ARCADIS Design & Consultancy for natural and built assets

ALLEGHENY COUNTY SANITARY AUTHORITY

WET WEATHER PLANT EXPANSION PROGRAM

CAPITAL PROJECT S430

WAS Thickening Pilot

February 2022 – Updated on April 4, 2022

This Page Left Intentionally Blank.

CONTENTS

FIGURES

TABLES

APPENDICES

1 WASTE ACTIVATED SLUDGE PILOT PLAN

The purpose of this document is to describe the Waste Activated Sludge (WAS) pilot testing that was conducted from September 2021 through November 2021, summarize the results and lessons learned, and provide recommendations to facilitate the WAS Thickening design as part of ALCOSAN's Wet Weather Plant Expansion Program.

Currently, WAS is co-settled in the primary clarifiers. However, according to ALCOSAN's Wet Weather Plan (WWP), the Wet Weather Plant Expansion Program will substantially increase flows through primary treatment increasing the hydraulic loading on the primary clarifiers. Initially, the WWP provides for an increase of plant capacity from 250 million gallons per day (MGD) to 480 MGD. Ultimately, with the addition of the Regional Tunnel System (RTS), the Wet Weather Pump Station (WWPS), and two additional primary sedimentation tanks the Woods Run WWTP capacity will be increased to 600 MGD (through primary treatment only). As a result of the increased flows, co-settling WAS will no longer be possible in the primary clarifiers. Therefore, WAS will need to be thickened separately from the primary sludge, resulting thickened WAS (TWAS). TWAS will be blended with the primary sludge in the dewatering wet well.

ALCOSAN selected a centrifuge as the means to thicken the WAS. This decision was based on the low mixed liquor concentration (4,000 to 6,000 (mg/L) of total suspended solids (TSS)) at ALCOSAN's WWTP as compared to other similarly sized wastewater treatment plants which results in a low WAS concentration. As a result, during the Basis of Design (BOD), it was anticipated that the average volume of sludge to be thickened would likely be high (approximately 2000 gpm). Since the completion of the BOD, flow meters were installed on the WAS headers. Based on this new data, the average total throughput is expected to be approximately 1000-1200 gpm. Thickening centrifuges can handle the high hydraulic load and throughput required for this application. However, at times, operations tend to waste more (approximately 1200-1600 gpm on each side) for shorter time periods to achieve a target mixed liquor concentration in the aeration tanks. This needs to be considered during design and procurement.

Table 1 shows information obtained from WAS flow data between February 16, 2020, and February 16, 2022, as received from ALCOSAN. During normal operation, ALCOSAN wastes sludge using 1 WAS pump on each side. Existing WAS pumps have a capacity of 600 gpm with a total of 3 pumps per side. Based on this data, Arcadis defined average conditions as a total WAS flow of 1200 gpm and peak conditions as a total WAS flow of 3600 gpm.

Table 1 WAS Flow Data

Flow Condition	East WAS Flow (gpm)	West WAS Flow (gpm)
Average	484	461
Peak	1577	1246

The primary objective of the pilot is to establish the expected performance criteria for the full-scale thickening installation. The objective is to demonstrate that total suspended solids concentration of the WAS can be increased from less than 1% to 4-6% solids. The pilot testing was expected to confirm if that target can be achieved and to provide other valuable process insights. This document is intended to supplement the Final Design Consultant (FDC) project knowledge and aid in developing the performance requirements for the process design.

During the pilot, three vendors conducted the testing:

a. Andritz – D4L Centrifuge
    i. September 20 – October 1, 2021
b. Centrisys – CS18-3 Skid Mounted THK200 Centrifuge
    i. October 12 – 22, 2021
c. Alfa Laval – G3-75 Centrifuge
    i. November 8 – 19, 2021

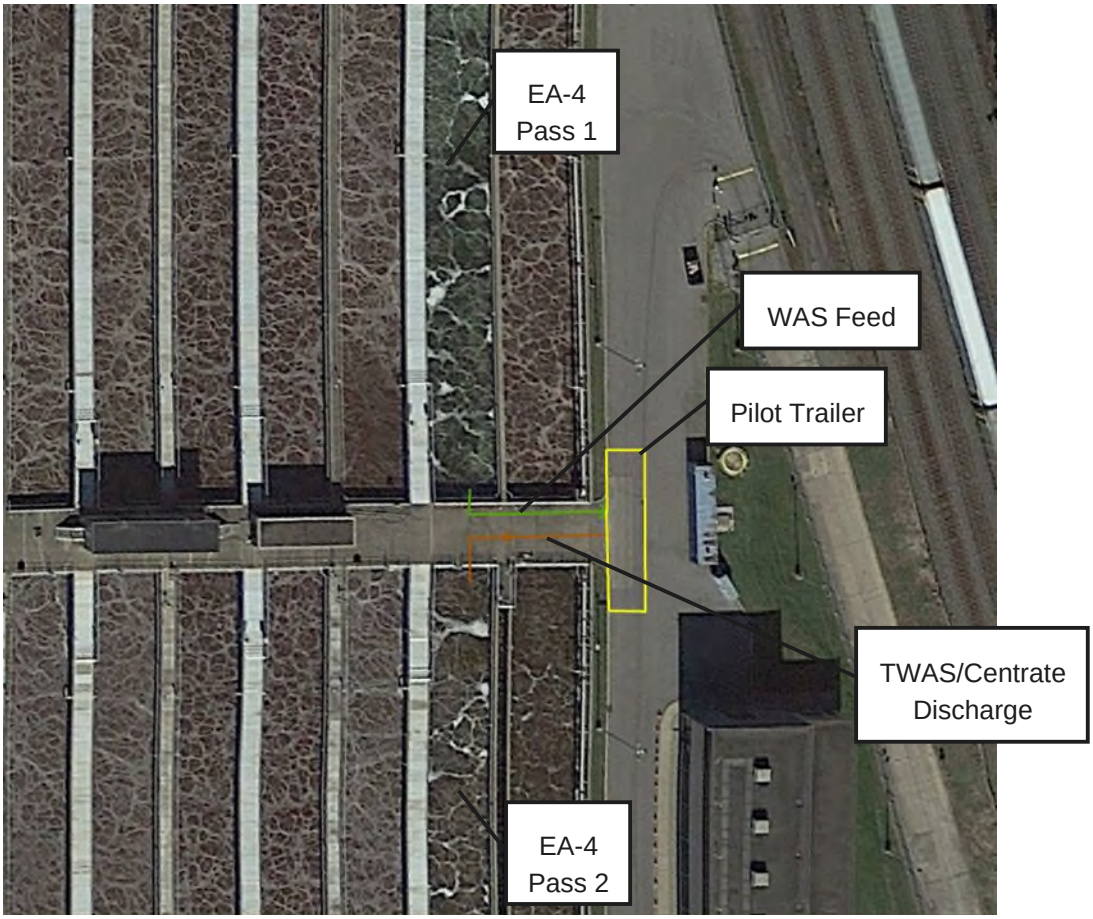
Each vendor operated their own equipment for a period of two working weeks. An average of 5-7 test runs were performed daily during that time period, excluding days required for pilot set up, utility hookups and subsequent disconnection. Each test run consisted of three (3) samples: WAS Feed, TWAS Discharge, Centrate Discharge. Each sample was split to be analyzed between a third-party independent testing laboratory (Eurofins Test America, Pittsburgh) and the vendor's own testing capabilities in the field to help them adjust the pilot unit parameters to achieve the desired performance. The vendors used their own scale, oven, and other bench lab equipment to perform on-site analyses.

In order to provide meaningful data, the following analyses were required for each test from Eurofins Test America:

a. WAS Feed:
    i. Total Solids (% TS)
    ii. Total Suspended Solids (% TSS)
    iii. Non-Volatile Solids (%)
b. TWAS Discharge:
    i. Total Solids (% TS)
    ii. Non-volatile (%)
c. Centrate Discharge:
    i. Total Suspended Solids (% TSS)

The pilot trailer was located to the east of EA-4 aeration tank as shown in Figure 1 to accommodate on-going construction requirements, proximity to required utilities to run the pilot and to the feed/discharge locations. The WAS feed to the pilot unit was drawn from the southern end of Pass 1 of EA-4 aeration tank. Currently, RAS flow from the final settling tanks is discharged at the northern end of Pass 1 of each aeration tank and WAS pumps waste the sludge from the southern end of Pass 1. The TWAS discharge and centrate discharge streams were both discharged to Pass 2 of EA-4 aeration tank.

Figure 1 WAS Pilot Trailer Location



Some key parameters that were evaluated during the pilot testing program are:

- Footprint required
- Low to no polymer consumption
- Low power consumption
- Desired performance – Thickened WAS in the range of 4-6% (TS)
- High hydraulic loading capacity – 1000 to 1200 gpm

The objectives of the pilot were:

1. To evaluate different equipment parameters (different pond levels, different speeds and/or G forces) without the use of polymer and optimize the centrifuge performance at the desired level.
2. To evaluate performance with and without a polymer and determine at which dosage rate the best results can be achieved.
3. To confirm centrifuge technology can achieve thickened WAS performance parameters.

To increase the solids recovery performance of the thickening centrifuge, there are three parameters that can be adjusted depending on the vendor's technology. First, the particle size of the solids can be increased. Polymer usage is the primary pathway available for this, and the cost of polymer is the

economic limit to this approach. Second, the G force applied to the feed by the bowl can be increased. Bowl speed is the control pathway for this, and the cost of power is the economic limit. Third, the residence time of the sludge in the unit can be increased. Larger capacity units or reduced flowrates are pathways to increase residence time. Capital costs and footprint of larger units along with increased power consumption are the economic limits to these pathways.

The operational costs of running the unit were determined on a basis of dry tons of WAS processed. An electricity price of $0.09 per kWh and a polymer price of $3.00 per active pound were used to estimate operational costs per dry ton of WAS processed at the sample conditions.

1.1 RESULTS DISCUSSION

In general, the pilot centrifuges were able to achieve thickening of solids to 4-6% TS. Occasionally, there were high or low outliers, but those results could be attributed to errors in sampling, analysis and/or human error. The pilot reports and additional information received from all three vendors are shown in Appendix A and a spreadsheet showing the test runs analyses received from Eurofins Test America can be found in Appendix B. Pilot testing photos can be found in Appendix C.

Andritz

The D4L Centrifuge from Andritz was able to achieve the desired results for this application.

Principle of Operation: Centrifugal force created by the rotation of the bowl forces solids particles to separate from the liquid and move away from the machine axis toward the bowl wall. The scroll conveyor located inside the bowl, rotates at a slightly faster speed than the bowl. The compacted solids along the bowl wall are advanced by the scroll conveyor to the tapered end of the bowl where they are discharged. The clarified liquid flows in the opposite direction from the solids, along the center axis, and overflows the adjustable weirs located in the liquid head. Centrate exits the machine through the liquid discharge compartment in the case bottom.

Pilot Results:

- At throughputs of 70 to 135 gpm, the pilot achieved thickened solids between 3 to 12% (TS) with and without the use of polymer.
- A polymer dosage rate of 3 (range of 2-4) active pounds of polymer per dry ton of sludge solids (active lbs/ton TS) was determined to be the optimum dosage for this application using Solenis 8846 FS, a high cationic charged density, high molecular weight, emulsion polyelectrolyte that was 40% active.
- With the use of polymer, the capture rate was an average of 99% and 95% on average without the use of polymer (see test runs # 26 through 35). Adding the polymer right before the WAS feed enters the centrifuge, allows for proper mixing of the polymer with the feed for optimum performance.
- A feed grinder was used to prevent large particles of plastics or rags from entering the centrifuge.
- The optimum G force was found to be in the range of 1800 – 1900 X G’s.

Figure 2 Andritz Decanter Centrifuge

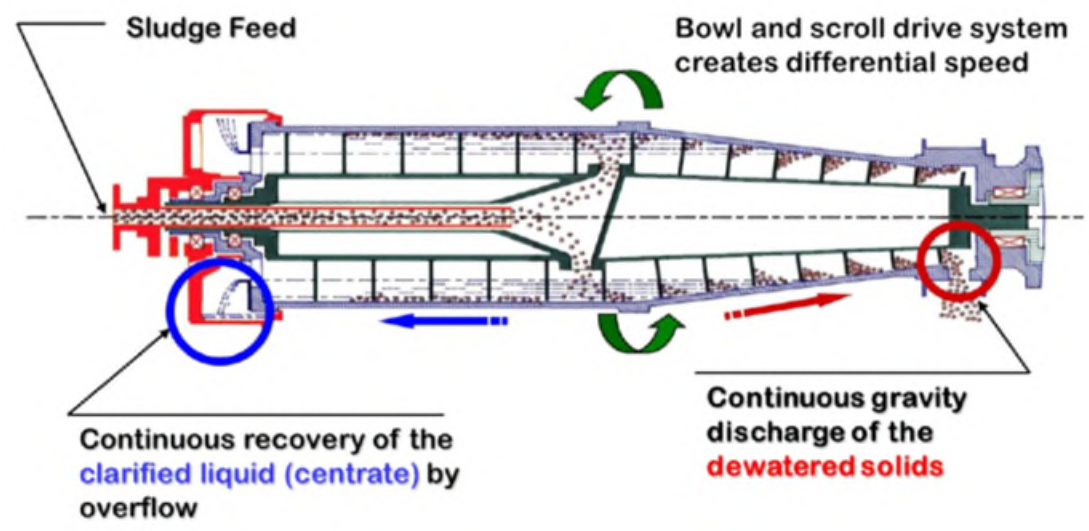


Table 2 Andritz D4L Centrifuge Performance

Feed Throughput (gpm)	TWAS (% TS)	Polymer Active Dosage Rate (lbs/DT)	Solids Capture Rate (%)	Power (kW/gpm)
135	4 – 7	None	>= 95	0.113
135	4 – 7	3	>= 98	0.115

Refer to Appendix E for the Vendor's full-scale recommendation and expected performance. Based on the pilot results, Andritz provided the following:

- Three (3) operating D12LL units (1400 gpm throughput each) and a single standby.
- A single unit can handle the normal loading of 1200gpm, however, ALCOSAN may choose to operate two (2) units at a lower throughput to avoid constantly operating at the upper limit of the centrifuge.
- The full-scale specific power consumption for the D12LL is between 0.3 to 0.5 kW/gpm.
- This unit is expected to achieve 93-95% capture and between 4-6% solids with no polymer.
- With polymer, these values increase to >95% capture and 6-7% solids.
- Estimated polymer usage is 3+/-1 active lbs/DT.
- Total installed horsepower is 575hp.
- Budgeted Costs $1,875,000 each or $7,500,000 total capital investment.

Centrisys

Pilot testing was carried out on Centrisys' THK200 mobile test skid and was able to achieve the desired results for this application.

Principle of Operation: A THK Series unit is specifically engineered to achieve high-performance thickening of biosolids and is dedicated to work as a thickener. During operation, sludge is continuously fed into the unit. The moving shaft has a set of helical scrolls, which push the solid waste towards one end, away from the liquid moving in the opposite direction. It is important to note that Centrisys using a patented hydro-pneumatic control technology using compressed air to produce desired thickening levels. Using injection of air into the thickened solids blanket, coupled with the centrifugal force, adjustment of the cake solids consistency can be made by a plant operator as desired to modify the cake solids consistency without any mechanical adjustments or shutting down the unit.

Pilot Results:

- The THK200 was able to thicken the WAS feed without polymer use to 6% solids (TS) with a capture rate of 94.7% solids recovery at a throughput of 230 gpm.
- To evaluate the performance improvement with polymer usage, the skid mounted Velodyne polymer system was used to dilute and dose emulsion polymer. The polymer used during testing was Solenis K144L, a high charge-density cationic linear emulsion polymer.
- With an active polymer dose of 1.5 lbs/DT, the solids capture rate was increased to 98.1% while maintaining performance and lowering power consumption.
- However, the variable air-injection of the THK200 system was critical in maintaining precise control of TWAS TS in the 5 – 6% range.

The THK200 can achieve the desired WAS thickening performance of 6% TS without polymer addition required at 230 GPM and low power consumption. With a small polymer dose, the solids capture rate can be increased to 98% with a 25% increase in operation costs.

Figure 3 Centrisys THK Thickening Centrifuge

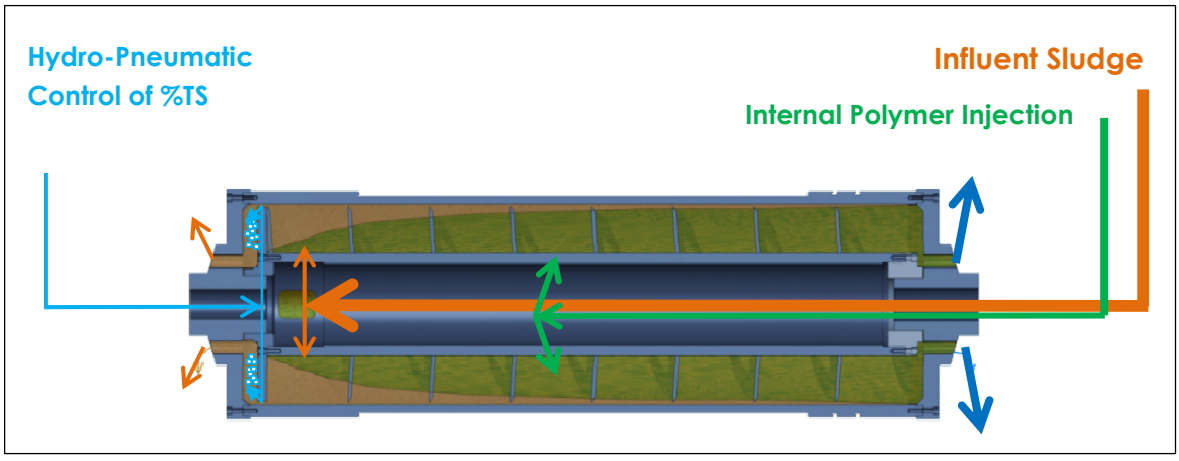


Table 3 Centrisys THK200 Centrifuge Performance

Feed Throughput (gpm)	TWAS (% TS)	Polymer Active Dosage Rate (lbs/DT)	Solids Capture Rate (%)	Power (kW/gpm)
230	6.2	None	94.7	0.086
230	6.0	1.50	98.1	0.066

Refer to Appendix E for the Vendor's full-scale recommendation and expected performance. Based on the pilot results, Centrisys provided the following:

- Three (3) operating THK600 units (1200 gpm throughput each) and a single standby.
- A single unit can handle the normal loading of 1200gpm, however, ALCOSAN may choose to operate two (2) units at a lower throughput to avoid constantly operating at the upper limit of the centrifuge.
- The full-scale specific power consumption for the THK600 is between 0.07 to 0.1 kW/gpm.
- This unit is expected to achieve >90-95% capture and at 6% solids with no polymer.
- With polymer, these values increase to >95% capture and 6% solids.
- Estimated polymer usage is 0-1.5 active lbs/DT.
- Total installed horsepower is 225hp.
- Budgeted Costs $797,800 each or $3,191,200 total capital investment.

Alfa Laval

Alfa Laval carried out pilot testing with the G3-75 trailer mounted centrifuge system and was able to achieve the desired results for this application.

Principle of Operation: Separation takes place in a horizontal cylindrical bowl equipped with a screw conveyor. The feed enters the bowl through a stationary inlet tube and is accelerated smoothly by an inlet distributor. The centrifugal force that results from this rotation then causes sedimentation of the solids on the wall of the bowl. The conveyor rotates in the same direction as the bowl, but slightly slower, thus moving the solids towards the conical end of the bowl. The cake leaves the bowl through the solids discharge openings into the casing. Separation takes place throughout the entire length of the cylindrical part of the bowl, and the clarified liquid leaves the bowl by flowing over power tubes into the casing.

Pilot Results:

- At a throughput of 100 gpm, the pilot achieved thickened solids between 3 to 12% (TS) without the use of polymer.
- Polymer was not used by Alfa Laval during this pilot because the polymer system for the unit was too large making the process of dosing and result not accurate. In the opinion of Alfa Laval, the quality of the WAS feed does not require much polymer, if any, to achieve desired separation.
- Without the use of polymer and at optimum equipment settings, the capture rate was around 94-95%.

- The pilot unit achieved desired performance with a differential speed of 7 rpm, a bowl speed of 2400 rpm, and a neutral (0) pond setting.
- A feed grinder was used to ensure all particles entering the centrifuge were less than 0.25 inches to keep plastics or rags out of the centrifuge.

Figure 4 Alfa Laval G3 Decanter Centrifuge

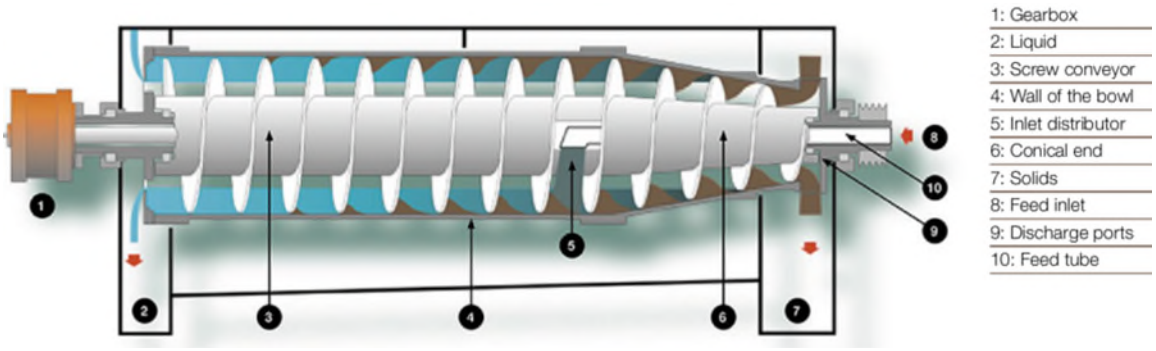


Table 4 Alfa Laval G3-75 Centrifuge Performance

Feed Throughput (gpm)	TWAS (% TS)	Polymer Active Dosage Rate (lbs/DT)	Solids Capture Rate (%)	Power (kW/gpm)
100	4.6 – 5.6	None	94 – 95	0.083

Refer to Appendix E for the Vendor's full-scale recommendation and expected performance. Based on the pilot results, Alfa Laval provided the following:

- Three (3) operating ALDEC G3-165 units (1200 gpm throughput each) and a single standby.
- A single unit can handle the normal loading of 1200gpm, however, ALCOSAN may choose to operate two (2) units at a lower throughput to avoid constantly operating at the upper limit of the centrifuge.
- The full-scale specific power consumption for the ALDEC G3-165 is between 0.23 to 0.31 kW/gpm.
- This unit is expected to achieve 85% capture and at 4-6% solids with no polymer at 600 gpm only. The manufacturer is unable to operate within the criteria at 1200 gpm with no polymer.
- With polymer, these values increase to 90-95% capture and 5-6% solids.
- Estimated polymer usage is 5-6 active lbs/DT.
- Total installed horsepower is 340hp.
- Budgeted Costs $997,000 each or $3,988,000 total capital investment.

Table 5 presents a comparison of all three vendors based on their pilot performance and results, their recommended scale up centrifuges models, and other information provided by the vendors for average WAS flows. The approximate layout of the recommended scale up models from each vendor can be found in Appendix D.

Table 5 Comparison of Vendors based on Pilot Performance (average conditions)

Key Parameter	Andritz	Centrisys	Alfa Laval
Scale Up Model	D12LL, (1400 gpm each)	THK600 (1200 gpm each)	ALDEC G3-165 (1200 gpm each)
Performance (4-6% TS)	Yes	Yes	Yes
Footprint (in.)	326 x 85 x 93	285 x 61 x 76	342 x 81 x 89
Expected Lead Time	4-6 weeks (submittal) + 60-70 weeks	4-6 weeks (submittal) + 30-32 weeks	8-12 weeks (submittal) 40 weeks
Total Centrifuge Cost per unit	$1,875,000	$797,800	$997,000
Main Motor Demand (HP)	500	200	300
Secondary Motor Demand (HP)	75	25	40
Total units (duty + standby, average)	2+2	2+2	2+2
Total units (duty + standby, peak)	3+1	3+1	3+1
Total Equipment Cost (all units, peak)	$7.5M	$3.1912M	$3.988M
Expected Unit Operating Cost ($/DT)*	$36.83 – $63.39	$7.19 – $14.78	$38.64 – $49.86
Expected Service Life	20-30 years	25 years	20+ years
Maintenance Frequency (Appendix A)	Drive/scroll thrust bearings to be replaced every 12,000 hours of operation. Internal gear box parts to be replaced at 24,000 hours of operation.	Rotating assembly to be inspected every 15,000 hours of operation or 5 years.	Gaskets, O-rings, V-belts to be replaced every 16,000 hours of operation or 4 years.
Closest Service Center	Scott Depot, WV	Kenosha, WI	Chesapeake, VA

*Pilot vendors provided recommended scale-up models and baseline expected performance data based on the WAS data presented in Table 1. The calculated costs are estimates based on pilot testing results, observed feed conditions, units sized to cover a broad operating capacity and information provided by vendors. The unit operating costs were calculated for a throughput of 1200 gpm and 0.35% WAS feed TS and have not been confirmed.

The pilot testing program provided the following insights and takeaways:

- Operational Cost ($/DT) is calculated as a sum of polymer cost and pilot power consumption cost. In Arcadis' experience, polymer dosing calculations can be scaled up in a reliable manner following pilot testing. However, power consumption witnessed during a pilot can be tricky and may not necessarily reflect full scale installation power consumption as it is dependent on a number of factors that may not be representative of the end installation on the pilot trailer. It is important to note that if this information is used to compare vendors, it is imperative to reflect on this caveat. The vendors have provided power consumption for the full-scale recommendations based on installation experience.
- The WAS feed is extremely thin, with a low total solids concentration ranging from 0.2-0.7% (TS) with an average of approximately 0.3-0.4% (TS) and a non-volatile solids concentration between 30-40%.
- The WAS feed solids varied significantly during the testing, subsequently some of the thickening results varied as well. A blend tank is recommended to make sure the WAS feed is homogenous going to the thickening centrifuge, to maintain consistent results.
- Design and layout of the complete system to be as modular as practically possible to facilitate strategic disassembly/reassembly.
- Some TSS results obtained from Eurofins Test America, for the WAS feed samples, were higher than the TS results, which is not correct. There were also some TWAS samples that were lower than the analyses performed in the field and at the vendor's laboratory. These incorrect correlations were attributed to human error and removed from analysis.
- Capture efficiency is an important parameter that needs to be evaluated during the design stage. While the vendors were able to run and achieve a 6% solids performance without the use of polymer, if desired to achieve a capture efficiency is >95%, polymer usage may be required.

1.2 RECOMMENDATIONS

The pilot program was successful in providing the proof of concept – thickening centrifuges would be capable of achieving the required performance of producing approximately 4-6% TS without the use of polymer. This would allow thickening of WAS prior to dewatering without diminishing the performance of dewatering centrifuges. Multiple vendors were involved in the pilot program to ensure that more than one vendor could achieve the desired results and to ensure ALCOSAN would have purchasing power without being limited to one centrifuge manufacturer. There are other vendors such as Flottweg, Westfalia, among others that were not a part of the pilot program due to time and schedule constraints, but it is highly recommended that they be considered by the FDC in their evaluation during design.

The recommended approach, as mentioned in the Basis of Design Report dated June 2018, is to provide WAS thickening with direct feed pumping based on discussions with ALCOSAN staff. Understanding that it is ALCOSAN's preference to direct feed these units, this was evaluated during the pilot. Vendors expressed concerns over the nature of the WAS feed as it was observed to be highly variable with a very low solids concentration. It is their recommendation to evaluate the nature of the WAS feed and pursue options to alleviate WAS concentration variability such as using a blend tank prior to thickening since

centrifuges tend to perform better in a steady state operation. However, all vendors were able to achieve the desired performance level. It is recommended that the FDC briefly reevaluates the direct feed concept of sending WAS from the WAS pumps directly to the thickening centrifuges and revisits the concept of utilizing the existing wet well to equalize the WAS feed to send a more consistent feed to the thickening centrifuges. It would be worth exploring further with input from ALCOSAN staff if it is possible to make some operational changes to produce a more consistent WAS feed. It is recommended that the operational complexity of a wet well and associated additional costs (eg. mixer) be evaluated by the FDC against a potentially simpler operation of direct feed with a less than optimum centrifuge performance.

Due to the highly variable WAS feed, the certainty and accuracy of a scale up analysis based on the pilot performance of each vendor's centrifuge is expected to have a lower confidence level than usual. It is also recommended that the FDC look into the risk to full scale operation during the design stage as scale up can be difficult under variable conditions.

It is recommended that one centrifuge unit is dedicated to each WAS header and one redundant unit, total of 4 units, with an interconnect between these headers for operational flexibility. If the FDC determines direct feed to the centrifuges is viable, WAS pumps will also act as centrifuge feed pumps and may need to be replaced with larger pumps. The hydraulics would need to be evaluated by the FDC during design stage to cover the extra length of WAS headers in the central pipe gallery and vertically to the second floor in the solids processing facility where the centrifuges will be installed.

Layout configurations shown in Appendix D are only representative figures and it is recommended that the FDC investigates this further as it can be highly dependent on the selected manufacturer and optimized after procurement during the design stage. In summary, the recommended thickening centrifuge arrangement for average design conditions is likely to fit for each vendor in the designated area with an ideal scenario consisting of four (4) centrifuges aligned in a west-east direction and a worst-case scenario represented in the original BODR drawing with more centrifuges and minimal space available around each unit.

APPENDIX A

WAS Pilot Vendor Reports

DEMONSTRATION REPORT

ALLEGHENY COUNTY SANITARY AUTHORITY “ALCOSAN”

Demo Report No.: D-14-21
Opportunity No.:
Application: 2997-0017
Product Home: 2997-0017
Product Group: 557
Division: 41

Date Report Issued: November 2, 2021
Testing Dates: September 21 -29, 2021
Personnel On-Site: Brandon Parker, Mitch Hanson
Author: Mitch Hanson
Copy: Walden, Hausegger

ALCOSAN
Shana Marcinik
3300 Preble Ave.
Pittsburgh, PA 15233
(412) 734-6200

Daman Superior,LLC
Mark Robinson
754 Kittanning Hollow Rd.
P.O. Box 486
East Brady, PA 16028
(412) 680 - 6373
mrobinson@damansuperior.com

ANDRITZ Separation Technologies Inc.
Steve Walden
1010 Commercial Blvd. South
Arlington, TX 76001
(817) 465-5611
steve.walden@andritz.com
www.andritz.com

ENGINEERED SUCCESS

TABLE OF CONTENTS

ENGINEERED SUCCESS

1. Executive Summary

The thickening performance capabilities of an ANDRITZ D4L model Decanter High Solids Centrifuge were evaluated at the Allegheny County Sanitary District (ALCOSAN), Pittsburgh, PA. from September 21 – 29, 2021

The plant currently does not have any thickening equipment at the plant but, would like to thicken the raw waste activated sludge (WAS) to a pumpable consistency of 3 to 7 percent total solids (% TS) to be blended with their primary sludge and dewatered by centrifuges.

The ANDRITZ D4L Centrifuge was very successful in achieving the desired results for this application. At throughputs of 70 to 135 gpm, the D4L Centrifuge achieved sludge thickened solids of 3 to 12 % TS with and without the use of polymer. A polymer dosage rate of 3 to 4 active pounds of polymer per dry ton of sludge solids (active lbs/ton TS) was determined to be the optimum dosage for this application using Solenis 8846 FS. The capture rate with the use of polymer averaged 99 % and without the use of polymer was 95 %.

Photo 1: ANDRITZ D4L Centrifuge Trailer

2. Introduction

ANDRITZ provided a trailer mounted D4L model Centrifuge and technicians for its operation. The equipment necessary to operate the dewatering system was provided with the trailer. Personnel from the ALCOSAN provided all power, water, sludge, and cake disposal.

The samples collected during the demonstration were analyzed by Eurofins TestAmerica, Pittsburg laboratory, the ANDRITZ laboratory in Arlington, TX, and onsite ANDRITZ field technicians. The data used in the conclusions of this report are based on the results received from Hooksett's laboratory. Several graphs are included which show how the analytical results from each entity correlate.

The ANDRITZ D4L Centrifuge is perfectly suited for automated operation with minimal operator attention while producing an excellent material for easy handling. Cleaning the centrifuge is automatic and programmed into the shutdown sequence. Wash water is injected into the centrifuge to flush out any remaining solids upon machine shutdown. The machine is also an enclosed system which reduces sludge odors during dewatering and water spillage during cleaning.

3. Plant Description

The ALCOSAN processes an average flow rate of 184 million gallons per day (mgd) of incoming domestic wastewater. The influent to the facility enters headworks of the facility where coarse screens and aerated grit removal systems are utilized. After screening, the wastewater goes to the primary clarifiers to allow for the larger particles of the wastewater to settle out. Effluent from the primary clarifiers is then sent to the aeration basins to allow for aerobic organisms to digest the organic material in the wastewater. After aeration, the wastewater goes to the final clarifiers to allow for the smaller particles to settle to the bottom. The effluent from the final clarifiers is disinfected using chlorine. It is then dechlorinated using sodium bisulfite before being discharged to the Ohio River. Sludge from the primary and final clarifiers are mixed together at an unknown ratio and dewater by centrifuges. Thirty two percent of the cake produced from the centrifuges is sent to the fluidized bed incinerator and the other sixty eight percent is treated with lime stabilization and land applied.

4. Sludge Description

The raw WAS sludge was brown in color with a wet soil type odor. The solids concentration of the sludge averaged 0.36 % TS. The ash content (non-volatile solids) was measured at 30 to 40 % of the total solids. The pre-demo sample received in the ANDRITZ laboratory on August 12, 2021 had a consistency of 0.28 % TS, an ash content of 33 % of the total solids, and was also brown in color with a wet soil type odor. The Capillary Suction Time (CST) of the sludge was 6.1 seconds indicating that the sludge contained an abundant amount of “free” water or, water that is not trapped by organic or cellular material.

Under optimized conditions the ANDRITZ D4L Centrifuge produced a thickened appearance resembling pudding. The centrate from the centrifuge was very clear and the amount of solids lost were easily controlled by adjusting the differential speed between the bowl and scroll of the centrifuge. With the use of polymer, the centrifuge captured 99% of the solids in the discharge from the centrifuge. Without the use of polymer, the average capture rate was 95 %.

This sludge would rate 3 to 4 on the ANDRITZ Abrasive Scale where 1 is least abrasive and 10 is most abrasive.

Photos 2 & 3: Centrifuge Thickened Solids

Photos 4 & 5: Centrate with and without the use of polymer

5. Testing Objectives

The objectives of the demonstration were:

1. Evaluate several different pond levels and G forces without the use of polymer and optimize the centrifuge.
2. To evaluate several different flocculants and determine which would produce the best results from the centrifuge at the lowest dosage rates.
3. To determine the benefits with and without the use of polymer.

The ANDRITZ D4L Centrifuge successfully evaluated each testing objectives. This report presents conclusions and recommendations for a future installation. The test results included in this report should not be averaged to reflect the overall performance of the D4L Centrifuge. In most of the test runs not all the parameters were optimized, in order to determine how changing a variable would affect the separation performance.

6. Chemical Conditioning

Of the three (3) polymers tested, Solenis 8846 FS was the most effective, and was selected on the basis of its ability to capture the solids. The polymer was added to the feed tube just before the sludge entered the centrifuge. The optimal dosage rate was 3 ± 1 active lbs/ton TS.

The three (3) polymers tested were:

Solenis 8846 FS: a high cationic charged density, high molecular weight, emulsion polyelectrolyte that is 40% active.

Polydyne C 6262: a high cationic charged density, medium molecular weight, emulsion polyelectrolyte that is 40% active.

Solenis 8868 FS: A very high charged, high molecular weight, emulsion cationic polyelectrolyte that is 40% active.

Note:

Neat Polymer: refers to the polymer as sold by the vendor in pounds of polymer, which is in liquid or dry form.

Active Polymer: refers to the active ingredients in pounds the polymer contains.

7. Results

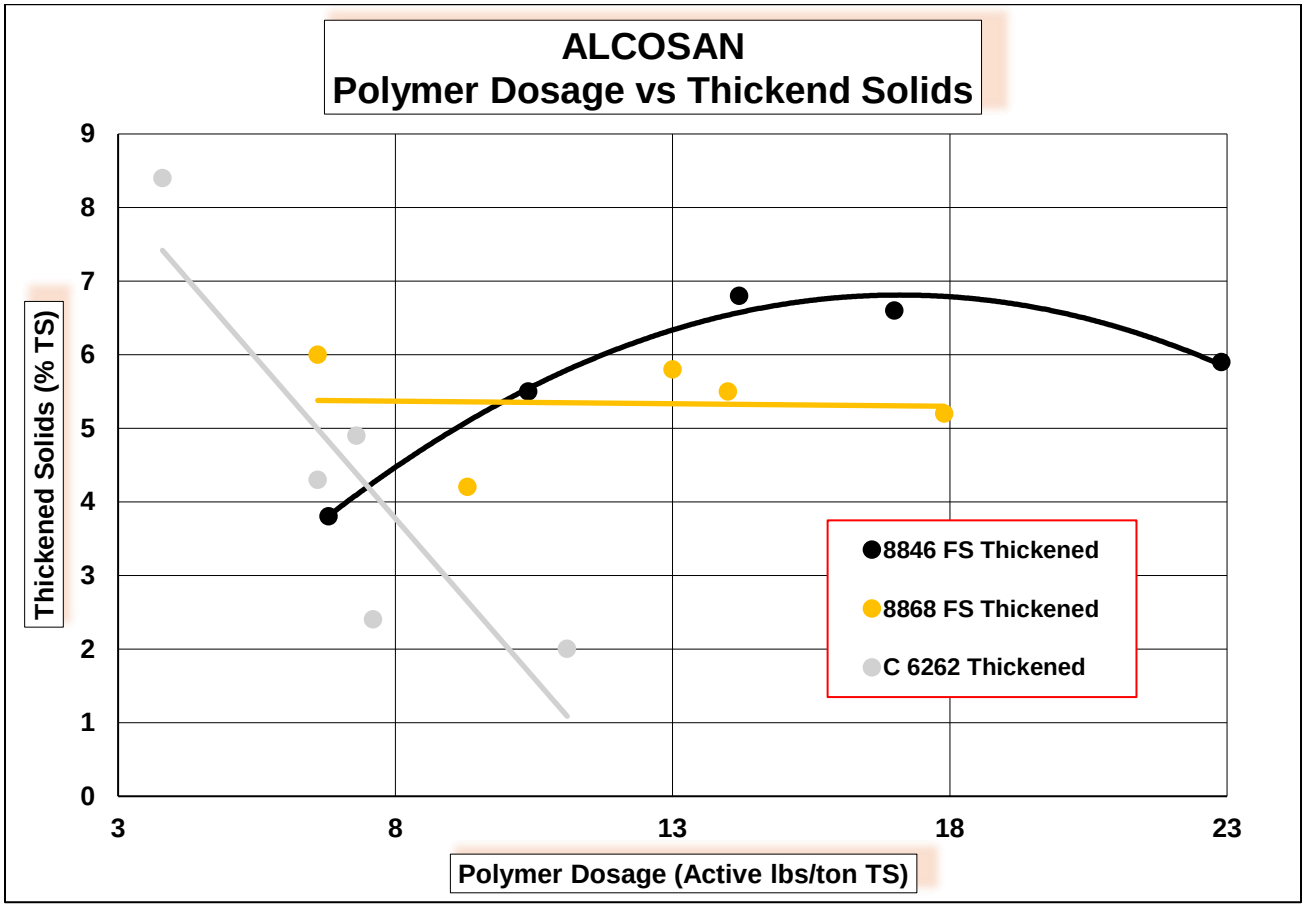
The ANDRITZ D4L Centrifuge proved to be effective for thickening the WAS sludge produced at this facility. The data presented is based on the analytical results from the ANDRITZ laboratory in Arlington, Texas. All test results are attached in Appendix 10.1.

Graphs were generated to analyze the influence of polymer dosage, and G force, had on the performance of the centrifuge. Several other graphs are included which show how the results from the field, Eurofins, and the ANDRITZ laboratories correlated.

Polymer Dosage vs Cake Dryness

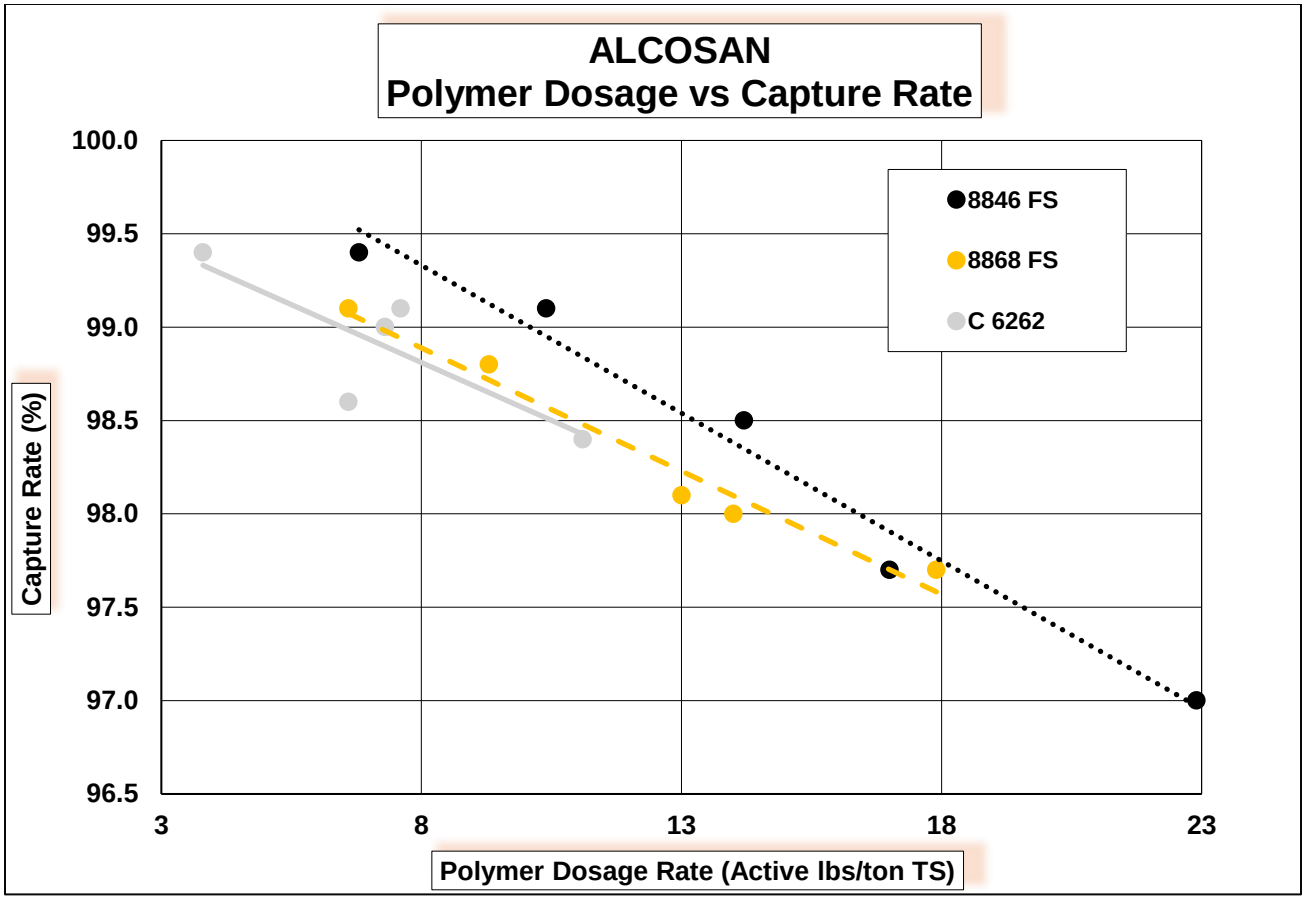
When the polymer dosage rate increases the stability of the sludge increases which improves the release of water from the solid particles. Once the sludge becomes overdosed, both the centrate and thickening qualities tend to decrease.

Graph 1 & 2 depict how the polymer dosage rate affects the thickened solids and capture rates. When generating these polymer curves, different polymer injection points and mixing schemes were evaluated. The best overall conditioning scheme for optimal polymer mixing and, polymer/sludge interaction was to add the polymer into the feed tube just before the sludge enters the centrifuge. The optimum dosage rate for Solenis 8846 FS was 3 ±1 active lbs/ton TS.



Graph 1: Polymer Dosage vs Thickened Solids

ENGINEERED SUCCESS

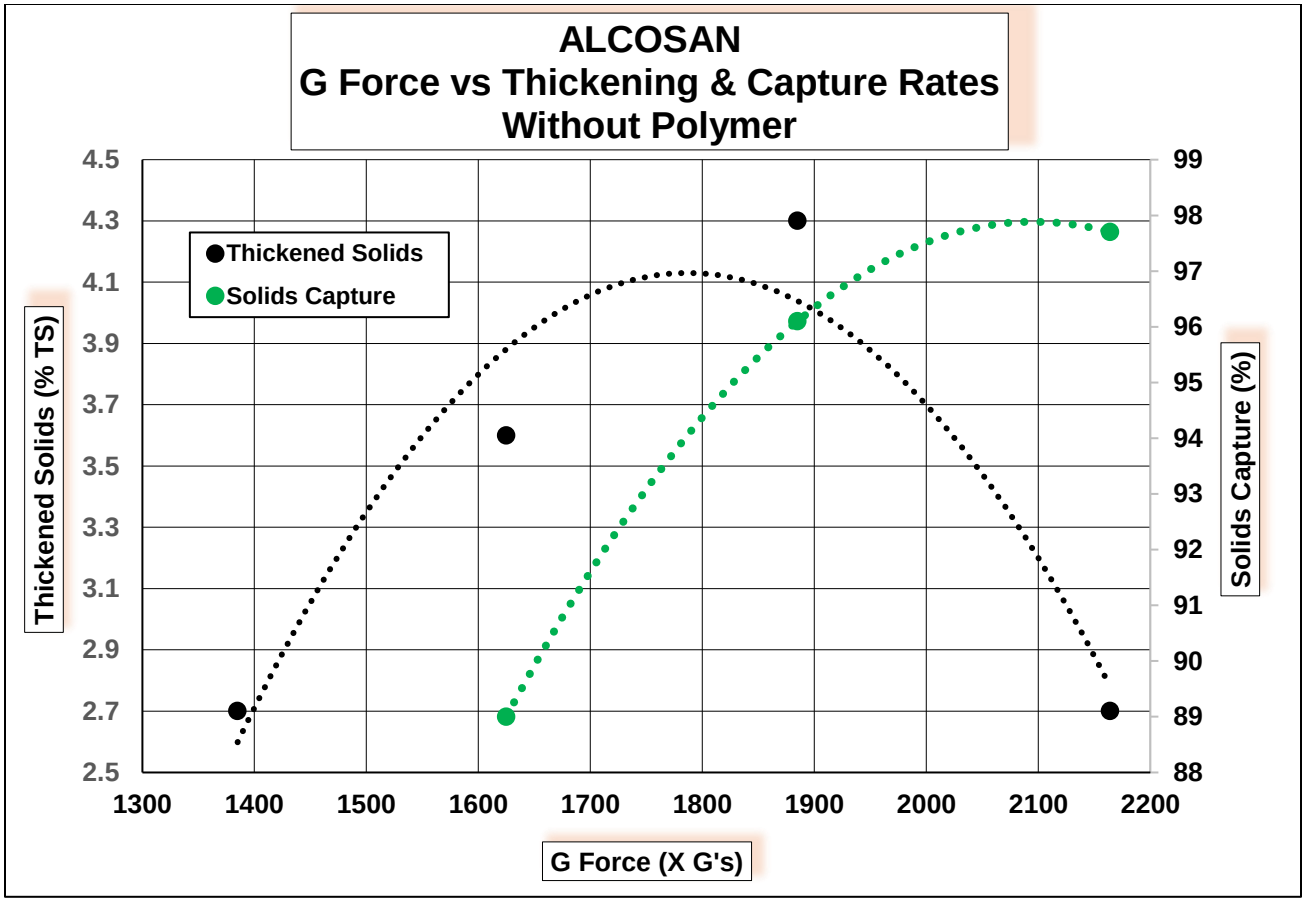


Graph 2: Polymer Dosage vs Capture Rate

ENGINEERED SUCCESS

G Force vs Thickening & Capture

Graph 3 illustrates the effects of G force on thickening and capture rates. When thickening WAS sludge, If the G force of the centrifuge is too high, the solids can be forced up the conical section by the higher G's rather than being scrolled out. This can produce wetter material but, higher solids recovery. Lowering the G force (reducing bowl speed) and scrolling, not having the material slide up through the conical section, will retain the solids inside the centrifuge producing thicker material and reducing the electrical consumption of the centrifuge but, reducing the solids capture rate by a fraction. The optimum G force for this application was found to be about 1800 to 1900 X G's. This curve was generated at a throughput of 70 gpm.

