	Pulled Filtrate Sample	[illegible]
1045			95	70	30	11.73	6.34		100.0	96.0	19.3		[illegible]
1100			95	70	30	11.81	6.35		101.0	96.5	19.7		[illegible]
1120			96	70	30	11.81	6.22		98	101	18.9	12.55 KW	[illegible]
1145			95	70	30	11.77	6.34		97	97.5	19.7		[illegible]
1200			95	70	30	11.72	6.35		96.5	95.0	19.0		[illegible]
1215			96	70	30	[illegible]	6.31		99.0	95.0	19.3		[illegible]
1230			96	70	30	11.82	6.33		100.0	95.5	19.2		[illegible]
1245			96	70	30	11.83	6.34		99.5	95.0	18.9		[illegible]
1300			96	70	30	11.84	6.31		99.5	95.5	18.8		[illegible]
1330			96	70	30	11.71	6.30		99.0	96.0	19.1		[illegible]
1345			96	70	30	11.82	6.29		98.0	95.5	19.0		[illegible]
1400			96	70	30	11.80	6.28		99.0	95.5	19.6		[illegible]
1415			96	70	30	11.79	6.23		99.5	95.5	19.1		[illegible]
1430			96	70	30	11.79	6.27		100.5	95.5	19.2	Pulled Filtrate Sample	[illegible]
~~1445~~			~~95~~										[illegible]
1450			96	70	30	11.80	6.18		97.5	93.0	19.1		[illegible]
1500			96	70	30	11.81	6.17		100.5	96.0	19.1		[illegible]
1515			96	70	30	11.82	6.22		100.0	96.0	19.5		[illegible]
1530			96	70	30	11.79	6.29		100.0	96.0	19.1	chiller to 65 °F	[illegible]
1607			96	70	30	11.86	6.10					chiller to 68.0° 12.74 KW	[illegible]
1650			95	70	30	11.78	6.26		98	100	19.3		[illegible]
1737			95	70	30	11.79	6.15		98.5	98.5	19.3		[illegible]
1818			95	70	30	11.77	6.18		99.5	99.5	19.7	shutdown	[illegible]

25 Disk Rotary Filter Data Sheet

Date: 2-15-08

Time hh:mm	Tank Level (gal)	Solids Loading (wt %)	Temp (F)	Conc. Press PG-1 (PSI)	Filtrate Press PG-2 (psi)	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed [hz)	Seal Temp (F)	Rotary Joint Temp (F)	Motor Current (amps)	Comments	Recorded by
1223	65	1.27	70	70	30	11.87	5.57	60	76.5	73.5	19.2	Started run	[illegible]
1300			[illegible]	[illegible]	30	11.72	5.77		99.0	96.0	19.2		[illegible]
1315			99	70	30	11.81	5.83		100.5	96.5	19.1		[illegible]
1330			96	70	38	11.78	6.13		101.5	96.5	19.1		[illegible]
1345			96	70	30	11.81	6.20		100.5	95.5	19.3	Pulled filtrate sample	[illegible]
1400			96	70	30	11.79	6.15		99.5	94.5	19.2		[illegible]
1415			95	70	30	11.78	6.13		99.5	94.5	19.3	Shut down	[illegible]

25 Disk Rotary Filter Data Sheet

Date: ~~2/29~~ 2/19

Time hh:mm	Tank Level (gal)	Solids Loading (wt %)	Temp (F)	Conc. Press PG-1 (PSI)	Filtrate Press PG-2 (psi)	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed (hz)	Seal Temp (F)	Rotary Joint Temp (F)	Motor Current (amps)	Comments	Recorded by
~~14:52~~ 1352	65	1.29	67	70	30	11.91	5.63	60	68	70.5	20.0	13.46 KW	[illegible]
14 10	65		86	70	30	11.65	5.82	6.12	83	90.5	19.1	12.67 KW	[illegible]
1420			95	70	30	11.69	5.99		89	95.5	16.8	12.41 KW [illegible]	[illegible]
1521			94	70	30	11.38	5.95		96	99.5	19.4	12.53 KW	[illegible]
1614			94	70	30	11.63	5.84		98	96	18.7	12.53 KW	[illegible]
1642			94	70	30	11.79	6.01		95.5	98.5	18.7	chiller Tc 64.7	[illegible]
1715			95	70	30	11.70	5.57		98	96.5	18.8	Sample filtrate	[illegible]
1738			96	70	30	11.64	5.93		96.5	100	15.5	shut down	[illegible]