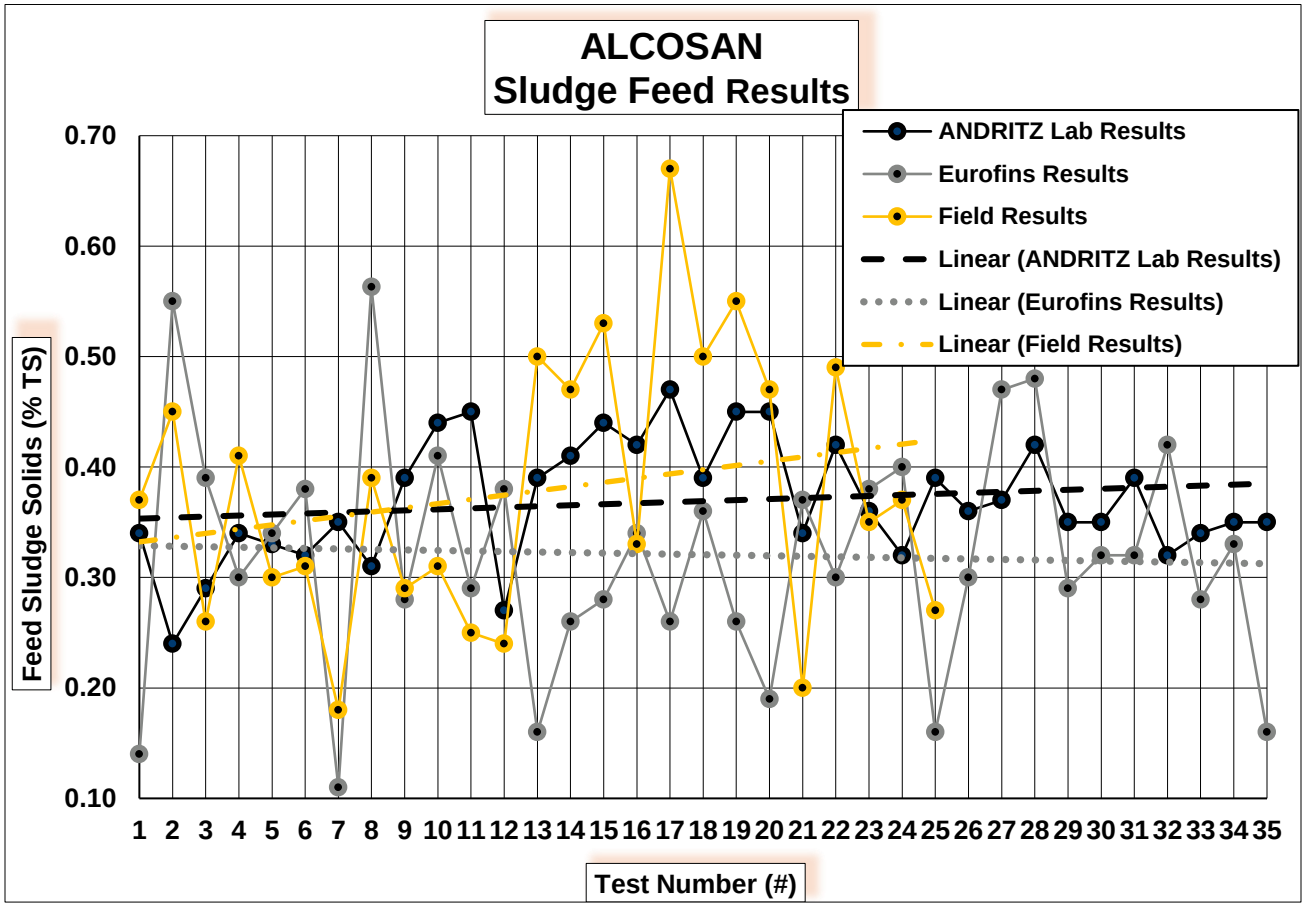


Graph 3: G Force vs Thickening and Capture

ENGINEERED SUCCESS

Feed Solids Results

Graph 4 shows how the results of the sludge feed consistency correlate with all of the samples that were analyzed during the demonstration. The linear trendlines of the ANDRITZ Lab and field results correlate more closely than the results from Eurofins. This is one reason that the results obtained by the ANDRITZ laboratory are used in the report instead of Eurofins. Another reason is that unlike an analytical laboratory that conducts many different laboratory procedures for different parameters, the ANDRITZ laboratory conducts solids and ash testing on a daily basis.

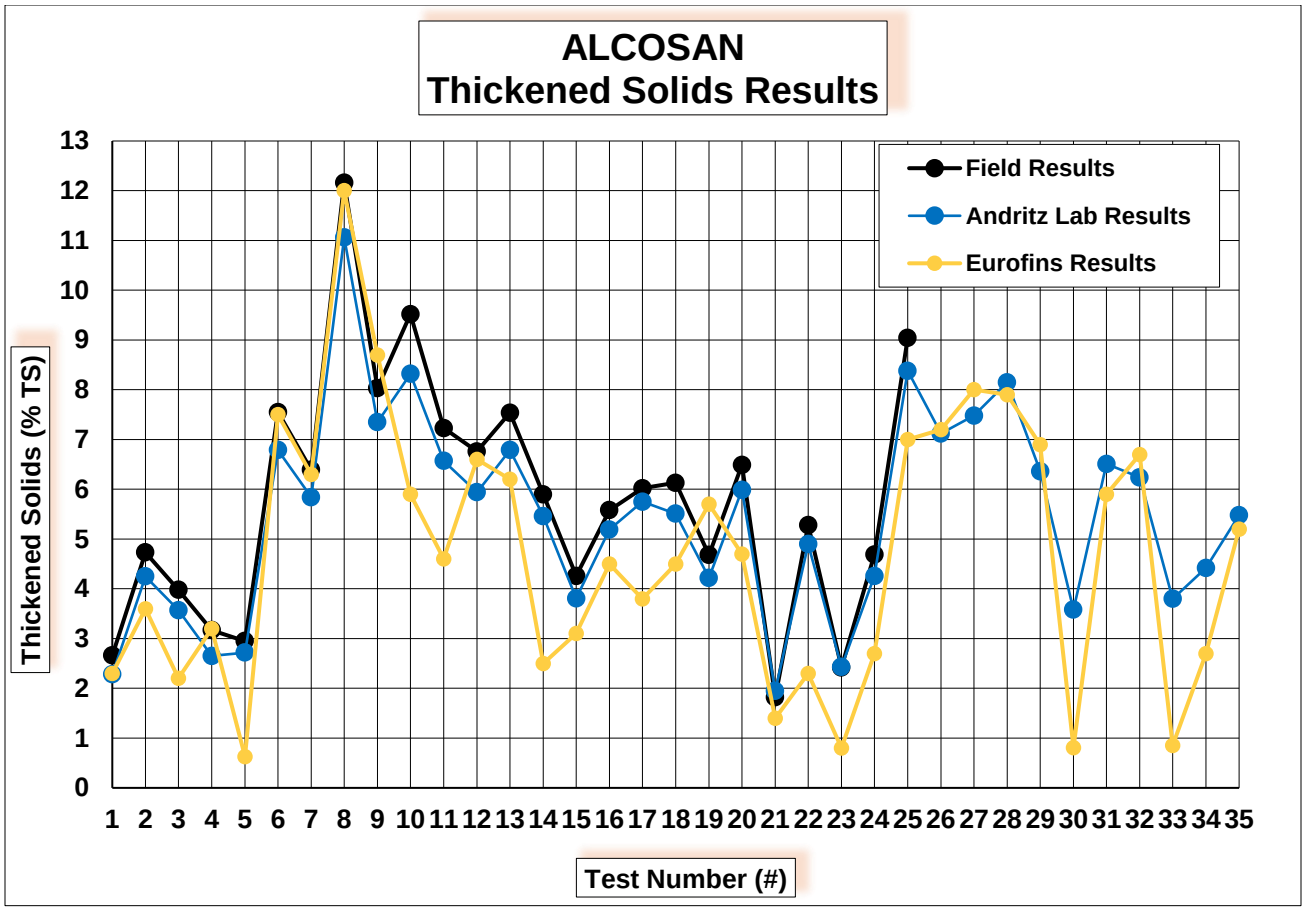


Graph 4: Sludge Feed Solids Results

ENGINEERED SUCCESS

Thickened Solids Results

Graph 5 Illustrates how the results of the thickened samples correlate. Again, as seen from the graph, both the ANDRITZ field and laboratory results appear to correlate much closer than Eurofins' results.



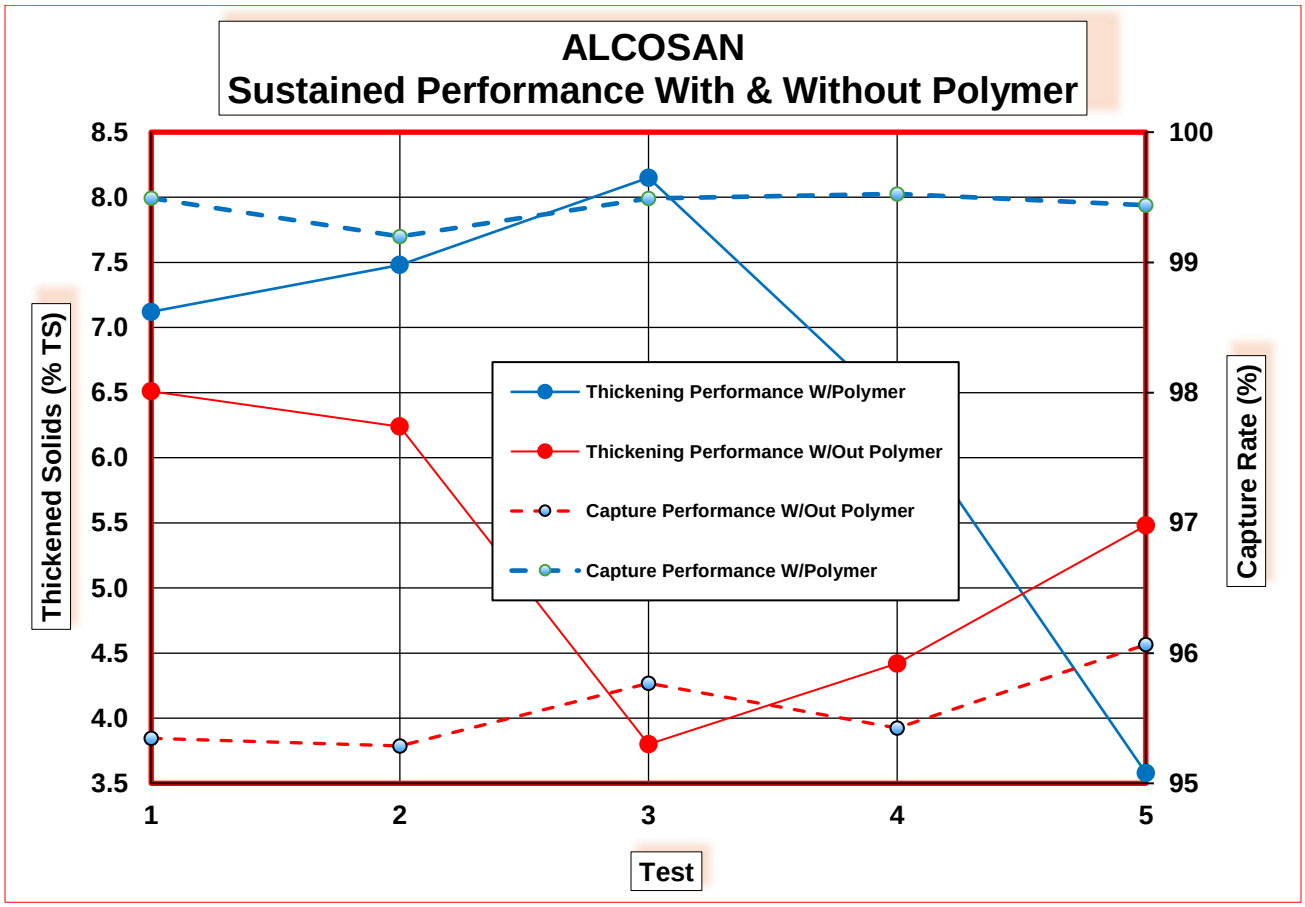
Graph 5: Torque vs Cake Dryness

ENGINEERED SUCCESS

Performance With & Without the Addition of Polymer

Graph 6 these graphs were produced at a throughput of 135 gpm. This was a continuous run for four (4) hours without any changes made to the centrifuge during that period. The first graph generated was without the use of polymer and represent test runs 26 through 30 in the spreadsheet. The only adjustments made, were done by the centrifuge's torque controller which increased or, decreased the speed of the scroll based on the torque of the centrifuge.

The blue lines on the chart represent the results of thickened sludge and capture rates when using Solenis 8846 FS at a dosage rate of 3 to 4 active lbs/ton TS. These test runs are actually 31 through 40, in the spreadsheet provided. The biggest differences seen with and without the use of polymer were the capture rates. Photos 4 & 5 show the color difference where the very clear centrate was during polymer use and, the browner looking colored water was without the use of polymer. Both curves had capture rates above 95%



Graph 6: Performance with and without polymer

ENGINEERED SUCCESS

8. Conclusions

The ANDRITZ D4L Centrifuge was very effective in thickening the WAS sludge at this facility. Based on the data and information gathered, the following performance can be anticipated from an ANDRITZ D4L model centrifuge:

Expected Performance ANDRITZ D4L Centrifuge

Sludge Throughput (GPM)	Sludge Throughput (lbs/hr TS)	Thickened Solids (%TS)	Polymer Active Dosage Rate (lbs/ton TS)	Solids Capture Rate (%)
135	243	4 – 7	None	≥ 95
135	243	4 – 7	3 ±1	≥ 98

Note:

This performance is based on the sludge characteristics as tested during the demonstration including a sludge consistency of 0.36% TS, a Capillary Suction Time (CST) of no more than 10 seconds, and a volatile solids content of 70% or less.

9. Discussion and Recommendations

The recommended polymer for this application is at the above dosage rate. Adding the polymer just at the feed tube, just before the sludge enters the centrifuge, will properly mix the polymer with the sludge for optimum centrifuge performance. A sludge grinder is recommended to prevent large particles of plastics or rags from entering the centrifuge.

The optimum G Force for this application was found to be between 1800 to 1900 X G's.

A centrifuge conical angle of no greater than 15% is recommended for this application to ensure the quick formation of a plug during the start-up of the centrifuge.

I would like to thank Ken Conaty and the fine staff of the Hooksett WWTF for their outstanding assistance, preparation, and patience in making this a successful venture. I would also like to thank Ross Baker with Underwood Engineering who supervised sampling during the demonstration. We at ANDRITZ look forward to working with you on this or any other future project.

Mitch Hanson
Manager of Field-Testing Services

10. Appendices

10.1 ANDRITZ Data Sheet

CUSTOMER:	ALCOSAN PITTSBURG, PA								MODE:		THICKENING							
TESTING DATES:	Test Runs 1 thru 5 (100% = 7830 Nm)								MACHINE:		D4L HIGH SOLIDS CENTRIUGE							
OPPORTUNITY #:									SLUDGE TYPE:		WASTE ACTIVATED SLUDGE							
TEST RUN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
DATE	9/21/2021	9/21/2021	9/21/2021	9/21/2021	9/21/2021	9/22/2021	9/22/2021	9/22/2021	9/22/2021	9/22/2021	9/22/2021	9/22/2021	9/22/2021	9/23/2021	9/23/2021	9/23/2021	9/23/2021	9/23/2021
TIME	12:00	12:30	1:00	1:45	2:30	8:30	9:00	9:45	10:30	11:15	12:00	12:30	1:30	8:45	9:30	10:15	11:00	11:45
FIELD FEED CONSIST. (% TS)	0.37	0.45	0.26	0.41	0.30	0.31	0.18	0.39	0.29	0.31	0.25	0.24	0.50	0.47	0.53	0.33	0.67	0.50
ANDRITZ LAB FEED CONSIST. (% TS)	0.34	0.24	0.29	0.34	0.33	0.32	0.35	0.31	0.39	0.44	0.45	0.27	0.39	0.41	0.44	0.42	0.47	0.39
Eurofins FEED CONSIST. (% TS)	0.14	0.55	0.39	0.30	0.34	0.38	0.11	0.56	0.28	0.41	0.29	0.38	0.16	0.26	0.28	0.34	0.26	0.36
Eurofins FEED SUSPENDED SOLIDS (% SS)	0.33	0.35	0.31	0.33	0.33	0.35	0.29	0.33	0.36	0.33	0.33	0.33	0.39	0.40	0.41	0.42	0.40	0.38
ANDRITZ FIELD OVEN THICKENED SOLIDS (%TS)	2.7	4.7	4.0	3.2	3.0	7.6	6.4	12.2	8.0	9.5	7.2	6.8	7.5	5.9	4.3	5.6	6.0	6.1
ANDRITZ LAB THICKENED SOLIDS (% TS)	2.3	4.3	3.6	2.7	2.7	6.8	5.8	11.1	7.4	8.3	6.6	5.9	6.8	5.5	3.8	5.2	5.8	5.5
Eurofins THICKENED SOLIDS (% TS)	2.3	3.6	2.2	3.2	0.6	7.5	6.3	12.0	8.7	5.9	4.6	6.6	6.2	2.5	3.1	4.5	3.8	4.5
ANDRITZ LAB CENTRATE (MG/L TSS)	89	98	89	89		169	194	189	235	235	109	86	64	41	31	106	96	83
Eurofins CENTRATE SOLIDS (MG/L TSS)	12	13	13	12	12	200	230	250	280	270	100	88	68	36	28	120	110	100
ANDRITZ SOLIDS CAPTURE (%)	97.8	96.1	97.2	97.7		95.0	94.8	94.1	94.3	94.9	97.7	97.0	98.5	99.1	99.4	97.7	98.1	98.0
Eurofins SOLIDS CAPTURE (%)	99.2	99.8	99.7	99.6	99.8	95.0	79.4	95.8	90.3	93.8	96.8	97.8	95.9	98.8	99.1	96.7	96.0	97.4
SLUDGE FLOW (GPM)	70	70	70	70	70	100	120	120	131	131	131	131	131	131	133	133	133	133
ANDRITZ THRUPUT (Lbs/Hr TS)	119	84	102	119	116	160	210	186	256	288	295	177	256	269	293	280	313	260
POLYMER TYPE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8846 FS	8846 FS	8846 FS	8846 FS	8846 FS	8868 FS	8868 FS	8868 FS
POLYMER FLOW (GPM)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.0	4.1	3.6	2.8	2.0	5.0	4.1	3.6
POLYMER CONSISTENCY (%)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
ANDRITZ NEAT DOSAGE RATE (Lbs/Ton TS)											42.4	57.3	35.6	26.0	17.0	44.8	32.4	35.1
ANDRITZ ACTIVE DOSAGE RATE (Lbs/Ton TS)											17.0	22.9	14.2	10.4	6.8	17.9	13.0	14.0
Eurofin NEAT DOSAGE RATE (lbs/ton TS)											65.8	40.7	86.8	41.0	26.7	55.3	58.6	38.0
Eurofins ACTIVE DOSAGE RATE (lbs/ton TS)											26.3	16.3	34.7	16.4	10.7	22.1	23.4	15.2
POLYMER INJECTION POINT	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Feed Tube	Feed Tube	Feed Tube	Feed Tube	Feed Tube	Feed Tube	Feed Tube	Feed Tube
POLMER/SLUDGE MIXING ENERGY	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
BOWL SPEED (RPM)	2800	2800	2600	3000	2400	2700	2700	2700	2700	2700	2700	2700	2700	2700	2700	2700	2700	2700
G FORCE (X G's)	1885	1885	1625	2164	1385	1753	1753	1753	1753	1753	1753	1753	1753	1753	1753	1753	1753	1753
DIFFERENTIAL SPEED (RPM)	2.3	2.2	2.3	2.2	2.2	2.4	2.8	2.8	3.2	3.2	3.8	3.7	3.7	4.6	4.6	4.4	4.4	4.3
TORQUE (%)	6	6	5	6	12	20	19	19	19	18	22	22	21	23	23	22	22	24
POND LEVEL (MM)	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250
CENTRIFUGE AMPS (POWER METER)	26.6	26.9	25.4	27.6	24.6	29.5	31.4	31.2	32.9	32.9	33.5	33.7	33.7	34.2	34.3	33.5	33.6	34.2
AVERAGE VOLTAGE (3 LEGS)	388	388	360	415	332	374	375	374	375	375	375	375	375	375	375	378	378	376
ABSORBED POWER (kW)	10.9	10.7	9.3	12.7	7.9	13.1	14.5	14.5	15.4	15.5	16.1	16.4	16.2	16.5	16.5	16.7	16.2	16.4
	G Force, Differential Speed and, Throughput Adjustments Without Polymer.										Polymer Curve: Solenis 8846 FS					Polymer Curve: Solenis 8868 FS		

Test Runs 6 thru 30 (100% = 2160 Nm)

Test Runs 31 & 32 (100% = 870 Nm)

Test Runs 33 thru 35 (100% = 1218 Nm)

TEST RUN #	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
DATE	9/23/2021	9/23/2021	9/27/2021	9/27/2021	9/27/2021	9/27/2021	9/27/2021	9/28/2021	9/28/2021	9/28/2021	9/28/2021	9/28/2021	9/29/2021	9/29/2021	9/29/2021	9/29/2021	9/29/2021
TIME	12:30	1:15	9:30	10:00	11:15	11:45	12:15	9:00	10:00	11:00	12:00	1:00	8:30	9:30	10:30	11:30	12:30
FIELD FEED CONSIST. (% TS)	0.55	0.47	0.20	0.49	0.35	0.37	0.27										
ANDRITZ LAB FEED CONSIST. (% TS)	0.45	0.45	0.34	0.42	0.36	0.32	0.39	0.36	0.37	0.42	0.35	0.35	0.39	0.32	0.34	0.35	0.35
Eurofins FEED CONSIST. (% TS)	0.26	0.19	0.37	0.30	0.38	0.40	0.16	0.30	0.47	0.48	0.29	0.32	0.32	0.42	0.28	0.33	0.16
Eurofins FEED SUSPENDED SOLIDS (% SS)	0.38	0.40	0.32	0.33	0.34	0.36	0.33	0.33	0.33	0.37	0.36	0.33	0.33	0.33	0.35	0.33	0.34
ANDRITZ FIELD OVEN THICKENED SOLIDS (%TS)	4.7	6.5	1.8	5.3	2.4	4.7	9.0										
ANDRITZ LAB THICKENED SOLIDS (% TS)	4.2	6.0	2.0	4.9	2.4	4.3	8.4	7.1	7.5	8.2	6.4	3.6	6.5	6.2	3.8	4.4	5.5
Eurofins THICKENED SOLIDS (% TS)	5.7	4.7	1.4	2.3	0.8	2.7	7.0	7.2	8.0	7.9	6.9	0.8	5.9	6.7	0.9	2.7	5.2
ANDRITZ LAB CENTRATE (MG/L TSS)	59	45	65	48	40	49	23	176	183	187	169	152	21	27	19	18	21
Eurofins CENTRATE SOLIDS (MG/L TSS)	72	80	60	60	24	36	28	23	20	24	22	20	40	28	20	20	28
ANDRITZ SOLIDS CAPTURE (%)	98.8	99.1	98.4	99.0	99.1	98.6	99.4	95.3	95.3	95.8	95.4	96.1	99.5	99.2	99.5	99.5	99.4
Eurofins SOLIDS CAPTURE (%)	97.4	96.0	98.8	98.3	99.7	99.2	98.3	99.3	99.6	99.5	99.3	99.6	98.8	99.4	99.5	99.5	98.3
SLUDGE FLOW (GPM)	133	133	133	133	133	133	133	135	135	135	135	135	135	135	135	135	135
ANDRITZ THRUPUT (Lbs/Hr TS)	299	299	226	280	240	213	260	243	250	284	236	236	263	216	230	236	236
POLYMER TYPE	8868 FS	8868 FS	C 6262	C 6262	C 6262	C 6262	C 6262	NA	NA	NA	NA	NA	8846 FS	8846 FS	8846 FS	8846 FS	8846 FS
POLYMER FLOW (GPM)	2.8	2.0	5.0	4.1	3.6	2.8	2.0	NA	NA	NA	NA		2.0	2.0	2.0	2.0	2.0
POLYMER CONSISTENCY (%)	0.25	0.25	0.13	0.13	0.13	0.13	0.13	NA	NA	NA	NA	NA	0.1	0.1	0.1	0.1	0.1
ANDRITZ NEAT DOSAGE RATE (Lbs/Ton TS)	23.3	16.6	27.6	18.1	19.0	16.4	9.6						7.6	9.2	8.7	8.4	8.4
ANDRITZ ACTIVE DOSAGE RATE (Lbs/Ton TS)	9.3	6.6	11.1	7.3	7.6	6.6	3.8						3.0	3.7	3.5	3.4	3.4
PLANT NEAT DOSAGE RATE (lbs/ton TS)			25.4	25.4	18.0	13.1	23.4						9.2	7.0	10.5	8.9	18.4
PLANT ACTIVE DOSAGE RATE (lbs/ton TS)			10.2	10.2	7.2	5.2	9.4						3.7	2.8	4.2	3.6	7.4
POLYMER INJECTION POINT	Feed Tube	Feed Tube	Feed Tube	Feed Tube	Feed Tube	Feed Tube	Feed Tube	NA	NA	NA	NA	NA	Feed Tube	Feed Tube	Feed Tube	Feed Tube	Feed Tube
POLMER/SLUDGE MIXING ENERGY	Normal	Normal	Normal	Normal	Normal	Normal	Normal	NA	NA	NA	NA	NA	Normal	Normal	Normal	Normal	Normal
BOWL SPEED (RPM)	2700	2700	2700	2700	2700	2700	2700	2700	2700	2700	2700	2700	2700	2700	2700	2700	2700
G FORCE (X G's)	1753	1753	1753	1753	1753	1753	1753	1753	1753	1753	1753	1753	1753	1753	1753	1753	1753
DIFFERENTIAL SPEED (RPM)	4.2	4.1	3.4	3.3	2.9	3.0	2.9	2.2	3.0	3.2	2.6	2.6	2.9	3.3	2.9	3.0	2.9
TORQUE (%)	23	22	25	25	24	24	24	21	21	21	20	19	72	69	49	43	43
POND LEVEL (MM)	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250
CENTRIFUGE AMPS (POWER METER)	34.3	33.8	35.0	33.9	33.6	34.2	33.3	33.3	33.2	33.0	33.3	33.8	34.0	33.7	33.4	33.7	33.4
AVERAGE VOLTAGE (3 LEGS)	459	375	375	460	460	466	460	460	460	459	460	460	460	460	460	460	460
16.2	16.2	16.3	16.9	16.4	16.6	16.4	15.8	15.9	15.6	15.7	15.7	16.3	16.3	16.2	16.1	15.8	15.9
			Polymer Curve: Polydyne C 6262					Consistent Running Without Polymer, in Auto Torque					Consistent Running With Polymer, in Auto Torque				

10.2 Chronological Summary of Testing

Monday, September 20th: We arrived onsite and met with Rucha Shah and to start making the necessary connections for the test trailer. The electrical cable was somewhat short of the connection box, so the trailer had to be repositioned in order to connect the electricity. All connections were completed by 2:30 pm. The electrical was checked for rotation and we departed the plant by 2:30 pm.

Tuesday, September 21st: Several different pond levels and bowl speeds were tested at a throughput of 70 gpm. Five (5) tests were completed during the day.

Wednesday, September 22nd: Once the optimum bowl speed and pond level were determined, the throughput to the centrifuge was gradually increased from 70 to 130 gpm without the use of polymer and, samples taken at every interval. A polymer curve was then started using Solenis 8846 FS. A total of eight (8) test runs were completed during the day.

Thursday, September 23rd: We completed the polymer curve using Solenis 8846 FS and generated another polymer curve using Solenis 8868 FS. It appeared that both polymers performed the best at dosage rates between 4 to 6 active pounds of polymer per dry ton of sludge solids. Seven test runs were conducted during the day.

Friday, September 24th: Andritz personnel came to the plant and weighed the samples that were taken the day before and shut down the laboratory equipment for the weekend. No testing was conducted during the day.

Monday, September 27th: A third polymer curve was generated using Polydyne C 6262. Five (5) test runs were completed.

Tuesday, September 28th: The centrifuge was set up in the auto torque mode to run consistently for a 6-hour period at a throughout of 135 gpm (trailer pump's maximum). The centrifuge easily produced thickened sludge without the use of polymer for 6 hours.

Wednesday, September 29th: The centrifuge was set up for another consistent 6 hour run with the addition of Solenis 8846 FS at a dosage rate of 3 to 4 active lbs/ton TS, at a throughput of 135 gpm.

Thursday, September 30th: The centrifuge was cleaned, packed and made ready for transport.

10.3 General Information About Testing

The ANDRITZ D4L Series Centrifuge employs the principle of accelerated settling to separate solids from a liquid. Feed is introduced through a stationary feed tube into a rotating bowl where G-Force causes the solids to sediment against the bowl wall. The scrolling action of a screw conveyor mounted concentrically within the bowl transports the solids up an incline and out of the machine. The centrate flows axially toward the front of the machine and is discharged over adjustable weirs.

For flocculation, polyelectrolyte is added upstream of the Centrifuge, preferably on the discharge side of the feed pump or at the feed tube. Mixing, when necessary, can be achieved by using a Venturi Mixer.

The three (3) primary parameters analyzed during a demonstration test are sludge feed rate, relative speed between the bowl and screw (determines residence time), and flocculant dosage. Variations of these parameters will yield a series of process relationships from which typical performance during full-scale operation can be predicted.

10.4 Demonstration Trailer Description

ANDRITZ provided a model D4L Centrifuge on a covered 48-foot trailer. All controls and ancillary equipment necessary for operation of the production unit were mounted on the trailer. The test trailer was furnished with the following equipment:

a. Model D4L solid bowl decanter.

b. Conveyor system to transport separated solids away from the Centrifuge.

c. Polymer makeup and metering system:

   Two (2) Moyno variable speed pumps (capacity 0 – 10 gpm).

   Two (2) 300-gallon polymer makeup tanks with agitators.

   Two (2) dilution water flow meters (0 – 12 gpm).

d. One (1) variable speed slurry pump (capacity 5 – 160 gpm).

e. One (1) portable Netzsch feed pump (capacity 0 – 50 gpm).

f. Moyno pipeline grinder.

g. One (1) high pressure water booster pump.

h. One (1) Deming sump pump (capacity 0 – 100 gpm) for centrate disposal.

i. Control panels to operate auxiliary equipment and production unit.

10.5 Calculations

Calculations

Recovery

$$\%R = \frac{c\,(f - e)}{f\,(c - e)} \times 100$$

Where: R = Recovery
c = Cake concentration (%TS)
F = Feed concentration (%TS)
e = Centrate concentration (%TSS)

Polymer Dosage

$$PD = \frac{2000\,(P)\,(p)}{F\,(f)}$$

Where: PD = Polymer dose (lbs/ton)
P = Polymer rate (gpm)
p = Polymer concentration (%TS)
F = Feed rate (gpm)
f = Feed concentration (%TS)

Relative Speed

$$RS = \frac{BS - IS}{K}$$

Where: RS = Relative speed (rpm)
BS = Bowl speed (rpm)
IS = Inlet shaft speed (rpm)
K = Gear ratio

PREVENTIVE MAINTENANCE / SPARE PARTS REQUIRED - DECANTER TYPE D6LX - D7LL

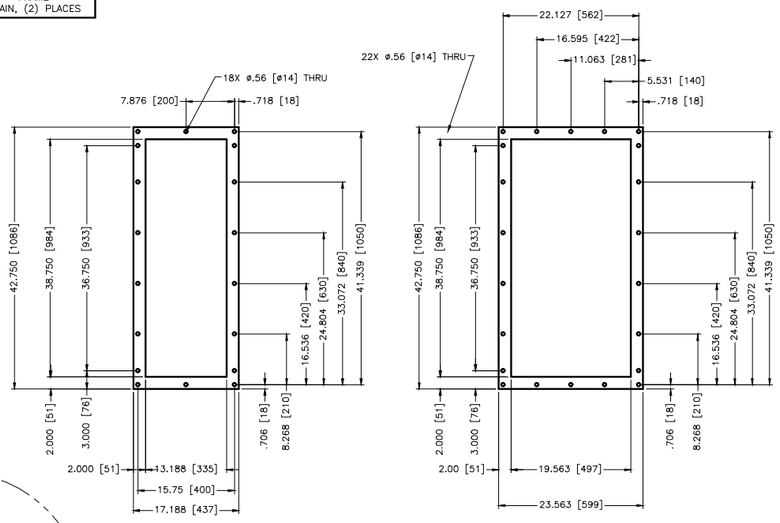
CUSTOMER: **1 - MACHINE**

OPERATING TIME	SERVICE REQUIREMENT	PARTS REQUIRED	Valid Until January 1, 2017	PRICE DOLLARS
AT 3,000 HRS	Grease Scroll Bearings	2 grease cartridge SKF2		24.00
	Gearbox Lubrication Change	2 Gallons Oil - SP100		280.00
	Replace Oil Filter	1 Oil Filter		130.00
	Copper Seals	6 Copper Seals		22.00
	Belt Tension		Parts Total	456.00
			Estimated Labor & Expenses	4,600.00
			TOTAL	5,056.00
AT 6,000 HRS	Belt Replacement	1 set of 8 belts		650.00
2-DAYS	Grease Scroll Bearings	2 grease cartridge SKF2		24.00
	Gearbox Lubrication Change	2 Gallons Oil - SP100		280.00
	Copper Seals	6 Copper Seals		22.00
	Replace Oil in Lube Unit	20 Gallons Oil - SP68		900.00
			Parts Total	1,876.00
			Estimated Labor & Expenses	6,500.00
			TOTAL	8,376.00
AT 9,000 HRS	Grease Scroll Bearings	2 grease cartridge SKF2		24.00
	Gearbox Lubrication Change	2 Gallons Oil - SP100		280.00
	Replace Oil Filter	1 Oil Filter		130.00
	Copper Seals	4 Copper Seals		22.00
	Belt Tension		Parts Total	456.00
			Estimated Labor & Expenses	4,600.00
			TOTAL	5,056.00
AT 12,000 HRS	Replace Drive and Feed High Speed Bearing	2 Bearings		4,420.00
	Replace Scroll Thrust Bearing	3 Bearings		1,560.00
	Grease for Bearing Replacement	8 grease cartridge SKF2		96.00
	Replace Oil and Filter in Lube Unit	20 Gallons Oil - SP68 - 1 Filter		1,030.00
	Seals Set for 12K HRS Service	Complete Seals for service		2,800.00
	Replace Eccentric Bearing in Gear Box	1 Eccentric Bearing		4,530.00
	Replace Bowl Nozzles	8 Nozzles		7,700.00
	Repalce Scroll Nozzles	4 Nozzles		5,636.00
	Gearbox Lubrication Change	2 Gallons Oil - SP100		280.00
	Copper Seals	6 Copper Seals		22.00
	Belt Replacement	1 set of 8 belts		650.00
			Parts Total	28,724.00
	The service is normally performed at a local Service Center - Labor quoted by Service Center			0.00
			TOTAL	28,724.00
AT 15,000 HRS	Grease Scroll Bearings	2 grease cartridge SKF2		24.00
	Gearbox Lubrication Change	2 Gallons Oil - SP100		280.00
	Replace Oil Filter	1 Oil Filter		130.00
	Copper Seals	4 Copper Seals		22.00
	Belt Tension		Parts Total	456.00
			Estimated Labor & Expenses	4,600.00
			TOTAL	5,056.00

AT 18,000 HRS	Belt Replacement	1 set of 8 belts		650.00
2-DAYS	Grease Scroll Bearings	2 grease cartridge SKF2		24.00
	Gearbox Lubrication Change	2 Gallons Oil - SP100		280.00
	Copper Seals	6 Copper Seals		22.00
	Replace Oil in Lube Unit	20 Gallons Oil - SP68		900.00
			Parts Total	1,876.00
			Estimated Labor & Expenses	6,500.00
			TOTAL	8,376.00
AT 21,000 HRS	Grease Scroll Bearings	2 grease cartridge SKF2		24.00
	Gearbox Lubrication Change	2 Gallons Oil - SP100		280.00
	Copper Seals	6 Copper Seals		22.00
	Replace Oil Filter	1 Oil Filter		130.00
	Belt Tension		Parts Total	456.00
			Estimated Labor & Expenses	4,600.00
			TOTAL	5,056.00
AT 24,000 HRS	Replace Drive and Feed High Speed Bearing	2 Bearings		4,420.00
	Replace Scroll Thrust Bearing	3 Bearings		1,560.00
	Grease for Bearing Replacement	8 grease cartridge SKF2		96.00
	Replace Oil and Filter in Lube Unit	20 Gallons Oil - SP68 - 1 Filter		1,030.00
	Seals Set for 12K HRS Service	Complete Seals for service		2,800.00
	Replace All Interanl Parts in Gear Box	1 Set Internal Parts		36,376.00
	Replace Bowl Nozzles	8 Nozzles		7,700.00
	Repalce Scroll Nozzles	4 Nozzles		5,636.00
	Gearbox Lubrication Change	2 Gallons Oil - SP100		280.00
	Copper Seals	6 Copper Seals		22.00
	Belt Replacement	1 set of 8 belts		650.00
			Parts Total	60,570.00
	The service is normally performed at a local Service Center - Labor quoted by Service Center			0.00
			TOTAL	60,570.00
AT 27,000 HRS	Grease Scroll Bearings	2 grease cartridge SKF2		24.00
	Gearbox Lubrication Change	2 Gallons Oil - SP100		280.00
	Copper Seals	6 Copper Seals		22.00
	Replace Oil Filter	1 Oil Filter		130.00
	Belt Tension		Parts Total	456.00
			Estimated Labor & Expenses	4,600.00
			TOTAL	5,056.00
AT 30,000 HRS	Belt Replacement	1 set of 5 belts		650.00
2-DAYS	Grease Scroll Bearings	2 grease cartridge SKF2		24.00
	Gearbox Lubrication Change	2 Gallons Oil - SP100		280.00
	Copper Seals	4 Copper Seals		22.00
	Replace Oil in Lube Unit	20 Gallons Oil - SP68		900.00
			Parts Total	1,876.00
			Estimated Labor & Expenses	6,500.00
			TOTAL	8,376.00

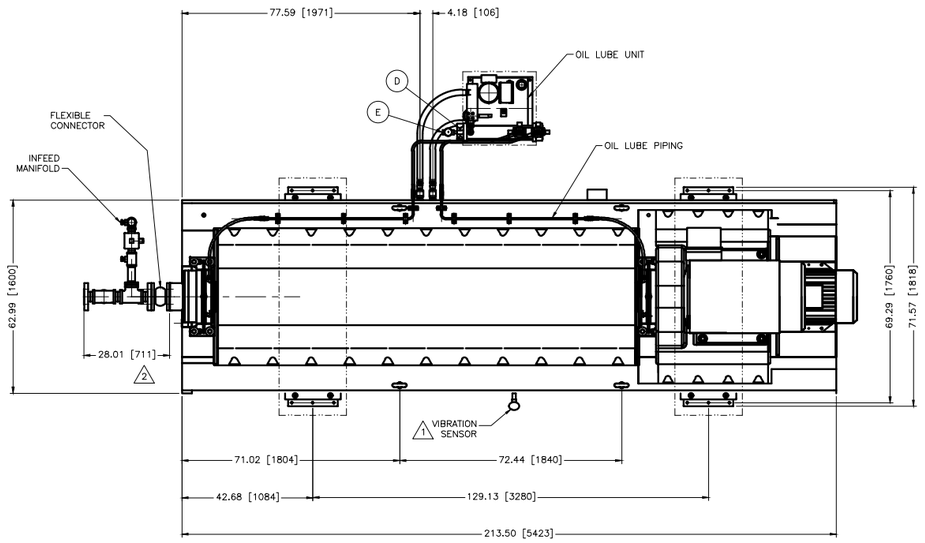
PIPING CONNECTIONS		
PORT	SIZE	DESCRIPTION
A	4" CLASS 150 ANSI RF FLANGE	FEED INLET
B	38 3/4" x 19 9/16" RECTANGULAR	SOLIDS DISCHARGE
C	38 3/4" x 19 9/16" RECTANGULAR	CENTRATE DISCHARGE
D	3/4" FNPT	COOLING WATER INLET
E	3/4" FNPT	COOLING WATER OUTLET
F	1" FNPT	SLUDGE SAMPLE
G	2" FNPT	WASHWATER CONNECTION
H	2" FNPT	POLYMER CONNECTION
H	1-1/4" PIPE PLAIN END	FRAME DRAIN, (2) PLACES

NOTES:
1. ALL DIMENSIONS ARE IN INCHES WITH MILLIMETERS IN [ ].
2. ALL PIPING TO AND FROM THE MACHINE TO BE COMPLETED WITH FLEXIBLE CONNECTIONS.
3. SEE FOUNDATION DRAWING DMF1453 FOR DESIGN LOADS AND ANCHOR BOLT DETAILS.
4. PROCESS REQUIREMENTS:
   SLUDGE FEED PRESSURE: 8PSI [0.6bar] AT THE CENTRIFUGE FEED FLANGE.
   POLYMER FEED PRESSURE: 5PSI ABOVE SLUDGE FEED PRESSURE
   WASH WATER: 250gpm [57cm/hr] @ 45-75psi [3.1-5.2bar]
   DURATION: SHUT DOWN: 15min.
   C.I.P.: 10min.
   AIR FLOW FROM CENTRATE CASING: 350 cfm [600/hr] △7
   OIL LUBE COOLING POTABLE WATER REQUIREMENT: 10gpm [2cm/hr] @ 70°F [21°C]
5. NOISE LEVEL: 86db MEASURED AT 1 METER WHILE EMPTY.
6. ALL VIBRATION PADS TO BE LEVEL WITHIN 1/32in [0.79mm].
7. APPROXIMATE WEIGHT:
   TOTAL MACHINE EMPTY: 29,542lbs [13,400kg]
   TOTAL MACHINE FULL (WATER): 35,350lbs [16,080kg]
   SCROLL+LIFTING BEAM 3,547lbs [1,609kg]
   LUBE UNIT WITH OIL: 450lbs [204kg]
   △4 △5 △6
8. SEE OIL LUBE DRAWING DMA2531 FOR LUBE SYSTEM.
9. LEFT HAND MACHINE AS SHOWN.
   RIGHT HAND MACHINE OPPOSITE.

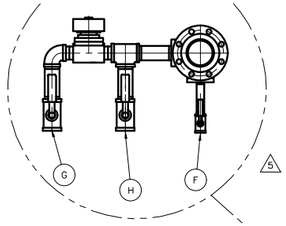


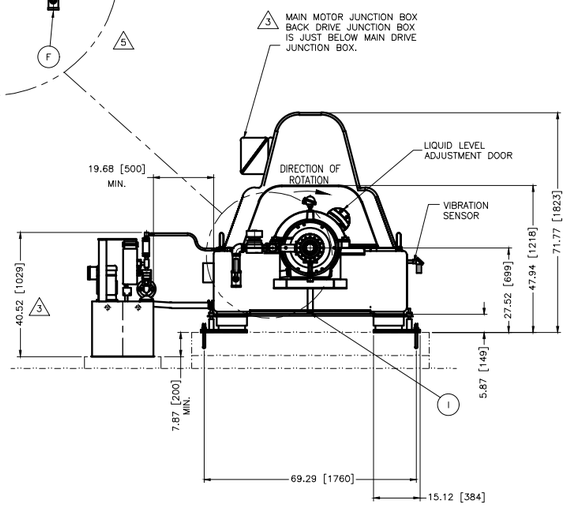
VIEW A-A
2X SCALE
CENTRATE DISCHARGE FLANGE PATTERN

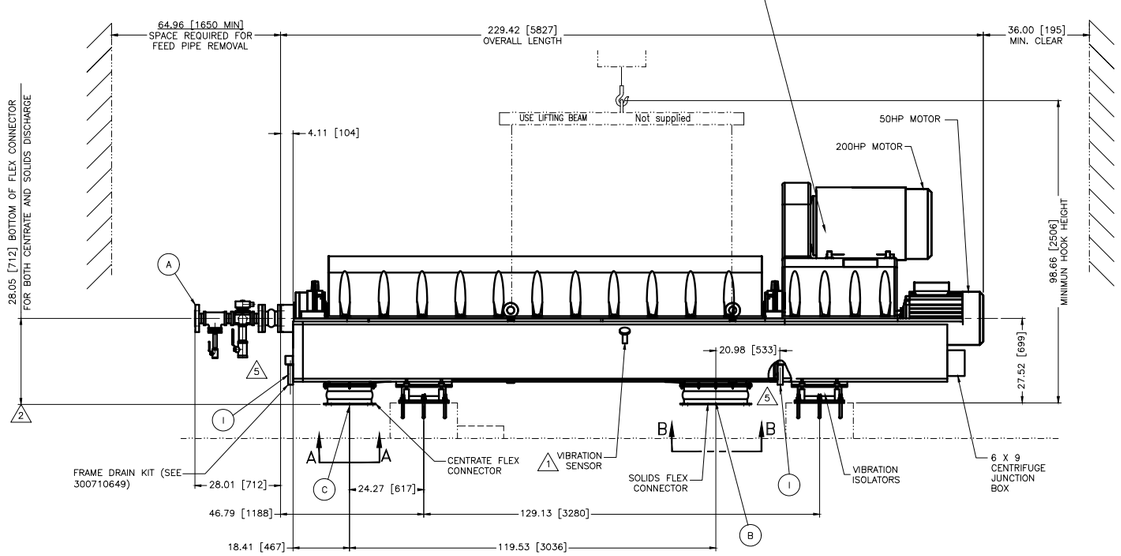
VIEW B-B
2X SCALE
SOLIDS DISCHARGE FLANGE PATTERN



NOTE: KEEP MOTOR CONDUITS AWAY FROM IN FRONT OF FIBERGLASS GUARDS. RUN MOTOR CONDUITS TOWARD REAR OF MACHINE. THIS IS TO ALLOW FOR COVER AND REMOVAL.







REV	EIR	REVISION	BY	APVD	DATE
7	NONE	REVISED NOTE 4 AIRFLOW	RR	TYLER	08/31/20
6	NONE	REVISED MACHINE WEIGHTS	MDW	TYLER	10/17/19
5	NONE	REVISED MACHINE WEIGHTS, MANIFOLD AND DRAINS	BP	TYLER	09/05/18
4		UPDATED NOTE 7	JJA	JJA	8/27/17
3	NONE	GENERAL UPDATES NOTE. AND DIM	QC	KTL	06/16/16
2	NONE	UPDATED VENT REQUIRMENTS	TB	TJB	10/30/15

FOR INFORMATION ONLY
NOT FOR CONSTRUCTION PURPOSES

ESTIMATED WEIGHT IN LBS.	DRAWN BY: CDH	DATE 08/09/13
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES	CHECKED BY:	DATE
FABRICATION TOLERANCES .XXX±.040 ANG±1° HOLE±.020	APPROVED BY: TJB	DATE 9/24/15
MACHINING TOLERANCES .XXX±.005 ANG±.5° HOLE±.020	THIRD ANGLE PROJECTION	
MILL FINISH ALL OVER		

ANDRITZ SEPARATION, INC.
1010 COMMERCIAL BLVD. SOUTH
ARLINGTON, TEXAS 76001
PHONE: (817) 465-5611

TITLE: D7LL E2 CENTRIFUGE
D7LL E2 CENTRIFUGE
GENERAL ARRANGEMENT

SIZE E | DRAWING NUMBER DMA2635 | REV 7
SCALE 1/16 | FILE DMA2635 | SHEET 1 OF 1

Centrifuge Budgetary Proposal for ALCOSAN Pittsburgh, PA

Proposal No.: 3517192-1
Version No.: 01

Date: February 11, 2022

ENGINEERED SUCCESS

Rucha Shah (she/her) EIT, CDT
Water Engineer 2
Arcadis U.S., Inc.
6041 Wallace Road Extension, Suite 300 | Wexford, PA | 15090 | USA
Rucha.Shah@arcadis.com
T +1 (724) 934-9546
www.arcadis.com

Subject: Centrifuge Thickening Budget Proposal for ALCOSAN Pittsburgh, PA

Dear Ms. Shah:

Thank you for your interest in the ANDRITZ centrifuge and we are pleased to submit our information offering the ANDRITZ D7LL decanter centrifuge with Easy Pond technology for your sludge thickening project.

Enclosed you will find, technical specifications and drawings as well as general information on the ANDRITZ D7LL high performance decanter centrifuge.

The ANDRITZ centrifuge is one of the mechanical dewatering solutions we offer to the thickening and dewatering challenges to the environmental market. ANDRITZ designs manufactures and assembles our centrifuges and system controls to provide a single source solution including analytical process sizing (both laboratory and field testing), full after-market support via our five (5) regional service centers and with the quality of manufacture and reliability you would expect from a world leader in liquid solids separation.

Benefits of the ANDRITZ centrifuge include:

- HP scroll for the highest cake dryness
- Open flights for the best centrate quality,
- Bowl of 2304 Duplex construction,
- Field replaceable tungsten carbide conveyor tiles the full length of the scroll - with up to a 15,000 hour wear warranty,
- Field replaceable tungsten carbide protected feed and discharge ports,
- Field replaceable tungsten carbide protected discharge casings,
- Independent balancing of bowl, gearbox and scroll
- Simple operation due to fully automatic torque-controlled regulation,
- VFD controlled bowl and scroll conveyor

- Minimum space and maintenance requirement due to in-line design,
- Scroll exchange program to minimize down time and reduce inventory
- More than 10,000 ANDRITZ centrifuges are installed around the world and have placed ANDRITZ at the forefront of centrifuge technology.
- Five (5) dedicated service centers within North America.

The information is being furnished based on the ANDRITZ standard scope of supply and design. Should you have any further questions or concerns regarding this quotation, please contact our local representative Mark Robinson @ 412-680-6373.

Once again, we thank you for your time and look forward to working with you on this project.

Sincerely,

Steve Walden

Steve Walden
Regional Sales Manager

TABLE OF CONTENT

Table of Contents

DECANTER CENTRIFUGE TYPE D7LL

1.0 ANTICIPATED OPERATING CONDITIONS

Application	**Sludge Thickening**
Sludge Description (Municipal)	Waste Activated Sludge
Feed solids concentration (%TS)	0.36
Feed volatile solids content (%) Dry weight basis	≤ 70
Capillary Suction Time (CST)	≤ 10 seconds

1.1 ANTICIPATED SIZING & PERFORMANCE

Decanter type	**D7LL**
Number of machines	Two (2)
Feed Solids Loading (per unit)	1080 lbs/hr
Hydraulic Loading Rate (gpm per unit)	600
Polymer consumption (active lbs/ton TS)	No Polymer
Dryness (%TS)	4-7
Capture rate (%TSS)	93-95

Decanter type	**D7LL**
Number of machines	Two (2)
Feed Solids Loading (per unit)	1080 lbs/hr
Hydraulic Loading Rate (gpm per unit)	600
Polymer consumption (active lbs/ton TS)	2 to 4
Dryness (%TS)	4-7
Capture rate (%TSS)	≥ 95

- Sizing and anticipated performance is based on data obtained from our on-site pilot testing.

2.0 TECHNICAL DATA

CHARACTERISTICS

Size (L x W x H)	229 x 69 x 75 inch (5,827 x 1,760 x 1883mm) (without lubrication unit) (Anchor bolts not supplied)
Weight with driving system	31,473 pounds (14,276 Kg)

CHUTE DIMENSIONS

Solids outlet	38.90 x 19.5 inch (988 x 496 mm)
Centrate outlet	38.90 x 13.1 inch (988 x 334 mm)

DRIVE

Main motor (hp)	250
Secondary motor (hp)	40
Cyclo reducer (gearbox), nominal torque	181,440 inch pounds (20,500 Nm)

FREQUENCY INVERTERS

Brand:	Allen Bradley Power Flex Series 755 (6 Pulse)
Communication:	Ethernet

CONTROLS

PLC:	Allen Bradley Contrologix PLC Processor with Ethernet
Touchscreen:	Allen Bradley Panel View Plus

SCROLL SPEED ADJUSTMENT

Range:	0 - 20 rpm
Torque control (dewatering):	based on conveying torque

MATERIAL OF CONSTRUCTION

Wetted parts:	316L Stainless Steel
Frame	Painted Steel
Bowl & Drive Cover	316L Stainless Steel

BOWL

Inner diameter	29.52” (750 mm)
L/D ratio	4.1
Total length	121” (3075 mm)
Speed	2,700 rpm
G Force	3,011

SCROLL

Counter current design high performance

For dismantling purposes:

Total length of scroll with handling hoist	158” (4,000 mm)
Weight of scroll with handling hoist	3,241 pounds (1,470 Kg)

POND DEPTH ADJUSTMENT

Sliding Turbo Jet weir plates, range of diameter	12.2” x 16.1” (310 to 410 mm)

WEAR PROTECTION

Inner bowl surface	Welded strips
Scroll	Replaceable tungsten carbide tiles the entire length of scroll
Scroll feed chamber (distributor)	polurethane liner and tungsten carbide
Scroll feed chamber (ports)	sintered tungsten carbide nozzles
Bowl discharge (ports)	sintered tungsten carbide nozzles

SEALS

Type	BUNA N
Maximum temperature	176°F (80°C)

LUBRICATION

Main bearings are forced oil lubricated

The reducer is lubricated exclusively with the type of grease specified by ANDRITZ

NOISE LEVEL

88 dB(A) sound pressure measured in free field conditions, at nominal speed, from a distance of 39 inches (1 meter).

VIBRATION LEVEL 0.18 inch/s (4.5 mm/s) max.

(Registered on test bench at nominal speed according ISO 10816-1)

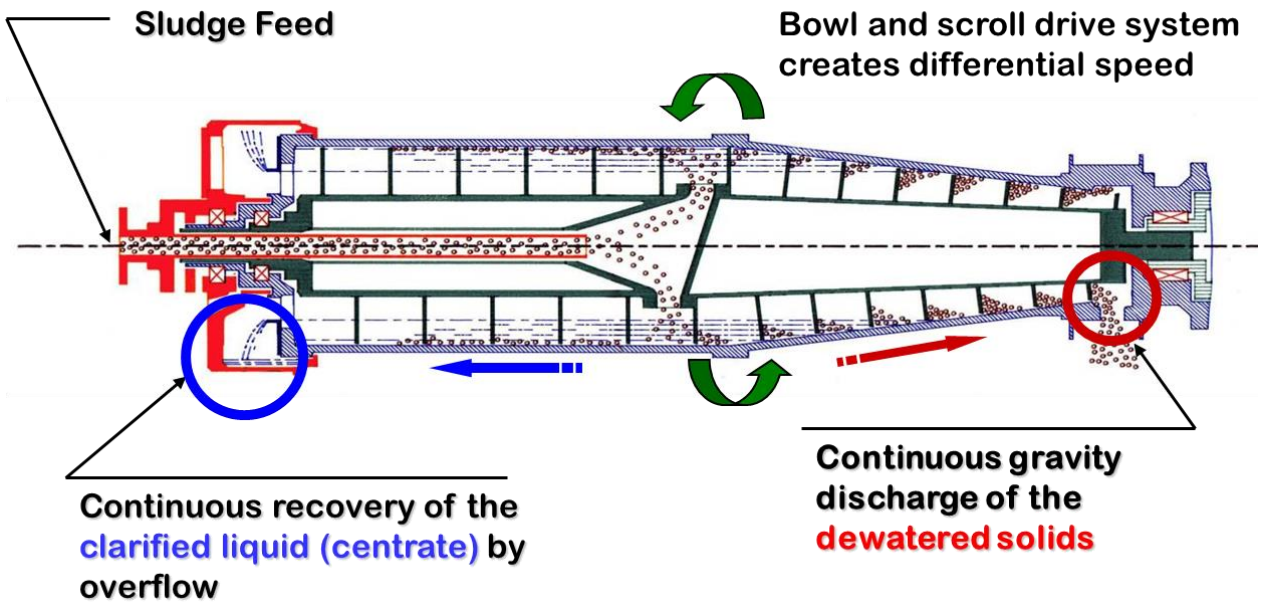
MISCELLANEOUS

Wash water flow rate	130 to 220 GPM (30 to 50 m^3/hr) for up to 45 min. at each stop (Non-potable water supply / 40 to 60 psi (3 to 4 bars))
Air evacuation	600 cfm (1,000 m^3/hr)
Feed Inlet flange	4 inch ANSI (DN 100)

3.0 CENTRIFUGE INFORMATION

3.1 DECANTER CENTRIFUGE GENERAL DESCRIPTION

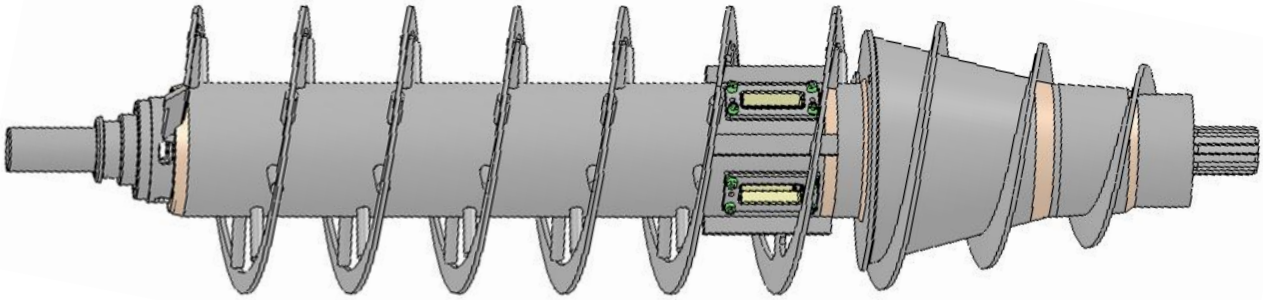
The ANDRITZ decanter centrifuge is composed of a rotating assembly, driven by electrical motors, supported by two pillow block bearings on a base frame. The rotating assembly includes a cylindrical and conical bowl, a scroll conveyor, and a gear box, which creates the differential speed between the scroll conveyor and the bowl.



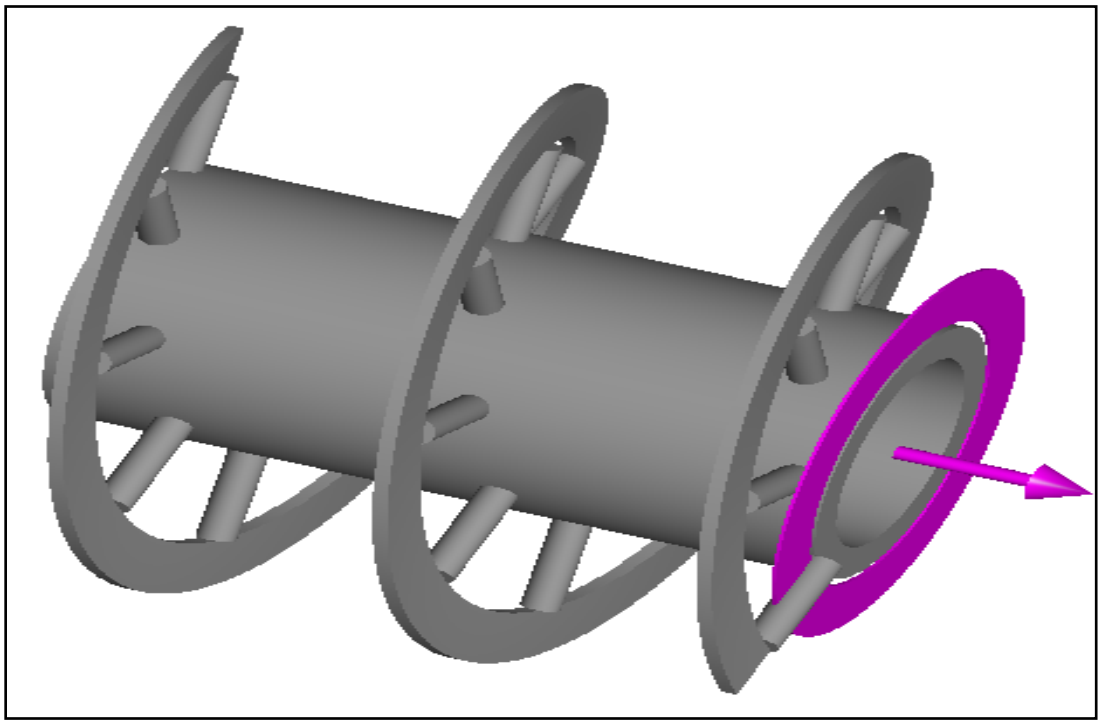
Centrifugal force created by the rotation of the bowl (greater than 3,000 g) forces solids particles to separate from the liquid and move away from the machine axis toward the bowl wall. The solids will compact on the cylindrical or settling section of the bowl wall. The scroll conveyor located inside the bowl, rotates at a slightly faster speed than the bowl. The compacted solids along the bowl wall are advanced by the scroll conveyor to the tapered end of the bowl where they are discharged. The clarified liquid flows in the opposite direction from the solids, along the center axis, and overflows the adjustable weirs located in the liquid head. This continuous liquid (centrate) exits the machine through the liquid discharge compartment in the case bottom.

3.2 HIGH PERFORMANCE SCROLL

The High Performance scroll produces the right combination of high cake solids, maximum throughput, and the highest capture rate in the industry. The design optimizes the solids residence time. Turbulence is minimized for the hydraulic flow of the clarified liquid.

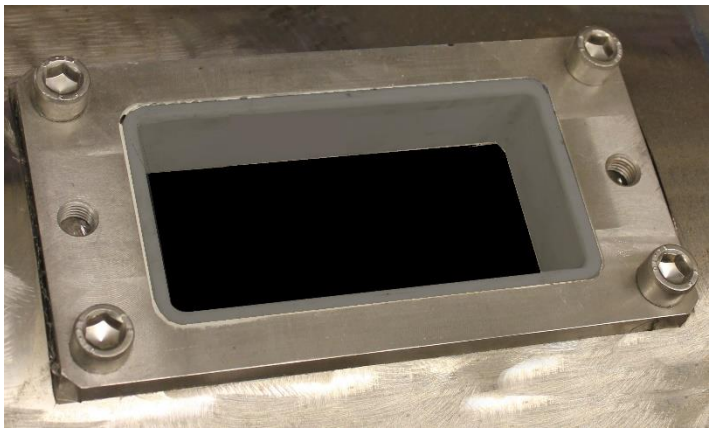


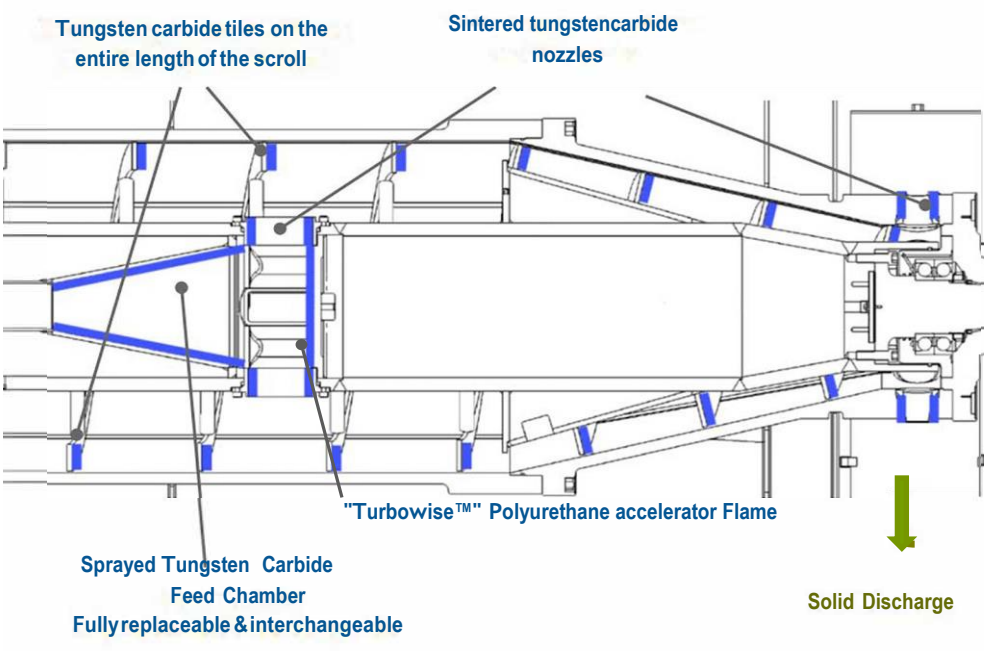
Thanks to the open flight design the centrate travels in a direct path to the discharge, flowing parallel to the length of the scroll. This is an improvement over outdated full-flight designs that forced the liquid flow to travel in a spiral path in the opposite direction of the conveyed solids.



3.3 WEAR AND ABRASION PROTECTION

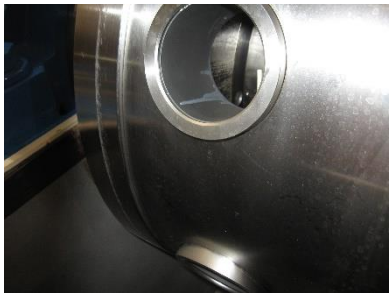
Field replaceable tungsten carbide feed ports.





Field replaceable sintered tungsten carbide tiles the entire length of the scroll

Field replaceable tungsten carbide cake discharge ports.



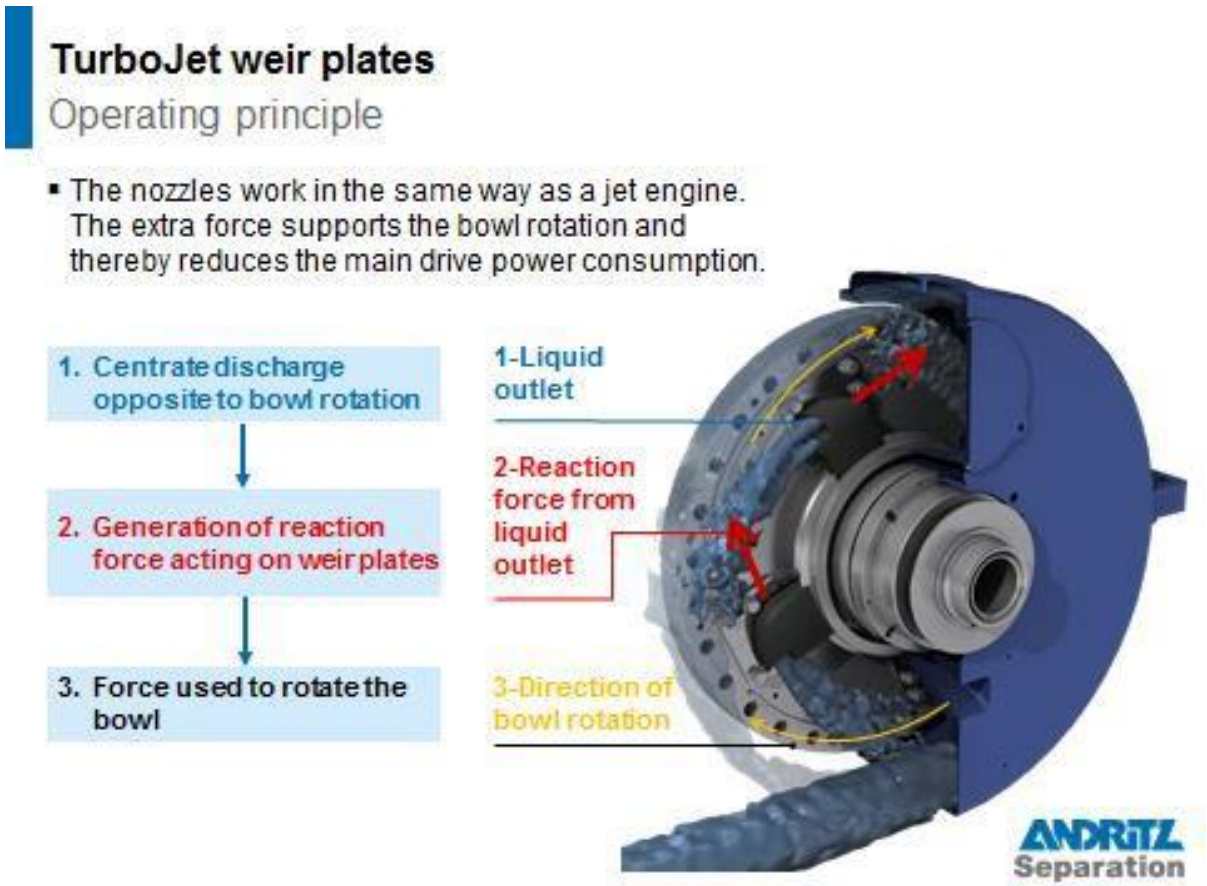
3.4 LOW ENERGY SYSTEM

The ANDRITZ D7LL centrifuge offers innovation designed to reduce power consumption and consequently, reduce your operating costs.

Our low power design achieves this by a combination of features with the main three described below:

3.4.1 TURBO JET

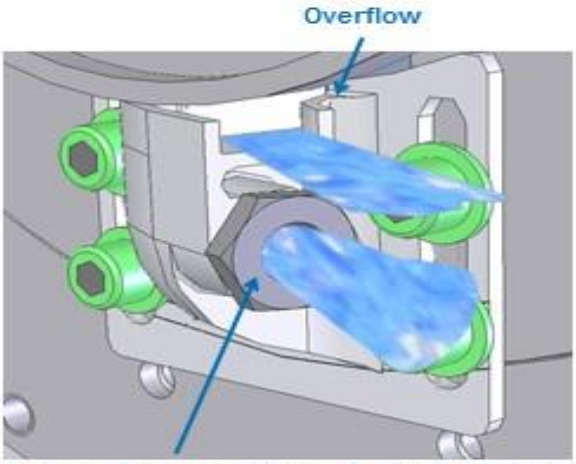
Specially designed Turbo Jet weir plates are installed to utilize the energy available from the liquid discharge of the centrifuge. Operating on a similar principal of jet engines, the Turbo Jet creates liquid jets directed opposite to the rotor direction of flow.



TurboJet weir plates

Operating principle

- ANDRITZ's new weir plate is provided with exchangeable nozzles and open channel (overflow).
- The flow through the nozzle can thus be maximised while maintaining the liquid level at the overflow.
- Closed and submerged inlet giving a much more efficient guidance of the liquid → Higher velocity
  → Better recovery of the hydraulic power.



Exchangeable nozzle to control the liquid level inside the rotor more accurately, reducing the cresting.

ANDRITZ Separation

TurboJet weir plates

Up to 30% power savings for all decanters

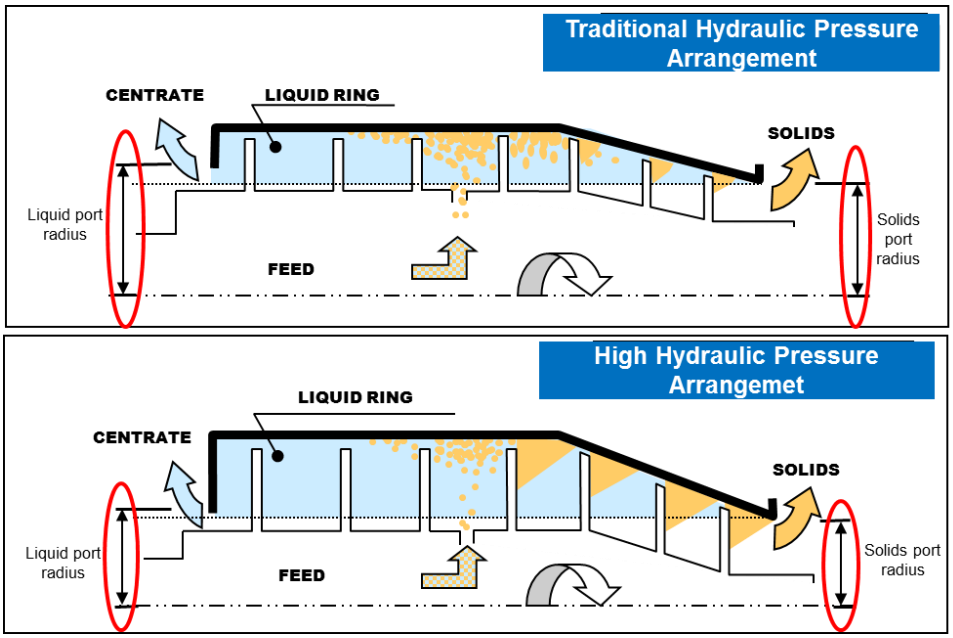
- Power consumption reduction by TurboJet weir plates has been proven for several applications:
  - Waste Water Treatment Plant (WWTP)
  - Bioethanol production
  - Food industry
  - Calcium carbonate separation
  - Various chemical and industrial applications
- Same separation performance (cake dryness, capture rate, etc.)
- Interchangeable nozzles are provided to fine-tune power savings for different flowrates

6

ANDRITZ Separation

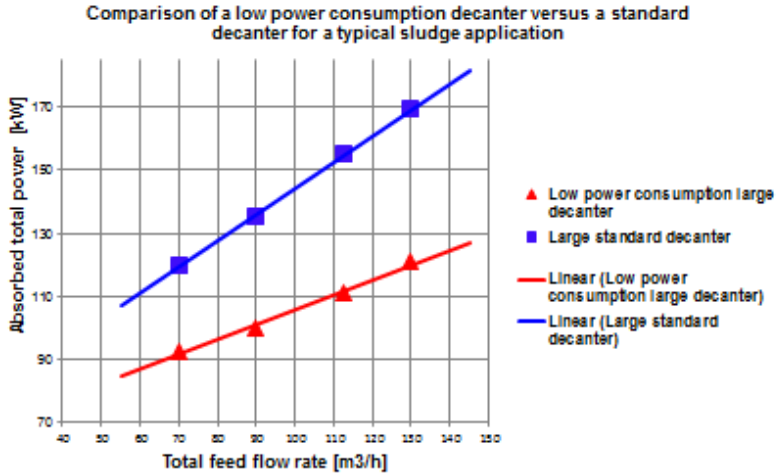
3.4.2 HIGH HYDRAULIC PRESSURE (HHP) DECANTER

The HHP bowl of the D7LL design provides for a reduced radius of the liquid and solids ejection ports, allowing for both improved process performance and significant reductions in consumed power.



High Hydraulic Pressure

Performances



11

ANDRITZ Separation

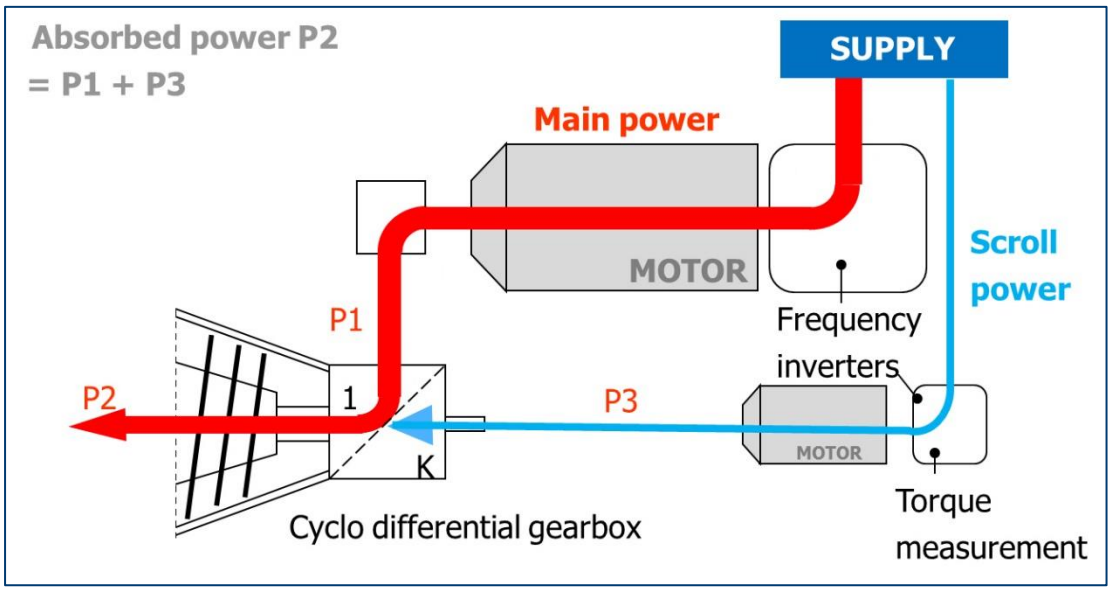
3.4.3 DIRECT DRIVE GEARBOX

ANDRITZ was the original pioneer of the regenerative drive system and while this has proven to be very successful in the past, market demands for lowest possible energy consumption has driven us forward to produce ever lower adsorbed power targets.
The direct drive gearbox is driven by a secondary motor avoiding recirculation loses in the main motor and frequency invertors.
Featured on our High Performance decanter centrifuges, the rotating assembly is driven by a main and a secondary motor. Each motor is controlled by a variable frequency invertor (VFD)

This unique system reduces power consumption up to 30% compared to standard systems.

The scroll speed and bowl speed are independent of each other and are controlled via dedicated VFD's.

This independent control increases the accuracy of speed control and, by eliminating pulleys from the system losses in the motor and VFD are greatly reduced therefore reducing the potential motor size and lowering total power requirements.

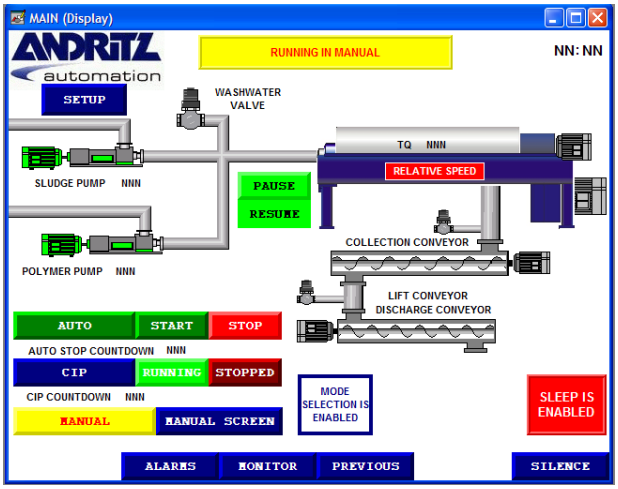


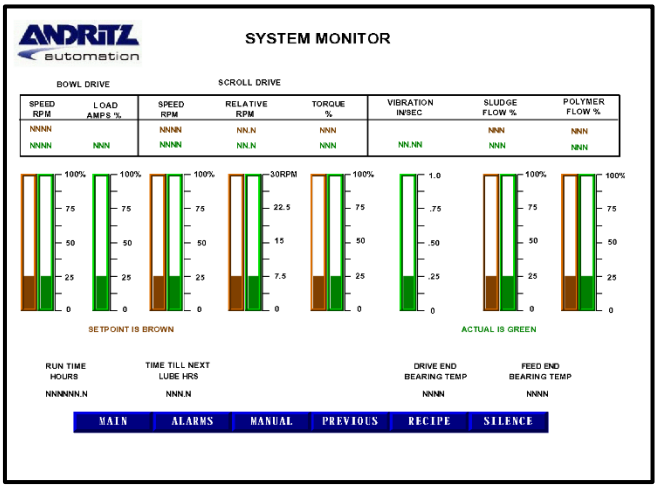
3.5 OPERATOR-FRIENDLY CONTROLS

The ANDRITZ centrifuge is designed for continuous, attention-free operation. The advanced centrifuge control system allows full monitoring and control of the system. The start-up and shutdown of the centrifuge can be programmed to occur outside of the operators' working hours and can also allow for 24/7 operation if required.

ANDRITZ supplies a complete control system with touch-screen interface which is capable of controlling the complete dewatering system including centrifuge, polymer system, sludge feed pump, wash water flow and discharge conveyor. The control system allows for totally automatic operation with operational features including Early Start, Extended Run, Pause & Resume and One Touch.

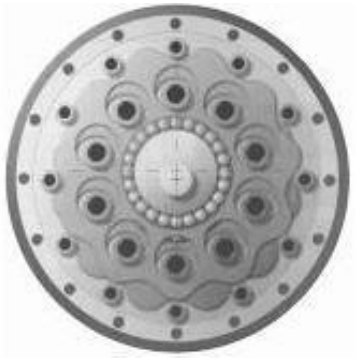
The centrifuge control systems are designed and programmed in-house in Arlington, Texas, and are not outsourced to third party vendors.





3.6 CYCLO-SUMITOMO GEAR BOX

This reducer creates the differential speed between the bowl and the scroll conveyor and bears the torque required to convey the solids out of the centrifuge.



CYCLO®-Sumitomo™ •ZSPR is a very special double stage centrifuge reducer with a Cyclo Drive stage and a differential planetary stage. This version allows variable relative speed over the full control range of the motor with slower as well as faster conveyor. The direct drive gearbox is driven by a secondary motor, avoiding recirculation losses in main motor and variable frequency converters. The proprietary design minimize frictions and provides for best efficiencies and torque capacities (able to support up to 200% of its nominal capacity).

3.7 INSTALLATION OF THE DECANTER

The IN-LINE design of our ANDRITZ decanter centrifuges reduces the floor space requirements to a minimum. Its isostatic design minimizes vibrations and noise level.

The decanter is typically installed on concrete supports, resting on vibration shock isolators (included in our scope).

The feed must be consistent and homogenous by an adjustable flow rate positive displacement volumetric pump. Provisions will be made for a wash water connection in the centrifuge feed (to be used only during shut down or Clean In Place (CIP) procedure).

The open solids discharge casing facilitates the installation of any evacuation system. We recommend the installation of an inclined shaftless screw conveyor with a bottom drain hole for the gravity discharge of the slops at the beginning and the end of each operating cycle.

The power and control panel, in which the frequency inverters (VFD) will be mounted, should be installed in an electrical room with fresh air ventilation, without any contact with the dewatering room, in order to prevent electrical wires and electronic cards corrosion. A local control panel can be installed on a wall near by the decanter if required.

4.0 DOCUMENTATION & COMMISSIONING

4.1 TECHNICAL DOCUMENTATION

The Operation and Maintenance Manuals are sent upon delivery of the equipment.
They include among others:
- Instructions regarding installation, automation, commissioning, piloting and maintenance of the equipment
- Parts manuals: including drawings with detailed part number and location for easy service.

4.2 COMMISSIONING

The installation will be carried out and controlled by the customer before arrival of our start-up technician, in accordance with our instructions. Upon his arrival, power, water, product to be treated and chemical aid products must be available on-site.

As soon as the machine is ready and the sludge available, our technician completes performance tests and optimization of the machine. During this commissioning, the personnel on site will be trained for operation of the centrifuge.

5.0 PRICING INDICATION

5.1 PRICING SUMMARY

Item	Qty.	Description
1	2 ea.	**ANDRITZ D7LL Decanter Centrifuge, including**: • 2304 Lean Duplex solid bowl with welded strips • 316L stainless steel HP Scroll conveyor • 316L stainless steel wetted parts • Frame painted standard 2 part epoxy paint • Field replaceable Sintered Tungsten Carbide tiles from two wraps beyond the feed zone with the remainder of the scroll flame sprayed tungsten carbide tiles • Field-replaceable sintered tungsten carbide feed ports • Field-replaceable sintered tungsten carbide discharge ports • Feed Chamber protected by TurboWise (PU liner) and flames sprayed Tungsten Carbide • 316L Stainless Steel Bowl Cover and drive guard • In-line drives 200 HP/50 HP providing space saving advantages • In-line double stage centrifuge reducer with a Cyclo Drive stage and a differential planetary stage • Bearings are L-10 for over 100,000 hours • Vibration Isolators • Forced oil lubrication system • Flexible connectors for sludge feed, centrate discharge and solids discharge
2	2 ea.	**EASY POND SYSTEM WITH SERVOS**
3	2 ea.	**NEMA 12 Painted Carbon Steel Starter Control Panel (Rockwell Automation)** • Power input: 460 VAC, 3 Phase, 60 Hz • Allen Bradley Powerflex 755 VFD-6 Pulse 250 HP Main Drive • Allen Bradley Powerflex 755 VFD-6 Pulse 40 HP Back Drive • Auto Transformer (5% line reactor) • Input Reactor 5% • Circuit Breakers with external Mechanical Door Interlock • Elapsed Time Meter • Control Relay • Time Delay Relay • Control Transformer • Input semiconductor fuses • Door Mounted Nameplate • Grace Port

Item	Qty.	Description
4	2 ea.	**NEMA 4X 304 SST Operator Control Panel** • Allen Bradley Compactlogix PLC Processor • Allen Bradley PanelView Plus 7-10” OIT touch screen • Automatic torque control operation • Automatic clean-in-place • NEMA 4X 304L stainless steel cabinet • Air Conditioned • Horn / Beacon • Grace Port
5	1 lot	**Tools Included with Equipment Supply** • One (1) Bowl lifter (Spreader Beam) with Ratchet strap and shackles • One (1) Bowl Truck (Cart) • One (1) Scroll lifter • One (1) Set Nylon Straps and Shackles for lifting case top • One (1) Each Nylon Straps and shackle for lifting drive motor • One (1) Each Nylon Straps and Shackles for lifting gearbox • One (1) Headwall bearing extractor • One (1) Pillow block bearing extractor • One (1) Greasing set • One (1) set of wrenches • One (1) set of threaded rods • One (1) grease pump • One (1) tool box
6	1 lot	**Spare Parts Included with Equipment Supply as described below:** • Four (4) Set of Turbo Jet weir plates • Two (2) Set Drive V-Belts • Two (2) Set Gaskets, Seals and O-rings • Two (2) Each Proximity Sensors • One (1) Year Supply of Lubricants • One (1) Lot Misc. PLC spares, push buttons, selector switches, contact blocks, lamps, fans, filters, Dc Power Supply, etc.

Item	Qty.	Description
7	1 lot	**Engineering and Documentation** ANDRITZ will supply the following documents (one e-copy and 3 hard copies): • Arrangement drawings with dimensions for the ANDRITZ scope • Motor list • Written sequence of operation including all interlocks • Control panel layout • Electrical drawings • Mechanical drawings • Terminal box details • Installation, operating and maintenance manuals
8	1 lot	**On-Site Services** • Installation, Start-up, Testing and Training (4 days / 1 trip) Note: aforementioned service is minimum time on-site exclusive of travel and may be combined with other services depending on the installing contractors schedule
9	1 lot	**Freight to job site (not including unloading)**
TOTAL BUDGET PRICE FOR ITEMS 1 THRU 9 ABOVE		**$1,350,000.00**

5.2 EXCLUDED FROM ANDRITZ SCOPE OF SUPPLY

The ANDRITZ scope of supply does not include the following items (unless previously mentioned) as may be necessary for equipment installation & operation to the performance levels specified:

- Civil and structural engineering work.
- Building and building plans (ANDRITZ will furnish load data and layout drawings but is not responsible for updating of building or building plans)
- Building modifications
- Platforms and access stairs or ladders
- All utilities required for operation and erection
- Unloading at site (by others)
- Cranes or other lifting devices to offload and/or install equipment
- Other instruments not specified in our scope of supply / outside of panel
- Polymer feed system
- Flow Meters
- Sludge Grinder
- Wash water booster pump
- Cake Discharge Pumps
- Centrate Discharge Pump
- Polymer, coagulants or other chemicals
- Lubricants
- Conveyors
- Diverter gate
- Laboratory Testing
- Discharge Chute
- Centrate Chute
- Sludge feed pump

6.0 COMMERCIAL SUMMARY

6.1 GENERAL COMMERCIAL TERMS

Terms and Conditions

This proposal is based on the attached ANDRITZ Separation Technologies “Standard Terms and Conditions of Sale”.

Special Provisions

- All prices quoted in US Dollars,
- Pricing quoted DDP jobsite per 2020 Incoterms.
- Pricing does not include any local, state or federal taxes, permits, duties or other fees. Any taxes or fees that may apply must be added to the quoted price and paid by the buyer. Bonding is not included.

The quoted price in this proposal has been calculated based on the current market prices required to manufacture the quoted equipment and services pursuant to regulations, duties and law in effect as of the date of this proposal. The quoted price shall remain firm for a period of thirty (30) days, except and subject to the following. In the event that the introduction of new tariffs, levies, duties, regulations, or any type of legislation by a domestic or foreign government has the effect of increasing the price of the quoted equipment or services, Andritz reserves its right to adjust its quoted price in order to reflect these increases in cost. Nothing in this document, or in any of the applicable contractual documentation shall be construed as a waiver of this right.

Validity

This budget proposal is valid for ninety (90) days.

Terms of Payment

ANDRITZ Separation Technologies agrees to the following payment terms (on a net 30 day basis):

- 30% of Order Value upon submittal of Approval Drawings
- 70% of Order Value upon Shipment

Delivery

Submittals will be provided 4 to 6 weeks after signed Purchase Order.
Equipment delivery is anticipated to be 36 - 40 weeks from receipt of Approved Submittals.

Field Service

ANDRITZ will provide additional erection and start-up supervision for $1,500.00 per day plus expenses, eight (8) hours/day. At the request of the Purchaser, overtime service will be provided at a rate of 1.5 times quoted rates for weekdays and 2.0 times quoted rates for weekends. Expenses are defined as the cost of travel from Seller's plant to the point of installation and return, together with all living expenses during the period of service.

The above charges shall be made for time involved including delays which are beyond the Seller's control.

7.0 STANDARD TERMS AND CONDITIONS OF SALE

ANDRITZ SEPARATION TECHNOLOGIES INC. STANDARD TERMS AND CONDITIONS OF SALE

1. TERMS APPLICABLE

(a) These Terms and Conditions of Sale are the only terms which govern the sale of the products, equipment, or parts ("Products") pursuant to the quotation or acknowledgement of the Andritz entity supplying the same ("Seller") or Buyer's purchase order or other written document issued by Buyer. These Terms and Conditions of Sale control, supersede and replace any and all other additional and/or different terms and conditions of Buyer, and Seller hereby objects to and rejects all such terms and conditions of Buyer without further notification, except to the extent Seller expressly agrees to such conditions in writing. Buyer's authorization for Seller to commence work under the Agreement or Buyer's acceptance of delivery of or payment for any Products covered by this Agreement, in whole or in part, shall be deemed Buyer's acceptance of these Terms and Conditions of Sale. The term "Agreement" as used herein means (1) these Terms and Conditions of Sale, (2) Seller's quotation or acknowledgment together with any attachment thereto and any documents expressly incorporated by reference, and (3) Buyer's purchase order or other written document issued by Buyer, together with any attachment thereto and any documents expressly incorporated by reference (but excluding any Buyer terms and conditions attached thereto or incorporated therein by reference).. In the event of a conflict between any documents forming the Agreement, such documents shall be construed in the above-listed order of precedence.

(b) Prior to Buyer's acceptance of any Seller quotation in which these Terms and Conditions of Sale are incorporated, in the event that the introduction of new tariffs, levies, duties, taxes, regulation, or any type of legislation by a domestic or foreign government has the effect of increasing the price of the quoted Products, Seller reserves its right to adjust its quoted price in order to reflect these increases in cost. Nothing in this document, or any of the applicable contractual documentation shall be construed as a waiver of this right.

2. DELIVERY; RISK OF LOSS AND TITLE

(a) Delivery dates are good faith estimates and do not mean that "time is of the essence." Buyer's failure to promptly make advance or interim payments, supply technical information, drawings and approvals will result in a commensurate delay in delivery. If the parties have agreed to liquidated damage in this Agreement for Seller's delay in achieving certain milestones, (i) the parties acknowledge and agree that Buyer's damages for Seller's delay are difficult to predict with any certainty, and such liquidated damages are not a penalty but a reasonable estimate of Buyer's delay damages; (ii) such liquidated damages shall not exceed an aggregate value of five percent (5%) of the Agreement price and shall be Buyer's exclusive remedy for any delay by Seller in performing any of its obligations under this Agreement; and (iii) Buyer agrees Seller shall not be liable for liquidated damages if Seller's delay in achieving a milestone subject to liquidated damages has not delayed Buyer's ability to use the applicable Products.

(b) Upon and after delivery, risk of loss or damage to the Products shall be Buyer's. Delivery of the Products hereunder will be made on the terms agreed to by the parties as set forth in this Agreement, according to INCOTERMS 2010. If no INCOTERM is agreed elsewhere in the Agreement, delivery of the Products will be made FCA. Title to the Products shall transfer to Buyer upon final payment therefor.

3. WARRANTY

(a) Seller warrants to Buyer that the Products manufactured by it will be delivered free from defects in material and workmanship. This warranty shall commence upon delivery of the Products and shall expire on the earlier to occur of 12 months from initial operation of the Products and 18 months from delivery thereof (the "Warranty Period"). If during the Warranty Period Buyer discovers a defect in material or workmanship of a Product and gives Seller written notice thereof within 10 days of such discovery, Seller will, at its option, either deliver to Buyer, on the same terms as the original delivery was made, according to INCOTERMS 2010, a replacement part or repair the defect in place. Any repair or replacement part furnished pursuant to this warranty are warranted against defects in material and workmanship for one period of 12 months from completion of such repair or replacement, with no further extension. Seller will have no warranty obligations for the Products under this Paragraph 3(a): (i) if the Products have not been stored, installed, operated and maintained in accordance with generally approved industry practice and with Seller's specific written instructions; (ii) if the Products are used in connection with any mixture or substance or operating condition other than that for which they were designed; (iii) if Buyer fails to give Seller such written 10 day notice; (iv) if the Products are repaired by someone other than Seller or have been intentionally or accidentally damaged; (v) for corrosion, erosion, ordinary wear and tear or in respect of any parts which by their nature are exposed to severe wear and tear or are considered expendable; or (vi) for expenses incurred for work in connection with the removal of the defective articles and reinstallation following repair or replacement.

(b) THE EXPRESS WARRANTIES SELLER MAKES IN THIS PARAGRAPH 3 ARE THE ONLY WARRANTIES IT WILL MAKE. THERE ARE NO OTHER WARRANTIES, WHETHER STATUTORY, ORAL, EXPRESS OR IMPLIED. IN PARTICULAR, THERE ARE NO IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

(c) The remedies provided in Paragraph 3(a) are Buyer's exclusive remedy for breach of warranty.

(d) With respect to any Product or part thereof not manufactured by Seller, Seller shall pass on to Buyer only those warranties made to Seller by the manufacturer of such Product or part which are capable of being so passed on.

4. LIMITATION OF LIABILITY

Notwithstanding any other provision in this Agreement, the following limitations of liability shall apply:

(a) In no event, whether based on contract, tort (including negligence), strict liability or otherwise, shall Seller, its officers, directors, employees, subcontractors, suppliers or affiliated companies be liable for loss of profits, revenue or business opportunity, loss by reason of shutdown of facilities or inability to operate any facility at full capacity, or cost of obtaining other means for performing the functions performed by the Products, loss of future contracts, claims of customers, cost of money or loss of use of capital, in each case whether or not foreseeable, or for any indirect, special, incidental or consequential damages of any nature resulting from, arising out of or connected with the Products or this Agreement or from the performance or breach hereof.

(b) The aggregate liability of Seller, its officers, directors, employees, subcontractors, suppliers or affiliated companies, for all claims of any kind for any loss, damage, or expense resulting from, arising out of or connected with the Products or this Agreement or from the performance or breach hereof, together with the cost of performing make good obligations to pass performance tests, if applicable, shall in no event exceed the Agreement price. The foregoing notwithstanding, Seller's aggregate and sole liability for any claims for (a) delay in delivery shall not exceed 5% and (b) failure to achieve performance requirements, shall not exceed 15% of the contract price.

(c) The limitations and exclusions of liability set forth in this Paragraph 4 shall take precedence over any other provision of this Agreement and shall apply whether the claim of liability is based on contract, warranty, tort (including negligence), strict liability, indemnity, or otherwise. The remedies provided in this Agreement are Buyer's exclusive remedies.

(d) All liability of Seller, its officers, directors, employees, subcontractors, suppliers or affiliated companies, resulting from, arising out of or connected with the Products or this Agreement or from the performance or breach hereof shall terminate on the third anniversary of the date of this Agreement.

(e) In no event shall Seller be liable for any loss or damage whatsoever arising from its failure to discover or repair latent defects or defects inherent in the design of goods serviced (unless such discovery or repair is normally discoverable by tests expressly specified in the scope of work under this Agreement) or caused by the use of goods by the Buyer against the advice of Seller. If Seller furnishes Buyer with advice or assistance concerning any products or systems that is not required pursuant to this Agreement, the furnishing of such advice or assistance will not subject Seller to any liability whether in contract, indemnity, warranty, tort (including negligence), strict liability or otherwise.