25 Disk Rotary Filter Data Sheet

Date: 2-20-08

Time hh:mm	Tank Level (gal)	Solids Loading (wt %)	Temp °F)	Conc. Press PG-1 (PSI)	Filtrate Press PG-2 (psi)	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed (hz)	Seal Temp (F)	Rotary Joint Temp (F)	Motor Current (amps)	Comments	Recorded by
0913	60	1.29	79	70	30	11.93	5.58	60	69	77.5	19.5	STARTED RUN	[illegible]
0930			93	70	30	11.87	5.92		94.5	93.0	19.9		[illegible]
0945			94	70	30	11.92	6.10		91.0	92.9	19.1		[illegible]
0900			94	70	30	11.90	6.10		93.0	93.8	19.1		[illegible]
0913			94	70	30	11.82	6.06		94.3	93.3	19.4	Pulled Filtrate Sample	[illegible]
0930			93	70	38	11.78	6.11		96.0	94.8	19.0		[illegible]
945			94	70	30	11.84	6.17		96.5	88	19.0	17.67 KW [illegible] 64.6	[illegible]
1000			94	71	30	11.82	6.11		98.8	88.5	19.0		[illegible]
1015			95	70	30	11.78	6.11		97.0	97.0	19.2		[illegible]
1030			95	70	30	11.76	6.07		98.0	98.0	19.2		[illegible]
1045			95	70	30	11.77	6.11		98.5	97.0	19.2		[illegible]
1100			95	70	30	11.79	6.16		95.5	97.0	18.9		[illegible]
11:19			95	70	30	11.79	6.19		98.5	98	19.3	12.52 KW	[illegible]
11:35			95	70	30	11.74	6.07		97	97	19.9	12.52 KW	[illegible]
1200			95	70	30	11.77	6.06		—	—	19.7		[illegible]
1215			95	70	30	11.77	6.05		—	—	19.0		[illegible]
1230			95	70	30	11.72	6.01		—	—	19.3		[illegible]
1245			95	70	30	11.77	6.06		97.3	94.5	18.9		[illegible]
1300			95	70	30	11.78	6.03		96.0	94.0	18.7		[illegible]
1330			95	70	30	11.79	6.07		95.5	94.0	18.9		[illegible]
1345			94	70	30	11.73	6.02		97.5	94.0	19.4		[illegible]
1400			95	70	30	11.70	6.09		96.0	94.5	18.8	Pulled Filtrate Sample	[illegible]
1430			95	70	30	11.72	6.07		98.0	94.5	19.1		[illegible]
1445			95	70	30	11.70	6.03		98.5	94.5	19.3		[illegible]
1500			95	70	30	11.73	6.09		98.5	95.0	19.3		[illegible]
1515			95	70	30	11.76	6.07				19.6		[illegible]
1557			95	70	30	11.68	5.94		97.5	95.5	15.1	12.66 KW	[illegible]
1700			95	70	30	11.77	5.86		97.5	97.5	13.6		[illegible]
[illegible]			95	70	30	11.76	5.92		97.5	98.5	13.3		[illegible]

25 Disk Rotary Filter Data Sheet

Date: 2-21-08

Time hh:mm	Tank Level (gal)	Solids Loading (wt %)	Temp (F)	Conc. Press PG-1 (PSI)	Filtrate Press PG-2 (psi)	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed (hz)	Seal Temp (F)	Rotary Joint Temp (F)	Motor Current (amps)	Comments	Recorded by
1235	60	1.79	86	70	30	11.82	5.52	60	66.0	72.5	19.6	Started Run	[illegible]
1243			85	70	30	11.85	5.71		77.5	86.5	19.3		[illegible]
1300			90	70	30	11.79	5.31		86.5	90.5	19.2		[illegible]
1320			92	70	30	11.77	5.36		92.5	91.5	19.4		[illegible]
1330			93	70	30	11.78	5.92		93.0	92.5	19.2		[illegible]
1344			94	70	30	11.79	5.92		96.5	95.0	19.2	Pulled Filtrate Sample	[illegible]
1400			94	70	30	11.80	5.95		92.5	94.0	19.1		[illegible]
1415			95	70	30	11.91	5.95		95.0	96.0	19.1		[illegible]
1430			94	70	30	11.50	5.94		99.0	95.5	19.1		[illegible]
1445			95	70	30	11.54	5.93		96.5	96.5	19.1		[illegible]
1500			93	70	30	11.72	5.97		97.5	95.0	19.1		[illegible]
1525			95	70	30	11.83	5.72		91.3	94.5	19.1		[illegible]
1606			95	70	30	11.34	5.57		98	101.5	19.1	12.66 KW	[illegible]
1645			95	70	30	11.36	5.86		97	102.5	19.0		[illegible]
1739			94	70	30	11.37	5.53		98	99.5	19.0	Shutdown	[illegible]

25 Disk Rotary Filter Data Sheet

Date: 1/27

Time hh:mm	Tank Level (gal)	Solids Loading (wt %)	Temp (F)	Conc. Press PG-1 (PSI)	Filtrate Press PG-2 (psi)	Feed Flow (mA)	Filtrate Flow (mA)	Rotor Speed (hz)	Seal Temp (F)	Rotary Joint Temp (F)	Motor Current (amps)	Comments	Recorded by
												0.010" shims for disk	
1125	60	1.25	71	70	30	11.72	5.72	60	76	74	14.2	13.19 KW	[illegible]
1145	60		88	70	30	11.75	5.81		86	90	15.5	12.92 [illegible] after reading	[illegible]
1205			92	70	30	11.70	5.91		94	94	15.3	feed + filtrate sample taken	[illegible]
1225			93	70	30	11.72	5.83		97	96.5	15.1		[illegible]

Appendix B: Solid Particles