5. CHANGES, DELETIONS AND EXTRA WORK.

Seller will not be required to make changes in the Products unless Buyer and Seller have executed a written Change Order for such change. Any such Change Order will include an appropriate adjustment to the Agreement price and/or schedule. If the change impairs Seller's ability to satisfy any of its obligations to Buyer, the Change Order will include appropriate modifications to this Agreement. Seller shall be entitled to a Change Order adjusting the Agreement price, schedule and/or any affected obligations of Seller if after the effective date of this Agreement (a) a change in applicable law, tariffs, levies, duties, taxes, regulations or ordinances or (b) any act or omission of Buyer or any other party for whom Buyer is responsible, or any error or change in Buyer-provided information should require a change in the Products or cause an increase in the cost or change in the schedule to supply the Products.

6. TAXES

Seller's prices do not include any sales, use, excise or other taxes. In addition to the price specified herein, the amount of any present or future sales, use, excise or other tax applicable to the sale or use of the Products shall be billed to and paid by Buyer unless Buyer provides to Seller a tax-exemption certificate acceptable to the relevant taxing authorities.

7. SECURITY INTEREST

Seller shall retain a purchase money security interest and Buyer hereby grants Seller a lien upon and security interest in the Products until all payments hereunder have been made in full. Buyer acknowledges that Seller may file a financing statement or comparable document as required by applicable law and may take all other action it deems reasonably necessary to perfect and maintain such security interest in Seller and to protect Seller's interest in the Products.

8. SET OFF

Neither Buyer nor any of its affiliates shall have any right to set off claims against Seller or any of its affiliates for amounts owed under this Agreement or otherwise.

9. PATENTS

Unless the Products or any part thereof are designed to Buyer's specifications or instructions and provided the Product or any part thereof is not used in any manner other than as specified or approved by Seller in writing or modified by Buyer without the written consent of Seller, (i) Seller shall defend against claims made in a suit or proceeding brought against Buyer by an unaffiliated third party that any Product infringes a device claim of a patent issued as of the effective date of this Agreement in the country in which the Product will be operated, and limited to the field of the specific Products provided under this Agreement; provided Seller is notified promptly in writing and given the necessary authority, information and assistance for the defense of such claims; (ii) Seller shall satisfy any judgment (after all appeals) for damages entered against Buyer on such claims so long as such damages are not attributable to willful conduct or sanctioned litigation conduct; and (iii) if such judgment enjoins Buyer from using any Product or a part thereof, then Seller will, at its option: (a) obtain for Buyer the right to continue using such Product or part; (b) eliminate the infringement by replacing or modifying all or part of the Products; or (c) take back such Product or part and refund to Buyer all payments on the Agreement price that Seller has received for such Product or part. The foregoing states Seller's entire liability for patent infringement by any Product or part thereof.

10. SOFTWARE LICENSE, WARRANTY, FEES

If Buyer and Seller have not entered into a separate license agreement, the following Software Terms and Conditions apply to any embedded software produced by Seller and furnished by Seller hereunder:

(a) The Software, as described in the Agreement ("Software"), and all written materials or graphic files that are fixed in any tangible medium and that relate to and support the Software ("Documentation"), and all present and future worldwide copyrights, trademarks, trade secrets, patents, patent applications, mask work rights, moral rights, contract rights, and other proprietary rights recognized by the laws of any country inherent therein, including all changes and improvements requested or suggested by Buyer in the support and maintenance of the Software are the exclusive property of Seller ("Seller's Intellectual Property Rights"). All rights in and to the Software not expressly granted to Buyer in the Agreement are reserved by Seller. Nothing in this Agreement will be deemed to grant, by implication, estoppel, or otherwise, a license under any of Seller's existing or future patents. Software will not include any upgrades, new versions, releases, enhancements, or updates to the Software, unless agreed to by Seller in writing and at its sole discretion. To the extent any upgrades, new versions, releases, enhancements, or updates to the Software are provided by Seller, the term "Software" shall be deemed to include such upgrades, new versions or releases, enhancements or updates. To the extent any ownership right arises in Buyer with respect to the above, Buyer hereby assigns all of its right, title, and interest in and to any intellectual property embodied in in the Seller's Intellectual Property Rights, including enforcement rights, to Seller without the payment of any additional consideration thereof either to Buyer, or its employees, agents, or customers and agrees to execute any documents Seller deems necessary to effect such assignment.

(b) Seller hereby grants to Buyer a non-exclusive, non-transferable, non-sub-licensable, revocable license to install, run, and use the Software, and any modifications made by Seller thereto only in connection with configuration of the Products and operating system for which the Software is ordered hereunder, and for the end-use purpose stated in the Documentation. Buyer agrees that neither it nor any third party shall modify, reverse engineer, decompile or reproduce the Software, except Buyer may create a single copy for backup or archival purposes in accordance with the Documentation (the "Copy"). Buyer's license to use the Software and the Copy of such Software shall terminate upon any breach of this Agreement by Buyer. All copies of the Software, including the Copy, are the property of Seller, and all copies for which the license is terminated shall be returned to Seller, or deleted from Buyer's computer systems, with written confirmation after termination.

(c) Seller warrants that, on the date of shipment of the Software or the Products containing the Software to Buyer: (1) the Software media contain a true and correct copy of the Software and are free from material defects; (2) Seller has the right to grant the license hereunder; and (3) the Software will function substantially in accordance with the related Seller operating documentation. In no event does Seller warrant that the Software is error free or that Buyer will be able to operate the Software without impairments or interruptions. In addition, due to the continual development of new techniques for intruding upon and attacking networks, Seller does not warrant that the Software or any equipment, system, or network on which the Software is used will be free of vulnerability to intrusion or attack.

(d) If within 12 months from the date of delivery of the Products containing the Software, Buyer discovers that the Software is not as warranted above and notifies Seller in writing prior to the end of such 12 month period, and if Seller determines that it cannot or will not correct the nonconformity, Buyer's and Buyer's Seller-authorized transferee's exclusive remedies, at Seller's option, are: (1) replacement of the nonconforming Software; or (2) termination of this license and a refund of a pro rata share of the Agreement price or license fee paid.

(e) If any infringement claims are made against Buyer arising out of Buyer's use of the Software in a manner specified by Seller, Seller shall: (i) defend against any claim in a suit or proceeding brought by an unaffiliated third party against Buyer that the Software violates a registered copyright or a confidentiality agreement to which Seller was a party, provided that Seller is notified promptly in writing and given the necessary authority, information and assistance for the defense and settlement of such claims (including the sole authority to select counsel and remove the Software or stop accused infringing usage); (ii) Seller shall satisfy a final judgment (after all appeals) for damages entered against Buyer for such claims, so long as such damages are not attributable to willful conduct or sanctioned litigation conduct; and (iii) if such judgment enjoins Buyer from using the Software, Seller may at its option: (a) obtain for Buyer the right to continue using such Software; (b) eliminate the infringement by modifying the Software or replacing it with a functional equivalent (in which case, Buyer shall immediately stop use of the allegedly infringing Software), or (c) take back such Software and refund to Buyer all payments on the Agreement price that Seller has received. However, Seller's obligations under this Paragraph 10 shall not apply to the extent that the claim or adverse final judgment relates to: (1) Buyer's running of the Software after being notified to discontinue; (2) non-Seller software, products, data or processes; (3) Buyer's alteration of the Software; (4)

Buyer's distribution of the Software to, or its use for the benefit of, any third party not approved in writing by Seller; or (5) Buyer's acquisition of confidential information (a) through improper means; (b) under circumstances giving rise to a duty to maintain its secrecy or limit its use; or (c) from a third party who owed to the party asserting the claim a duty to maintain the secrecy or limit the use of the confidential information. Buyer will reimburse Seller for any costs or damages that result from actions 1 to 5. **THE FOREGOING PROVISIONS OF THIS SECTION 10(e) STATE THE ENTIRE LIABILITY AND OBLIGATIONS OF SELLER AND THE EXCLUSIVE REMEDY OF BUYER, WITH RESPECT TO ANY VIOLATION OR INFRINGEMENT OF ANY PROPRIETARY RIGHTS UNDER SECTION 10, INCLUDING BUT NOT LIMITED TO PATENTS AND COPYRIGHTS, BY THE SOFTWARE OR ANY PART THEREOF.**

(f) This warranty set forth in subparagraph (c) above shall only apply when: (1) the Software is not modified by anyone other than Seller or its agents authorized in writing; (2) there is no modification in the Products in which the Software is installed by anyone other than Seller or its agents authorized in writing; (3) the Products are in good operating order and installed in a suitable operating environment; (4) the nonconformity is not caused by Buyer or a third party; (5) Buyer promptly notifies Seller in writing, within the period of time set forth in subparagraph (c) above, of the nonconformity; and (6) all fees for the Software due to Seller have been timely paid. **SELLER HEREBY DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, WITH REGARD TO THE SOFTWARE, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, COURSE OF DEALING AND USAGE OF TRADE.**

(g) Buyer and its successors are limited to the remedies specified in this Paragraph 10.

(h) Any subsequent modifications or enhancements to the Software made by Seller are, at Seller's option, subject to a fee.

11. TERMINATION

(a) Buyer may terminate this Agreement upon breach by Seller of a material obligation hereunder and Seller's failure to cure, or to commence a cure of, such breach within a reasonable period of time (but not less than 30 days) following written receipt of notice of the same from Buyer.

(b) Buyer may only terminate this Agreement for Buyer's convenience upon written notice to Seller and upon payment to Seller of Seller's termination charges, which shall be specified to Buyer and shall take into account among other things expenses (direct and indirect) incurred and commitments already made by Seller, overhead, and an appropriate profit. In case of such termination, the licenses granted in Paragraphs 10 and 12 hereof shall terminate.

(c) Seller shall have the right to suspend and/or terminate its obligations under this Agreement if payment is not received within 30 days of due date. In the event of the bankruptcy or insolvency of Buyer or in the event of any bankruptcy or insolvency proceeding brought by or against Buyer, Seller shall be entitled to terminate any order outstanding at any time during the period allowed for filing claims against the estate and shall receive reimbursement for its cancellation charges.

12. INTELLECTUAL PROPERTY; CONFIDENTIALITY

(a) All intellectual property embodied in the Products and Software provided to Buyer is the property of Seller, and any intellectual property developed, at least in part, by Seller under this Agreement is and remains the sole and exclusive property of Seller.

(b) Buyer acknowledges that the information that Seller submits to Buyer in connection with this Agreement and the performance hereof is Seller's confidential and proprietary information. Buyer agrees not to disclose such information to third parties without Seller's prior written consent. Seller grants to Buyer a non-exclusive, royalty-free, non-transferrable license to use Seller's confidential and proprietary information for the purpose of the installation, operation, maintenance and repair of the Products that are the subject of this Agreement only; provided, however, that Buyer further agrees not to, and not to permit any third party to, analyze, measure the properties of, or otherwise reverse engineer the Products or any parts thereof, fabricate the Products or any parts thereof from Seller's drawings or to use the drawings other than in connection with this Agreement. Buyer will defend and indemnify Seller from any claim, suit or liability based on personal injury (including death) or property damage related to any Product or part thereof which is fabricated by a third party without Seller's prior written consent and from and against related costs, charges and expenses (including attorneys' fees). All copies of Seller's confidential and proprietary information shall remain Seller's property and may be reclaimed by Seller at any time in the event Buyer is in breach of its obligations under this Paragraph 12, or in case of Buyer's termination pursuant to Paragraph 11(b).

13. END USER

If Buyer is not the end user of the Products sold hereunder (the "End User"), then Buyer will use its best efforts to obtain the End User's written consent to be bound to Seller by the provisions hereof. If Buyer does not obtain such End User's consent, Buyer shall defend and indemnify Seller and Seller's agents, employees, subcontractors and suppliers from any action, liability, cost, loss, or expense for which Seller would not have been liable or from which Seller would have been indemnified if Buyer had obtained such End User's consent.

14. FORCE MAJEURE

(a) Force Majeure Defined. For the purpose of this Agreement "Force Majeure" will mean all events, whether or not foreseeable, beyond the reasonable control of either party which affect the performance of this Agreement, including, without limitation, acts of God, acts or advisories of governmental or quasi-governmental authorities, laws or regulations, strikes, lockouts or other industrial disturbances, acts of public enemy, wars, insurrections, riots, epidemics, pandemics, outbreaks of infectious disease or other threats to public health, lightning, earthquakes, fires, storms, severe weather, floods, sabotage, delays in transportation, rejection of main forgings and castings, lack of available shipping by land, sea or air, lack of dock lighterage or loading or unloading facilities, inability to obtain labor or materials from usual sources, serious accidents involving the work of suppliers or sub-suppliers, thefts and explosions.

(b) Suspension of Obligations. If either Buyer or Seller is unable to carry out its obligations under this Agreement due to Force Majeure, other than the obligation to make payments due hereunder, and the party affected promptly notifies the other of such delay, then all obligations that are affected by Force Majeure will be suspended or reduced for the period of Force Majeure and for such additional time as is required to resume the performance of its obligations, and the delivery schedule will be adjusted to account for the delay.

(c) Option to Terminate. If the period of suspension or reduction of operations will extend for more than four (4) consecutive months or periods of suspension or reduction total more than 6 months in any 12 month period, then either Buyer or Seller may terminate this Agreement.

15. INDEMNIFICATION AND INSURANCE

(a) Indemnification. Seller agrees to defend and indemnify Buyer from and against any third-party claim for bodily injury or damage to tangible property ("Loss") arising in connection with the Products provided by Seller hereunder, but only to the extent such Loss has been caused by the negligence, willful misconduct or other legal fault ("Fault") of Seller. Buyer shall promptly tender the defense of any such third-party claim to Seller. Seller shall be entitled to control the defense and resolution of such claim, provided that Buyer shall be entitled to be represented in the matter by counsel of its choosing at Buyer's sole expense. Where such Loss results from the Fault of both Seller and Buyer or a third party, then Seller's defense and indemnity obligation shall be limited to the proportion of the Loss that Seller's Fault bears to the total Fault.

(b) Insurance. Seller shall maintain commercial general liability insurance with limits of $2,000,000 per occurrence and in the aggregate covering claims for bodily injury (including death) and physical property damage arising out of the Products. Seller shall also provide workers' compensation insurance or the like as required by the laws of the jurisdiction where the Services will be performed, and owned and non-owned auto liability insurance with limits of $1,000,000 combined single limit. Seller will provide a Certificate of Insurance certifying the existence of such coverages upon request.

16. U.S. EXPORT CONTROL

Buyer recognizes that any Products that are the subject of Agreement and originate in the U.S. remain subject to U.S. export laws and regulations even after such Products are exported from the U.S. (if applicable). Buyer certifies that such Products will not be diverted, transshipped, re-exported, or otherwise transferred in contravention of U.S. export laws and regulations. Buyer further affirms that such Products will not be used, directly or indirectly, in any application involving missile technology, nuclear proliferation, or chemical and biological weapons proliferation.

17. GENERAL

(a) Seller represents that any Products or parts thereof manufactured by Seller will be produced in compliance with all applicable federal, state and local laws applicable to their manufacture and in accordance with Seller's engineering standards. Seller shall not be liable for failure of the Products to comply with any other specifications, standards, laws or regulations.

(b) This Agreement shall inure only to the benefit of Buyer and Seller and their respective successors and assigns. Any assignment of this Agreement or any of the rights or obligations hereunder, by either party without the written consent of the other party shall be void.

(c) This Agreement contains the entire and only agreement between the parties with respect to the subject matter hereof and supersedes all prior oral and written understandings between Buyer and Seller concerning the Products and any prior course of dealings or usage of the trade not expressly incorporated herein.

(d) This Agreement may be modified, supplemented or amended only by a writing signed by an authorized representative of Seller. Seller's waiver of any breach by Buyer of any terms of this Agreement must also be in writing and any waiver by Seller or failure by Seller to enforce any of the terms and conditions of this Agreement at any time, shall not affect, limit or waive Seller's right thereafter to enforce and compel strict compliance with every term and condition hereof.

(e) All terms of this Agreement which by their nature should apply after the cancellation, completion or termination of this Agreement, including, but not limited to, Paragraphs 4, 12, 16 and 17, shall survive and remain fully enforceable after any cancellation, completion or termination hereof.

(f)(i) If Seller's office is located in the United States, this Agreement and the performance hereof will be governed by and construed according to the laws of the State of Georgia.

(ii) If Seller's office is located in Canada, this Agreement and the performance hereof will be governed by and construed according to the laws of the Province of New Brunswick...

(g) (i) In the circumstances of f(i) above, any controversy or claim arising out of or relating to this Agreement, or the breach hereof, or to the Products provided pursuant hereto, shall be definitively settled by arbitration, to the exclusion of courts of law, administered by the American Arbitration Association ("AAA") in accordance with its Construction Industry Arbitration Rules in force at the time this Agreement is signed and to which the parties declare they will adhere (the "AAA Rules"), and judgment on the award rendered by the arbitrator(s) may be entered in any court having jurisdiction over the party against whom enforcement is sought or having jurisdiction over any of such party's assets. The arbitration shall be conducted in Atlanta, Georgia by a panel of three members, one of whom will be appointed by each of Buyer and Seller and the third of whom will be the chairman of the panel and will be appointed by mutual agreement of the two party appointed arbitrators. All arbitrators must be persons who are not employees, agents, or former employees or agents of either party. In the event of failure of the two party appointed arbitrators to agree within 45 days after submission of the dispute to arbitration upon the appointment of the third arbitrator, the third arbitrator will be appointed by the AAA in accordance with the AAA Rules. In the event that either of Buyer or Seller fails to appoint an arbitrator within 30 days after submission of the dispute to arbitration, such arbitrator, as well as the third arbitrator, will be appointed by the AAA in accordance with the AAA Rules.

(ii) In the circumstances of f(ii) above, any controversy or claim arising out of or relating to this Agreement, or the breach hereof, or to the Products provided pursuant hereto, shall be definitively settled under the auspices of the Canadian Commercial Arbitration Centre ("CCAC"), by means of arbitration and to the exclusion of courts of law, in accordance with its General Commercial Arbitration Rules in force at the time the Agreement is signed and to which the parties declare they will adhere (the "CCAC Rules"), and judgment on the award rendered by the arbitrator(s) may be entered in any court having jurisdiction over the party against whom enforcement is sought or having jurisdiction over any of such party's assets. The arbitration shall be conducted in Saint John, New Brunswick by a panel of three arbitrators, one of whom will be appointed by each of Buyer and Seller and the third of whom will be the chairman of the arbitral tribunal and will be appointed by mutual agreement of the two party-appointed arbitrators. All arbitrators must be persons who are not employees, agents, or former employees or agents of either party. In the event of failure of the two party-appointed arbitrators to agree within 45 days after submission of the dispute to arbitration upon the appointment of the third arbitrator, the third arbitrator will be appointed by the CCAC in accordance with the CCAC Rules. In the event that either of Buyer or Seller fails to appoint an arbitrator within 30 days after submission of the dispute to arbitration, such arbitrator, as well as the third arbitrator, will be appointed by the CCAC in accordance with the CCAC Rules.

(h) In the event this Agreement pertains to the sale of any goods outside the United States or Canada, the parties agree that the United Nations Convention for the International Sale of Goods shall not apply to this Agreement.

(i) The parties hereto have required that this Agreement be drawn up in English. Les parties aux présentes ont exigé que la présente convention soit rédigée en anglais.

Feb. 2019 Rev.

ALCOSAN
THK200 Pilot Test Report

Prepared For:
Arcadis

Prepared By: Nathan Nowicki
Date: 11/22/21

Location:

Allegheny County Sanitary Authority
3300 Preble Ave
Pittsburgh, PA 15233

Arcadis Personnel:

Rucha Shah
Rucha.shah@arcadis.com
(412) 583-7432

Cord McKenna
cord.mckenna@arcadis.com
(724) 494-4750

Centrisys

Sanjeev Verma
sanjeev.verma@centrisys.us
(262) 612-9318

Nathan Nowicki
nathaniel.nowicki@centrisys.us
(262) 716-9819

Kappe

Brian Fenstamaker
brian@kappe-inc.com
(412) 334-2985

Test Dates:

October 12th to 22nd, 2021

Centrisys Corporation Model:

THK200

Job #:

10252-43

Material Classification:

Waste Activated Sludge

Conditioning Evaluated:

No Conditioning, K144L

EXECUTIVE SUMMARY

The Allegheny County Sanitary Authority is looking to install thickening equipment for its waste activated sludge to maximize its solids handling capacity with minimal footprint and cost. The design intent is for thickened WAS to be blended with primary sludge and dewatered.

To demonstrate the thickening capabilities of the Centrisys THK series of specialized thickening centrifuges on WAS at the ALCOSAN facility, pilot testing was carried out on a THK200 mobile test skid.

The THK200 was able to thicken the WAS with no polymer required to 6% total solids with 94.7% solids recovery at a rate of 230 GPM and a specific power of 0.086 kW/GPM.

With an active polymer dose of 1.5 lbs/DT, the solids capture rate was increased to 98.1% while maintaining performance and lowering power consumption to 0.066 kW/gpm.

At lower feed rates, performance was maintained with slightly increased solids capture rates.

Table 1. Performance Summary

Sample	Sludge Feed Rate	Solids Loading	Thickened Stream	Solids Capture, Dilution Factored	Power	Active Polymer Dose
	[GPM]	[lb/hr]	[% TS]	[% w/w]	[kW/gpm]	[lb/DT]
4.3	230	391	6.2%	94.7%	0.086	0.00
3.4	200	380	5.5%	95.1%	0.068	0.00
2.6	150	240	5.7%	97.0%	0.069	0.00
5.2	230	391	6.0%	98.1%	0.066	1.50
2.1	200	320	8.9%	94.9%	0.060	0.00

Based on the results of the pilot test, THK600 units are recommended as an efficient means of thickening the WAS prior to blending with primary sludge and dewatering.

Table 2. THK series scale up.

THK200	THK350	THK600
150 GPM	320 GPM	680 GPM
200 GPM	420 GPM	900 GPM
230 GPM	510 GPM	1000 GPM

Polymer flocculant addition was not required for operation of the THK even at peak capacities. While the THK was able to produce TWAS with total solids contents up to 10% without sacrificing solids capture, overthickened TWAS may be difficult to blend and dewater. The variable air-injection of the THK200 system was critical in maintaining precise control of TWAS TS in the 5 – 6% range.

INTRODUCTION

The Allegheny County Sanitary Authority has enlisted the engineering firm Arcadis to conduct a preliminary evaluation of several centrifugal thickeners for future plant upgrades. The plant currently processes approximately 55 million gallons per day of wastewater, with a peak design capacity of 72 MGD. After aerated degritting and primary settling, the primary clarifier supernatant is introduced to aeration basins in the facilities activated sludge process. Waste activated sludge is blended with the settled primary sludge and dewatered by centrifuge. A portion of the dewatered sludge is incinerated, while the rest is lime-stabilized and land-applied or sent to landfill.

Key parameters desired in the new thickening equipment include:

- Low footprint — limited space for new installed equipment
- Low to no polymer consumption: — 0 – 2 active lbs / dry ton of solids
- Low specific power consumption: — less than 0.1 kW/GPM processed
- Moderately thickened TWAS: — 4-6% blended with Primary Sludge and dewatered
- High hydraulic loading capacity: — 1000 GPM per activated sludge train

A pilot test evaluating the performance capabilities of the Centrisys THK line of thickening centrifuges was conducted on a trailer mounted THK200 skid at the ALCOSAN facility. The THK200 was inserted into the plant process without disruption by discharging the separated centrate and TWAS streams together into the aeration basin directly downstream of the feed location. WAS is returned to the aeration basins in Pass-1, and influent from the primary clarifier overflow is not introduced until Pass-2 of the aeration basins.

SET UP

Upon delivery, the trailer mounted THK200 test skid was positioned outside on a stretch of pavement next to the aeration basins.

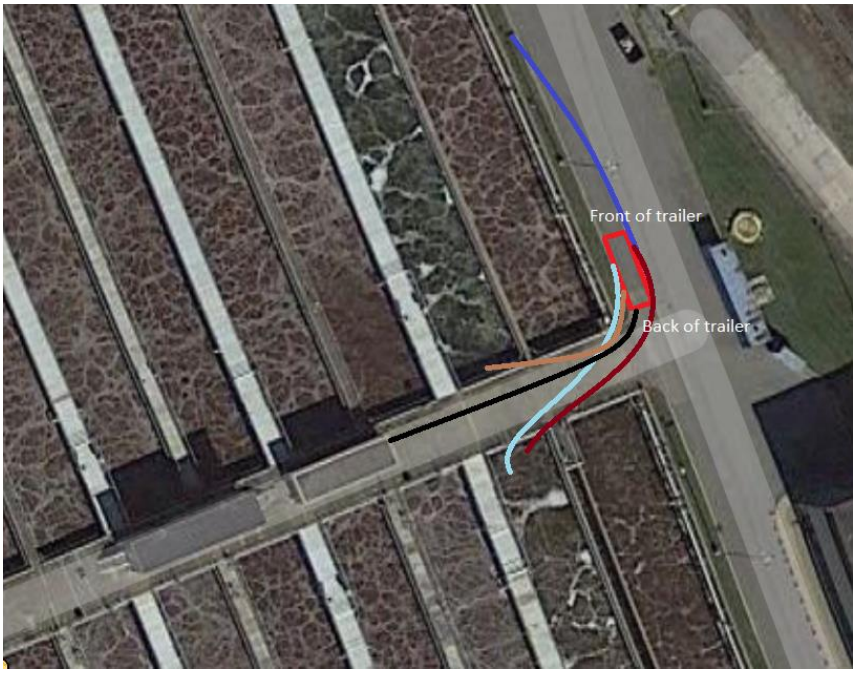


Figure 1. Planned trailer positioning and hose layout.

Figure 2. Trailer mounted Centrisys THK200 thickening centrifuge skid.

Figure 3. Sample collection side of THK200 skid trailer.

Feed waste activated sludge for the pilot was supplied to the unit by a skid mounted progressive cavity pump. A four-inch camlock hose was lowered into the aeration basin to supply the PC pump.

Figure 4. WAS feed hose pulling out of EA-4 Pass-1.

Thickened waste activated sludge produced by the unit was discharged via progressive cavity pump into an aeration basin.

Figure 4. Centrate and TWAS hoses discharging into EA-4 Pass-2.

Clarified centrate was pumped via four-inch camlock hose into the same aeration basin.

A 480V, 100 amp service power source was supplied by the plant and connected by plant electricians.

Process water was supplied to the unit via two-inch camlock hose connected to a hydrant. Process water was shutoff in between test days with a two-inch ball valve supplied by the plant.

Figures 5 and 6. Thickener skid 480V power supply connection and process water connection.

To evaluate the performance improvements with polymer conditioning, the skid-mounted Velodyne polymer system was used to dilute and dose emulsion polymer fed from a hopper. One-minute drawdown measurements were conducted during this subset of testing to ensure an accurate dose was recorded. The polymer used during testing was Solenis K144L, a high charge-density cationic linear emulsion polymer.

Figure 7. Sample set 1.1 comprising of two feed samples, one centrate sample, and one TWAS sample.

Process streams were sampled at several feed flow rates and rotational speeds, allowing a minimum of 45 minutes between parameter adjustments for the process to reach steady state. On THK200 units, a key parameter for adjustment is the depth of discharge. Both the solids end and liquid end of the THK200 have adjustable eccentric nozzles that determine discharge depth. Because the contents of the bowl are forced towards the bowl wall, the deepest nozzle setting occurs when the eccentric orifice of the nozzle is nearest the axis of rotation of the centrifuge, and the shallowest setting is nearest the bowl wall. Two nozzle configurations were investigated during this test: Liquid end nozzles offset 45° from the deepest setting paired with solids end nozzles at the deepest setting, denoted as (45°, 0°), and Liquid end nozzles offset 90° from the deepest setting paired with solids end nozzles at the deepest setting, denoted as (90°, 0°). Stream samples were taken by Centrisys personnel with Arcadis personnel present and were measured for TS and TSS content by a third-party laboratory. One liter feed and centrate samples were measured for TSS, and 500 mL feed and TWAS samples were measured for TS. Feed and centrate samples were also analyzed in a laboratory centrifuge for %v/v total suspended solids readings to give volumetric suspended solids recovery estimates. Select TWAS samples were measured for approximate TS with a moisture balance. Special thanks should be given to Arcadis and ALCOSAN staff for their support throughout the test.

DISCUSSION

Testing began by evaluating unit performance at a range of flowrates without air injection. This was performed at two bowl speed setpoints.

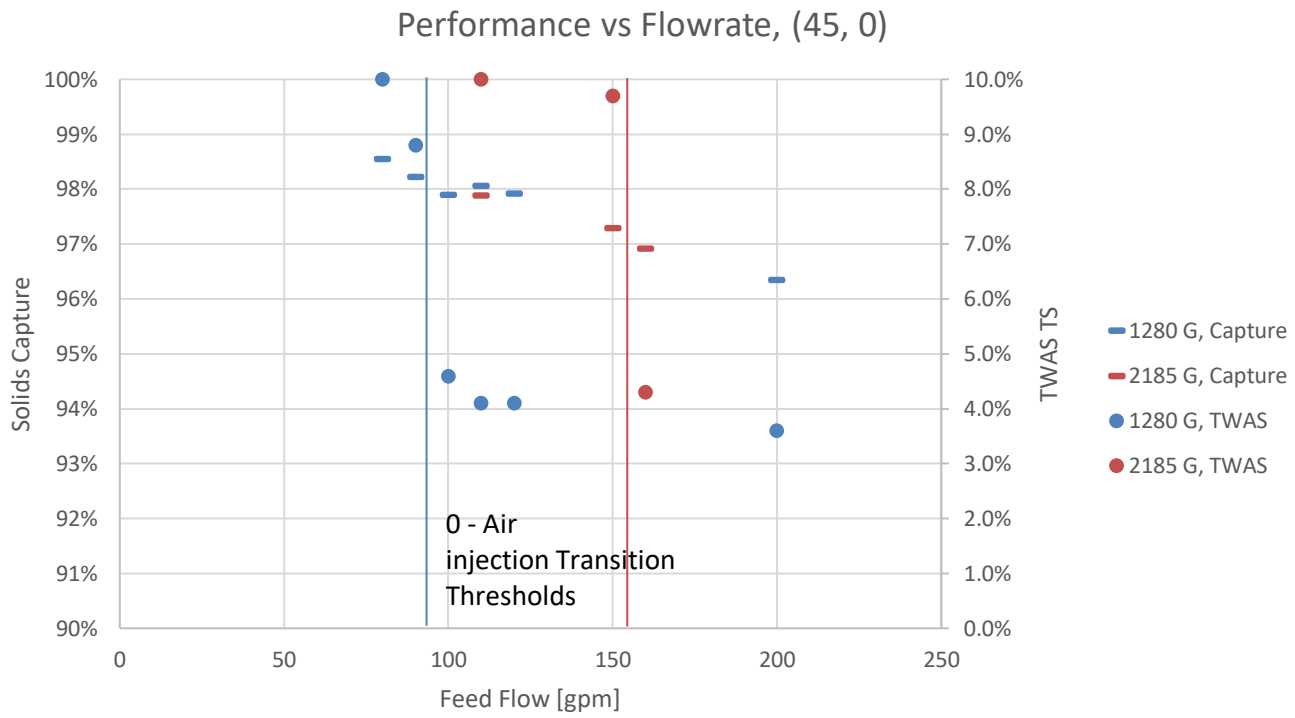


Figure 8. Impact of feed flow on performance with nozzles at (45°, 0°) at two G-levels.

This section demonstrates the use of air for better control of thickening: Testing without air injection demonstrated a thickening change in which the TWAS total solids jumped from below 5% to over 8%. At lower feed rates, the hydraulic forces exerted on the settled solids blanked were lower, allowing a plug of viscous thick solids to form and restrict solids end discharge. As flow rates increased, the liquid end cresting increased, increasing the hydraulic head at the solids end discharge.

With all other parameters fixed, increasing bowl speed improves solids capture and increases TWAS solids concentrations. Without air compensation, the higher G-level also increases the flow threshold for overcoming the solids plug, as shown by the TWAS greater than 9% up to 150 gpm at 2185 G. The increased performance comes at the cost of increased power consumption. At a nozzle setting of (45°, 0°) and 200 GPM of flow, running the main motor at 65% speed, 1280 G, required 0.066 kW/gpm of power, while increasing the speed to 85%, 2185 G, required 0.161 kW/gpm, including both the main motor and the hydraulic motor power consumption. This was the highest specific power consumption

observed throughout testing. Power consumption did not exceed 0.1 kW/gpm for the remainder of testing.

Between test days, the liquid end nozzles were adjusted to evaluate the impact of varying pool levels. Throughout testing, WAS feed flow, centrifuge bowl speed, and air injection rates were varied to determine optimal operation and to characterize performance of the unit under different conditions.

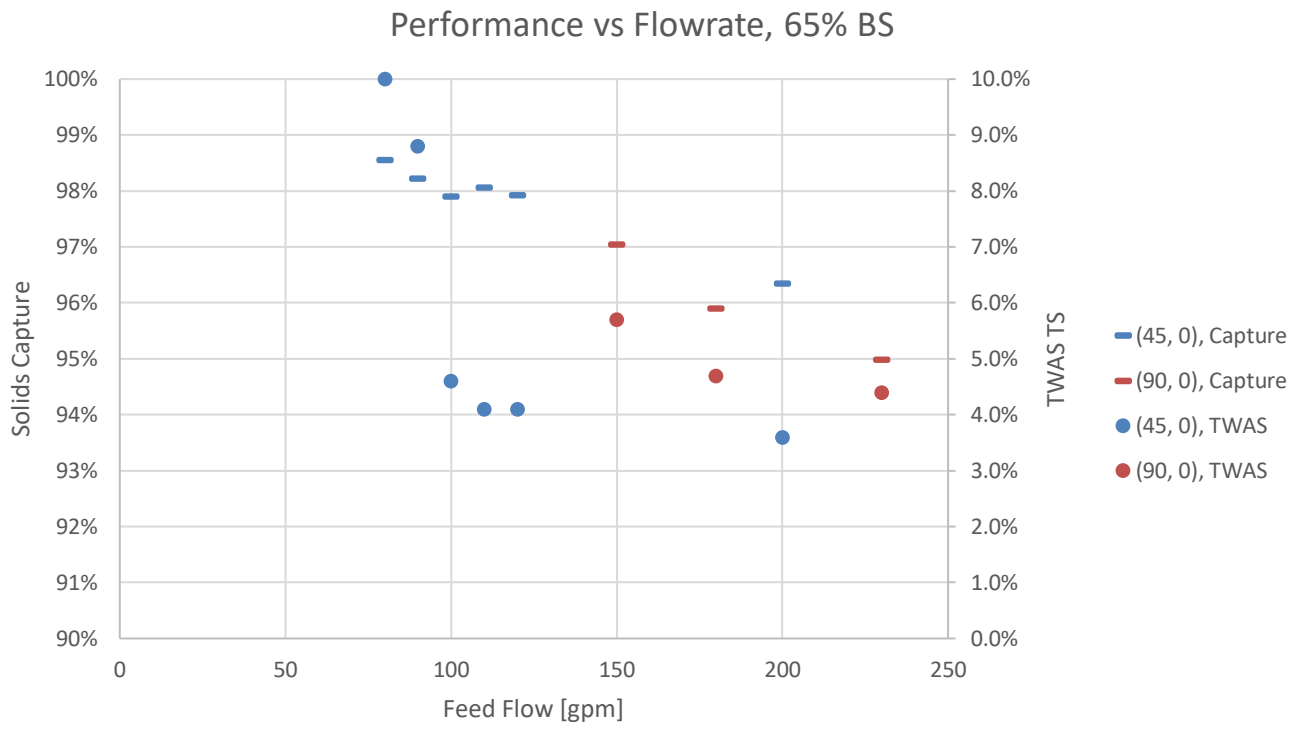


Figure 9. Impact of feed rate on solids recovery and TWAS for several nozzle settings without polymer addition.

Generally, as feed flow rates increased, the capture of suspended solids decreased. As flows increased, TWAS solids decreased slightly. The shallower 90° liquid end nozzle setting had lower recoveries and higher TWAS solids, and the deeper 45° LE nozzle setting had higher solids recoveries and lower TWAS solids. As the LE nozzle setting increased and the pool depth decreased, TWAS concentrations increased.

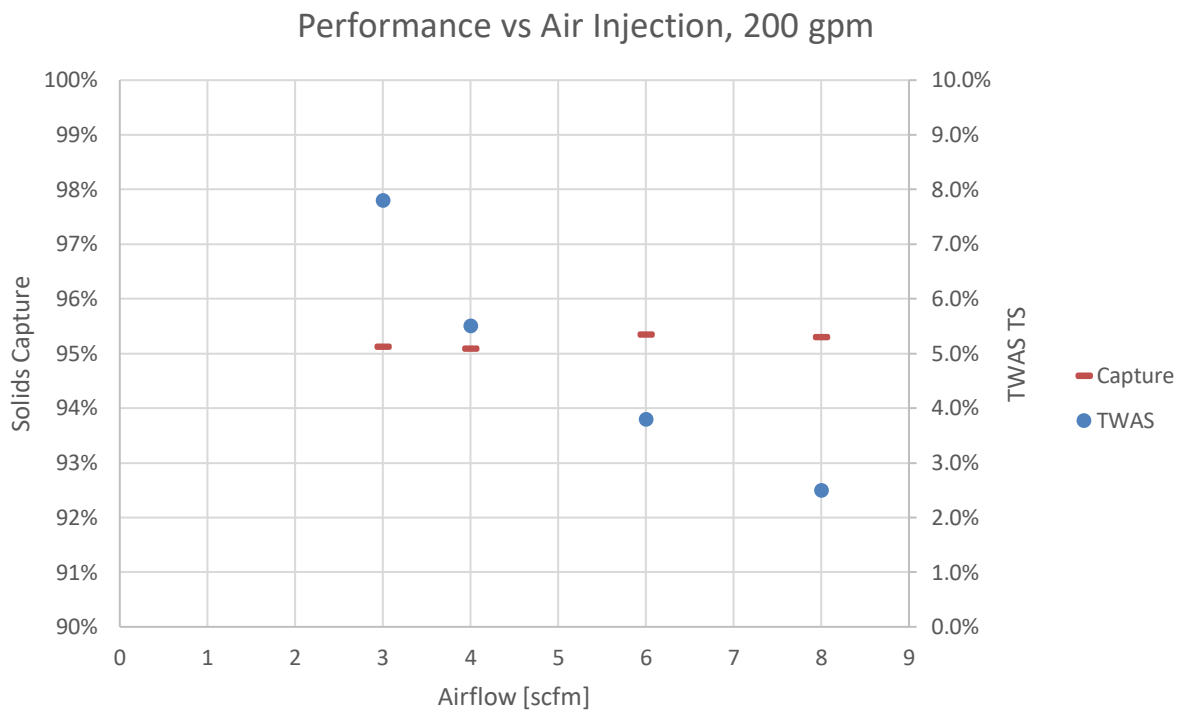


Figure 10. Air injection control of TWAS total solids at 200 gpm.

The operational limitations of the plug phenomenon, as evidenced by the sudden sharp increases in TWAS total solids, can be avoided by variable air injection into the solids plug on the outer diameter of the solids baffle disc. Air flow assists in solids transport against the high G-force at the bowl wall towards the solids end discharge nozzles. After leaving the centrifuge through the solids end discharge nozzles, the injected air is then vented away. By varying air flow, the TWAS discharge rate can be precisely controlled without impacting solids recovery. As the airflow rate increases, the TWAS discharge rate increases, producing lower total solids TWAS.

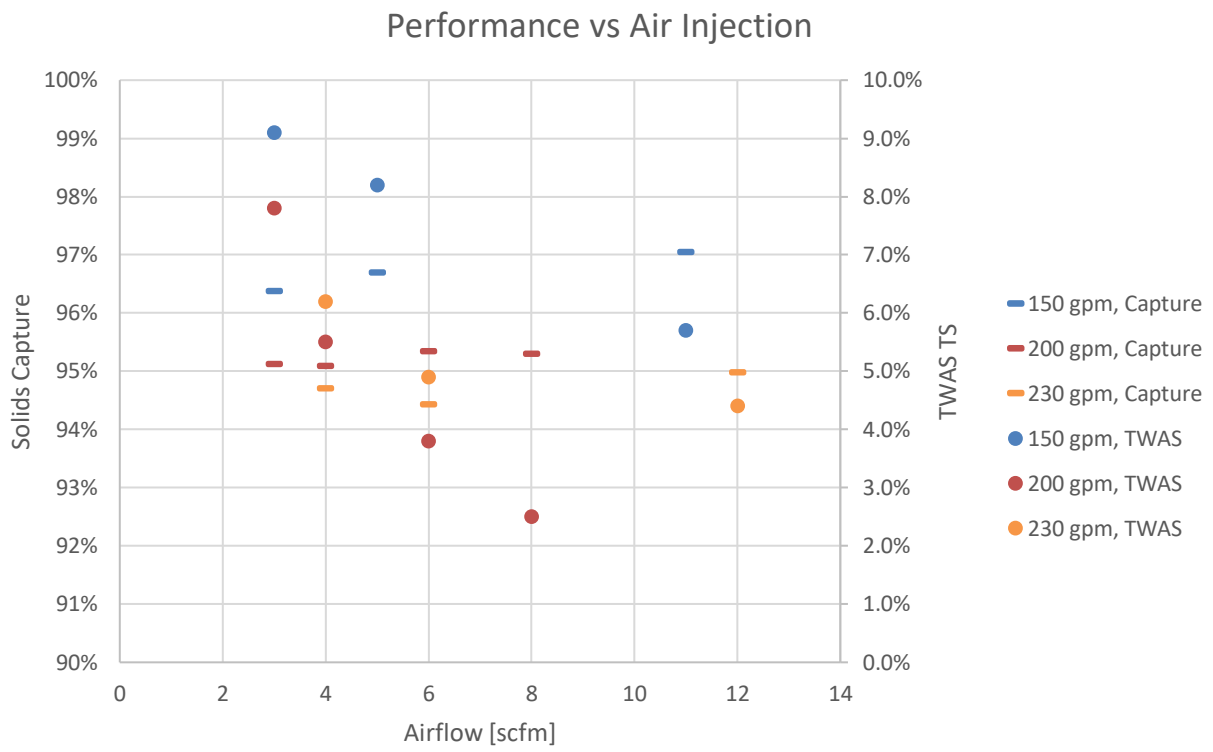


Figure 11. Air injection control at several flow rates with nozzles at (90°, 0°)

In this application, polymer was not necessary to achieve capture rates of approximately 95% and higher even at peak capacities. Nonetheless, the impact of polymer on unit performance was investigated, as shown in Figure 12. The THK200 has an internal injection option for polymer dosing that introduces polymer to the sludge after the largest particles of the sludge have been accelerated to high G and allowed to settle so that polymer is only applied to the fine particles that would not otherwise settle over the residence time of the sludge inside the centrifuge. This method of polymer dosing is most effective at lower flowrates, however, because the polymer requires time to interact with the fine particles. Because this application has high solids recovery even at the peak capacity of the skid's feed pump, the conventional external polymer dosing is more effective. The addition of 1.5 active pounds of polymer per dry ton of solids increased solids capture at peak capacity to 98%. Additionally, polymer slightly increased TWAS total solids.

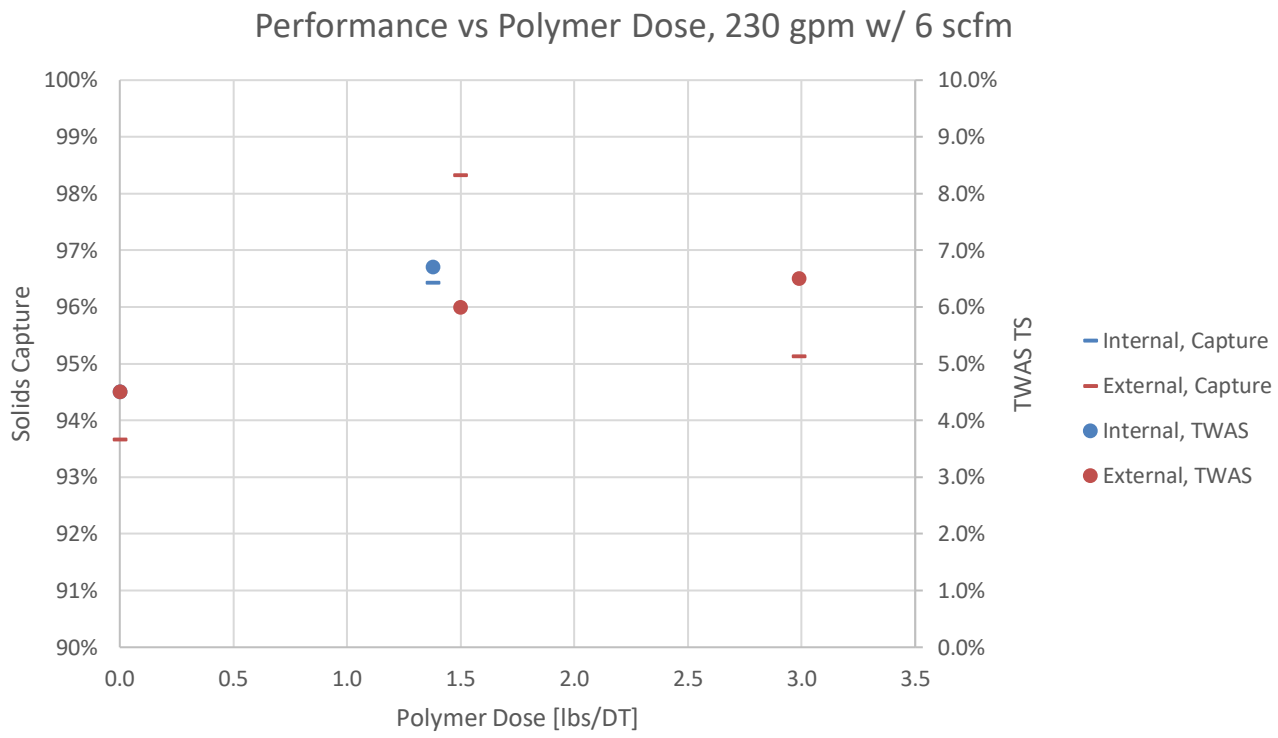


Figure 12. Impact of polymer on performance injected externally and internally at 230 gpm.

To increase the solids recovery performance of the thickener, there are three parameters that can be adjusted. First, the particle size of the solids can be increased. Polymer conditioning is the primary pathway available for this, and the significant cost of polymer is the economic limit to this approach. Second, the G force applied to the sludge by the bowl can be increased. Bowl speed is the control pathway for this, and the cost of power is the economic limit. Third, the residence time of the sludge in the unit can be increased. Larger capacity units or reduced flowrates are pathways to increase residence time. Capital costs of larger units along with increased specific power consumption are the economic limits to these pathways.

Table 3. Pathways to increasing solids recovery.

Factor	Pathway	Economic Limit	Degree of Impact
Solids Particle Size	Polymer conditioning	Polymer cost	Medium impact
Applied G - Force	Bowl speed	Power cost	Small impact
Residence Time	Larger unit	Capital cost	Large impact

Assuming high solids capture rates are achieved, the total solids content of the thickened stream is determined by the ratio of centrate flow through the liquid end discharge nozzles and the thickened stream through the solids end discharge nozzles. As a greater portion in the incoming feed flow is

discharged in the thickened stream, the thickened stream TS decreases. As more feed flow is discharged in the centrate stream, the thickened stream TS increases. Because the THK200 does not have a conical section and the scroll conveyor flights end at the solids baffle disc, the discharge rates of the two output streams are controlled by the hydraulics inside the centrifuge. Adjusting the depth of discharge on each end gives the strongest control over this. When the liquid end discharge is deeper than the solids end, the hydraulic head of the difference drives more flow to the solids end, producing a lower TS thickened stream. While the nozzle settings have the largest impact on thickness, they can only be adjusted while the centrifuge is not operating. Air injection at the solids end allows for control over the solids end discharge rate while operating. However, increasing the air flow gives produces diminishing returns in control. As air flow increases, channels form in the thickened solids which let the air exit the solids end without efficiently increasing the flow of thickened solids.

Table 4. Mechanisms of regulating TWAS total solids.

Factor	Mechanism	Limitations	Degree of Impact
Solids End / Liquid End Hydraulics	Nozzle Adjustments	Only while shutdown	Large impact
	Liquid End Cresting	Set by Flowrate	Small impact
	Air Injection Rate	Diminishing Returns	Medium impact

Overall, the THK200 skid was able to thicken the WAS to 6% total solids with high suspended solids recovery with no polymer required and low power consumption. To provide a standardized basis for evaluation, the operational costs of running the unit were determined a basis of dry tons of WAS processed. An electricity price of $0.09 per kWh and a polymer price of $3.00 per active pound were used to estimate operational costs per dry ton of WAS processed at the sample conditions.

Table 5. Operation costs per dry ton processed of select samples.

Sample	Sludge Feed Rate	Solids Loading	Thickened Stream	Solids Capture, Dilution Factored	Power	Active Polymer Dose	Op Cost
	[GPM]	[lb/hr]	[% TS]	[% w/w]	[kW/gpm]	[lb/DT]	[$/DT]
3.4	200	380	5.5%	95.1%	0.068	0.00	$ 6.39
2.6	150	240	5.7%	97.0%	0.069	0.00	$ 7.79
4.3	230	391	6.2%	94.7%	0.086	0.00	$ 9.06
5.2	230	391	6.0%	98.1%	0.066	1.50	$ 11.45

The THK200 can achieve the desired WAS thickening performance without polymer addition required at 230 GPM. With a small polymer dose, the solids capture rate can be increased to 98% with a 25% increase in operation costs.

The unit was able to process up to 230 GPM of WAS, which was the maximum flow output of the skid-mounted PC feed pump. With 1.5 active lbs per dry ton of polymer, the targeted 6% TWAS was achieved with over 98% solids recovery.

Overall, high solids recoveries were achieved without polymer dosing while maintaining TWAS concentrations of 5-6% and processing 200 – 230 gpm of WAS. Higher thickness TWAS of 10% was also achieved without polymer.

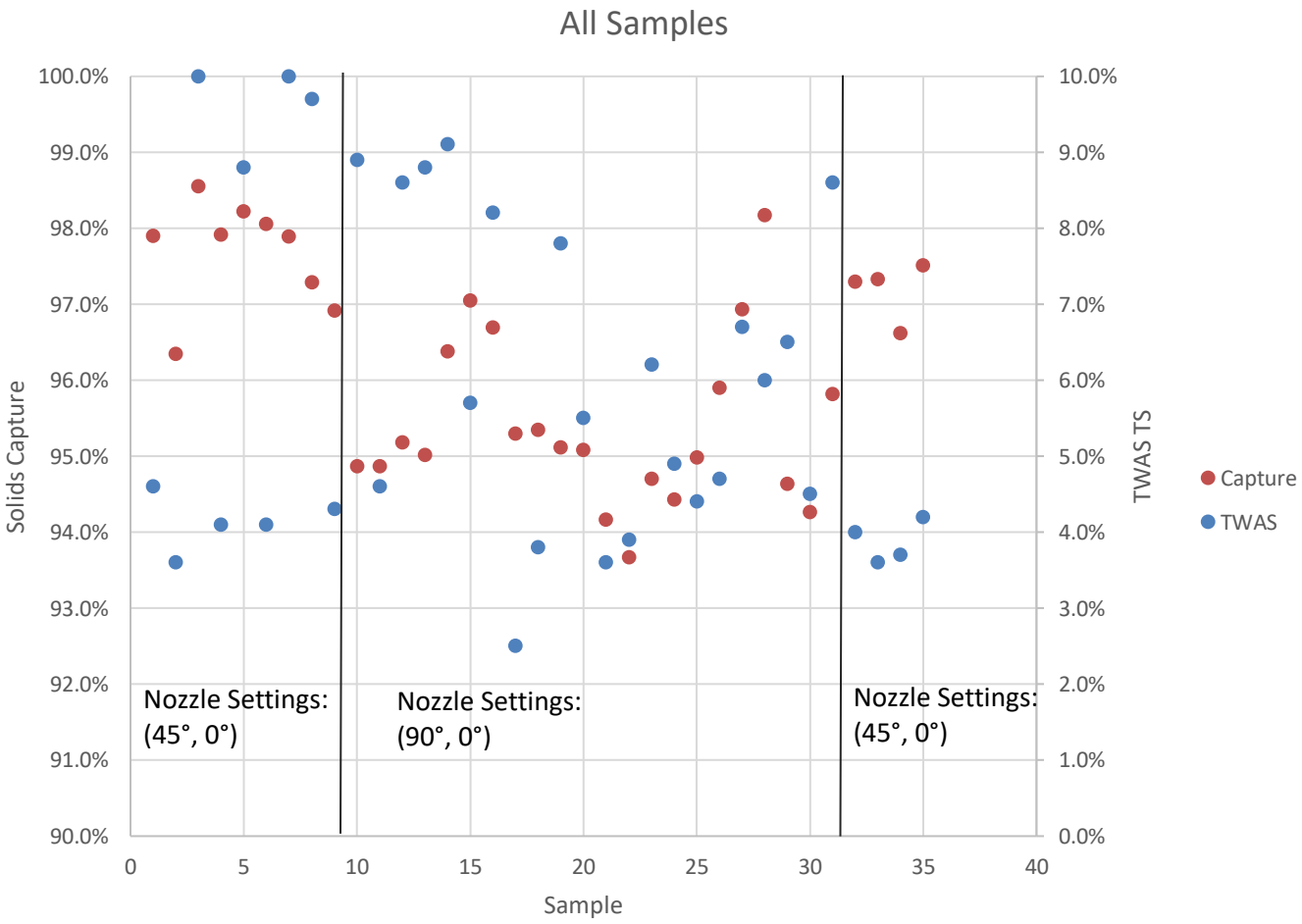


Figure 12. Solids recoveries and TWAS solids contents for all samples with nozzle adjustments indicated.

While all of the operational parameters work together to control performance, the nozzle settings have the largest impact on performance. Using the notation of (Liquid End Nozzle Rotation, Solids End Nozzle Rotation) with 0° representing the deepest possible setting and 180° representing the shallowest, nozzle settings of (90°, 0°) and (45°, 0°) were evaluated during testing.

While each individual sample had a unique set of operation parameters, leading to the scatter seen in Figure 12, the (45°, 0°) nozzle settings data was lower TS TWAS with higher solids captures than the (90°, 0°) nozzle settings.

SCALE-UP:

Flow rates between 80 to 230 gpm were tested to cover the range of operation required in the future upon scaling up operation to a THK600. Scale-up within the THK series is proportional to the clarifying volume of units. In contrast with most centrifuges used for thickening or dewatering, THK thickening centrifuges do not have a conical section. This allows for more clarifying volume with lower installed footprints relative to centrifuges with equivalent bowl diameters.

Table 5. Centrisys THK series hydraulic loading scale-up table for equivalent G-levels.

THK200	THK350	THK600
18”	21”	26”
75 GPM	160 GPM	325 GPM
100 GPM	210 GPM	435 GPM
150 GPM	320 GPM	650 GPM
175 GPM	370 GPM	760 GPM
200 GPM	420 GPM	870 GPM
230 GPM	510 GPM	1000 GPM

For full scale installation at the ALCOSAN facility, one THK600 unit is recommended for each WAS train with low to no polymer dosing.

APPENDIX A:

Centrifuge Background & Sample Testing Information

Discharge Nozzles

In thickening centrifuges, the hydraulic driving force is a key factor in separation, arising from differing distances between the discharge nozzles and the axis of rotation. The liquid-end nozzles are typically positioned nearer the axis of rotation (deeper pool depth), and the solids-end nozzles are typically positioned further from the axis of rotation (shallow pool depth). Increasing the difference between nozzle depths improves centrate quality while decreasing cake thickness, and decreasing the difference negatively impacts centrate quality while thickening the cake. On the THK200 models, the discharge nozzles are rotated with eccentric orifices to adjust pool depths. On larger THK models, discharge levels are adjusted by interchangeable weir rings.

Table A1. Description of nozzle settings and performance impacts on THK200 models.

Weir Setting	Radial Distance from Axis	Pool Depth	Liquid End Weirs		Solids End Weirs	
			Recovery	Cake TS	Recovery	Cake TS
0°	Minimum	Maximum	↑	↓	↓	↑
180°	Maximum	Minumum	↓	↑	↑	↓

Test Program

The purpose of sampling is to obtain sufficient data to characterize the performance of the Centrisys centrifuge. The test program is designed to demonstrate the full range of capabilities of the equipment. Each set of tests will focus on a specific operating characteristic of the centrifuge. These tests can investigate the effects of G-force, air injection rate, nozzle settings, feed rate, and polymer dosage on the centrifuge performance. The number of samples taken will depend on the extent of the test program and the variability of the process. Typically, the following procedure is recommended for pilot plant testing:

1. Nozzle Optimization: The optimal nozzle settings to achieve the range of performance desired for the test.
2. Polymer Comparisons: Additional polymer types are compared for operating characteristics.
3. Performance Characterization: Using the most effective polymer/dose, other performance parameters (bowl speed, feed rate, etc.) are optimized around expected operating conditions.
4. Operator Training: If time allows, plant operators may be given time to operate the equipment under supervision of Centrisys personnel.

Sampling

Sample analysis is the only way to effectively determine the overall performance of the centrifuge. Samples must be representative of the centrifuge's operating conditions. Therefore, the following is recommended for sampling:

1. All samples should be of sufficient volume such that duplicate lab tests can be performed.
2. All samples should be retained in a refrigerated container until testing is completed and/or the data can be reviewed.
3. For each set of sampling conditions, the cake, centrate, and feed must be sampled.
    a. Some situations may allow for fewer samples to be taken; for example, with a stable feed, feed samples may not be necessary at every sampling period.
    b. Centrate and cake should be sampled first, followed by the feed. This allows for the polymer injection pump to be turned off before sampling feed, if necessary.
4. When changes are made to the operating parameters, sufficient time must be allowed for the process to reach a new steady-state. The centrate discharged from the centrifuge will reach a steady-state after 2 – 4 minutes; the cake discharge will take between 10 – 20 minutes to reach a steady-state due to the higher residence time of solids inside the machine.

Lab Testing

The basic requirements of lab testing are summarized as follows:

1. Sample analysis should follow ASTM procedures (or equivalent) for the Total Suspended Solids (TSS), Total Solids (TS), Total Volatile Solids (TVS), and Sludge Volume Index (SVI). If alternative procedures are being used, (i.e. Moisture Balance, Volumetric Spin-Down, etc.), the type of equipment and procedure should be noted. If possible, attempts should be made to correlate to ASTM standards.
2. For each sample, the following lab analysis is required (minimum):
    a. Feed Solids: TS
    b. Centrate Solids: TSS (or TS & Mother Liquor TDS)
    c. Cake Solids: TS
3. For each sample set, it is recommended that the TVS be determined for the feed solids.

4. Hard copies of all lab data should be retained until it is transferred to a spreadsheet incorporating the centrifuge operating parameters. It is recommended that original lab sheets are still retained, either through a paper copy or in a scanned document.

Calculations

Recovery

Recovery is defined as the percentage of insoluble solids from the feed sludge that exit in the cake solids stream. This is defined in Equation 1.

$$R = \frac{x_S S}{x_F F} \times 100\% \; [=] \; \% \qquad (1)$$

$R = \text{Recovery}$

$x_S = \text{cake solids } \% \; [=] \; \%$

$S = \text{cake solids discharge rate } [=] \; \text{lb/min}$

$x_F = \text{feed solids } \% \; [=] \; \%$

$F = \text{sludge feed rate } [=] \; \text{lb/min}$

The overall mass balance and the solids mass balance can be seen in Equations 2 and 3 below.

Overall Mass Balance: $$F + W = S + E \qquad (2)$$

Solids Mass Balance: $$x_F F = x_S S + x_E E \qquad (3)$$

$W = \text{additional water fed to system (polymer dilution)} [=] \frac{\text{lb}}{\text{min}}$

E = effluent (centrate)discharge rate

x_E = total suspended solids [=] %

By solving Equations 2 and 3 for E and S, respectively, and substituting into Equation 1, the following equation can be obtained (Equation 4):

$$R = \left(\frac{x_S}{x_F}\right)\left[\frac{(x_F - x_E)}{(x_S - x_E)} - \frac{(x_E W)}{F(x_S - x_E)}\right] \times 100\% \text{ [=] \%} \quad (4)$$

Polymer Dosage

Polymer dosage defines the amount of polymer consumed for the amount of cake produced. As polymer can be supplied in many forms (emulsion, gel, Manic, dry) the calculation can be slightly different for each.

For neat polymer, the following calculation determines the polymer dosage:

$$P = A\frac{p}{x_F V_F} \text{ [=]} \frac{lb\ polymer_{neat}}{dry\ ton\ solids} \quad (5)$$

$P = polymer\ dosage\ rate$[=] $\frac{lb\ polymer_{neat}}{dry\ ton\ solids}$

$A = unit\ correction\ factor = \frac{2000}{3785.41}$ [=] $\frac{lb/ton}{mL/gal}$

$p = neat\ polymer\ flow\ rate$ [=] $\frac{mL}{min}$

$x_F = feed\ solids/feed\ sludge\ ratio$ [=] $\frac{lb\ solids}{lb\ feed}$

$V_F = volumetric\ flow\ of\ feed$ [=] $\frac{gallon\ feed}{min}$

$$\boldsymbol{P} = \left(\frac{2000\ {}^{lb}/_{ton}}{3785.41\ {}^{mL}/_{gal}}\right)\frac{0.050\ {}^{mL\ polymer_{neat}}/_{min}}{\left(0.080\ {}^{lb\ dry\ solids}/_{lb\ feed}\right)\left(69\ {}^{gal\ feed}/_{min}\right)}\ [=]\ \mathbf{180}\ \boldsymbol{{}^{lb\ polymer_{neat}}/_{ton\ solids}}$$

Polymer dosage is often reported in terms of *active polymer* which comes from the polymer's characteristic *activity*. Activity is the percentage of the polymer able to interact with the sludge and cause flocculation. Neat polymer can be converted to active polymer by multiplying by the polymer's activity.

$$(Active\ Polymer) = (Neat\ Polymer)(Activity)$$

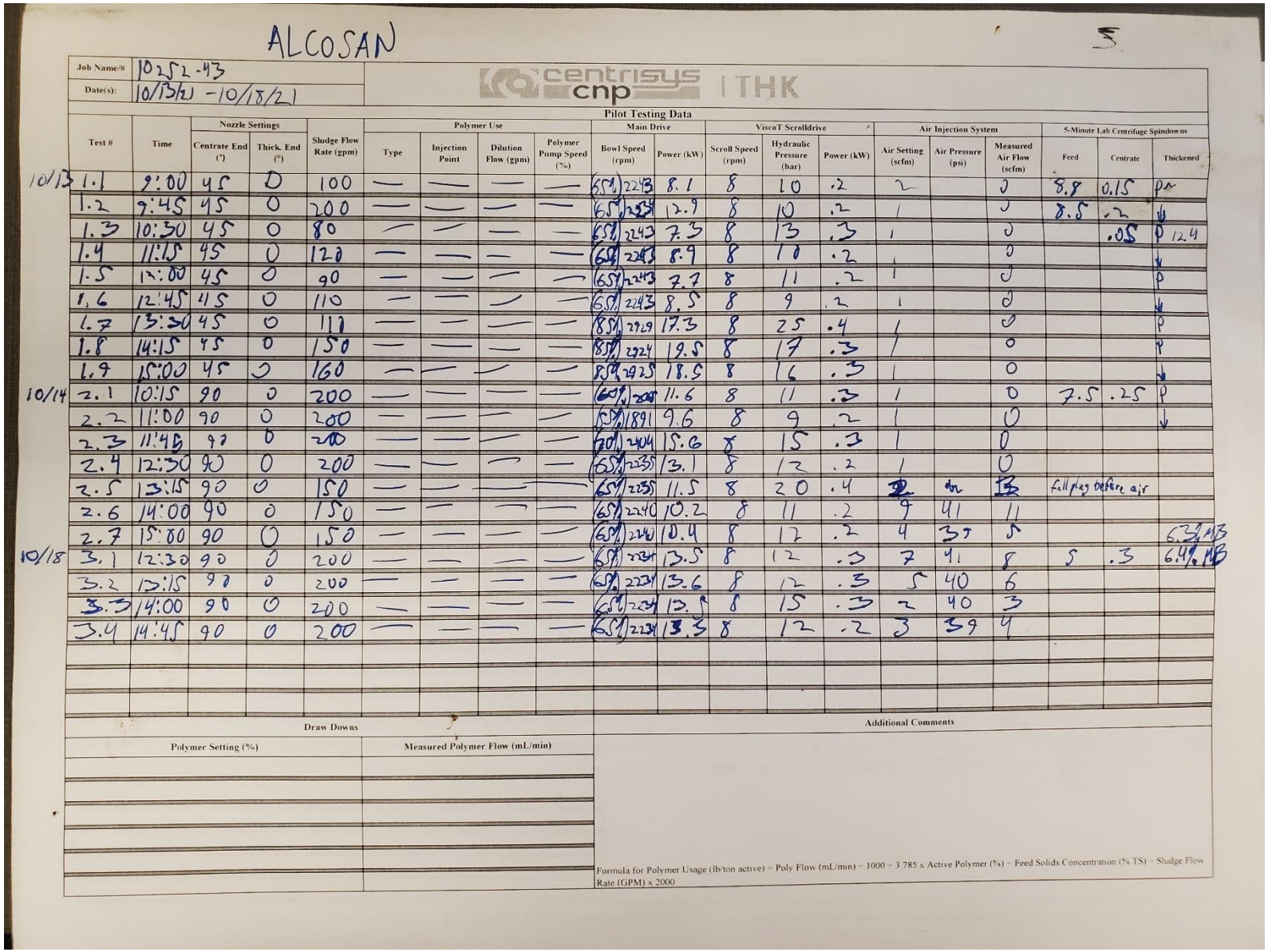
Activity for polymers can vary significantly based on the polymer type. Below are typical activity ranges:

- Dry polymer: usually considered to be 100% active.
- Emulsion polymer: between 30 – 50% active.
- Gel polymer: between 10 – 30% active.

APPENDIX B:

Pilot Testing Data

Logsheets



ALCOSAN

5

Job Name/#: 10252-43
Date(s): 10/13/21 - 10/18/21

centrisys cnp | THK

Pilot Testing Data

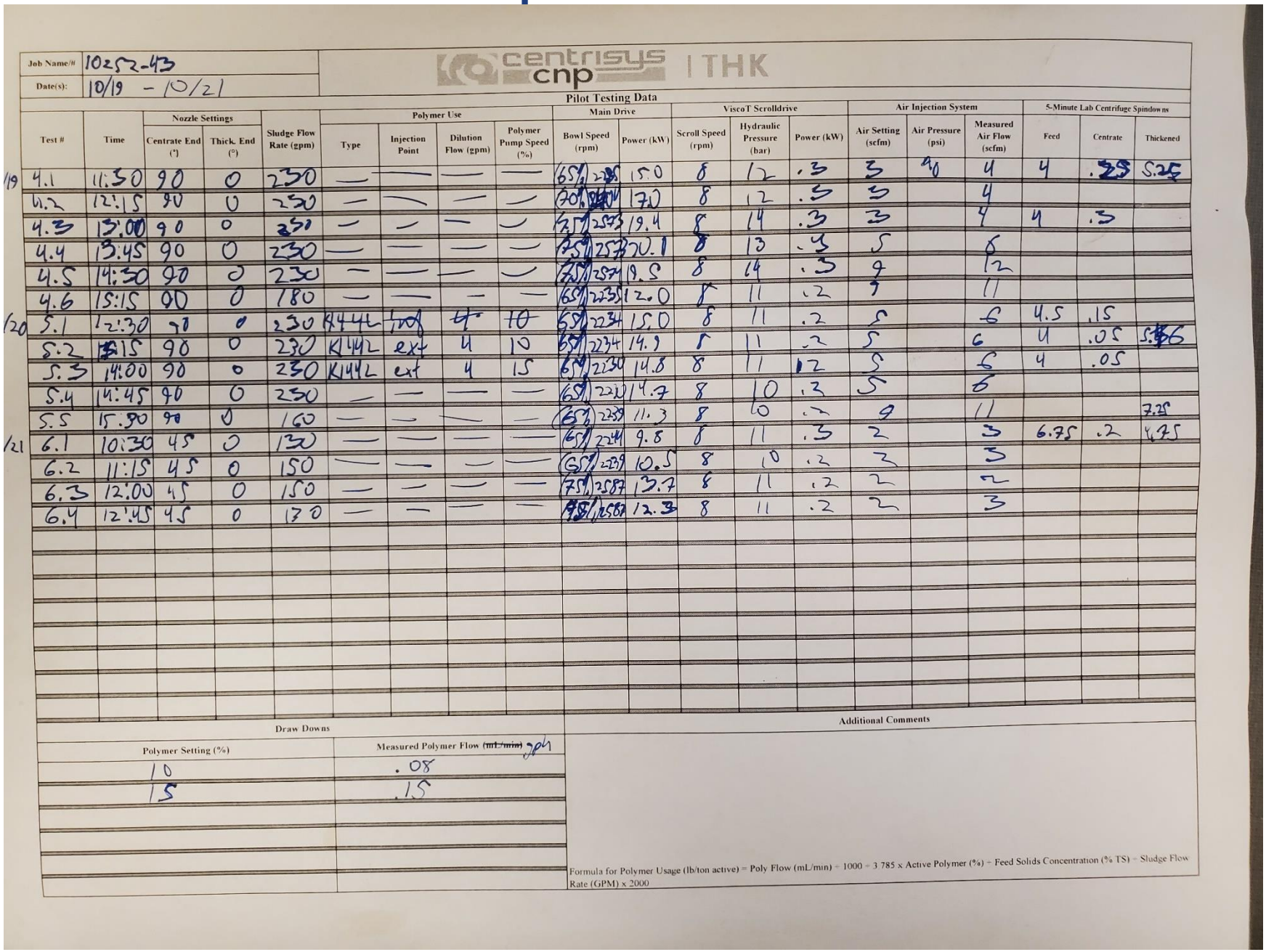
	Test #	Time	Nozzle Settings: Centrate End (°)	Nozzle Settings: Thick. End (°)	Sludge Flow Rate (gpm)	Polymer Use: Type	Polymer Use: Injection Point	Polymer Use: Dilution Flow (gpm)	Polymer Use: Polymer Pump Speed (%)	Main Drive: Bowl Speed (rpm)	Main Drive: Power (kW)	ViscoT Scrolldrive: Scroll Speed (rpm)	ViscoT Scrolldrive: Hydraulic Pressure (bar)	ViscoT Scrolldrive: Power (kW)	Air Injection System: Air Setting (scfm)	Air Injection System: Air Pressure (psi)	Air Injection System: Measured Air Flow (scfm)	5-Minute Lab Centrifuge Spindowns: Feed	5-Minute Lab Centrifuge Spindowns: Centrate	5-Minute Lab Centrifuge Spindowns: Thickened
10/13	1.1	9:00	45	0	100	—	—	—	—	65% 2243	8.1	8	10	.2	2		0	8.8	0.15	p↓
	1.2	9:45	45	0	200	—	—	—	—	65% 2243	12.9	8	10	.2	1		0	8.5	.2	↓
	1.3	10:30	45	0	80	—	—	—	—	65% 2243	7.3	8	13	.3	1		0		.05	0 12.4
	1.4	11:15	45	0	120	—	—	—	—	65% 2243	8.9	8	10	.2			0			↓
	1.5	12:00	45	0	90	—	—	—	—	65% 2243	7.7	8	11	.2	1		0			p
	1.6	12:45	45	0	110	—	—	—	—	65% 2243	8.5	8	9	.2	1		0			↓
	1.7	13:30	45	0	111	—	—	—	—	85% 2929	17.3	8	25	.4	1		0			p
	1.8	14:15	45	0	150	—	—	—	—	85% 2924	19.5	8	17	.3	1		0			p
	1.9	15:00	45	0	160	—	—	—	—	85% 2925	18.5	8	16	.3	1		0			↓
10/14	2.1	10:15	90	0	200	—	—	—	—	60% 2044	11.6	8	11	.3	1		0	7.5	.25	p
	2.2	11:00	90	0	200	—	—	—	—	55% 1891	9.6	8	9	.2	1		0			↓
	2.3	11:45	90	0	200	—	—	—	—	70% 2404	15.6	8	15	.3	1		0			
	2.4	12:30	90	0	200	—	—	—	—	65% 2235	13.1	8	12	.2	1		0			
	2.5	13:15	90	0	150	—	—	—	—	65% 2235	11.5	8	20	.4	32	dn	13	full plug before air		
	2.6	14:00	90	0	150	—	—	—	—	65% 2240	10.2	8	11	.2	9	41	11			
	2.7	15:00	90	0	150	—	—	—	—	65% 2240	10.4	8	12	.2	4	39	5			6.3% MB
10/18	3.1	12:30	90	0	200	—	—	—	—	65% 2234	13.5	8	12	.3	7	41	8	5	.3	6.4% MB
	3.2	13:15	90	0	200	—	—	—	—	65% 2234	13.6	8	12	.3	5	40	6			
	3.3	14:00	90	0	200	—	—	—	—	65% 2234	13.5	8	15	.3	2	40	3			
	3.4	14:45	90	0	200	—	—	—	—	65% 2234	13.5	8	12	.2	3	39	4			

Draw Downs

Polymer Setting (%)	Measured Polymer Flow (mL/min)

Additional Comments

Formula for Polymer Usage (lb/ton active) = Poly Flow (mL/min) ÷ 1000 ÷ 3.785 x Active Polymer (%) ÷ Feed Solids Concentration (% TS) ÷ Sludge Flow Rate (GPM) x 2000



Job Name/#: 10252-43	centrisys cnp | THK
Date(s): 10/19 - 10/21	

Pilot Testing Data

	Test #	Time	Nozzle Settings: Centrate End (°)	Nozzle Settings: Thick. End (°)	Sludge Flow Rate (gpm)	Polymer Use: Type	Polymer Use: Injection Point	Polymer Use: Dilution Flow (gpm)	Polymer Use: Polymer Pump Speed (%)	Main Drive: Bowl Speed (rpm)	Main Drive: Power (kW)	ViscoT Scrolldrive: Scroll Speed (rpm)	ViscoT Scrolldrive: Hydraulic Pressure (bar)	ViscoT Scrolldrive: Power (kW)	Air Injection System: Air Setting (scfm)	Air Injection System: Air Pressure (psi)	Air Injection System: Measured Air Flow (scfm)	5-Minute Lab Centrifuge Spindowns: Feed	5-Minute Lab Centrifuge Spindowns: Centrate	5-Minute Lab Centrifuge Spindowns: Thickened
10/19	4.1	11:30	90	0	230	—	—	—	—	65% 2285	15.0	8	12	.3	3	90	4	4	.25	5.25
	4.2	12:15	90	0	250	—	—	—	—	70% 2504	17.0	8	12	.5	5		4			
	4.3	13:00	90	0	250	—	—	—	—	65% 2283	19.4	8	14	.3	3		4	4	.3	
	4.4	13:45	90	0	230	—	—	—	—	75% 2578	20.1	8	13	.4	5		6			
	4.5	14:30	90	0	230	—	—	—	—	75% 2584	19.5	8	14	.3	4		12			
	4.6	15:15	90	0	180	—	—	—	—	65% 2335	12.0	8	11	.2	4		11			
10/20	5.1	12:30	90	0	230	K442L	inj	4	10	65% 2234	15.0	8	11	.2	5		6	4.5	.15	
	5.2	13:15	90	0	230	K442L	ext	4	10	65% 2234	14.9	8	11	.2	5		6	4	.05	5.25
	5.3	14:00	90	0	230	K442L	ext	4	15	65% 2230	14.8	8	11	.2	5		6	4	.05	
	5.4	14:45	90	0	250	—	—	—	—	65% 2220	14.7	8	10	.3	5		6			
	5.5	15:30	90	0	160	—	—	—	—	65% 2239	11.3	8	10	.2	4		11			7.25
10/21	6.1	10:30	45	0	130	—	—	—	—	65% 2244	9.8	8	11	.3	2		3	6.75	.2	4.75
	6.2	11:15	45	0	150	—	—	—	—	65% 2239	10.5	8	10	.2	3		3			
	6.3	12:00	45	0	150	—	—	—	—	75% 2587	13.7	8	11	.2	2		2			
	6.4	12:45	45	0	170	—	—	—	—	75% 2587	12.3	8	11	.2	2		3			

Draw Downs

Polymer Setting (%)	Measured Polymer Flow (~~ml/min~~ gph)
10	.08
15	.15

Additional Comments

Formula for Polymer Usage (lb/ton active) = Poly Flow (mL/min) ÷ 1000 ÷ 3.785 x Active Polymer (%) ÷ Feed Solids Concentration (% TS) ÷ Sludge Flow Rate (GPM) x 2000

Input Data

		TEST DATA																				
Label				Setup					Feed Rates			Operation										
Test Run	Date	Sample	Time	LE Weir Setting [degrees]	SE Weir Setting [degrees]	Polymer Type	Polymer Activity [%]	Polymer Injection Point	Sludge Feed Rate [GPM]	Neat Polymer Flow [GPH]	Polymer Dilution Flow [GPM]	Bowl Speed [%]	Bowl Speed [RPM]	Main Power [kW]	Differential Scroll Speed [RPM]	Hydraulic Pressure [bar]	Scroll Power [kW]	Air Flow [SCFM]	Feed Spin [%v/v]	Centrate Spin [%v/v]	Moisture Balance Cake [%TS]	Recovery [%]
sim		sim.1		0	0	-		Internal	140	0	0	75%	2586	14	10.0	21	0.5	10				
sim		sim.2		0	0		44%	Internal	200	0.25	5.0	70%	2100	20	10.0	21	0.5	10				
1	2021.10.13	1.1	9:00	45	0				100			65%	2243	8.1	8	10	0.2	0	8.8	0.15		98%
1	2021.10.13	1.2	9:45	45	0				200			65%	2234	12.9	8	10	0.2	0	8.5	0.20		98%
1	2021.10.13	1.3	10:30	45	0				80			65%	2243	7.3	8	13	0.3	0	8.0	0.05		99%
1	2021.10.13	1.4	11:15	45	0				120			65%	2243	8.9	8	10	0.2	0				
1	2021.10.13	1.5	12:00	45	0				90			65%	2243	7.7	8	11	0.2	0				
1	2021.10.13	1.6	12:45	45	0				110			65%	2243	8.5	8	9	0.2	0				
1	2021.10.13	1.7	13:30	45	0				110			85%	2929	17.3	8	25	0.4	0				
1	2021.10.13	1.8	14:15	45	0				150			85%	2924	19.5	8	17	0.3	0				
1	2021.10.13	1.9	15:00	45	0				160			85%	2925	18.5	8	16	0.3	0				
2	2021.10.14	2.1	10:15	90	0				200			60%	2065	11.6	8	11	0.3	0	7.5	0.25		97%
2	2021.10.14	2.2	11:00	90	0				200			55%	1891	9.6	8	9	0.2	0				
2	2021.10.14	2.3	11:45	90	0				200			70%	2404	15.6	8	15	0.3	0				
2	2021.10.14	2.4	12:30	90	0				200			65%	2235	13.1	8	12	0.2	0				
2	2021.10.14	2.5	13:15	90	0				150			65%	2235	11.5	8	20	0.4	3				
2	2021.10.14	2.6	14:00	90	0				150			65%	2250	10.2	8	11	0.2	11				
2	2021.10.14	2.7	15:00	90	0				150			65%	2250	10.4	8	12	0.2	5			6.3%	
3	2021.10.18	3.1	12:30	90	0				200			65%	2234	13.5	8	12	0.3	8	5.0	0.30	6.4%	94%
3	2021.10.18	3.2	13:15	90	0				200			65%	2234	13.6	8	12	0.3	6				
3	2021.10.18	3.3	14:00	90	0				200			65%	2234	13.5	8	15	0.3	3				
3	2021.10.18	3.4	14:45	90	0				200			65%	2234	13.3	8	12	0.2	4				
4	2021.10.19	4.1	11:30	90	0				230			65%	2235	15	8	12	0.3	4	4.0	0.25	5.3%	94%
4	2021.10.19	4.2	12:15	90	0				230			70%	2404	17	8	12	0.3	4				
4	2021.10.19	4.3	13:00	90	0				230			75%	2573	19.4	8	14	0.3	4	4.0	0.30		93%
4	2021.10.19	4.4	13:45	90	0				230			75%	2573	20	8	13	0.3	6				
4	2021.10.19	4.5	14:30	90	0				230			75%	2574	19.5	8	14	0.3	12				
4	2021.10.19	4.6	15:15	90	0				180			65%	2235	12	8	11	0.2	11				
5	2021.10.20	5.1	12:30	90	0	*K144L*	44%	Internal	230	0.080	4	65%	2234	15	8	11	0.2	6	4.5	0.15	5.4%	97%
5	2021.10.20	5.2	13:15	90	0	*K144L*	44%	after pump	230	0.080	4	65%	2234	14.9	8	11	0.2	6	4.0	0.05		99%
5	2021.10.20	5.3	14:00	90	0	*K144L*	44%	after pump	230	0.150	4	65%	2230	14.8	8	11	0.2	6	4.0	0.05		99%
5	2021.10.20	5.4	14:45	90	0				230			65%	2230	14.7	8	10	0.2	6				
5	2021.10.20	5.5	15:30	90	0				160			65%	2239	11.3	8	10	0.2	11			7.3%	
6	2021.10.21	6.1	8:00	45	0				130			65%	2244	9.8	8	11	0.3	3	6.8	0.2	4.8%	97%
6	2021.10.21	6.2	8:45	45	0				150			65%	2239	10.5	8	10	0.2	3				
6	2021.10.21	6.3	9:30	45	0				150			75%	2587	13.7	8	11	0.2	2				
6	2021.10.21	6.4	10:15	45	0				130			75%	2587	12.3	8	11	0.2	3				

Laboratory Results

Sample	Time	% Total Solids, Ext Lab	TSS, Ext Lab	Sample	% Total Solids, Ext Lab	Sample	Total Suspended Solids, Ext Lab
		[%]	[mg/L]		[%]		[mg/L]
1.1-Feed	8:15	0.29%	2900	1.1-Thick	4.60%	1.1-Centrate	65
1.2-Feed	9:15	0.37%	3000	1.2-Thick	3.60%	1.2-Centrate	150
1.3-Feed	10:15	0.41%	2900	1.3-Thick	10.00%	1.3-Centrate	62
1.4-Feed	11:15	0.38%	3400	1.4-Thick	4.10%	1.4-Centrate	87
1.5-Feed	12:15	0.33%	3100	1.5-Thick	8.80%	1.5-Centrate	61
1.6-Feed	12:30	0.37%	3100	1.6-Thick	4.10%	1.6-Centrate	79
1.7-Feed	13:30	0.40%	3000	1.7-Thick	10.00%	1.7-Centrate	88
1.8-Feed	14:30	0.39%	3100	1.8-Thick	9.70%	1.8-Centrate	110
1.9-Feed	15:30	0.33%	3100	1.9-Thick	4.30%	1.9-Centrate	110
2.1-Feed	16:30	0.32%	3200	2.1-Thick	8.90%	2.1-Centrate	170
2.2-Feed	8:15	0.31%	3000	2.2-Thick	4.60%	2.2-Centrate	170
2.3-Feed	9:15	0.32%	3000	2.3-Thick	8.60%	2.3-Centrate	160
2.4-Feed	10:15	0.31%	3000	2.4-Thick	8.80%	2.4-Centrate	160
2.5-Feed	11:15	0.32%	3100	2.5-Thick	9.10%	2.5-Centrate	120
2.6-Feed	12:15	0.32%	3100	2.6-Thick	5.70%	2.6-Centrate	100
2.7-Feed	12:00	0.32%	3000	2.7-Thick	8.20%	2.7-Centrate	110
3.1-Feed	13:00	0.35%	3500	3.1-Thick	2.50%	3.1-Centrate	190
3.2-Feed	14:00	0.37%	3500	3.2-Thick	3.80%	3.2-Centrate	190
3.3-Feed	15:00	0.39%	3400	3.3-Thick	7.80%	3.3-Centrate	200
3.4-Feed	16:00	0.38%	3600	3.4-Thick	5.50%	3.4-Centrate	200
4.1-Feed	11:30	0.30%	3000	4.1-Thick	3.60%	4.1-Centrate	190
4.2-Feed	12:15	0.28%	3100	4.2-Thick	3.90%	4.2-Centrate	190
4.3-Feed	13:00	0.34%	3200	4.3-Thick	6.20%	4.3-Centrate	190
4.4-Feed	13:45	0.32%	3400	4.4-Thick	4.90%	4.4-Centrate	190
4.5-Feed	14:30	0.35%	3300	4.5-Thick	4.40%	4.5-Centrate	190
4.6-Feed	15:15	0.34%	3400	4.6-Thick	4.70%	4.6-Centrate	150
5.1-Feed	12:30	0.37%	3200	5.1-Thick	6.70%	5.1-Centrate	120
5.2-Feed	13:15	0.34%	3700	5.2-Thick	6.00%	5.2-Centrate	66
5.3-Feed	14:00	0.32%	3500	5.3-Thick	6.50%	5.3-Centrate	180
5.4-Feed	14:45	0.34%	3100	5.4-Thick	4.50%	5.4-Centrate	210
5.5-Feed	15:30	0.30%	3300	5.5-Thick	8.60%	5.5-Centrate	130
6.1-Feed	8:00	0.37%	3400	6.1-Thick	4.00%	6.1-Centrate	110
6.2-Feed	8:45	0.37%	3300	6.2-Thick	3.60%	6.2-Centrate	110
6.3-Feed	9:30	0.30%	3000	6.3-Thick	3.70%	6.3-Centrate	110
6.4-Feed	10:15	0.35%	2900	6.4-Thick	4.20%	6.4-Centrate	95

Analysis

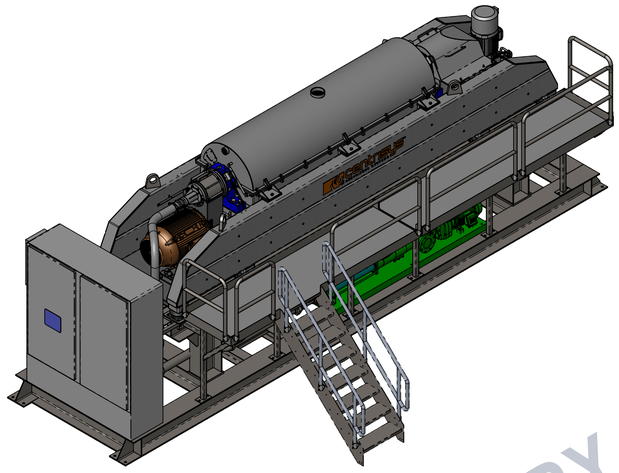
		Feed Sludge					Operational					
Date	Sampl	Sludge Feed Rate	Feed Solids		LE Weirs	SE Weirs	Bowl Speed		G-Force	Differential Scroll Speed	Hydraulic Pressure	Air Flow
		[GPM]	[% TS]	[mg/L]	[°]	[°]	[%]	[RPM]	[G]	[dRPM]	[bar]	[SCFM]
1/0	sim.1	140	0.60%	5000	0	0	75%	2586	1709	10.0	21	10
1/0	sim.2	200	0.60%	5000	0	0	70%	2100	1127	10.0	21	10
10/13	1.1	100	0.29%	2900	45	0	65%	2243	1286	8.0	10	0
10/13	1.2	200	0.37%	3000	45	0	65%	2234	1276	8.0	10	0
10/13	1.3	80	0.41%	2900	45	0	65%	2243	1286	8.0	13	0
10/13	1.4	120	0.38%	3400	45	0	65%	2243	1286	8.0	10	0
10/13	1.5	90	0.33%	3100	45	0	65%	2243	1286	8.0	11	0
10/13	1.6	110	0.37%	3100	45	0	65%	2243	1286	8.0	9	0
10/13	1.7	110	0.40%	3000	45	0	85%	2929	2193	8.0	25	0
10/13	1.8	150	0.39%	3100	45	0	85%	2924	2185	8.0	17	0
10/13	1.9	160	0.33%	3100	45	0	85%	2925	2187	8.0	16	0
10/14	2.1	200	0.32%	3200	90	0	60%	2065	1090	8.0	11	0
10/14	2.2	200	0.31%	3000	90	0	55%	1891	914	8.0	9	0
10/14	2.3	200	0.32%	3000	90	0	70%	2404	1477	8.0	15	0
10/14	2.4	200	0.31%	3000	90	0	65%	2235	1277	8.0	12	0
10/14	2.5	150	0.32%	3100	90	0	65%	2235	1277	8.0	20	3
10/14	2.6	150	0.32%	3100	90	0	65%	2250	1294	8.0	11	11
10/14	2.7	150	0.32%	3000	90	0	65%	2250	1294	8.0	12	5
10/18	3.1	200	0.35%	3500	90	0	65%	2234	1276	8.0	12	8
10/18	3.2	200	0.37%	3500	90	0	65%	2234	1276	8.0	12	6
10/18	3.3	200	0.39%	3400	90	0	65%	2234	1276	8.0	15	3
10/18	3.4	200	0.38%	3600	90	0	65%	2234	1276	8.0	12	4
10/19	4.1	230	0.30%	3000	90	0	65%	2235	1277	8.0	12	4
10/19	4.2	230	0.28%	3100	90	0	70%	2404	1477	8.0	12	4
10/19	4.3	230	0.34%	3200	90	0	75%	2573	1692	8.0	14	4
10/19	4.4	230	0.32%	3400	90	0	75%	2573	1692	8.0	13	6
10/19	4.5	230	0.35%	3300	90	0	75%	2574	1693	8.0	14	12
10/19	4.6	180	0.34%	3400	90	0	65%	2235	1277	8.0	11	11
10/20	5.1	230	0.37%	3200	90	0	65%	2234	1276	8.0	11	6
10/20	5.2	230	0.34%	3700	90	0	65%	2234	1276	8.0	11	6
10/20	5.3	230	0.32%	3500	90	0	65%	2230	1271	8.0	11	6
10/20	5.4	230	0.34%	3100	90	0	65%	2230	1271	8.0	10	6
10/20	5.5	160	0.30%	3300	90	0	65%	2239	1281	8.0	10	11
10/21	6.1	130	0.37%	3400	45	0	65%	2244	1287	8.0	11	3
10/21	6.2	150	0.37%	3300	45	0	65%	2239	1281	8.0	10	3
10/21	6.3	150	0.30%	3000	45	0	75%	2587	1711	8.0	11	2
10/21	6.4	130	0.35%	2900	45	0	75%	2587	1711	8.0	11	3

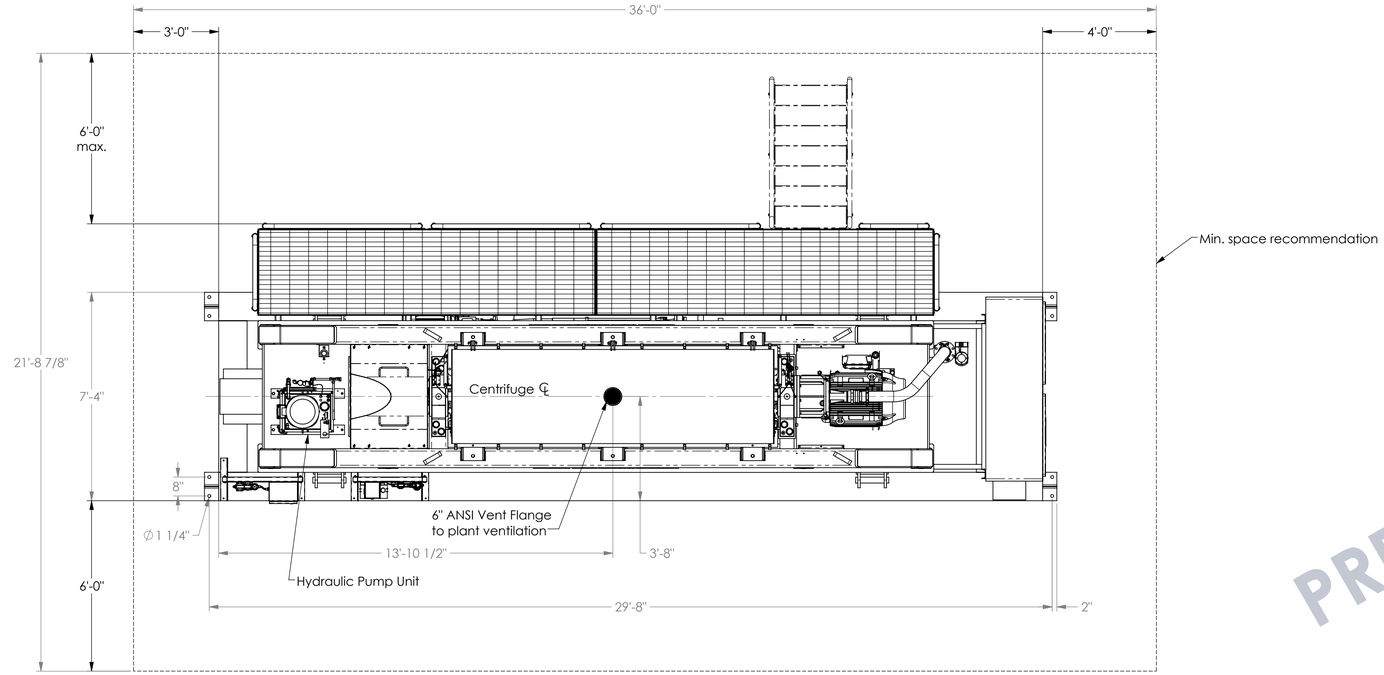
					Polymer Flow															
Date	Sampl	Power	Power Cost		Polymer Ty	Neat Polymer Flowrate	Dilution Flow	Polymer Injection Point	Polymer Active Conc.	Active Polymer Dose	Poly Cost	Solids Loading	Thickened Stream	Centrate TSS	Solids Capture		Solids Capture, Dilution Factored		Op Cost
															TS	TSS	TS	TSS	
		[kW/gpm]	$/Mgal	$/DT		[GPH]	[GPM]		[%]	[lb/DT]	[$/DT]	[lb/hr]	[% TS]	[mg/L]	[% w/w]	[% w/w]	[% w/w]	[% w/w]	[$/DT]
1/0	sim.1	0.104	155	6.2	-	0.000	0	Internal	0%	0.0	0.0	420	6.0%	300	95.5%	94.5%	95.5%	94.5%	$ 6.21
1/0	sim.2	0.103	154	6.1	*0*	0.250	5	Internal	44%	3.1	9.2	600	6.0%	330	95.0%	93.9%	94.9%	93.7%	$ 15.31
10/13	1.1	0.083	125	10.3	*0*	0.000	0	0	0%	0.0	0.0	145	4.6%	65	97.9%	97.9%	97.9%	97.9%	$ 10.30
10/13	1.2	0.066	98	6.4	*0*	0.000	0	0	0%	0.0	0.0	370	3.6%	150	96.3%	95.4%	96.3%	95.4%	$ 6.37
10/13	1.3	0.095	143	8.3	*0*	0.000	0	0	0%	0.0	0.0	164	10.0%	62	98.5%	97.9%	98.5%	97.9%	$ 8.33
10/13	1.4	0.076	114	7.2	*0*	0.000	0	0	0%	0.0	0.0	228	4.1%	87	97.9%	97.6%	97.9%	97.6%	$ 7.18
10/13	1.5	0.088	132	9.6	*0*	0.000	0	0	0%	0.0	0.0	149	8.8%	61	98.2%	98.1%	98.2%	98.1%	$ 9.57
10/13	1.6	0.079	119	7.7	*0*	0.000	0	0	0%	0.0	0.0	204	4.1%	79	98.1%	97.6%	98.1%	97.6%	$ 7.69
10/13	1.7	0.161	241	14.5	*0*	0.000	0	0	0%	0.0	0.0	220	10.0%	88	97.9%	97.2%	97.9%	97.2%	$ 14.47
10/13	1.8	0.132	198	12.2	*0*	0.000	0	0	0%	0.0	0.0	293	9.7%	110	97.3%	96.6%	97.3%	96.6%	$ 12.17
10/13	1.9	0.118	176	12.8	*0*	0.000	0	0	0%	0.0	0.0	264	4.3%	110	96.9%	96.7%	96.9%	96.7%	$ 12.81
10/14	2.1	0.060	89	6.7	*0*	0.000	0	0	0%	0.0	0.0	320	8.9%	170	94.9%	94.9%	94.9%	94.9%	$ 6.69
10/14	2.2	0.049	74	5.7	*0*	0.000	0	0	0%	0.0	0.0	310	4.6%	170	94.9%	94.7%	94.9%	94.7%	$ 5.69
10/14	2.3	0.080	119	8.9	*0*	0.000	0	0	0%	0.0	0.0	320	8.6%	160	95.2%	94.8%	95.2%	94.8%	$ 8.94
10/14	2.4	0.067	100	7.7	*0*	0.000	0	0	0%	0.0	0.0	310	8.8%	160	95.0%	94.8%	95.0%	94.8%	$ 7.72
10/14	2.5	0.079	119	8.9	*0*	0.000	0	0	0%	0.0	0.0	240	9.1%	120	96.4%	96.3%	96.4%	96.3%	$ 8.92
10/14	2.6	0.069	104	7.8	*0*	0.000	0	0	0%	0.0	0.0	240	5.7%	100	97.0%	96.9%	97.0%	96.9%	$ 7.79
10/14	2.7	0.071	106	7.9	*0*	0.000	0	0	0%	0.0	0.0	240	8.2%	110	96.7%	96.5%	96.7%	96.5%	$ 7.94
10/18	3.1	0.069	104	7.1	*0*	0.000	0	0	0%	0.0	0.0	350	2.5%	190	95.3%	95.3%	95.3%	95.3%	$ 7.09
10/18	3.2	0.070	104	6.8	*0*	0.000	0	0	0%	0.0	0.0	370	3.8%	190	95.3%	95.0%	95.3%	95.0%	$ 6.76
10/18	3.3	0.069	104	6.4	*0*	0.000	0	0	0%	0.0	0.0	390	7.8%	200	95.1%	94.4%	95.1%	94.4%	$ 6.36
10/18	3.4	0.068	101	6.4	*0*	0.000	0	0	0%	0.0	0.0	380	5.5%	200	95.1%	94.8%	95.1%	94.8%	$ 6.39
10/19	4.1	0.067	100	8.0	*0*	0.000	0	0	0%	0.0	0.0	345	3.6%	190	94.2%	94.2%	94.2%	94.2%	$ 7.98
10/19	4.2	0.075	113	9.7	*0*	0.000	0	0	0%	0.0	0.0	322	3.9%	190	93.7%	94.3%	93.7%	94.3%	$ 9.66
10/19	4.3	0.086	128	9.1	*0*	0.000	0	0	0%	0.0	0.0	391	6.2%	190	94.7%	94.4%	94.7%	94.4%	$ 9.06
10/19	4.4	0.088	132	9.9	*0*	0.000	0	0	0%	0.0	0.0	368	4.9%	190	94.4%	94.8%	94.4%	94.8%	$ 9.92
10/19	4.5	0.086	129	8.8	*0*	0.000	0	0	0%	0.0	0.0	403	4.4%	190	95.0%	94.7%	95.0%	94.7%	$ 8.85
10/19	4.6	0.068	102	7.2	*0*	0.000	0	0	0%	0.0	0.0	306	4.7%	150	95.9%	95.9%	95.9%	95.9%	$ 7.17
10/20	5.1	0.066	99	6.4	*K144L*	0.080	4	Internal	44%	1.4	4.1	426	6.7%	120	96.9%	96.4%	96.9%	96.4%	$ 10.56
10/20	5.2	0.066	98	6.9	*K144L*	0.080	4	after pump	44%	1.5	4.5	391	6.0%	66	98.2%	98.3%	98.1%	98.3%	$ 11.45
10/20	5.3	0.065	98	7.3	*K144L*	0.150	4	after pump	44%	3.0	9.0	368	6.5%	180	94.6%	95.1%	94.5%	95.0%	$ 16.30
10/20	5.4	0.065	97	6.9	*0*	0.000	0	0	0%	0.0	0.0	391	4.5%	210	94.3%	93.7%	94.3%	93.7%	$ 6.85
10/20	5.5	0.072	108	8.6	*0*	0.000	0	0	0%	0.0	0.0	240	8.6%	130	95.8%	96.2%	95.8%	96.2%	$ 8.62
10/21	6.1	0.078	117	7.6	*0*	0.000	0	0	0%	0.0	0.0	241	4.0%	110	97.3%	97.0%	97.3%	97.0%	$ 7.55
10/21	6.2	0.071	107	6.9	*0*	0.000	0	0	0%	0.0	0.0	278	3.6%	110	97.3%	97.0%	97.3%	97.0%	$ 6.93
10/21	6.3	0.093	139	11.1	*0*	0.000	0	0	0%	0.0	0.0	225	3.7%	110	96.6%	96.6%	96.6%	96.6%	$ 11.11
10/21	6.4	0.096	144	9.9	*0*	0.000	0	0	0%	0.0	0.0	228	4.2%	95	97.5%	96.9%	97.5%	96.9%	$ 9.88

Centrifuge Maintenance Schedule

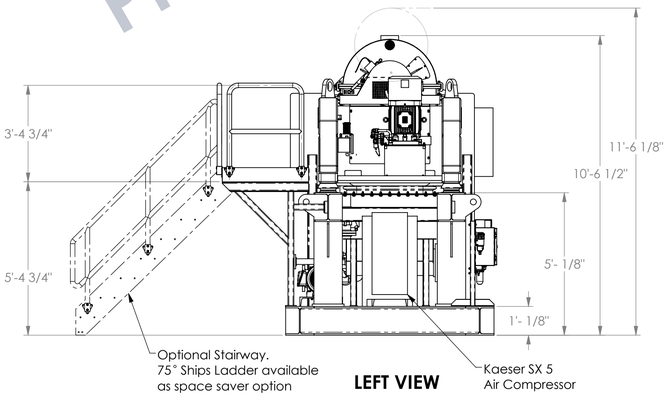
Centrifuge Model

Standard maintenance		Notes			
Daily maintenance	Description				
Fasteners and guards	Visually check externall fasteners for looseness and guards for cracking	done by plant personnel			
Discharge hoppers and piping	Check visually for leaks	done by plant personnel			
Operations log	Fill out normal operations log to record Temp, vibration, diff speed, torque, flow rate etc.	done by plant personnel			
Lubricator and hydraulic tank	Check level visually	done by plant personnel			
Control Panel	Check for faults and verify normal readings	done by plant personnel			
Noise and vibration	Observe noise and vibration levels on panel	done by plant personnel			
Weekly maintenance					
Grease internal bearings	See O&M	done by plant personnel			
Check belt tension	See O&M	done by plant personnel			
Check lubricant and oil levels	See O&M	done by plant personnel			
Discharge areas	Check solids and liquid discharge areas for wear and obstruction	done by plant personnel			
Monthly maintenance					
Inspection for wear	Open top cover, remove safety covers and inspect rotor and houisng for wear.	done by plant personnel			
Monitor vibration	Verify vibration levels are below normal operating levels on Panel display	done by plant personnel			
Wiring, electrical cords, etc.	Check for wear or damage. Replace if necessary.	done by plant personnel			
Check panel filters	Check for contamination and function of control panel cooling system	done by plant personnel			
Check oil tank sample	Visual observation of small sample to check for contamination.	done by plant personnel			
Annual					
Function check	Verify function of interlocks and syatem controls, check PLC battery	done by plant personnel			If desired technician available for serice
Repair Rebuild, Preventive maintenance		**Schedule**		**Notes**	
Bearings and seals					
Main bearings	Replace	15000 hrs or 5 years			see service bulletin for special applications
Internal bearings	Replace	15000 hrs or 5 years			see service bulletin for special applications
Wear components					
Feed nozzles	Inspect for wear, only worn need replacing	as needed			
Discharge ports	Inspect for wear, only worn need replacing	as needed			
Feedchamber area	Inspect for wear, replace wearcompound	as needed			
Internal inspection of rotor					
Remove scroll	Inspect for wear and damaged missing components				
Hydraulic system					
Oil and filter change	Change oil and filter	4000 hrs			Upon startup, oil filter does need to be changed after 200 hours
Hydraulic pump unit	Inspect for leaks and damage to hoses	4000 hrs			
Rotodiff hydraulic motor	Inpsect and change bearings and seals	15000 hrs or 5 years			
Balancing				**Date last completed**	
Bowl	Balance to specification	15000 hrs			
Scroll	Balance to specification	15000 hrs			

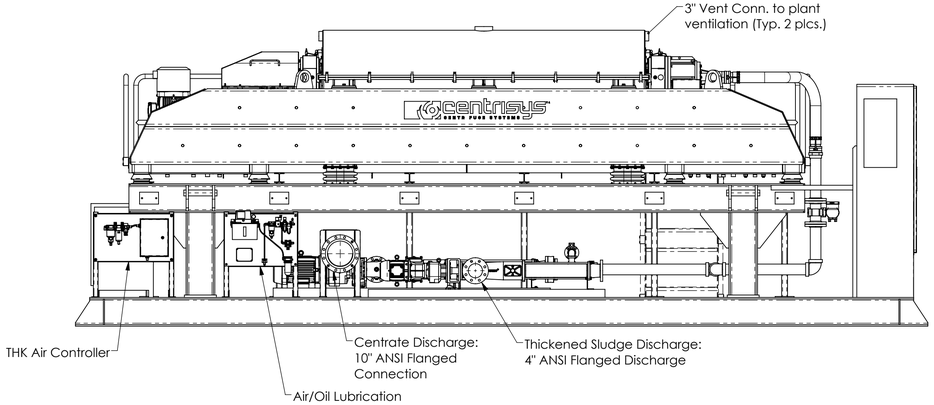




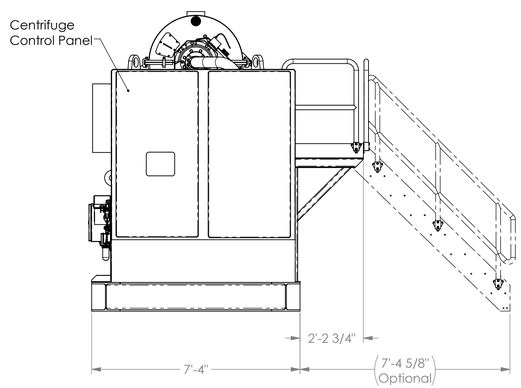
TOP VIEW



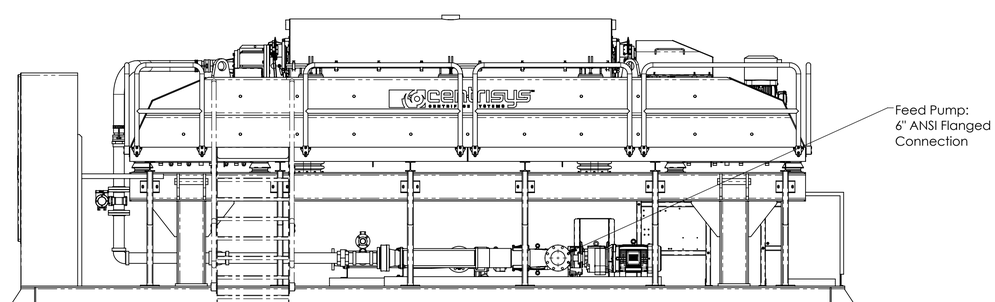
LEFT VIEW



FRONT VIEW



RIGHT VIEW



BACK VIEW

REVISE ON CAD ONLY

centrisys CENTRIFUGE SYSTEMS
9586 58th Place
Kenosha, WI 53144
Tel: (262) 654-6006
Fax: (262) 764-8705

Designed by: A.A.	Date: 5/4/17
Drawn by: A.A.	Date: 5/4/17
Chk'd by: -	Date: -
Approved by: -	Date: -

GD&T ASME Y14.5M1994 tolerancing Std. & Rules apply

3rd Angle Projection

Material(s): NA

Estimated weight (lbs): -

Title: THK 600 Skid Unit GA

Project:

Sheet Size: D | Drawing #: IM33009

Sht: 1 OF 1 | Scale: 1:32 | PRELIMINARY

MASTER CONTROL PANEL

CUSTOMER SUPPLIED

PLANT CONTROL PANEL

CENTRIFUGE CONTROL PANEL

CENTRIFUGE CONTROL PANEL

FEED FLOW METER INPUT — AI
FEED PUMP #1 SPEED FEEDBACK — AI
FEED PUMP #2 SPEED FEEDBACK — AI
POLYMER SYSTEM SPEED FEEDBACK — AI
POLYMER SYSTEM SPEED COMMAND — AO
FEED PUMP #1 SPEED COMMAND — AO
FEED PUMP #2 SPEED COMMAND — AO
FEED PUMP #1 RUNNING — DI
FEED PUMP #1 FAULTED — DI
FEED PUMP #2 RUNNING — DI
FEED PUMP #2 FAULTED — DI
POLYMER SYSTEM RUNNING — DI
POLYMER SYSTEM FAULTED — DI
THICKENED SLUDGE TANK HIGH LEVEL SWITCH — DI
CAKE HOPPER HIGH LEVEL SWITCH — DI
FEED PUMP #1 RUN COMMAND — DO
FEED PUMP #2 RUN COMMAND — DO
POLYMER SYSTEM RUN COMMAND — DO

CENTRIFUGE BOWL MOTOR VFD RUN
CENTRIFUGE BOWL MOTOR VFD RUNNING
CENTRIFUGE BOWL MOTOR VFD FAULTED
CENTRIFUGE BOWL MOTOR VFD SPEED FEEDBACK
CENTRIFUGE BOWL MOTOR VFD SPEED REFERENCE
ETHERNET
VFD

480VAC SUPPLIED POWER TO AIR COMPRESSOR #1 — DO
480VAC SUPPLIED POWER TO AIR COMPRESSOR #2 — DO
BOWL FLUSH SOLENOID — DO
BOWL FLUSH SOLENOID — DO
BOWL FLUSH SOLENOID — DO
DISCHARGE FLUSH SOLENOID — DO
CENTRIFUGE BOWL MOTOR THERMOSTAT — DI
VIBRATION SENSOR — AI
LIQUID END BEARING TEMP. — AI
SOLID END BEARING TEMP. — AI
BOWL SPEED PROX. — AI
SCROLL SPEED PROX. — AI
LUBE SYSTEM AIR PRESSURE SWITCH — DI
LUBE SYSTEM SWITCH (ON MOMENTARY SWITCH — DI
LUBE SYSTEM OIL LEVEL SWITCH — DI
LUBE SYSTEM OIL PRESSURE SWITCH — DI
AIR SUPPLY SOLENOID OPEN COMMAND — DO
OIL CYCLE MOTOR RUN COMMAND — DO
AIR CONTROL VALVE PRESSURE FEEDBACK — AI
AIR CONTROL VALVE FLOW FEEDBACK — AI
AIR CONTROL VALVE STATUS OUTPUT — AO
HYDRAULIC MOTOR THERMOSTAT — DI
HYDRAULIC PUMP RUN — DO
HYDRAULIC PUMP RUNNING — DI
HYDRAULIC OIL PRESSURE — AI
HYDRAULIC FLOW CONTROL VALVE POSITION — AO
HYDRAULIC OIL TEMP. HIGH — DI
HYDRAULIC OIL LEVEL LOW — DI
HYDRAULIC COOLING WATER SOLENOID — DO

VT1261 Vibration Sensor
TE/TT1265 Solids End Bearing Temp.
TE/TT1269 Liquids End Bearing Temp.
ST1247 Bowl Speed Sensor
ST1251 Scroll Speed Sensor
TS211 Bowl Motor Thermostat
MTR206 Centrifuge Bowl Motor
M 200HP

CENTRISYS THICKENER

THICKENER

TS301 Hydraulic Motor Thermostat
MTR306 Hydraulic Pump Motor
PT1212 Hydraulic Pressure
LSL1201 Hydraulic Oil Low Level Switch
CV1208 Flow Control Valve
TSH1203 Hydraulic Oil High Temp Switch
SV631 Hydraulic Cooling Water Solenoid
M 25HP
HYDRAULIC PUMP UNIT
HYDRAULIC PUMP

HYDRAULIC OIL FLUID BLEED OFF
HYDRAULIC OIL FLUID FEED
HYDRAULIC OIL FLUID RETURN

PLANT SUPPLIED FEED
FEED
POLYMER DILUTION WATER TO POLMYER SYSTEM
PROCESS WATER
SV633 Polymer Dilution Water Solenoid
SV627 Bowl Flush Water Solenoid
PLANT SUPPLIED WATER
SV625 Cake Chute Water Solenoid
SV629 Spare Flush Water Solenoid

SOLIDS END #1
LIQUIDS END #1
LIQUIDS END #2

MTR672 OIL CYCLE MOTOR
SV670 AIR SUPPLY SOLENOID
PS660 LUBE SYSTEM OIL PRESSURE
LS662 LUBE SYSTEM OIL LEVEL
PB664 LUBE SYSTEM MOMENTARY ON
PS666 LUBE SYSTEM AIR PRESSURE
AIR OIL LUBE SYSTEM

Y646 Air Control Valve Pressure Feedback
Y646 Air Control Valve Flow Feedback
Y646 Air Control Valve Status Output
AIR CONTROLLER

AIR

M1
M2
AIR COMPRESSOR
CUSTOMER SUPPLIED

5/26/2020	0	Ksaam	GHarvey
DATE:	REVISION:	BY:	CH'D:

centrisys® CENTRIFUGE SYSTEMS

Centrisys Corporation
9586, 58th Place
Kenosha, WI 53144
Phone (262-654-6006)
Fax (262-654-6063)
www.centrisys.us
info@centrisys.us

CUSTOMER: Welcome Trading Co.

TITLE: P&ID

MACHINE TYPE: THK600

CREATION DATE: 5/26/2020

SHEET 1 OF 1 OF SHEETS

DRAWING NO. 12309-P&ID /1

NUMBER: 08361

DATE: 2/14/22

TO: Alcosan
3300 Preble Ave.
Pittsburgh, PA, 15212
Attn: Dan Lockard
Tel: (412) 734 8370
Email : daniel.lockard@alcosan.org

REF.: Thickening Centrifuge

Budget Proposal
Alcosan Woods Run WWTP
Pittsburgh, PA
THK 350 Thickening Unit

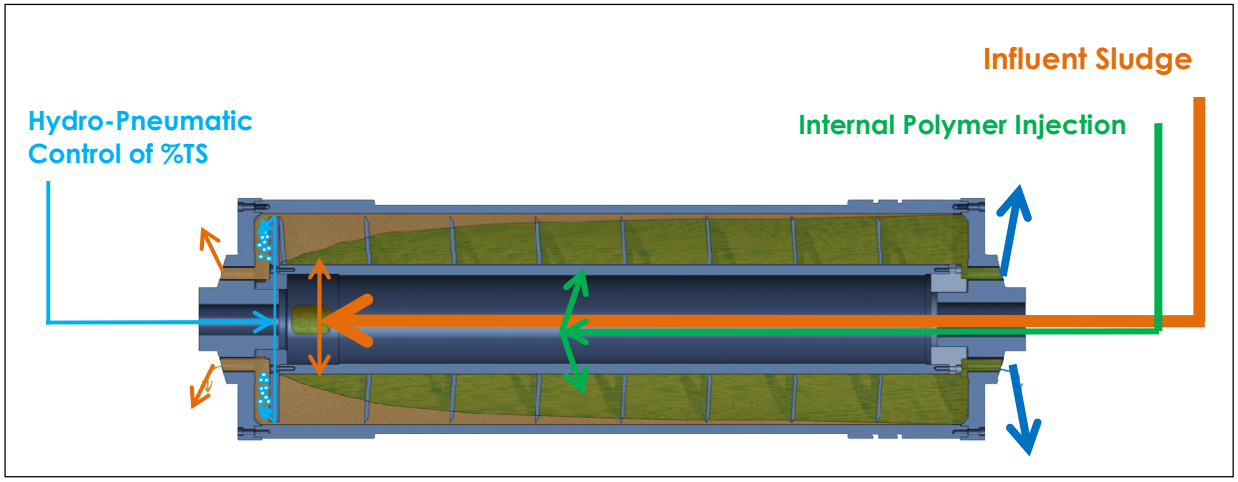
Centrisys Contact
Sanjeev Verma
Regional Sales Manager
9586 58th place
Kenosha, WI 53144
Ph: (262) 654-6006
Direct: (262) 612-9318
Email: sanjeev.verma@centrisys.us

Centrisys Representative
Brian Fenstemaker
Kappe Associates, Inc.
4268 Northern Pike
Monroeville, PA, 15146
Ph: (412) 373-9303
Direct: (412) 334-2985
Fax (412) 373-9343
Email: brian@kappe-inc.com

Process Description: Centrisys THK Series

The THK Thickening Centrifuge:

Sludge thickening using centrifugal force is a common process that can be applied to increase the concentration of sludge for further processing. During operation, sludge is continuously fed into the unit. The moving shaft has a set of helical scrolls, which push the solid waste towards one end, away from the liquid moving in the opposite direction. Centrisys' innovative, patented Hydraulic Assist Technology discharges the thickened sludge more efficiently while reducing costs. Our centrifugal thickening process is the smallest footprint approach to reduce volume while increasing digesting capacity and performance.



The most significant differentiator of the Centrisys THK product is its ability to achieve 2 -6% cake solids **without the use of polymer**. Within this range, the solids content can be reliable controlled at the desired level. We've validated these results in pilots and demonstration installations across the United States for waste active sludge. This is a huge benefit to water & wastewater treatment facilities by substantially reducing their operating costs. Compared to gravity belt thickeners, a comparable Centrisys THK unit thickener has demonstrated a potential payback of 5 years, or less, based on reductions in polymer, water & electricity usage. We've recorded similar results compared to DAF thickening systems, while using a fraction of the required footprint.

9586 58th Place | Kenosha, WI 53144 USA | +1 (262) 654-6006 | info@centrisys-cnp.com | centrisys-cnp.com
CNP - a subsidiary of Centrifuge-Systems, LLC | ISO 9001:2015

The Centrisys THK Series Design

Centrisys considers all critical design elements including axial flow, pitch design, scroll hub design, cone angles, feed chamber design and disc design, hydra-pneumatic control of the cake solids, Rotor aerodynamics, discharge nozzle geometry, plus our advanced high torque hydraulic Centrisys scroll-drive to achieve the highest performance of any decanter centrifuge. The bowl section is maximized in length (varying from 3.5 to 4.5, depending on the size) for high flow rate and efficient clarification.

Feed Flow

The Centrisys advanced feed chamber design minimizes wear and maximizes performance. This design gently accelerates the continuous incoming feed and distributes it evenly over a larger area as it enters the bowl through multiple field-replaceable tungsten carbide nozzles. This maximizes separation and clarification while minimizing wear, and avoids disturbing already-separated cake solids in the liquid layer.

Patented Hydro-Pneumatic Solids Control

Using injection of air into the thickened solids blanket, coupled with the already present centrifugal force, adjustment of the cake solids consistency can be made on the fly.

- If a plant operator desires to modify the cake solids consistency, the airflow of the THK thickener can be adjusted via the HMI, quickly changing output solids consistency on-demand, without any mechanical adjustments or shutting down the unit.

Polymer Feed Injection Option

The proprietary internal polymer injection design provides the option to inject polymer directly into the fast moving layer of water which flows axially along the hub towards the liquids end of the bowl. Generally, for WAS we do not foresee the necessity for polymer use under normal circumstances. However, use of polymer can be used to substantially increase throughput of the THK (typically by 75 to100%) while maintaining high solids capture efficiencies. Because of the internal polymer injection design, polymer doses are typically 10 to 20% of other mechanical thickening technologies, even at maximum capacities.

Low Speed Operation

The THK series centrifuge is designed to for operation up to 3,000 G – standard for decanting centrifuges. However, because the separation and discharge mechanisms for the THK units are so much different than for conventional centrifuges, the typical bowl speeds required are much lower – typically within the 1,000 to 2,000 G range. This means less power is consumed and the machine's wear is much less than what is typically observed in modern decanter centrifuges.

Centrisys is pleased to provide this quotation for the following:

Option 1: Three (3) THK350 Thickeners

ITEM 1. THREE (3) THICKENING CENTRIFUGE UNITS, MODEL THK 350 COMPLETE WITH AUTOMATIC HYDRAULIC BACKDRIVE

a. Basis of Design – Sludge Feed Characteristics

Industry Type:	Municipal
Application:	WAS
Number of units:	3 (2 duty, 1 standby)
Design Feed Flow rate/Unit:	1020 gpm (excluding polymer flow)
Dry Solids loading:	2252 lbs/hr
Feed Concentration:	0.5 %
Organic/Volatile Content:	TBD %
Operation time:	24 hrs/day; 7 days/week
Temperature:	Ambient F
pH:	6-8

b. Anticipated Performance

Per lab report

1.A Centrifuge specification

Model:	THK 350
Inside bowl diameter (in):	21
Bowl length (in):	80
Bowl length to diameter ratio:	3.7:1
Maximum Bowl speed (RPM):	3150
Type of lubrication:	Grease
Main Motor HP:	75
Back Drive Motor HP:	15

1.B Scope of supply

1. Each unit will be provided based on the attached drawing THK 350 GA.pdf
   (i) Centrifugally Casted Duplex SS Solid bowl
   (ii) Scroll conveyor with Duplex SS Scroll shaft; 316SS flights
   (iii) 316 SS lower and upper casing
   (iv) Solid and liquid flexible connectors
   (v) Dewatered Sludge and Centrate Chutes/Hoppers
   (vi) Powder coated carbon steel base/frame

(vii) Vibration isolators
(viii) Spare parts/tools
(ix) Control Panel (water cooled)
A. 304SS NEMA 4X Enclosure for each centrifuge
B. Main circuit breaker
C. VFD for main drive motor
D. Allen Bradley PLC (compact logix), valve amplifier and motor starter for automatic hydraulic back drive system
E. Ethernet communication and historical trending of key parameters
F. 10" Allen-Bradley panel view touch screen
(x) Instrumentation
A. One (1) vibration sensor per unit
B. One (1) main bearing temperature sensor, type PT100 on each bearing
C. One (1) each Bowl/Scroll speed sensor/unit
D. One (1) Hydraulic oil level/temp, hydraulic pressure sensor/unit
(xi) Automatic Grease Lubrication System
A. One (1) low grease level sensor per unit
(xii) One (1) trip and 5 days or 40 hours (whichever occurs first) of startup assistance

Option 2: Two (2) THK600 Thickeners

ITEM 2. TWO (2) THICKENING CENTRIFUGE UNITS, MODEL THK 600 COMPLETE WITH AUTOMATIC HYDRAULIC BACKDRIVE

a. Basis of Design – Sludge Feed Characteristics

Industry Type:	Municipal
Application:	WAS
Number of units:	2 (1 duty, 1 standby)
Design Feed Flow rate/Unit:	1000 gpm (excluding polymer flow)
Dry Solids loading:	2,252 lbs/hr
Feed Concentration:	0.5 %
Organic/Volatile Content:	TBD %
Operation time:	24 hrs/day; 7 days/week
Temperature:	Ambient F
pH:	6-8 (assumed)

b. Anticipated Performance

Per lab report

9586 58th Place | Kenosha, WI 53144 USA | +1 (262) 654-6006 | info@centrisys-cnp.com | centrisys-cnp.com
CNP - a subsidiary of Centrifuge-Systems, LLC | ISO 9001:2015

1.C Centrifuge specification

Model:	THK 600
Inside bowl diameter (in):	26
Bowl length (in):	118
Bowl length to diameter ratio:	4.5:1
Maximum Bowl speed (RPM):	2850
Type of lubrication:	Air/Oil
Main Motor HP:	150
Back Drive Motor HP:	25

1.D Scope of supply

1. Each unit will be provided based on the attached drawing THK 600 GA.pdf
   - (i) Centrifugally Casted Duplex SS Solid bowl
   - (ii) Scroll conveyor with Duplex SS Scroll shaft; 316SS flights
   - (iii) 316 SS lower and upper casing
   - (iv) Solid and liquid flexible connectors
   - (v) Dewatered Sludge and Centrate Chutes/Hoppers
   - (vi) Powder coated carbon steel base/frame
   - (vii) Vibration isolators
   - (viii) Spare parts/tools
   - (ix) Control Panel (water cooled)
     - A. 304SS NEMA 4X Enclosure for each centrifuge
     - B. Main circuit breaker
     - C. VFD for main drive motor
     - D. Allen Bradley PLC (compact logix), valve amplifier and motor starter for automatic hydraulic back drive system
     - E. Ethernet communication and historical trending of key parameters
     - F. 10” Allen-Bradley panel view touch screen
   - (x) Instrumentation
     - E. One (1) vibration sensor per unit
     - F. One (1) main bearing temperature sensor, type PT100 on each bearing
     - G. One (1) each Bowl/Scroll speed sensor/unit
     - H. One (1) Hydraulic oil level/temp, hydraulic pressure sensor/unit
   - *(xi)* Automatic Air/Oil Lubrication System
     - A. One (1) low air/oil level sensor per unit
   - (xii) One (1) trip and 5 days or 40 hours (whichever occurs first) of startup assistance

BUDGET PRICE:

Option 1: Three (3) THK350 Thickeners for ..... $**1,447,300** USD
Option 2: Two (2) THK600 Thickeners for ..... $**1,482,800** USD
F.O.B. Job Site, freight included, taxes excluded.

PAYMENT TERMS:

30% with order; 60% upon shipment; 10% after startup not to exceed 90 days after shipment.

Lead Time: 30 weeks following receipt of the Approval drawings

BUYER/OWNER RESPONSIBILITY:

- Stand
- Feed pump
- Polymer system
- Flow meter
- Air compressor
- Cake conveyor
- Anchor bolts.
- Building and building plans (Centrisys provides only the layout drawings without any responsibility of updating any plans or building)
- Building modifications
- Structural and Civil engineering labor
- Lubricants
- All utilities that are required for operation
- Unloading, uncrating, installation and installation supervision. Installation will, at minimum, require a forklift and possibly a crane/hoist.
- Readiness of the Equipment before requesting start-up service. Non-readiness may incur additional charges.
- Compatibility of Equipment materials of construction with process environment.
- Piping connections, platforms, gratings and railings unless stated otherwise.
- Any other auxiliary equipment or service not detailed above.

Issued by

Jeff Kin
Applications Engineer

Date: 02/14/22

9586 58th Place | Kenosha, WI 53144 USA | +1 (262) 654-6006 | info@centrisys-cnp.com | centrisys-cnp.com

Alfa Laval Inc
10470 Deer Trail Drive
Houston, TX 77038

3300 Preble Ave

Pittsburgh, PA 15233

ALFA LAVAL ALSYS G3-75 TRAILER MOUNTED CENTRIFUGE THICKENING SYSTEM

PILOT TEST REPORT

Test Dates: November 8th- November 19th, 2021

Pilot Test Conducted by Ross Locklin and Eric Csonka

Application: Waste activated sludge

Equipment: Alfa Laval ALSYS G3-75 Trailer Mounted Centrifuge Thickening System
Plant contact: Rucha Shah – Engineer - (724)-934-9546

Demo Date: November 8th – November 19th

1.0: INTRODUCTION

The Alcosan wastewater treatment plant is 59 acres on the Northside of Pittsburgh and treats 83 Allegheny County communities. The plant processes up to 250 million gallons daily. Alcosan is currently looking at different technologies for waste activated sludge thickening.

2.0: Pilot Summary

Process ranges from testing as complete data are shown in the table below:

Date of testing	Type Of Sludge	Sludge Flow (GPM)	Feed Solids % TS	Bowl Speed (rpm)	Differential Speed (rpm)	Thickened Sludge % TS	Recovery %
November 9	***WAS***	***100***	***.32-.37***	***3798-3800***	***3.00-14.00***	***9.50-11.00***	***>94%***
November 10	***WAS***	***100-125***	***.38-.44***	***2825-3799***	***1.00-5.00***	***.66-9.40***	***>96%***
November 11	***WAS***	***125***	***.34-.40***	***3797-3801***	***.60-.90***	***.52-16.00***	***>89%***
November 15	***WAS***	***100***	***.33-.40***	***2902-3802***	***25.00-28.00***	***9.10-10.00***	***>75%***
November 16	***WAS***	***100***	***.36-.45***	***2405-2801***	***7.00-28.00***	***2.90-8.20***	***>87%***
November 17	***WAS***	***100***	***.34-.74***	***2404-2405***	***7.00-10.00***	***3.00-4.10***	***>91%***
November 18	***WAS***	***100***	***.43-.47***	***2404-2405***	***7.00***	***4.10-5.60***	***>94%***

Alfa Laval ran a pilot test for thickening with the G3-75 trailer mounted centrifuge system. The target goal was to thicken sludge directly from the aeration basin to 4-6% with 90-95% capture. From the results above, the thickening unit performed its best with a differential speed set at 7, a bowl speed around 2400 revolutions per minute, and a neutral (0) pond setting. These set-points were achieved through operating the unit and adjusting variables to achieve the desired results. These settings were validated by independent laboratory.

No polymer was used during this trial because the polymer system for the test unit could was too large. The quality of the sludge was above average and really did not require much polymer if any to achieve separation.

Based upon the formal test results we found that the average feed solids concentration was 0.39%. This solids concentration is consider below the recommended minimum concentration of 0.5%.

3.0: PILOT TESTING UNIT

The Alfa Laval ALSYS G3-75 Trailer mounted Centrifuge Thickening System Demonstration Trailer was set-up on November 8th, 2021, and testing began on the 8th – concluding on the 19th.

The Mobile Test Trailer consists of the following main functional items:

- Alfa Laval ALSYS G3-75 Centrifuge
- 50 HP Main Drive Motor & 15 HP Backdrive Motor
- Norchem Polymer Blend/Feed System
- Seepex Macerator
- Seepex Progressive Cavity Feed Pump
- Centrate discharge system (a gravity drain system)
- Cake solids auger (shaftless screw conveyor)
- NEMA 4X Control Panel with air-conditioner unit
- Alfa Laval DLM+ Automation System

Over the course of the testing, the centrifuge was operated for continuous periods of time to establish the optimum physical settings for the machine, as well as to demonstrate consistent operation with varied solids loading. Test samples of feed, thickened sludge, and centrate were periodically taken and measured by the plant's independent lab. The lab results provide the data for this report as shown at the end of this report.

The sludge was pumped from an aeration basin tank to the centrifuge using the pilot test trailer progressive cavity pump, which regulated the flow rate to centrifuge skid. Before reaching the centrifuge mounted PCP, it passed through a macerator to make sure all particles were less than 0.25 inches. Sludge flow was measured by a magnetic flow meter on the centrifuge skid.

4.0 DISCUSSION OF RESULTS

Table: 1 Differential Speed vs Thickened Sludge (*Alfa Laval)*

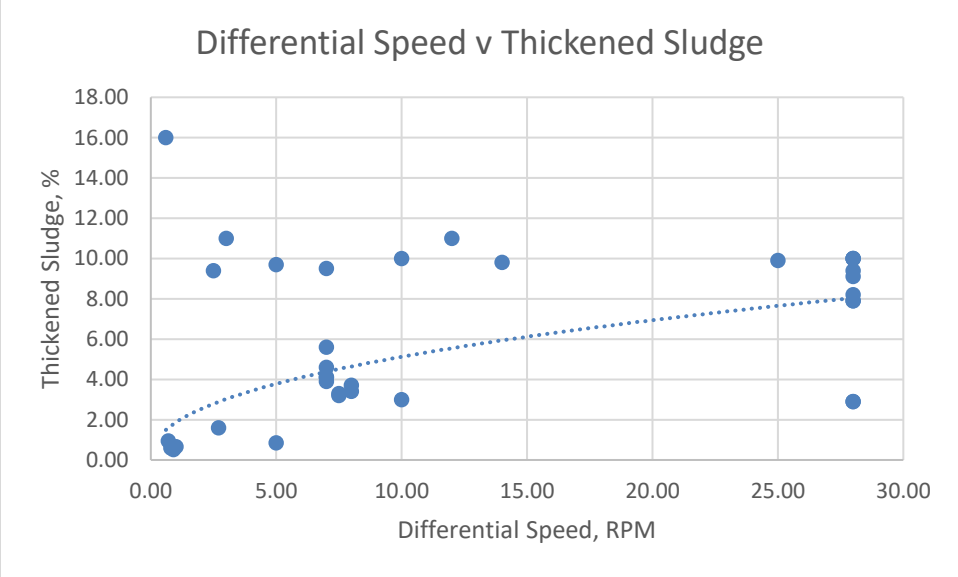


Table: 2 Bowl Speed vs Thickened Sludge (*Alfa Laval)*

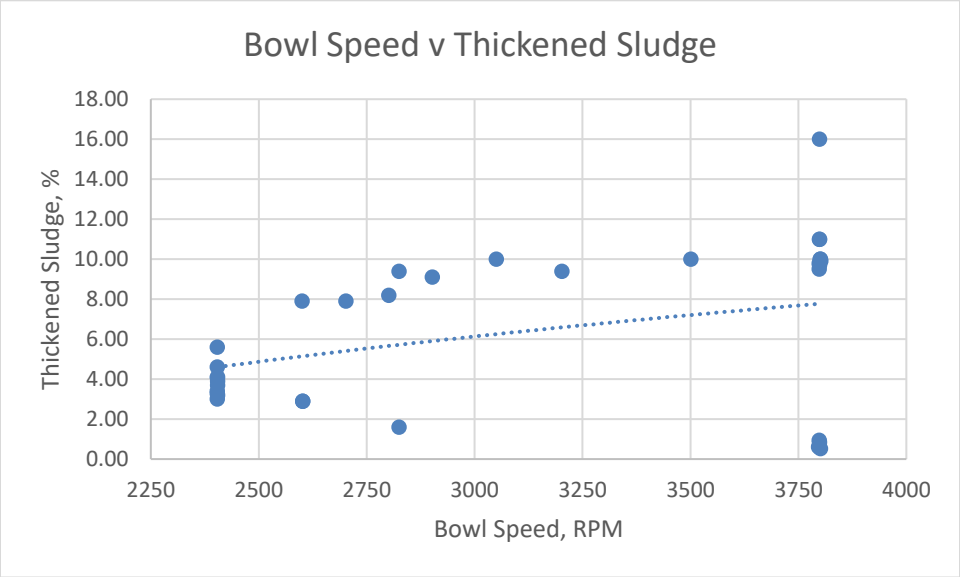


Table: 5 Pilot Data and Machine Set-points

			Machine Conditions							Feed Parameters					Additive Conditions		Product Conditions			
Date	Time	Run Number	Pond Radius mm	Bowl Speed rpm	Diff. Speed (Δn) rpm	Main Drive KW per leg	Total KW	Torque %	Torque kNm (formula)	Feed Rate gpm	Feed Conc %TS (trailer oven)	Feed Conc %TS (Plant)	Solids Loading Lbs/hr (formula)	Volatile Solids %TVS one / day	Polymer Dosage #/TDS (formula)	Addition Point	Cake Conc %TS (oven)	Cake Conc %TS (Plant MB)	Effluent Conc %TSS (Plant)	Recovery % (formula)
9-Nov-21	9:15	1	-2	3800	10.00	6.11	18.33	4.7	0.38	100	0.40	0.37	185	62.1	0.0	Elbow	11.47	10.00	0.022	94.3
9-Nov-21	10:15	2	-2	3799	12.00	5.95	17.85	4.9	0.39	100	0.33	0.32	160	62.5	0.0	Elbow	11.04	11.00	0.017	94.8
9-Nov-21	11:15	3	-2	3798	14.00	5.74	17.22	5.3	0.42	100	0.35	0.36	180	63.8	0.0	Elbow	11.09	9.80	0.020	94.6
9-Nov-21	2:15	4	-4	3799	3.00	5.60	16.80	5.0	0.40	100	0.31	0.34	170	61.8	0.0	Elbow	12.61	11.00	0.012	96.6
9-Nov-21	3:00	5	-4	3799	5.00	5.72	17.16	3.7	0.30	100	0.42	0.37	185	62.1	0.0	Elbow	11.32	9.70	0.0130	96.6
9-Nov-21	3:30	6	-4	3798	7.00	5.67	17.01	3.5	0.28	100	0.40	0.34	170	64.7	0.0	Elbow	10.85	9.50	0.0140	96.0
10-Nov-21	10:00	7	-4	3799	5.00	7.00	21.00	3.0	0.24	100	0.33	0.40	200	62.5	0.0	Elbow	0.91	0.85	0.0200	97.3
10-Nov-21	11:30	8	-4	2825	2.50	3.23	9.69	3.6	0.29	100	0.37	0.44	220	63.0	0.0	Elbow	10.78	9.40	0.0160	96.5
10-Nov-21	12:00	9	-4	2825	2.70	3.59	10.77	2.9	0.23	100	0.44	0.38	190	60.5	0.0	Elbow	1.65	1.60	0.0170	96.6
10-Nov-21	3:30	10	-6	3798	1.00	8.19	24.57	7.2	0.58	125	0.43	0.38	238	60.5	0.0	Elbow	0.69	0.66	0.011	98.8
11-Nov-21	8:30	11	-6	3801	0.90	8.32	24.96	7.0	0.56	125	0.34	0.36	225	61.0	0.0	Elbow	0.53	0.52	0.020	98.2
11-Nov-21	9:30	12	-6	3797	0.80	8.35	25.05	7.4	0.59	125	0.34	0.39	244	61.5	0.0	Elbow	0.58	0.60	0.013	98.8
11-Nov-21	10:30	13	-6	3798	0.70	7.71	23.13	9.1	0.73	125	0.38	0.40	250	62.5	0.0	Elbow	0.86	0.95	0.013	98.1
11-Nov-21	11:30	14	-6	3799	0.60	8.21	24.63	11.0	0.88	125	0.44	0.34	213	61.8	0.0	Elbow	16.25	16.00	0.038	89.0
15-Nov-21	10:00	15	2	3050	28.00	4.32	12.96	9.4	0.75	100	0.34	0.38	190	73.7	0.0	Elbow	10.05	10.00	0.095	75.7
15-Nov-21	11:00	16	0	3802	25.00	6.20	18.60	7.4	0.59	100	0.42	0.37	185	67.5	0.0	Elbow	9.83	9.90	0.028	92.7
15-Nov-21	11:45	17	0	3801	28.00	6.30	18.90	7.5	0.60	100	0.36	0.40	200	70.0	0.0	Elbow	9.93	10.00	0.028	93.3
15-Nov-21	12:30	18	0	3501	28.00	5.40	16.20	7.8	0.62	100	0.36	0.39	195	60.0	0.0	Elbow	9.68	10.00	0.027	93.3
15-Nov-21	1:30	19	0	3202	28.00	4.52	13.56	7.4	0.59	100	0.40	0.33	165	63.0	0.0	Elbow	9.33	9.40	0.024	93.0
15-Nov-21	2:30	20	0	2902	28.00	3.87	11.61	7.3	0.58	100	0.36	0.40	200	70.0	0.0	Elbow	8.93	9.10	0.028	93.3
16-Nov-21	9:00	21	0	2801	28.00	3.75	11.25	7.7	0.62	100	0.36	0.42	210	60.0	0.0	Elbow	8.17	8.20	0.026	94.1
16-Nov-21	10:00	22	0	2702	28.00	3.59	10.77	7.1	0.57	100	0.39	0.36	180	60.0	0.0	Elbow	8.13	7.90	0.046	87.7
16-Nov-21	11:30	23	0	2600	28.00	3.41	10.23	7.2	0.58	100	0.39	0.41	205	68.3	0.0	Elbow	9.61	7.90	0.027	93.7
16-Nov-21	12:00	24	0	2602	28.00	3.43	10.29	7.0	0.56	100	0.39	0.45	225	68.0	0.0	Elbow	4.48	2.90	0.027	94.9
16-Nov-21	2:00	25	0	2602	28.00	3.00	9.00	4.8	0.38	100	0.44	0.38	190	71.1	0.0	Elbow	4.50	2.90	0.028	93.5
16-Nov-21	2:30	26	0	2405	7.00	2.46	7.38	3.0	0.24	100	0.29	0.38	190	68.4	0.0	Elbow	4.08	3.90	0.025	94.0
17-Nov-21	9:15	27	0	2404	10.00	2.88	8.64	3.3	0.26	100	0.35	0.35	175	74.3	0.0	Elbow	2.96	3.00	0.029	92.6
17-Nov-21	10:00	28	0	2405	8.00	2.74	8.22	2.9	0.23	100	0.27	0.37	185	72.9	0.0	Elbow	3.29	3.70	0.027	93.4
17-Nov-21	11:00	29	0	2404	7.50	2.71	8.13	3.0	0.24	100	0.32	0.34	170	64.7	0.0	Elbow	3.59	3.30	0.028	92.5
17-Nov-21	12:00	30	0	2404	7.00	2.64	7.92	3.0	0.24	100	0.41	0.38	190	65.8	0.0	Elbow	4.42	4.10	0.033	92.1
17-Nov-21	1:00	31	0	2404	8.00	2.80	8.40	3.0	0.24	100	0.29	0.74	370	44.6	0.0	Elbow	3.55	3.40	0.033	96.5
17-Nov-21	2:00	32	0	2405	7.50	2.77	8.31	2.9	0.23	100	0.40	0.34	170	70.6	0.0	Elbow	3.49	3.20	0.025	93.4
18-Nov-21	9:00	33	0	2404	7.00	2.79	8.37	3.1	0.25	100	0.45	0.47	235	48.9	0.0	Elbow	4.83	4.60	0.025	95.2
18-Nov-21	10:00	34	0	2404	7.00	2.73	8.19	3.0	0.24	100	0.41	0.43	215	60.5	0.0	Elbow	5.19	5.60	0.028	94.0
18-Nov-21	11:00	35	0	2405	7.00	7.77	23.31	3.0	0.24	100	0.46	0.43	215	55.8	0.0	Elbow	4.15	4.10	0.024	95.0

Figure 1.0:

Figure 2.0:

Figure 1.0 is a visual representation of the feed, thickened sludge, and centrate liquor produced by the ALSYS G3-75 thickening unit.
Figure 2.0 is a visual representation of the feed from the aeration basin

5.0: CONCLUSIONS

Based upon the results of this testing, we can conclude that a decanter centrifuge will meet the performance requirements to thicken the waste activated sludge produced by the plant. However, W.A.S. thickening with a centrifuge is not that common of an application in the industry. There are two primary drivers for the limited use of a decanter in thickening applications. The first is power consumption followed by maintenance costs. Alternative thickening technologies such as gravity belt thickeners and rotary drum thickeners use less energy because they are slower moving pieces of equipment versus that of a decanter. When it comes to the cost of maintenance of decanters versus a G.B.T. or R.D.T., the maintenance costs will always be higher over the life cycle of the decanter even with a top-notch preventive maintenance program because of its complexities. Decanters in wastewater applications are best used for high solids dewatering. In dewatering with a decanter, the higher cake dryness reduces total hauling costs. Hauling costs typically tend to be higher than the combined cost of power, maintenance, and polymer usage on an annual basis. Gravity thickening with a decanter is not able to generate cost savings as efficiently as an R.D.T. or G.B.T.

A final point of consideration for a decanter in gravity thickening is the footprint and infrastructure required for the unit. It is a given that the decanter will have a higher dynamic load which will generate higher construction material costs. The G.B.T. and R.D.T. are significantly lighter so the total installation cost would be lower.

In summary, we feel that the most sustainable and cost-effective means of thickening would not be with a decanter. The most efficient means to thicken would be with either a gravity belt thickener or a rotary drum thickener.

Table 6: Calculations

All calculations were done by the following equations, based on the mass balance:

SL = 60*(f/100)*F*8.34

$$\mathrm{PD} = \frac{\mathrm{P} * \mathrm{p}}{\mathrm{F} * \mathrm{f}} * 2000$$

PC = (P*p)/(H + P*p)

$$\%\mathrm{Recovery} = \frac{\mathrm{s} * (\mathrm{f} - \mathrm{e})}{\mathrm{f} * (\mathrm{s} - \mathrm{e})} * 100$$

SL = ***Solids Loading (lbs./hr)***

f = ***Feed concentration (%TS)***

F = ***Feed Rate (GPM)***

PD = ***Active Polymer dosage (#/dry ton)***

P = ***Polymer rate (GPM)***

p = ***Active Polymer concentration (%)***

PC = ***Active Polymer concentration in water (%)***

H = ***Water Flow (GPM)***

s = ***Cake Dryness (%TS)***

e = ***Effluent Concentration (%TSS)***

Project Name: ALCOSAN

ALDEC G3-165 Decanter Centrifuge for Sludge Thickening

Alfa Laval Reference No. 0103834 Rev 0
February 18, 2022
Quote Validity: 30 Days

Prepared by:

Brian Ayres
Applications Engineer
brian.ayres@alfalval.com

Alfa Laval, Inc.
804-222-5300
5400 International Trade Drive
Richmond, VA 23231

Prepared for:

Allegheny County Sanitary Authority
3300 Preble Ave.
Pittsburgh, PA 15233

February 18, 2022

ALCOSAN
REF: 0103834

To whom it may concern,

Thank you for your enquiry. We are pleased to enclose our non-binding Budget Quotation for **One (1) ALDEC G 3 - 165 Decanter Centrifuge** for the ALCOSAN project.

As part of Alfa Laval's dedication to continuous innovation, the ALDEC Decanter Centrifuge is the industry benchmark for dewatering and thickening in wastewater treatment. In summary…

- **ALDEC decanters deliver greater operational efficiency,** allowing for increased sludge treating capacity or dryer sludge cake for reducing sludge disposal costs.
- **Lowest energy consumption,** with optimized motors & drives, delivering the lowest installed power and energy consumption.
- **Low maintenance costs,** with reduced planned maintenance and easily replaceable wear parts.

Alfa Laval offers unrivalled **24-hour service agreements**, placing your needs as close as a phone call away! Our certified field service engineers are available for installation, commissioning, maintenance, repairs, and process optimization. Additionally, Alfa Laval provides original equipment manufacturer (OEM) parts direct from our US Distribution Center in Indianapolis.

As requested, we have included the scope of supply and applicable process guarantees based on the defined influent sludge parameters. Technical details along with dimensional drawing for the proposed centrifuge including weights, bowl diameter, speed, installed power, power consumption and G-Force are enclosed in the proposal.

Alfa Laval recommends the described equipment per the outlined technical specifications, and additional clarifications for greater understanding of the offer. We trust that we have interpreted your requirements correctly and shall be pleased to provide any additional information which may be required in support of our proposal.

Note: Kindly indicate our Quotation Reference in your Purchase Order/ Letter of Acceptance/ Sales Contract and all our correspondences if the order is confirm to us.

Regards,

Sean Tierney

Sean Tierney
Northeast Regional Sales Manager
Alfa Laval

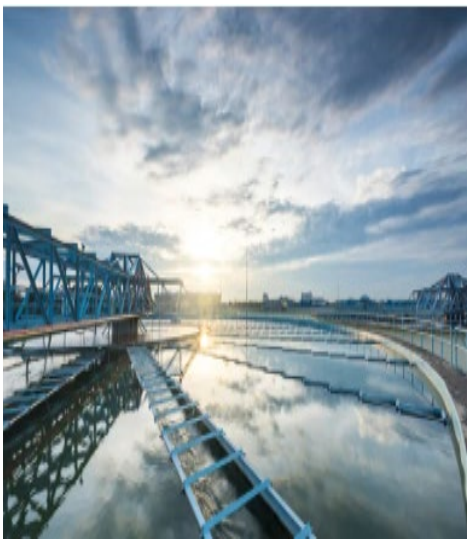
CONTENTS

1. ALFA LAVAL

1.1. About us

Alfa Laval is a leading global provider of separation, heat transfer, and fluid handling technology. Founded in 1883 and for more than 130 years, we have built a global presence with service centers and partners in nearly 100 countries. This offers local expertise, supported by the global breadth and depth of Alfa Laval. With these as its base, Alfa Laval aims to help enhance the productivity and competitiveness of its customers in various industries all over the world. Alfa Laval – Our Company.

1.2. Wastewater Separation Technologies



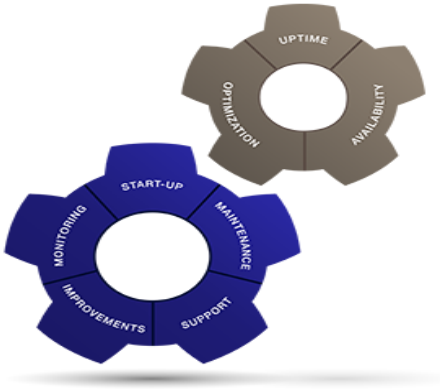
Alfa Laval has been manufacturing Municipal Water and Wastewater decanters centrifuges for over 50 years. There are 50,000+ units operating worldwide, with 5,000+ in the US. We remain committed to being the technology leader in design innovations, delivering reduced power & polymer consumption, increased cake dryness, and increased capacity within the same footprint. Alfa Laval - Municipal wastewater treatment

- Decanter Centrifuge
- Belt Filter Press
- Gravity Belt Thickener
- Rotary Drum Thickener
- Plate & Frame Press
- Tertiary Water Filtration
- SBR / MBR / Pkg. Plants

1.3. Lab & Pilot Testing

Alfa Laval's DNA is to continuously bring value to our customers. Our state-of-the-art wastewater laboratory, located in the Houston, TX service center; allows Alfa Laval to analyze the optimal technology for your specific separation requirements. Additionally, Alfa Laval provides separation equipment available for on-site field testing and demonstration. These include decanter centrifuge, rotary drum filter, and belt press.

1.4. Always at Your Service:



- 24/7 Support
- 75+ Authorized Service Providers
- 4 - USA Service Centers -
- Indianapolis US Parts Distribution Center
- OEM Parts – 450,000+ Spare Parts in Stock
- 50+ Field Technicians
  Alfa Laval - Service and support in the USA

1.5. Spare Parts

A smart choice
Boost productivity and maximize uptime with quality genuine parts from Alfa Laval. With easy access to a broad range of long-lasting high-quality parts, you can lower your total cost of ownership and preserves the value of your equipment throughout its entire life cycle.

Available everywhere
Through our global service network, you have easy access to our extensive genuine spare parts inventory through 11 major Alfa Laval distribution centers.

Alfa Laval maintains an extensive inventory of spare parts that supports our current product range as well as some legacy parts, which are up to 100 years old. Our parts inventory system contains specific information, such as technical details and availability, for more than 450,000 parts, and we have more than 50,000 unique items in stock.

The Americas are conveniently served through the American Distribution Center (AMDC), which is centrally located in Greenwood, IN, USA.

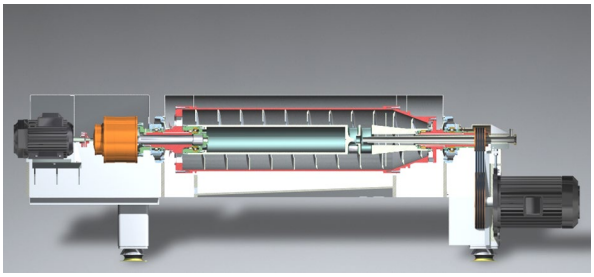
Alfa Laval AMDC
200 South Park Blvd
Greenwood, IN 46143

Unmatched quality
Designed for durability, reliability and productivity, our parts deliver outstanding performance time and time again. Manufactured to precise specifications, Alfa Laval parts have proven performance in our material and test laboratories as well as in process lines around the world.

Traceability and certification
Parts are continuously improved to meet the highest standards and comply with various certification requirements and regulations, such as REACH.
Alfa Laval - Spare parts

2. ALDEC CENTRIFUGE GENERAL DESCRIPTION

See how it work in less than 2 min Decanter Animation Dewatering



The ALDEC Decanter Centrifuge is an open, non-pressured horizontal decanter centrifuge. It features a solid horizontal bowl and scroll type conveyor, with counter current flow design. The centrifuge is designed and built to operate continuously at a maximum g-force. All parts of the centrifuge in contact with the process material are made of type Duplex stainless steel or AISI 316 stainless steel except O-rings, seals, feed tube and abrasion resistant materials. Process seals and other O-rings and seals are made of nitrile rubber, unless otherwise specified. The feed tube is fabricated from AISI 316 stainless steel. Alfa Laval - ALDEC

Frame and Casing Assembly

- The frame and casing are a box beam profile type with integral casing with or without hinges.
- The material of the casing and cover is AISI 316 stainless steel.
- The inside surface of the casing consists of stainless-steel liners in the discharge areas and a painted surface in the neutral compartment.
- Casing gaskets are of nitrile rubber. The material of the frame is painted mild steel.
- The cover is bolted in place

OPTIONAL: Hinged Cover

- Spring loaded hinges for ease of opening during maintenance or inspection (spring loading prevents cover from closing on its own).
- These can be located on the left or right side.
- The hinged cover provides the operator easy access **without the requirement of overhead crane and additional manpower** for routine inspections and maintenance.

Bowl Assembly

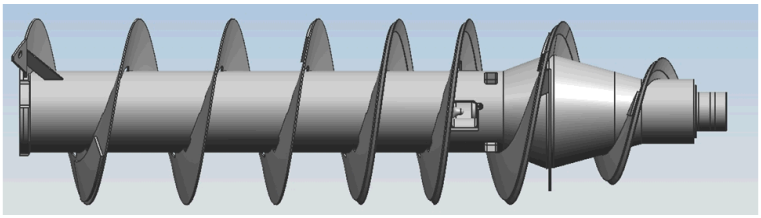
- Material: centrifugally cast duplex stainless steel, AISI 304 or AISI 316.
- End-hubs: centrifugally cast duplex stainless steel.
- All surfaces are examined for cracks, shrinkage, porosity, or other defects.
- The pool depth adjustable using plate dams at the large diameter end of the bowl.

Conveyor Assembly

- Material: AISI 316 stainless steel.
- Feed zone of a high-capacity design.
- Flights:
  - Windowed quasi-axial.
  - Material
    - Tiles-length: duplex stainless steel.
    - Remaining section: AISI 316.

Slim Line Conveyor – with G3 versions only

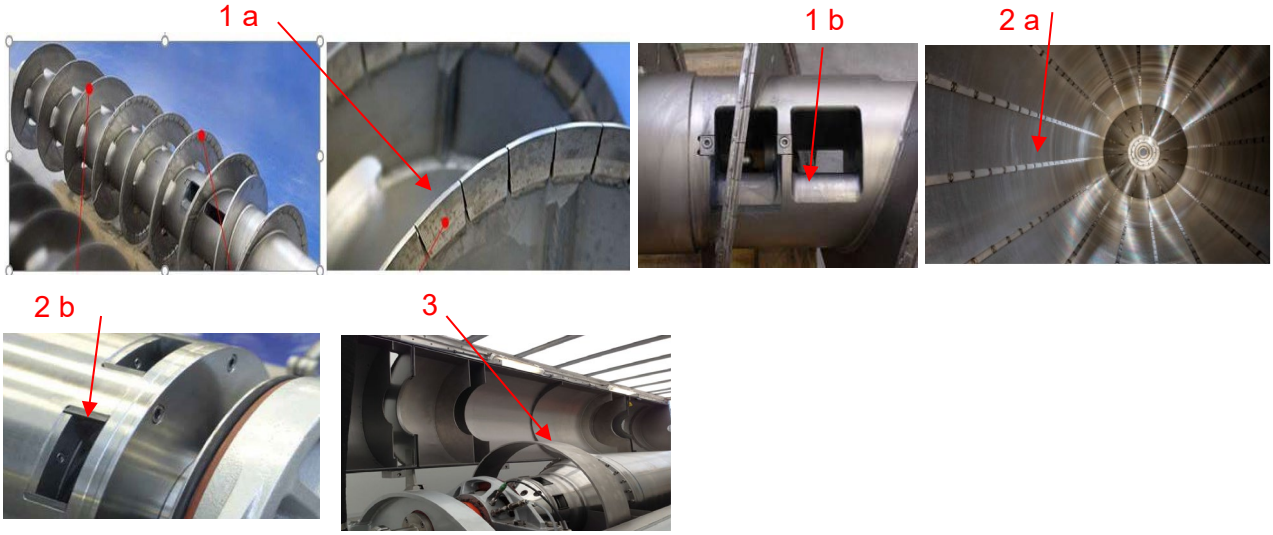
- The slim line conveyor helps to increase the capacity of the decanter and, at the same time, helps in substantial reduction in power consumption by allowing to rise the pond without the toll of increasing the bowl diameter.



This in turn increases the G-Volume thus increasing the process capacity of the machine. The smaller discharge radius saves a substantial amount of power.

Wear Protection

1. Conveyor
    a. Flights: With a series of welded-on sintered tungsten carbide (TC) tile assemblies and from two wraps beyond the feed zone through the solids discharge end, and with flame sprayed tungsten carbide (TC) for the remaining section.
    b. Feed zone wear liner
2. Bowl:
    a. Stainless steel strips to secure against abrasion.
    b. Solids discharge ports: field replaceable (TC) wear saddles, with 360º solids discharge to avoid blocking.
3. Replaceable stainless steel or urethane insert is available on certain decanters to protect the solids discharge casing.



Gearbox

- The gearbox is an Alfa Laval proprietary multi-stage “planetary“ gear or “direct” drive reducer unit.
- Controls the maximum differential speed between the centrifuge bowl and conveyor.
- Torque capacities
    - Planetary Gearbox (SPGB):
        - 16.0 kNm with a gear ratio of 1:90.3

Bearings

- Alfa Laval decanters have standardized grease lubricated bearings.
- These highly reliable bearings provide easier maintenance, greater reliability and lower power consumption.

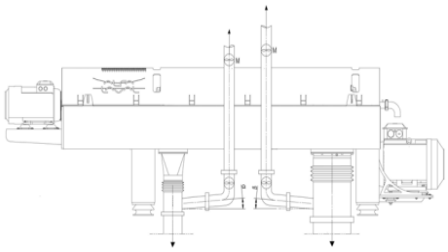
Lubrication

- Alfa Laval decanters have standardized grease lubricated bearings. For over a decade these highly reliable bearings provide easier maintenance, greater reliability and lower power consumption
- Also, there is an option for an automatic grease lubrication system to grease the main bearings. Auto-grease mechanisms along with our state-of-art Connect System create a reliable trouble-free sense of security.

Centrifuge Electrical Equipment

- Vibration Sensors
- Bearing Temperature
- Speed Sensors
- Main and Back motors' thermistors/thermostats/RDT

Other Requirements



Venting

- Venting of outlets reduces the pressure impact created by air suction from the bowl rotation. Alleviating this small pressure inside the casing reduces the possibility of bearing contamination, as well as excess bowl wear.

Other Features

Bowl configuration

- Baffle disc provides higher processing capacity and drier cake solids.

Cone configuration

- Steep or shallow cone configuration for optimum separation of any type of slurry.

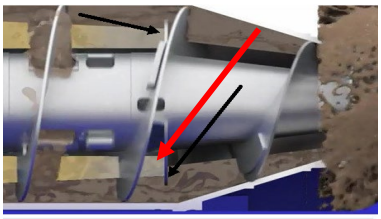


Figure 1. Steep cone configuration

Figure 2. Shallow cone configuration

Safety Features

- Cover Switch: Cover switch protection, to prevent the operation or shut down of the system if the cover switch is activated.
- E-Stop: Emergency Stop button to shut the system down.

3. Ancillaries

3.1. Feed Flexible Connector
150# ANSI flange with suction discharge hose and 24” long.

3.2. Polymer Flexible Connector
PTFE Lined SS braided, 24” long with crimped fittings.

3.3. Solids Discharge Flexible Connector
8" Tall rubber boot, flanged top & bottom, including 2 sets of Backer bar frames, and 304SS fasteners.

3.4. Solids Discharge Chute
Flange gasket, 4" sample port with plug, and 304SS fastener. Flanged chute top & bottom.

3.5. Centrate Flexible Discharge Connector
8" Tall Rubber Boot, Flanged Top & Bottom, 2 Sets of Backer Bar Frames, Lot of A2/304SS Fasteners

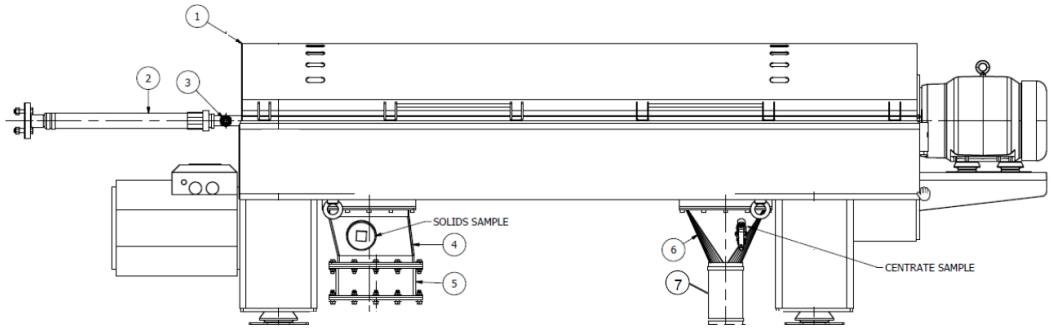
3.6. Centrate Discharge Funnel
Flange gasket, top flange to match centrifuge outlet, transition to 16" OD for hose connection. 1" Valved sample port, 16" 125# plate flange with a 12” long discharge hose and 304SS fastener.

3.7. Diverter Gate (Optional)
The diverter/slide gate is of the knife/gate type with an electric actuator, limit switches and position feedback relays specifically designed for diverting liquid flow, as specified and/or wastewater sludge. 110V Linear actuator, 4" inspection port, 24VDC position sensors, 16" pipe coupling, 1/2" flush nozzle, 316SS nameplate and caution labels. Diverter piping: 16" Sch40 welded piping, 16" 125# plate flange.

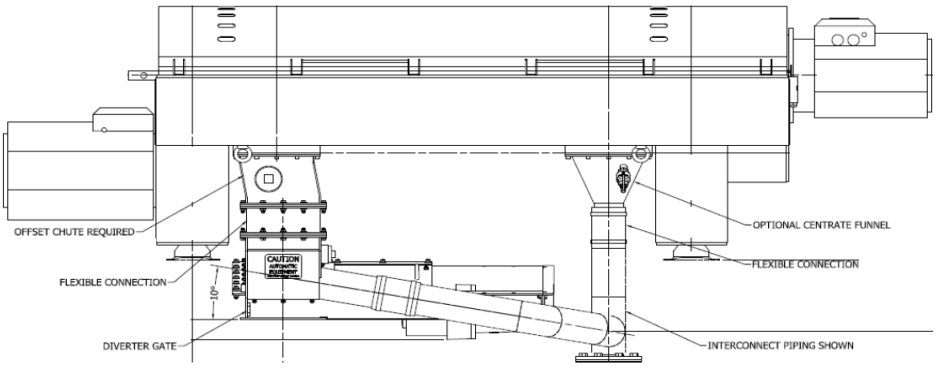
3.8. 4" 120V Motorized Ball Valve, Threaded, 316SS, NEMA 4 (High Speed)

3.9. 3" 120V Motorized Ball Valve, Threaded, 316SS, NEMA 4 (Low Speed)

3.10. 1/2" 120V Motorized Ball Valve, Threaded, 316SS, NEMA 4 (diverter gate or solids conveyor/chute)



1 - ALDEC Centrifuge
2 - Feed flexible connector
3 - Connection to the polymer flexible connector
4 - Solids discharge chute with sample port
5 - Solids discharge flexible connector
6 - Funnel centrate chute with sample port
7 - Centrate flexible connector



3.11. ALSYS – Centrifuge Skid System (Optional)

The ALSYS module is a compact, reliable and efficient solution for reducing the liquid content of sludge. It is specially configured for dewatering many of the sludge types normally encountered in industry and in smaller-scale municipal and potable water treatment plants.

It is a self-contained system that includes all the equipment required for on-site dewatering. This includes a progressing cavity feed pump, flow meters, polymer dosing pump and all the necessary piping and valves, along with a screw conveyor for the dewatered sludge.

- Plug-and-play" design that ensures rapid, easy installation on site
- Compact layout reduces floor space requirements and ensures easy maintenance
- Automatic operation does away with the need for continuous attendance
- Factory-tested modular construction paves the way for rapid commissioning by Alfa Laval field service personnel.

The ALSYS module is based on the ALDEC / ALDEC G3 decanter centrifuge and is available with Alfa Laval Decanter Connect System (DCS) technology, designed to make both installation and operation more efficient, simple and cheap. The very efficient DCS ensures trouble-free operation, with excellent levels of safety built in.

4. ELECTRICAL ASSEMBLY AND CONTROLS

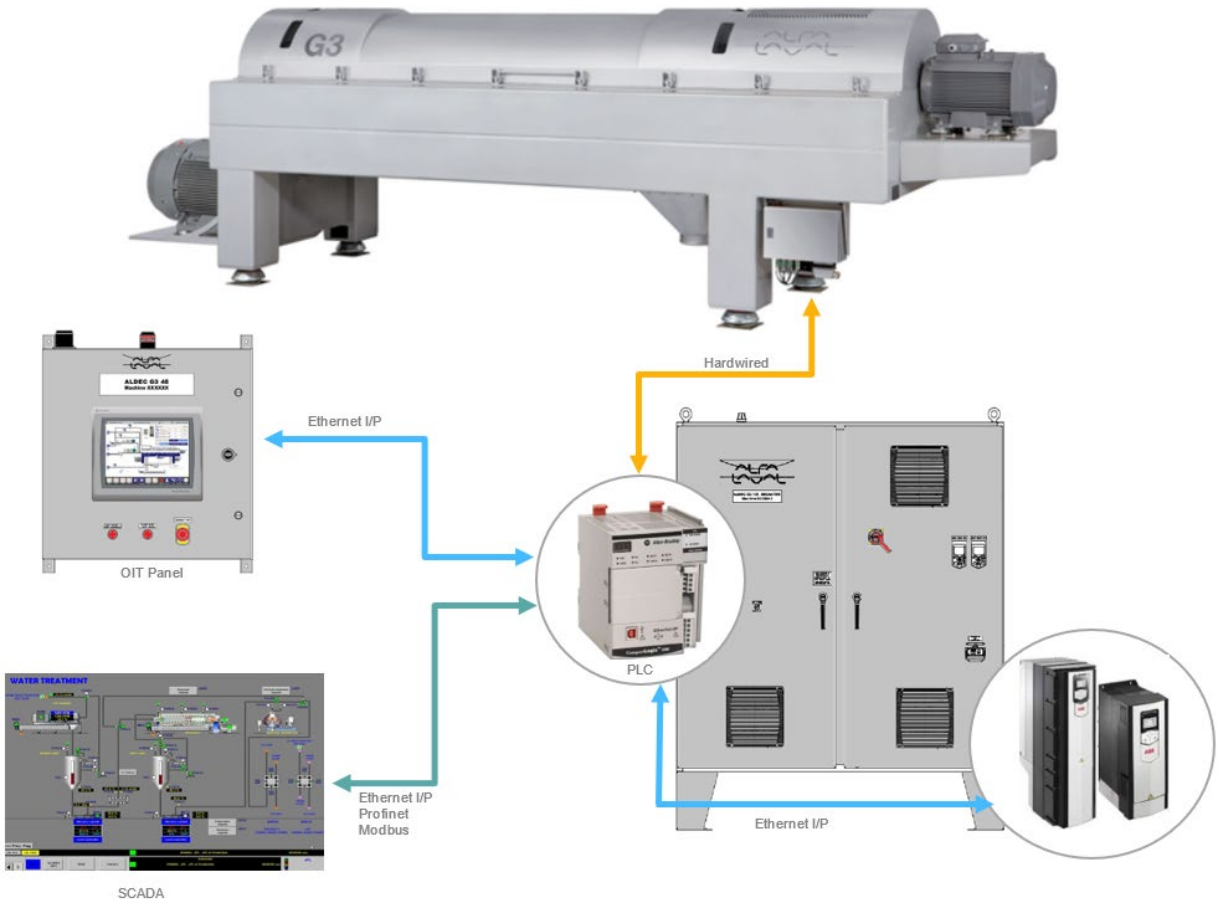
4.1. Electrical Assembly

- Main-drive motor: 300 HP
- Back-drive motor: 40 HP
- The selected main-drive motor and the back-drive motor are both VFD control, 460 Volt, 60 Hz, 3 phase power supply.

4.2. Controls

- Alfa Laval's standard design: **Alfa Laval's Decanter Connect Control Package**
  - Regulation of the conveying torque or differential speed between the conveyor and the bowl via the VFD-controlled back-drive motor
  - Control of associated equipment (e.g. sludge macerator, sludge feed pump, diverter-gate, cake-conveyor, flushing valve, etc., starter-panels of these to be provided by others).
- Centrifuge vibration sensor control and PT 100 for main bearings temperature control are incorporated for added safety of the machine.

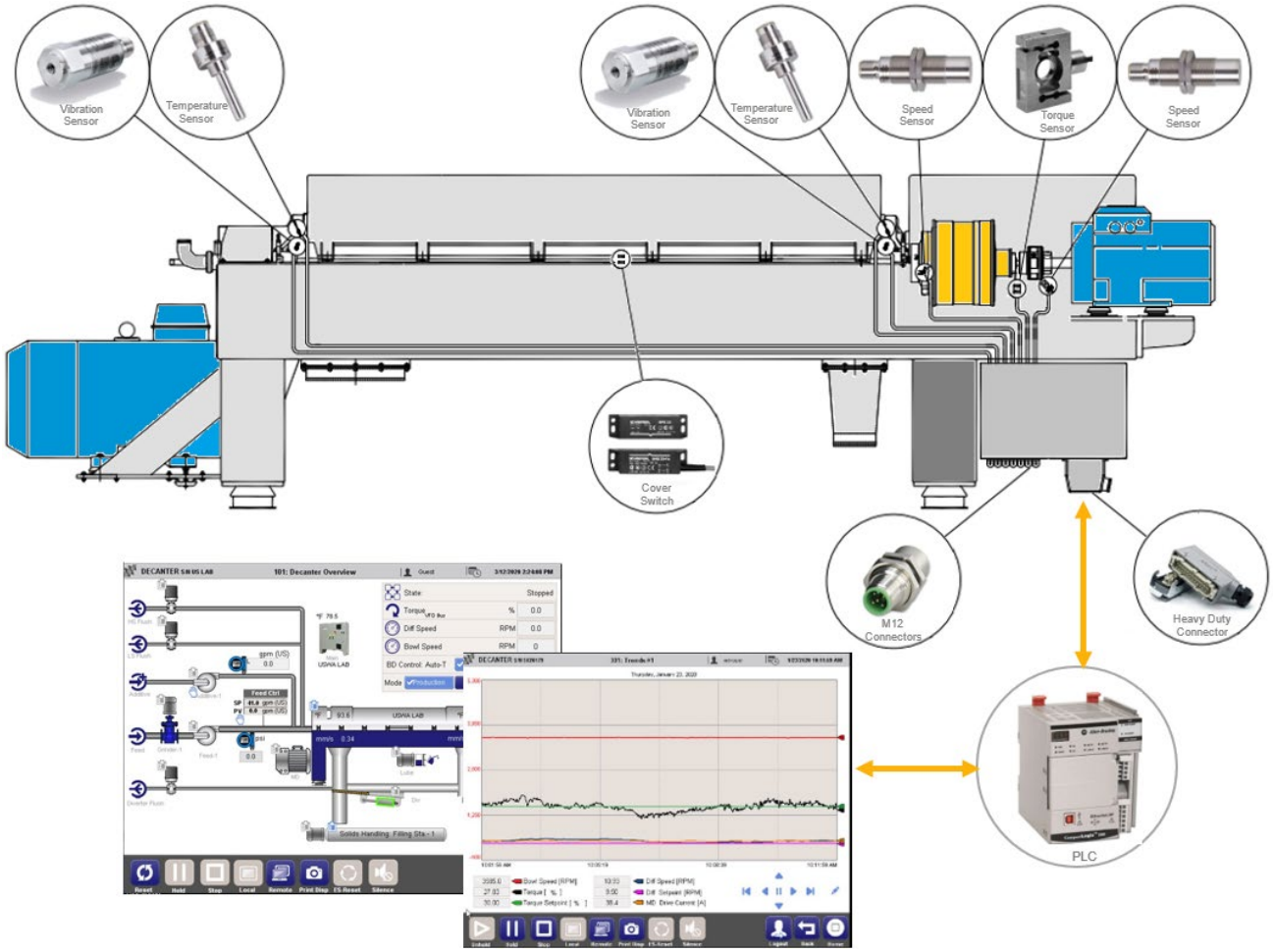
Alfa Laval Decanter-Connect Controls



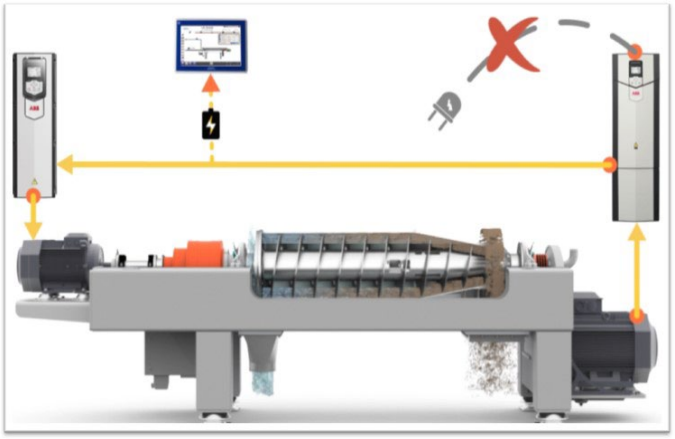
4.3. Alfa Laval Connect Control System

Key Features

a) Allen Bradley CompactLogix or ControlLogix PLC
b) Ability to use either ABB ACS 880 series or AB PF755 series VFDs
c) PanelView 7 Performance HMI – 10” (or optional 15”)
d) SCADA Communication to Allen Bradley, Delta V, ProfiNet, or Modbus TCP protocols
e) Fully assembled & wired to centrifuge instrumentation
f) Pre-wired and tested with all core centrifuge instrumentation: Speed sensors, backdrive torque sensor, main bearing vibration sensors, and main bearing PT-100 temperature sensors
g) Touch-screen 10” HMI-Display (or optional 15”)
   - Easy Navigation
   - Machine animated overview screen
   - Analog, Digital and Multi centrifuges data display
   - Alarms
   - Trend curves



h. **POWER LOSS-** The control of centrifuge during power loss or outage will allow the centrifuge to run through a short duration power blip, generally defined as 3-5 seconds. If the power outage extends past the 3-5 seconds the system will shut down the feed and polymer pumps and put the centrifuge into the production standby mode for a programmed set time. If power is restored during this time the feed pump and polymer pump will automatically restart and production will resume. Should the power not be restored, the control system will allow the centrifuge to be brought to a stop in a normal shutdown mode (as if it had power) maintaining the differential speed during the coast down period. This system will allow the centrifuge to scroll the solids out and be available for an immediate restart once power is restored. Click on the image to see how it works



i. Control Panel Optional Configurations
   - Different configurations for Local and Starter panels
   - NEMA 12 or NEMA 4X
   - VFD ABB Type ACS800 for Main Motor
   - VFD ABB Type ACS800 for Back-drive Motor
   - Power supply Source: 460 V / 60 Hz / 3 Ph
   - For locating within “safe” non-hazardous area,

5. ALFA LAVAL SERVICE

5.1. 360º Service Portfolio

Alfa Laval partners with you for the entire life cycle of your equipment – from start-up, through operation, monitoring and maintenance, all the way to reconditioning and eventual redesign. Our goal is to ensure that our equipment continuously gives you optimized process performance.

5.2. Alfa Laval Service Centers:

You can trust Alfa Laval service technicians to maintain your decanter centrifuges in peak performance and minimize the risk of unscheduled production stops. Our local service centers are equipped with the tools and expertise to improve the performance of your decanters. Join us on a virtual tour of our state-of-the-art facilities.

Learn more about Alfa Laval Decanter Service

Alfa Laval - Decanter centrifuge service

Alfa Laval - Chesapeake service center

Alfa Laval - Greenwood service center

Alfa Laval - Houston service center

Alfa Laval - Fresno service center

5.3. Commissioning

Services consist of:

- installation review,
- performance checks,
- process optimization,
- operator training.

The commissioning process ends with a handover or acceptance certificate and is often the first day of warranty.

The commissioning:

- Enables trouble-free start-up and process fine-tuning.
- Advice on optimizing process conditions.
- Checks on surrounding components, systems and controls and optimization recommendations.
- Help to reduce maintenance costs with a customized proposal to optimize maintenance.

5.4. Preventive Maintenance

- Highly experienced Alfa Laval specialists can formulate and implement an optimal maintenance plan for your equipment.
- Service intervals are determined by various factors, including type of application as well as the usage and condition of the equipment.
- The service can be performed on site or in one of the local Alfa Laval Service Centers located near you.

The preventive maintenance:

- Delivers peace of mind and operational reliability
- Secures maximum throughput
- Increases overall equipment lifetime and provides good cost control
- Maintains safe equipment operation

5.5. Repair

Alfa Laval specialists repair the equipment according to your needs, replacing unsafe or worn parts as required, and then reassemble the equipment.

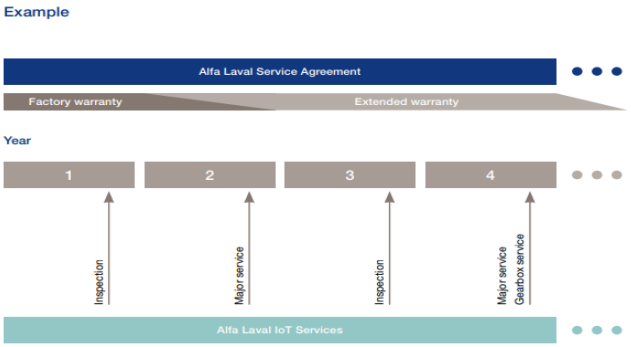
- Minimizes downtime
- Maximizes production performance
- Extends the lifetime of equipment
- Prevents equipment from consequential damage and accidents

5.6. Equipment Upgrades

- There is a wide range of upgrade solutions available to ensure your Alfa Laval equipment features the latest technical developments.
- As operating conditions change over time, new challenges can call for a review of the current installations.
- Equipment Upgrades can also include control upgrades that improve equipment automation.

6. ALFA LAVAL SUPPORT

6.1. Service Performance Agreements



With an Alfa Laval Service Agreement, you ensure outstanding performance from your Alfa Laval decanter and minimal total cost of ownership. Tailored to your priorities and requirements, a service agreement is the ideal maintenance solution from the original manufacturer of your equipment. Alfa Laval offers Service Performance Agreements which include premium customer discount levels on parts, preferential scheduling for field service and free unlimited access to Alfa Laval's Technical Helpdesk.

A quotation for a Service Agreement tailored to your requirements can be provided upon request. For more information on Service Performance Agreements, and our local service organization which includes 11 service centers, over 50 factory-trained field technicians, a centrally located parts distribution center, and our 24/7 365 Days Technical Helpdesk, visit our website link below
Alfa Laval - Performance Agreements

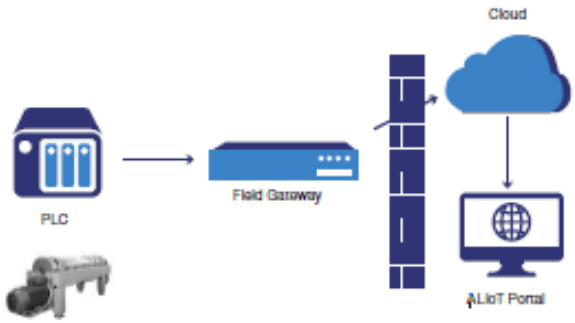
6.2. Connected Services

Imagine the possibilities if you could have an eagle eye's view of your equipment. At Alfa Laval, our top priority is ensuring that customers get outstanding and reliable performance from their equipment throughout its long lifetime. That's why we're investing heavily in R&D for IoT (internet of things) services to interconnect your production and control systems. You'll have vital information at your fingertips to truly get the most from your equipment – each and every day!

Alfa Laval IoT Services add new possibilities to your Alfa Laval wastewater decanter such as remote support and monitoring, condition monitoring, predictive maintenance and process optimization. The results are lower service costs, maximum operating reliability, higher process efficiency and more uptime. Learn more about Alfa Laval's IoT Services for decanters in wastewater plants in the sections below or contact us for a discussion on the best combination for your plant.
Alfa Laval - IoT Connected Services

6.2.1. Remote Monitoring & Support

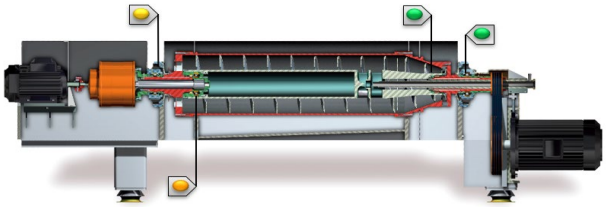
Remote Monitoring helps assure you that your decanter is running as expected. Access data like bowl speed and torque in the Alfa Laval IoT portal via your laptop, tablet or phone. Alarm notifications can be sent by e-mail or SMS/text message to let you know about anomalies.



Remote Support allows our experts insight to live and historic data to identify the problem more quickly and accurately when you call for support.

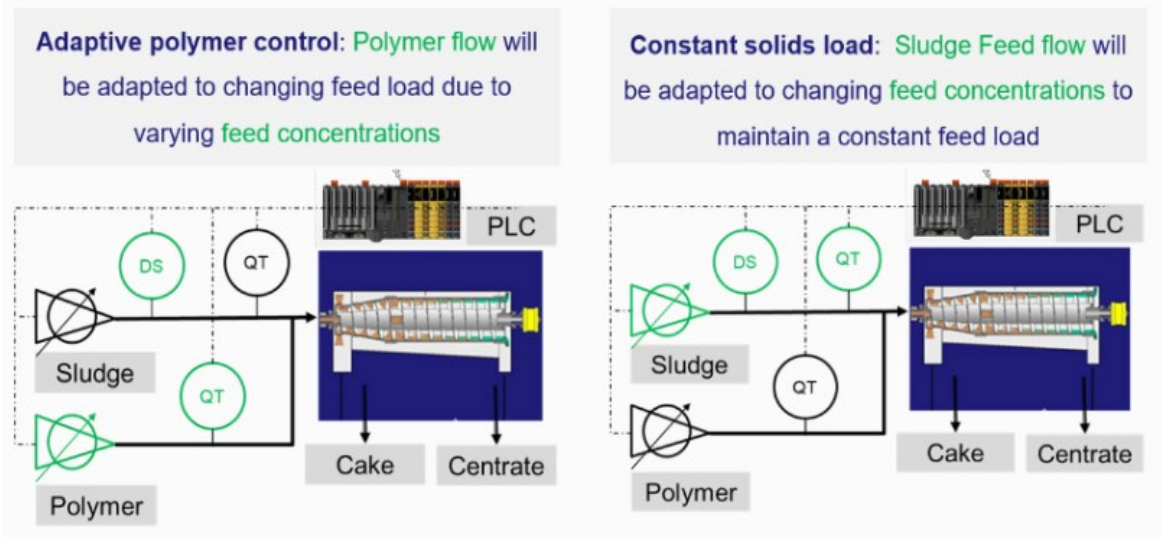
6.2.2. Predictive Maintenance

The Predictive Maintenance area of Connected Services develops services that help our customers improve reliability and avoid risk. The long-term objective is to develop a predictive maintenance solution that predicts failures before they ever happen. The first service in this area, is ConditionAlert™; based on vibration measurements and frequency analyses which can identify the source of abnormal vibration levels and suggest remedies. The customer is notified by Alfa Laval with a plan for service.



6.2.3. Process Optimization

The Process Optimization area of Connected Services develops services that help our customers optimize their decanter process, thereby reducing cost and increasing savings. Focused on the Wastewater Treatment industry, we offer Constant Solids Load & Adaptive Polymer Control, with the long-term objective of developing a self-optimizing decanter.



7. PROCESS DETAILS AND SIZING

7.1. General Data

Sludge Origin:	Municipal
Sludge Type:	Not provided
Duty:	Thickening

7.2. Sizing Data

Capacity per Machine

Hydraulic (gpm):	1200
Solids (lbs./hr.)	2340

Number of units

Operating:	1
Standby:	0

Feed Solids

Range (%):	0.39
Design (%):	0.39

Polymer Consumption:

Design Dosage (lbs./dT):	0
Expected Dosage (lbs./dT):	0

Centrifuge Performance

Cake Solids (%):	Can be determined once a representative sample has been tested
Expected Recovery (%)	95

Bowl Diameter (in)	40

Maximum Bowl Speed (rpm)	2,200

Installed Power (HP)	340

8. SCOPE OF SUPPLY

One (1) ALDEC G3-165 Centrifuge will come complete and include the following scope of supply:

- Modular frame with process contact areas in 316 SS
- Vibration isolators
- Singular cover in 316 SS (covers belts, rotating assembly and gearbox)
- Abrasion protection (Tungsten Carbide on wear surfaces)
- Fully covered feed zone
- Rotating assembly complete with 16.0 kNm planetary gearbox and pillow block bearings
- All bearings grease lubricated
- Vibration and temperature sensors in main bearing housings
- Main drive Motor: 300 Hp AC VFD
- Back drive Motor: 40 Hp AC VFD
- Starter Panel: NEMA 12 Free-Standing
- Local Control Panel: NEMA 4 X (304 SS) Wall mounted
- PLC: Allen Bradley CompactLogix
- HMI: Allen Bradley – 10 inch
- Main Drive VFD: ABB ACS880
- Back drive VFD: ABB ACS880
- Control of centrifuge during power loss or outage
- Flexible connectors
- Solids discharge chute
- Centrate discharge chute
- Factory Paint System
- One (1) set required lubricants
- One (1) set of required spares

Also included with pricing:

- Required Tools including bowl lifter and conveyor lifter
- Electronic Submittal and O&M Manual

8.1. **DIMENSIONED DRAWING** ALDEC G3-165 Dimension Drawing No. 61244725 (See Appendix A)

8.2. **NOTES OF CLARIFICATION**

Scope of supply is per Alfa Laval standard centrifuge configuration, and in accordance with typical specifications and drawings. Any additional items not explicitly stated in this proposal or standard to Alfa Laval's typical specifications are not included in this quotation. The specified equipment is intended for installation within a **non-hazardous** safe area.

Equipment to be supplied by Alfa Laval (and /or sub-supplier), as specified in this quotation, are standard machines. Any modifications / additions other than those expressly specified in the quotation shall incur extra engineering cost, material cost and delivery time.

Technical submittal documentation shall be per Alfa Laval's (and /or sub-supplier) standards, delivered electronically, in English language. Additional documentation requirements shall incur extra engineering cost, material cost and delivery time.

The enclosed quotation is a non-binding budgetary quotation. Therefore, price, scope and other terms contained within this budgetary quotation are subject to considerable variations when preparing our binding quotation. **All scope of supply modifications / additions requires prior agreement by both parties and written acknowledgement by Alfa Laval.**

Escalation Charges:

- In the event that delivery of equipment cannot be made on the scheduled delivery date agreed upon between Alfa Laval and Purchaser and as evidenced by the terms of the contract, due to Purchaser delay, Alfa Laval reserves the right to assess reasonable escalation charges to the project at the rate of 1% per month of the contract value for material price escalation for each month that the project is delayed.

- Given the current volatility in steel prices over the past twelve months, Alfa Laval has made this offer based upon shipment of the offered products contained herein within the schedule dictated above. Should the projected shipment schedule fall outside this period for any reason, pricing shall be subject to review and revision.

8.3. Exclusions from this quotation:

- All mechanical & electrical Installation, including but not limited to:
- Equipment offloading and placement
- Field wiring, conduit and electrical flexible connections...etc.; contractor shall remain responsible for meeting all relevant electrical codes
- Pipes, valves, and fittings...etc.
- Anchor bolts are supplied by others.
- Associated equipment, i.e., sludge macerators, feed pumps, polymer preparation & dosing unit, cake conveyors, centrate tanks and pumps…etc.
- Measuring instruments between centrifuges and associated equipment
- Noise abatement enclosures
- Odor control equipment
- Inspection and access platforms or ladders
- Utilities and consumables (polymer, power, water and other consumables required during testing, start-up and commissioning
- Detailed or project specific related engineering
- Duties, taxes, bonds…etc.
- Freight to job site. We are offering this FCA (Krakow, Poland) Incoterms 2020

8.4. Service time is included in the quoted price based on the following: (1) x Field Service Engineer, - up to ten (10) days, @ 10 hr./day, with up to two (2) round trips, per unit for start-up, commissioning, and training. Any additional service time resulting from non- Alfa Laval -warranty delays, will be charged at the rate in effect at the time of service.

8.5. Warranty: Per the enclosed Alfa Laval's Standard Terms & Condition of Sale. Alfa Laval reserves the right to review operating and maintenance records to ensure compliance.

8.6. Process performance achieved by the centrifuge (cake solids, loading, hydraulic throughput, etc.) is verified through onsite analysis of representative sampling during equipment commissioning.

9. COMMERCIAL TERMS

9.1. Pricing

Item	Description	Qty.	Unit Price	Extended Price
1	ALDEC G3-165	1	Included	Included
2	Set of Controls	1	Included	Included
3	Set of Ancillaries	1	Included	Included
4	Commissioning	1	Included	Included
Total Budget Price				**$997,000.00**

9.2. Payment Terms

10% with PO, N10 days
10% upon Alfa Laval Submittal Delivery, N30 days
75% upon delivery or availability to deliver should owner encounter delays, N30 days
5% upon acceptance or beneficial use, whichever comes first, N30 days, but not later than 180 days from shipment.

9.3. Estimated Manufacturing Time

Submittals: 8 -12 weeks from fully executed PO
Centrifuge: 34 – 38 weeks from release to manufacturing till centrifuge is manufactured and ready for shipment.

9.4. TERMS AND CONDITIONS OF SALES

These Terms and Conditions of Sale (“Terms and Conditions”) apply to all quotations, orders, and contracts for Alfa Laval Inc. products (hereafter "Equipment") and associated services (“Services”) as used in these Terms and Conditions, the word "Equipment" includes all hardware, parts, components, software, and options.

1. **ACCEPTANCE**: Our sale to you is limited to and expressly made conditional on your assent to these Terms and Conditions and, if applicable, on the attendant quotation, both of which form a part of the contract between us and which supersede and reject all prior agreements, representations, discussions, or negotiations, whether written or oral, with respect to this sale and any conflicting terms and conditions of yours, whether signed by you. Any terms and conditions contained in your purchase order or request for quotation or other form which are different from, in addition to, or vary from these Terms and Conditions are expressly rejected, shall not be binding upon us, and are void and of no force or effect. These Terms and Conditions may not be changed except by the written agreement of both parties.

2. **PRICES**: Unless otherwise specified in writing, all quoted prices are in U.S. Dollars and are firm for thirty (30) days from the date of offer. Prices quoted are exclusive of taxes, freight and insurance, and you agree to pay any and all sales, revenue, excise or other taxes (exclusive of taxes based on our net income) applicable to the purchase of Equipment. If you claim an exemption from any such taxes, you shall provide us with a tax exemption certificate acceptable to the taxing authorities.

3. **DELIVERY; FORCE MAJEURE**: Dates for the furnishing of Services and/or delivery or shipment of Equipment are approximate only and are subject to change. Quoted lead times are figured from the date of receipt of complete technical data and approved drawings as such may be necessary. We shall not be liable, directly, or indirectly, for any delay in delivery or failure to deliver caused by carriers or by labor difficulties, shortages, strikes or stoppages of any sort, or difficulties in obtaining materials from ordinary sources and suppliers. In addition, we shall not be liable for any such delays or for any failure to perform our obligations under an order or contract due to any one or more of the following events, whether foreseeable or not: war, hostilities, military operations, terrorism, riots, disorder, accidents, floods, storms, natural disasters, fires, acts of God, epidemics and/or pandemics (and specifically in relation hereto and notwithstanding anything else stated herein, whether or not outbreak of such epidemic or pandemic has occurred prior to acceptance of this order or execution of a contract for the Services), governmental, judicial or administrative decisions, decrees or orders, embargoes or blockades, or any causes beyond our reasonable control. Unless otherwise specifically agreed in writing by us, in no event shall we be liable for any damages or penalties whatsoever, or however designated, resulting from our failure to perform or delay in performing due to any of the causes specified in this paragraph 3.

4. **SHIPMENT, RISK OF LOSS, TITLE**: All sales are made F.O.B. Alfa Laval shipping point, unless otherwise noted. Duty, brokerage fees, insurance, packing and handling as applicable are not included unless otherwise noted. Our liability for delivery ceases upon making delivery of Equipment to the carrier at the shipping point in good condition. The carrier shall be your agent. Risk of loss shall pass to you upon such delivery. Regardless of the delivery term specified, we shall retain title to the Equipment until final payment thereof has been made.

5. **CREDIT AND PAYMENT**: Payment terms are (30) days net, unless agreed otherwise by us in writing. *Pro rata* payments shall become due with partial shipments. Any discount period which may be granted by us begins on the invoice date and all payments are due 30 days after the invoice date. All payments shall be made without deduction, deferment, set-off, lien or counterclaim of any nature.

All amounts due not paid within 30 days after the date such amounts are due and payable shall bear interest at the lesser of 1.5 percent per month or the maximum rate of interest allowed by law. We reserve the right at any time to suspend credit or to change credit terms provided herein, when, in our sole opinion, your financial condition so warrants. Failure to pay invoices when such invoices are due and payable, at our election, shall make all subsequent invoices immediately due and payable irrespective of terms, and we may withhold all subsequent deliveries until the full account is settled. We shall not, in such event, be liable for delay of performance or nonperformance of contract in whole or in part subsequent to such event.

6. **SECURITY AGREEMENT:** You hereby grant us a security interest in the Equipment, including a purchase money security interest, and in such materials, proceeds and accessories thereof, to secure payment of the purchase price of the Equipment. You authorize us to file or record a purchase order or copy thereof or any UCC financing statement
showing our interest in the Equipment in all jurisdictions where we may determine filing to be appropriate, and you agree to sign all such documents reasonably related thereto promptly following our request. You will not encumber the Equipment with any mortgage, lien, pledge or other attachment prior to payment in full of the price therefor.

7. **CANCELLATIONS AND CHANGES**: Orders which have been accepted by us are not subject to cancellation or changes in specification except upon prior written agreement by us and upon terms that will indemnify us against all losses resulting from or arising out of such cancellation or change in specifications. In the absence of such indemnification, we shall be entitled to recover all damages and costs of whatever nature permitted by the Uniform Commercial Code.

8. **DEFERRED SHIPMENT**: If shipment is deferred at your request, payment of the contract price shall become due when you are notified that the Equipment is ready for shipment. If you fail to make payment or furnish shipping instructions, we may either extend the time for so doing or cancel the contract. In case of deferred shipment at your request, storage and other reasonable expenses attributable to such delay shall be payable by you.

9. **EQUIPMENT WARRANTY AND REMEDY**:
(a) For new Equipment only, we warrant to you that the Equipment that is the subject of this sale is free from defects in design (provided that we have design responsibility), material and workmanship. The duration of this warranty is twelve (12) months from start-up or eighteen (18) months from delivery to you, whichever occurs first (the "Warranty Period"). If you discover within the Warranty Period a defect in design, material, or workmanship, you must promptly notify us in writing. Within a reasonable time after such notification, we shall repair, replace, or, at our option, refund you the price of the defective Equipment or part thereof.
(b) For repairs, parts and Services provided by us, we warrant to you that the repairs, parts and Services we provide to you will be free from defects in material and workmanship. The duration of this warranty is ninety (90) days from as applicable (i) the date the Equipment which required the repairs, parts or Services is returned to you by us, (ii) the date of your receipt of the part, or (iii) the date of completion of the repair or other Services, if performed at your facility. If during this ninety-day period you discover a defect in the repairs, parts or Services you must promptly notify us in writing, and we shall correct such defect with either new or used replacement parts or reperform the Services as applicable. If we are unable to correct the defect after a reasonable number of attempts, we will provide a refund of the price paid for the defective repair, parts or Services.
(c) All warranty service is subject to our prior examination and approval and will be performed by us at your facility or at service centers designated by us. All transportation to and from the designated service center will be at our expense. The remedies set forth above are your exclusive remedies for breach of

warranty. Unless otherwise agreed in writing by us, our warranty extends only to you and is not assignable to or assumable by any subsequent purchaser, in whole or in part, and any such attempted transfer shall render all warranties provided hereunder null and void and of no further force or effect.
(d) The warranties set forth above are inapplicable to and exclude any product, components or parts not manufactured by us or covered by the warranty of another manufacturer. We shall have no responsibility for defects, loss or damage to the extent caused by (i) normal wear and tear, (ii) your failure to follow all installation and operation instructions or manuals or to provide normal maintenance, (iii) repairs or modifications by you or by others not under our direct supervision, or (iv) a product or component part which we did not design, manufacture, supply, or repair.
(e) **DISCLAIMER OF IMPLIED WARRANTIES**. THE WARRANTIES SET FORTH ABOVE AND IN SECTION 12 BELOW ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

10. **LIMITATION OF LIABILITY**: In no event shall we be liable, and you hereby waive any claims against us and release us from liability to you, for any indirect, special, punitive, incidental, or consequential damages whatsoever based upon breach of warranty, breach of contract, negligence, strict tort, or any other legal theory. In no circumstance, shall we be liable for, however such damages are characterized, loss of profits, loss of savings or revenue, loss of use of the Equipment or any associated equipment, cost of capital, cost of any substitute Equipment, facilities or services, downtime, or loss of prospective economic advantage. **OUR AGGREGATE LIABILITY FOR FAILURE TO PERFORM, BREACH OF WARRANTY OR BREACH OF OTHER CONTRACTUAL OBLIGATIONS SHALL NOT EXCEED THE TOTAL PRICE PAID TO US FOR THE EQUIPMENT AND SERVICES THAT ARE THE SUBJECT OF ANY CLAIM BY YOU.**

11. **OWNERSHIP:** All drawings, designs, specifications, data and other proprietary rights supplied by us (including without limitation in connection with the Equipment) have been prepared or assembled by us and are (and shall remain) exclusively our property, and upon our request you agree to execute any additional documents needed to give effect to the foregoing. Such drawings, designs and specifications have been furnished in order to provide full documentation and on the condition that they shall not be disclosed, reproduced or copied in any manner whatsoever, in whole or in part, except for your internal use as necessary, and upon the further condition that, as our sole property, they shall not be used for furnishing information and/or disclosed, in whole or in part, to others or otherwise for any purpose not specifically authorized in a writing signed by one of our corporate officers.

12. **PATENT INFRINGEMENT**
(a) We make no express or implied warranties of non-infringement with respect to the Equipment. We will, however, defend, indemnify and hold you harmless from any third party apparatus claims based upon an issued U.S. patent to the extent such claim relates to the Equipment supplied and sold to you; provided, however, that we undertake no indemnification in respect of third-party rights (i) where the alleged patent infringement is based upon or related to any method, process or design claims in third-party U.S. patents, any combination of the Equipment with other equipment not supplied by us, or any modifications of the Equipment made by you and not approved by us, or (ii) to the extent the alleged infringement is directly attributable to the negligence or intentional misconduct of you or otherwise for which you are obligated to indemnify us for under paragraph 12(c).

(b) We shall assume defense of a claim at our expense in accordance with these Terms and Conditions, provided you shall notify us within 30 days of your receipt of notice of an alleged third-party claim that you believe would entitle you to patent infringement indemnification pursuant to paragraph 12(a). You acknowledge and agree that we shall have the sole right to settle or otherwise compromise such a third-

party claim, including but not limited to the right to either (i) modify the Equipment to avoid infringement if you are agreeable to the modification, (ii) repurchase the Equipment from you at a price equal to the then-current fair market value of the Equipment, or (iii) secure rights by assignment or license to permit continued use of the Equipment.

(c) If a third-party charges us with patent infringement relating to Equipment sold by us to you, we shall have the right to either (i) modify the Equipment to avoid infringement if you are agreeable to the modification, (ii) repurchase the Equipment from you at a price equal to the then-current fair market value of the Equipment, or (iii) secure rights by assignment or license to permit continued use of the Equipment. If a third party charges us with patent infringement on the bases set forth in paragraph 12(a)(i) or (ii), you shall indemnify and hold us harmless for all expenses as well as any awards of damage assessed against us, and, without limiting any of our other rights and remedies available at law or in equity, we shall also have the right to modify or repurchase the Equipment or to secure rights for continued use by way of assignment or license as set forth in this paragraph.

13. **INSPECTION**: Upon prior written notice, you may make reasonable inspections of Equipment at our facility. We reserve the right to determine the reasonableness of the request and to select an appropriate time and location for such inspection. You agree to execute appropriate confidentiality provisions upon our request prior to visiting our facility. All costs of inspection shall be solely determined by us and shall be payable by you. No inspection or expediting by you at the facilities of our suppliers is authorized.

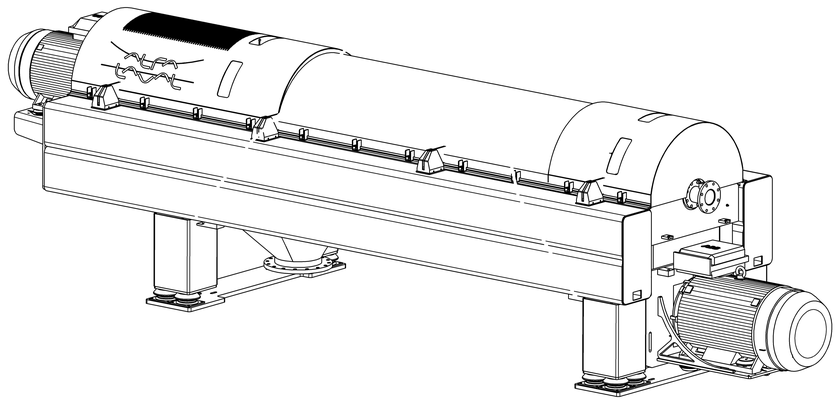
14. **SOFTWARE PROVISIONS**: If software is provided hereunder (whether such is integrated into the Equipment or otherwise operates alongside the same), you are hereby granted a non-exclusive, non-sublicensable, non-transferable, royalty free license to access and use such software as provided and as intended with our Equipment. Without limiting the foregoing, under the foregoing license you may specifically: (i) use our software in machine readable object code only and only with the Equipment provided; (ii) copy our software into any machine-readable object code form solely for back up purposes in support of your use of our software on the Equipment provided in accordance with these Terms and Conditions; and (iii) create one additional copy of the software for archival purposes only. This license may only be assigned, sublicensed, or otherwise transferred by you with our prior written consent. You hereby recognize and acknowledge that the software provided to you hereunder comprises valuable trade secret and/or copyright property of Alfa Laval (or its licensors) and you covenant that you will take adequate precautions against access to the software by, or disclosure of the software to, anyone not authorized hereunder to use or have access to the software as contemplated herein. The software is subject to the confidentiality obligations set forth below in paragraph 15.

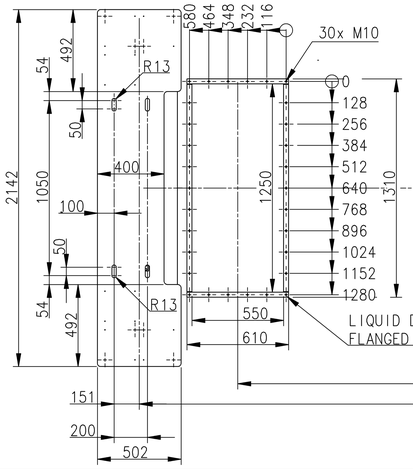
15. **CONFIDENTIALITY:** Subject to any non-disclosure or confidentiality agreement already in effect between us, any drawings, data, software or other information exchanged between us is proprietary or confidential to us and shall not be used or disclosed by you without our prior written consent. Confidential information shall not be any information that (i) is known previously to you under no obligation of secrecy; (ii) becomes known to the public through no breach of an obligation of secrecy by you; or (iii) is independently developed by you without use or reference to any of the confidential information or materials provided to you by us.

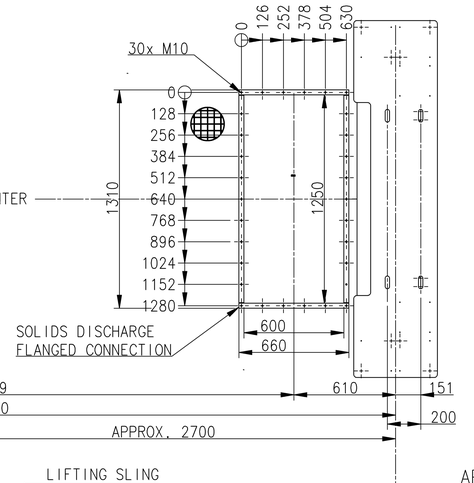
16. **INAPPLICABILITY OF CISG:** The parties specifically agree that the United Nations Convention on Contracts for the International Sale of Goods shall not apply to any sale or order or the contract between us.

17. **GOVERNING LAW & VENUE**: These Terms and Conditions and any dispute or claim arising out of or related to an order or the contract between us shall be finally decided in accordance with the laws of the Commonwealth of Virginia, without giving effect to the provisions thereof relating to conflict of laws. You agree that the venue for any such dispute shall lie in the United States District Court for the Eastern District of Virginia, Richmond Division. In the event that federal jurisdiction cannot be established pursuant to 28 U.S.C. §§ 1331 or 1332, the venue for any such dispute shall lie in the Circuit Court of Henrico County, Virginia. You expressly submit and waive any objection to the sole and exclusive jurisdiction of such courts.

18. **GENERAL:** All previous agreements or understandings between us, either oral or written, with regard to the subject order, with the exception of a pre-existing non-disclosure agreement between us, are void and these Terms and Conditions constitute the entire agreement between us with respect to the matters addressed herein. Neither of us shall assign an order or contract to which these Terms and Conditions apply without the prior written consent of the other party, which consent shall not be unreasonably withheld. If any provision of these Terms and Conditions is held to be invalid or unenforceable, such holding shall not affect the validity or enforceability of any other provision herein. No waiver by either of us of any default or breach by the other party will operate as or be deemed a waiver of any subsequent default or breach.

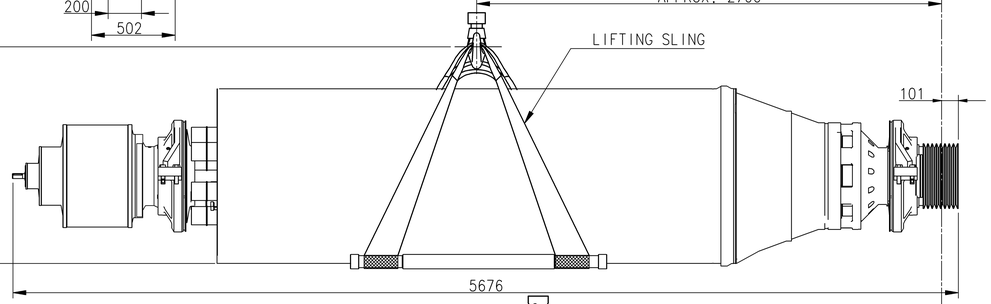


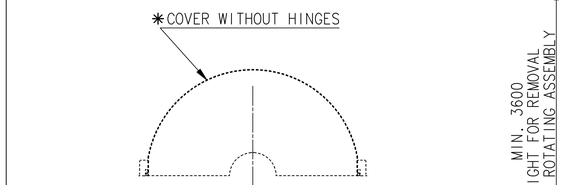


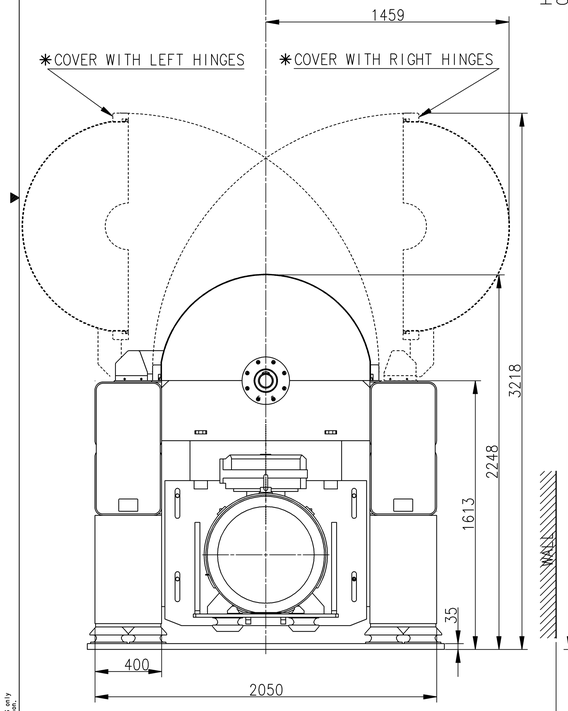


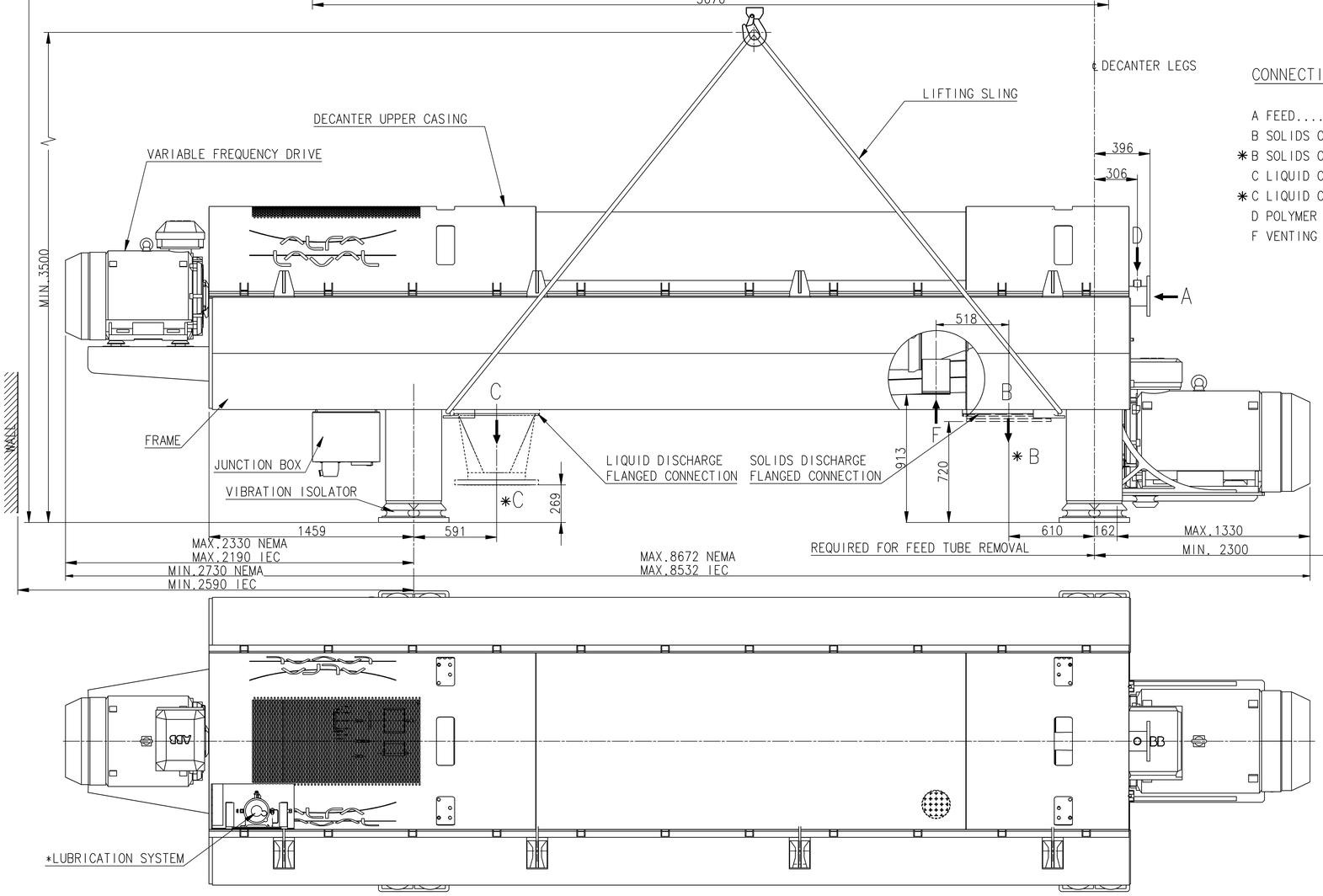
℄ DECANTER

3649
4850
APPROX. 2700









LOADING DATA:

DECANTER

1. MAX.STATIC LOAD
   - A-VERTICAL.....220000 N
   - B-HORIZONTAL.....0 N
2. MAX. DYNAMIC LOAD AT RUN DOWN (ADD TO STATIC LOAD)
   - A-VERTICAL.....± 120000 N
   - B-HORIZONTAL.....± 40000 N
3. MAX. DYNAMIC LOAD AT OPERATING SPEED
   - A-VERTICAL.....± 6000 N
   - B-HORIZONTAL.....± 6000 N

   ALL LOADS ARE EVENLY DISTRIBUTED ON THE DECANTER LEGS

APPROXIMATE WEIGHTS:

TOTAL WEIGHT OF EMPTY DECANTER	19000kg/42000lbs
ROTATING ASSEMBLY INCL. PILLOW BLOCKS	6500kg/14330lbs
CPL. FRAME ASSEMBLY EXCL. MAIN MOTOR AND ROT. ASSEMBLY	7500kg/16535lbs
MAIN MOTOR	2500kg/ 5512lbs
UPPER CASING	700kg/ 1543lbs
GEAR BOX	760kg/ 1675lbs
MIN. CRANE CAPACITY FOR LIFTING OF ROTATING ASSEMBLY	10000kg/22040lbs

CONNECTIONS:

	DIMENSION/TYPE
A FEED	FLANGE DIN150 PN10
B SOLIDS OUTLET	RECTANGULER FLANGE
✱B SOLIDS OUTLET FUNNEL	1250x600
C LIQUID OUTLET	RECTANGULER FLANGE
✱C LIQUID OUTLET FUNNEL	FLANGE DN400 PN10
D POLYMER ADDITION	ISO 228-G 1 1/2"B CONNECTION
F VENTING	8" HOSE CONNECTION

NOTES:

1. ALL CONNECTIONS MUST BE FLEXIBLE.
2. FOR PROPER VENTING OF DISCHARGE HOPPERS REFER TO THE INSTALLATION DRAWING. IMPROPER VENTING CAN LEAD TO LEAKAGE PROBLEMS.
3. CUSTOMER IS RESPONSIBLE FOR ANCHORING
4. FOR FURTHER INFORMATION, SEE INSTALLATION DATA MANUAL AND INSTALLATION DRAWING

✱OPTIONAL EQUIPMENT

COMPLEMENTARY DRAWING 61244726

CONNCTION TEXT:
✱C LIQUID OUTLET FUNNEL ....
REPLACES ✱C SOLIDS OUTLET FUNNEL ....

Rev. No.	Date	Modified By	Appr.
5	170803	AKE	OAN

Item	Article No.	Name/Designation	WEIGHT	Material
60 kNm DD GEARBOX				

Title: DIMENSIONED DRAWING

ALDEC G3-165

Alfa Laval Copenhagen A/S
SØBORG DENMARK

First angle projection	Surface roughness	Scale	Date	Design Code
	$R_A\mu m$	1:13	110322	NX10042 SL

Format	Drawn	Appr.	Model	Document No.
A0	DFa	OAN	Y	61244725

Maintenance Levels

Maintenance Levels		Description
A	Routine maintenance	Carried out by customer on a daily basis, to ensure good operating conditions.
B	Inspection by Alfa Laval	Conducted by experienced Alfa Laval Engineers. For identification of needed repair, Process optimization and upgrade opportunities.
C	Intermediate Service by Alfa Laval *	Conducted by trained Alfa Laval Engineers, with original parts, either on site, or at an Alfa Laval Service Center.
D	Major Service by Alfa Laval *	Conducted by trained Alfa Laval Engineers, with original parts, either on site, or at an Alfa Laval Service Center.
E	Gearbox Service by Alfa Laval *	Conducted by trained Alfa Laval Engineers, with original parts conducted at an Alfa Laval Service Center.
F	Preventive replacement of items	Preventive replacement of items due to their end of reliable lifetime. Can often be conducted at the same time as intermediate or major service.

* Additional items can be replaced as part of preventive maintenance at the same service. See maintenance tables below to identify the items exchange intervals

Spare Parts Kits

Alfa Laval supplies four types of spare parts kits for the decanter:

- **The Intermediate Kit —** For main bearings and conveyor bearings, respectively, contain seals and O-rings for the main bearings and the conveyor bearings. See volume SPC (Spare Parts Catalogue).
- **The Major Kit —** For main bearings and conveyor bearings, respectively, contains parts necessary for the complete overhaul of the decanter. It includes all sealing components and bearings. See volume SPC (Spare Parts Catalogue).
- **The Gearbox Kit —** Includes pre-mounted lip seals for the two sun wheels, mounting tools for both lip seals, and mounting instruction. This kit is available for DD-gearboxes only. See volume SPC (Spare Parts Catalogue).
- **The Rotating Feed Zone Kit —** Contains parts necessary for the complete overhaul of the rotating feed zone. It includes all sealing components and bearings. See volume SPC (Spare Parts Catalogue).

Maintenance Tables

Daily Inspection

Item	Daily Inspection	Maintenance Level
Decanter Assembly	Cleanliness. Look for oil spills, grease spots, liquid spills etc	A
	Check bearing and general machine noise	
	Look for loose nuts, bolts or screws etc. Tighten if necessary	
Back Drive	Check conveyor torque during operation	
Connections	Check flexible connections. Look for leaks and deterioration	
Feed	Check feed flow rate	
Gearbox	Check for oil leaks from gearbox	
	Check gearbox oil level	
Lubricate	Lubricate according to lubrication table	
Main Bearings	Check decanter vibration	
	Check temperature	
Motors	Check main motor current	
	Check temperatures	
Vibration Isolators	Check general condition	

Maintenance Table (General recommendations)

Item	Action	Operation hours/Time, whichever comes first															Maintenance Level
		150 hrs	300 hrs	500 hrs	1000 hrs	4000 hrs	8000 hrs	12000 hrs	16000 hrs	Manufacturer's interval	Monthly	2 Months	Yearly	2 years	3 years	4 years	5 years	
Back drive, VFD	Inspect the coupling rubber elements for cracks					X							X					B
	Check wear of coupling bushing					X							X					
	Replace coupling															X		F
	Replace torque arm bushings															X		
	Replace V-belts					X							X					
	Check motor alignment					X							X					B / C / D
	Replace vibration isolator																X	F
Back drive, Countershaft transmission	Check function of overload protection (GS coupling)					X							X					B / C / D
	Inspect GS coupling and replace the following parts if worn: Coupling part, Driver and Bushing															X		F
	Replace bearings in countershaft pulley															X		
Belts	Check belt tensions					X							X					A / B / C / D
	Replace V-belts								X							X		F
Bowl	Check wear liners (saddles) or bushings					X							X					C / D
	Check wear ring for wear					X							X					
	Check outside of bowl for wear or corrosion					X							X					
	Check fitting of bowl bolts (if Cl- or another corrosive agent is present). Remove one bolt at a time and return it before removing the next. Be sure to tighten to the correct torque					X							X					
	Check and tighten seating torque of bowl bolts					X							X					
	Check bowl interior for wear tear and corrosion					X							X					
Bowl Assembly	Thorough inspection of bowl assembly by authorized Alfa Laval Service							X							X			B

Item	Action	Operation hours/Time, whichever comes first																Maintenance Level
		150 hrs	300 hrs	500 hrs	1000 hrs	4000 hrs	8000 hrs	12000 hrs	16000 hrs	Manufacturer's interval	Monthly	2 Months	Yearly	2 years	3 years	4 years	5 years	
Bowl screws	Replace screws in bowl if running on chloride fluid														X			F
Casing	Check solids outlet wear protection. If damaged or excessively worn, renew immediately					X							X					C / D
	Check inside of casing. Remove deposits if necessary					X							X					
	Replace gaskets and O-rings															X		F
CIP bar	Replace gaskets															X		F
Connections	Check outlet chutes, funnels, tubes, flexible connections and pipes												X					A / C / D
	Look for leaks or deterioration												X					
Conveyor	Check tiles and wear protection visible through the solids outlet openings					X							X					B / C / D
	Check complete conveyor for wear, tear and corrosion												X					
	Check feed zone wear liner for wear and cracks													X				
	Thorough inspection of conveyor by authorized Alfa Laval Service							X							X			B
Conveyor Bearings	Lubricate, when feed > 90°C (194 °F)			X														A
	Lubricate, when feed < 90°C (194 °F)				X													
	Replace seals and O-rings					X							X					C
	Replace bearings						X							X				D
	Replace protecting tube, plastic													X				F
	Replace protecting tube, metal															X		
	Replace rotating feed zone inner bearing and seals						X							X				D
Cover	Inspect condition of weldings and outlets, Solids/Liquid												X					A / B
	Check functionality of springs in hinges												X					B / C / D
	Replace gaskets and O-rings															X		F

Item	Action	Operation hours/Time, whichever comes first																Maintenance Level
		150 hrs	300 hrs	500 hrs	1000 hrs	4000 hrs	8000 hrs	12000 hrs	16000 hrs	Manufacturer's interval	Monthly	2 Months	Yearly	2 years	3 years	4 years	5 years	
Discharge Funnels, Solids/Liquid	Inspect the outlets												X					B / C / D
	Look for leaks or deterioration																	
Electrical	Check all alarm function of control system. For VFD driven decanters, check overspeed alarm												X					C / D
	Check condition of electrical cables												X					
	Check condition of ground connection to frame and motors												X					
	Replace rubber elements, junction box																X	F
Feed Tube	Remove feed tube and check for clogging in feed inlet										X							A / C / D
	Check seating torque of feed tube bolts					X							X					
	Inspect feed tube (inner and outer), O-rings and gaskets for wear and cracks													X				C / D
Foundation	Check for wear/cracks												X					A / B
Foundation Bolts	Check and tighten loose bolts												X					A / B
Frame	Inspect condition of weldings and outlets, Solids/Liquid												X					A / B
	Inspect and replace the casing solids outlets wear liner if worn												X					B / F
Gearbox <30 kNm	Check oil Level and lip seal, If leakage is observed, fit new lip seal(s)				X							X						A / F
	Change oil					X								X				C / D
	Clean gearbox and replace seals and rolling type bearings													X				E
	Grease spline													X				D / E
Gearbox ≥30 kNm	Check oil Level and lip seal. If leakage is observed, fit new lip seal(s)				X							X						A / F
	Change oil						X							X				C / D
	Clean gearbox and replace seals and rolling type bearings													X				E
	Grease spline													X				D / E

Item	Action	Operation hours/Time, whichever comes first																Maintenance Level
		150 hrs	300 hrs	500 hrs	1000 hrs	4000 hrs	8000 hrs	12000 hrs	16000 hrs	Manufacturer's interval	Monthly	2 Months	Yearly	2 years	3 years	4 years	5 years	
Intermediate kit – Conveyor and Main bearing	Replace seals, gaskets and O-rings					X							X					C
Labels and Signs	Check presence and legibility												X					A
Main Bearings	Lubricate, when bearing > 85°C (185 °F)	X																A
	Lubricate, when bearing < 85°C (185 °F)		X															
	Check seating torque of main bearing pillow block bolts					X							X					C / D
	Replace seals and O-rings					X							X					C
	Replace						X							X				D
Main Drive	Check belt tensions and alignment					X							X					A / B / C / D
	Replace V-belts								X							X		F
	Replace vibration isolator																X	
Major kit –Conveyor and Main bearing	Replace bearings, seals, gaskets and O-rings						X							X				D
Motors	Lubricate bearings									X								A
	Control for bearing noise "Main Drive" / "Back Drive"					X							X					A / B / C / D
Paring disc	Replace sealing rings (plastic)						X							X				D / F
	O-rings (stationary and rotating parts)								X							X		F
	Gaskets and O-ring in outlet connection								X							X		
Rotating Feed Zone – Pulley Bearing	Lubricate, when feed > 90°C (194 °F)			X														A
	Lubricate, when feed < 90°C (194 °F)				X													
	Replace						X							X				D
Rotating Feed Zone – Inner Bearing	Replace						X							X				D
Rotating Feed Zone – Seals	Replace						X						X					C / D
Seals, stationary	Replace						X							X				D

Item	Action	Operation hours/Time, whichever comes first																Maintenance Level
		150 hrs	300 hrs	500 hrs	1000 hrs	4000 hrs	8000 hrs	12000 hrs	16000 hrs	Manufacturer's interval	Monthly	2 Months	Yearly	2 years	3 years	4 years	5 years	
Spline Shaft	Lubricate						X							X				D
Vibration Isolators –Frame, Main Drive and Back Drive	Check seating torque of vibration isolator bolts					X							X					B / C / D
	Check condition					X							X					
	Replace																X	F
Wear liner –Casing solids wear liner	Check for wear and corrosion					X							X					C / D
Wear liner –Solids discharge	Check for wear and cracks					X							X					C / D
Wear liner –Conveyer Tiles and wear protection	Check tiles and wear protection visible through the solids outlet openings					X							X					C / D
Wear liner –Conveyer feed zone	Check for wear and cracks						X							X				D
Wear liner – Rotating feed zone vanes	Check for wear and cracks					X							X					C / D
Wear liner –Race Track Scrapers	Check the scrapers for wear and defects					X							X					C / D
Wear ring – Bowl	Check for wear					X							X					C / D

APPENDIX B

Eurofins TestAmerica Results

Andritz	WAS Feed					TWAS Thickened		Centrate	Andritz
Test No.	Total Solids	Total Suspended Solids	Total Volatile Solids	pH	Temp.	Total Solids	Total Volatile Solids	Total Suspended Solids	Test No.
Test 1	0.14 %	0.33 %	ND %	7.6	22.1 °C	2.3 %	1.4 %	0.012 %	Test 1
Test 2	0.55 %	0.35 %	0.31 %	7.5	22.2 °C	3.6 %	2.1 %	0.013 %	Test 2
Test 3	0.39 %	0.31 %	0.28 %	7.5	22.1 °C	2.2 %	1.3 %	0.013 %	Test 3
Test 4	0.30 %	0.33 %	0.16 %	7.58	22.5 °C	3.2 %	1.9 %	0.012 %	Test 4
Test 5	0.34 %	0.33 %	0.20 %	7.4	22.4 °C	0.52 %	0.39 %	0.012 %	Test 5
Test 6	0.38 %	0.35 %	0.02 %	7.4	21.1 °C	7.5 %	0.23 %	0.02 %	Test 6
Test 7	0.11 %	0.29 %	0.03 %	7.6	20.6 °C	6.3 %	0.19 %	0.023 %	Test 7
Test 8	0.53 %	0.33 %	0.01 %	7.1	20.3 °C	12 %	62 %	0.025 %	Test 8
Test 9	0.28 %	0.36 %	0.01 %	7.2	20.1 °C	8.7 %	0.026 %	0.028 %	Test 9
Test 10	0.41 %	0.33 %	0.01 %	7.1	20.2 °C	5.9 %	0.18 %	0.027 %	Test 10
Test 11	0.29 %	0.33 %	0.19 %	7.1	21.0 °C	4.6 %	2.5 %	0.01 %	Test 11
Test 12	0.38 %	0.33 %	0.23 %	7.2	21.7 °C	6.6 %	4 %	0.0088 %	Test 12
Test 13	0.16 %	0.35 %	0.09 %	7.2	21.7 °C	6.2 %	3.8 %	0.0068 %	Test 13
Test 14	0.26 %	0.40 %	0.15 %	7.3	20.4 °C	2.5 %	1.5 %	0.0036 %	Test 14
Test 15	0.28 %	0.41 %	0.16 %	7.2	20.0 °C	3.1 %	1.8 %	0.0028 %	Test 15
Test 16	0.34 %	0.42 %	0.02 %	7.3	20.2 °C	4.5 %	2.7 %	0.012 %	Test 16
Test 17	0.26 %	4.40 %	0.14 %	7.3	20.8 °C	3.8 %	2 %	0.011 %	Test 17
Test 18	0.36 %	0.38 %	0.21 %	7.2	20.6 °C	45 %	2.7 %	0.01 %	Test 18
Test 19	0.26 %	0.38 %	0.16 %	7.2	20.5 °C	5.7 %	3.4 %	0.0072 %	Test 19
Test 20	0.19 %	0.40 %	0.10 %	7.3	21.1 °C	4.7 %	2.8 %	0.008 %	Test 20
Test 21	0.37 %	0.32 %	0.20 %	7.2	24.7 °C	1.4 %	0.55 %	0.006 %	Test 21
Test 22	0.30 %	0.33 %	0.16 %	7.2	24.6 °C	2.3 %	1.5 %	0.006 %	Test 22
Test 23	0.38 %	0.34 %	0.23 %	7.2	24.6 °C	0.8 %	0.51 %	0.0024 %	Test 23
Test 24	0.40 %	0.36 %	0.23 %	7.2	24.8 °C	2.7 %	1.7 %	0.0036 %	Test 24
Test 25	0.16 %	0.33 %	0.08 %	7.2	24.7 °C	7 %	4.2 %	0.0028 %	Test 25
Test 26	0.30 %	0.33 %	0.28 %	7.2	21.1 °C	7.2 %	7.2 %	0.023 %	Test 26
Test 27	0.47 %	0.33 %	0.45 %	7.2	21.2 °C	8 %	7.8 %	0.023 %	Test 27
Test 28	0.48 %	0.37 %	0.40 %	7.2	21.1 °C	7.9 %	7.6 %	0.024 %	Test 28
Test 29	0.29 %	0.36 %	0.22 %	7.1	21.1 °C	6.4 %	6.7 %	0.022 %	Test 29
Test 30	0.32 %	0.33 %	0.31 %	7.1	21.1 °C	0.81 %	0.55 %	0.02 %	Test 30
Test 31	0.32 %	0.33 %	0.21 %	7.2	17.3 °C	5.9 %	5.8 %	0.004 %	Test 31
Test 32	0.42 %	0.33 %	0.14 %	7.2	17.5 °C	6.7 %	6.5 %	0.0028 %	Test 32
Test 33	0.28 %	0.35 %	0.20 %	7.2	18.2 °C	0.85 %	0.63 %	0.002 %	Test 33
Test 34	0.33 %	0.33 %	0.30 %	7.2	18.2 °C	2.7 %	2.7 %	0.0032 %	Test 34
Test 35	0.16 %	0.34 %	0.02 %	7.2	17.8 °C	5.2 %	0.024 %	0.0028 %	Test 35

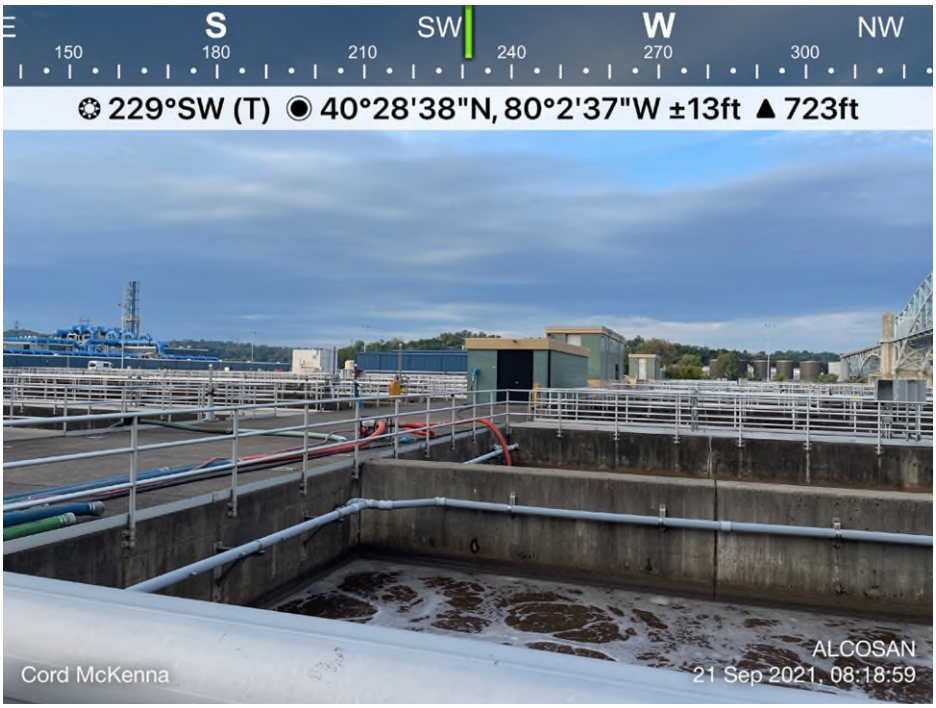
Centrisys	WAS Feed					TWAS Thickened		Centrate	Centrisys
Test No.	Total Solids	Total Suspended Solids	Total Volatile Solids	pH	Temp.	Total Solids	Volatile Solids	Total Suspended Solids	Test No.
Test 1.1	0.29 %	0.29 %	0.21 %	7.2	20.4 °C	4.6 %	91 %	0.0065 %	Test 1.1
Test 1.2	0.37 %	0.30 %	0.23 %	7.2	21.1 °C	3.6 %	91 %	0.015 %	Test 1.2
Test 1.3	0.41 %	0.29 %	0.27 %	7.1	20.8 °C	10 %	83 %	0.0062 %	Test 1.3
Test 1.4	0.38 %	0.34 %	0.23 %	7.2	21.3 °C	4.1 %	97 %	0.0087 %	Test 1.4
Test 1.5	0.33 %	0.31 %	0.22 %	7.2	21.6 °C	8.8 %	96 %	0.0061 %	Test 1.5
Test 1.6	0.37 %	0.31 %	0.23 %	7.1	21.7 °C	4.1 %	95 %	0.0079 %	Test 1.6
Test 1.7	0.40 %	0.30 %	0.26 %	7.2	21.3 °C	10 %	84 %	0.0088 %	Test 1.7
Test 1.8	0.39 %	0.31 %	0.24 %	7.1	21.2 °C	9.7 %	92 %	0.011 %	Test 1.8
Test 1.9	0.33 %	0.31 %	0.20 %	7.1	21.8 °C	4.3 %	95 %	0.011 %	Test 1.9
Test 2.1	0.32 %	0.32 %	0.17 %	7.4	19.6 °C	8.9 %	92 %	0.017 %	Test 2.1
Test 2.2	0.31 %	0.30 %	0.17 %	7.3	19.5 °C	4.6 %	92 %	0.017 %	Test 2.2
Test 2.3	0.32 %	0.30 %	0.18 %	7	19.5 °C	8.6 %	89 %	0.016 %	Test 2.3
Test 2.4	0.31 %	0.30 %	0.18 %	7.3	19.5 °C	8.8 %	95 %	0.016 %	Test 2.4
Test 2.5	0.32 %	0.31 %	0.19 %	7.3	19.5 °C	9.1 %	90 %	0.012 %	Test 2.5
Test 2.6	0.32 %	0.31 %	0.18 %	7.4	19.6 °C	5.7 %	85 %	0.01 %	Test 2.6
Test 2.7	0.32 %	0.30 %	0.18 %	7	16.9 °C	8.2 %	90 %	0.011 %	Test 2.7
Test 3.1	0.35 %	0.35 %	0.23 %	7.4	20.2 °C	2.5 %	75 %	0.019 %	Test 3.1
Test 3.2	0.37 %	0.35 %	0.24 %	7.3	20.2 °C	3.8 %	77 %	0.019 %	Test 3.2
Test 3.3	0.39 %	0.34 %	0.23 %	7.3	20.2 °C	7.8 %	72 %	0.02 %	Test 3.3
Test 3.4	0.38 %	0.36 %	0.23 %	7.3	20.2 °C	5.5 %	69 %	0.02 %	Test 3.4
Test 4.1	0.30 %	0.30 %	0.19 %	7.4	19.1 °C	3.6 %	86 %	0.019 %	Test 4.1
Test 4.2	0.28 %	0.31 %	0.20 %	7.5	19.4 °C	3.9 %	88 %	0.019 %	Test 4.2
Test 4.3	0.34 %	0.32 %	0.22 %	7.4	19.7 °C	6.2 %	70 %	0.019 %	Test 4.3
Test 4.4	0.32 %	0.34 %	0.20 %	7.5	19.4 °C	4.9 %	89 %	0.019 %	Test 4.4
Test 4.5	0.35 %	0.33 %	0.19 %	7.5	19.8 °C	4.4 %	82 %	0.019 %	Test 4.5
Test 4.6	0.34 %	0.34 %	0.19 %	7.4	20.4 °C	4.7 %	85 %	0.015 %	Test 4.6
Test 5.1	0.37 %	0.32 %	0.24 %	7.5	19.6 °C	6.7 %	56 %	0.012 %	Test 5.1
Test 5.2	0.24 %	0.37 %	0.13 %	7.4	19.3 °C	6 %	61 %	0.0066 %	Test 5.2
Test 5.3	0.32 %	0.35 %	0.18 %	7.4	18.9 °C	6.5 %	55 %	0.018 %	Test 5.3
Test 5.4	0.34 %	0.31 %	0.21 %	7.5	19.5 °C	4.7 %	77 %	0.21 %	Test 5.4
Test 5.5	0.30 %	0.33 %	0.25 %	7.5	19 °C	8.6 %	59 %	0.013 %	Test 5.5
Test 6.1	0.37 %	0.34 %	0.22 %	7.5	20.1 °C	4 %	79 %	0.011 %	Test 6.1
Test 6.2	0.37 %	0.33 %	0.21 %	7.5	20.5 °C	3.6 %	76 %	0.011 %	Test 6.2
Test 6.3	0.30 %	0.30 %	0.17 %	7.5	20.7 °C	3.7 %	80 %	0.011 %	Test 6.3
Test 6.4	0.35 %	0.29 %	0.20 %	7.4	20.4 °C	4.2 %	81 %	0.0095 %	Test 6.4

Alfa Laval	WAS Feed					TWAS Thickened		Centrate	Alfa Laval
Test No.	Total Solids	Total Suspended Solids	Total Volatile Solids	pH	Temp.	Total Solids	Total Volatile Solids	Total Suspended Solids	Test No.
Test 1	0.37 %	0.29 %	0.23 %	7.00	19.70 °C	10 %	73 %	0.022 %	Test 1
Test 2	0.32 %	0.20 %	0.20 %	7.30	19.70 °C	11 %	83 %	0.017 %	Test 2
Test 3	0.36 %	0.30 %	0.23 %	7.50	19.70 °C	9.8 %	74 %	0.02 %	Test 3
Test 4	0.34 %	0.30 %	0.21 %	7.40	19.70 °C	11 %	73 %	0.012 %	Test 4
Test 5	0.37 %	0.29 %	0.23 %	7.40	19.70 °C	9.7 %	77 %	0.013 %	Test 5
Test 6	0.34 %	0.30 %	0.22 %	7.30	19.80 °C	9.5 %	76 %	0.014 %	Test 6
Test 7	0.40 %	0.31 %	0.25 %	7.50	19.30 °C	0.85 %	0.54 %	0.02 %	Test 7
Test 8	0.44 %	0.33 %	0.28 %	7.40	19.50 °C	9.4 %	82 %	0.016 %	Test 8
Test 9	0.38 %	0.28 %	0.23 %	7.50	19.00 °C	1.6 %	1 %	0.017 %	Test 9
Test 10	0.38 %	0.31 %	0.23 %	7.40	19.10 °C	0.66 %	0.41 %	0.011 %	Test 10
Test 11	0.36 %	0.28 %	0.22 %	7.40	19.80 °C	0.52 %	0.32 %	0.02 %	Test 11
Test 12	0.39 %	0.33 %	0.24 %	7.40	19.60 °C	0.6 %	0.38 %	0.013 %	Test 12
Test 13	0.40 %	0.23 %	0.25 %	7.20	19.70 °C	0.95 %	0.61 %	0.013 %	Test 13
Test 14	0.34 %	0.33 %	0.21 %	7.30	19.80 °C	16 %	65 %	0.038 %	Test 14
Test 15	0.38 %	0.31 %	0.28 %	7.40	19.50 °C	10 %	68 %	0.095 %	Test 15
Test 16	0.37 %	0.31 %	0.25 %	7.40	19.40 °C	9.9 %	70 %	0.028 %	Test 16
Test 17	0.40 %	0.35 %	0.28 %	7.50	19.10 °C	10 %	67 %	0.028 %	Test 17
Test 18	0.39 %	0.24 %	0.26 %	7.50	18.80 °C	10 %	68 %	0.027 %	Test 18
Test 19	0.33 %	0.31 %	0.21 %	7.50	19.60 °C	9.4 %	68 %	0.024 %	Test 19
Test 20	0.40 %	0.30 %	0.28 %	7.50	19.70 °C	9.1 %	69 %	0.028 %	Test 20
Test 21	0.42 %	0.33 %	0.28 %	7.50	19.10 °C	8.2 %	69 %	0.026 %	Test 21
Test 22	0.36 %	0.33 %	0.24 %	7.40	19.00 °C	7.9 %	70 %	0.046 %	Test 22
Test 23	0.41 %	0.39 %	0.28 %	7.50	19.40 °C	7.9 %	71 %	0.027 %	Test 23
Test 24	0.45 %	0.22 %	0.31 %	7.50	19.20 °C	2.9 %	1.9 %	0.027 %	Test 24
Test 25	0.38 %	0.30 %	0.27 %	7.20	19.20 °C	2.8 %	2 %	0.028 %	Test 25
Test 26	0.38 %	0.36 %	0.26 %	7.30	19.20 °C	3.9 %	68 %	0.025 %	Test 26
Test 27	0.35 %	0.43 %	0.26 %	7.40	20.00 °C	3 %	2 %	0.029 %	Test 27
Test 28	0.37 %	0.33 %	0.27 %	7.40	19.70 °C	3.7 %	2.2 %	0.027 %	Test 28
Test 29	0.34 %	0.29 %	0.22 %	7.40	20.10 °C	3.3 %	2.2 %	0.028 %	Test 29
Test 30	0.38 %	0.35 %	0.25 %	7.50	19.50 °C	4.1 %	2.8 %	0.033 %	Test 30
Test 31	0.74 %	0.30 %	0.33 %	7.40	19.70 °C	3.4 %	2.3 %	0.033 %	Test 31
Test 32	0.34 %	0.32 %	0.24 %	7.40	19.60 °C	3.2 %	2.1 %	0.025 %	Test 32
Test 33	0.47 %	0.33 %	0.23 %	7.40	19.80 °C	4.6 %	2.9 %	0.025 %	Test 33
Test 34	0.43 %	0.30 %	0.26 %	7.40	19.70 °C	5.6 %	3.7 %	0.028 %	Test 34
Test 35	0.43 %	0.27 %	0.24 %	7.40	19.70 °C	4.1 %	2.7 %	0.024 %	Test 35

APPENDIX C

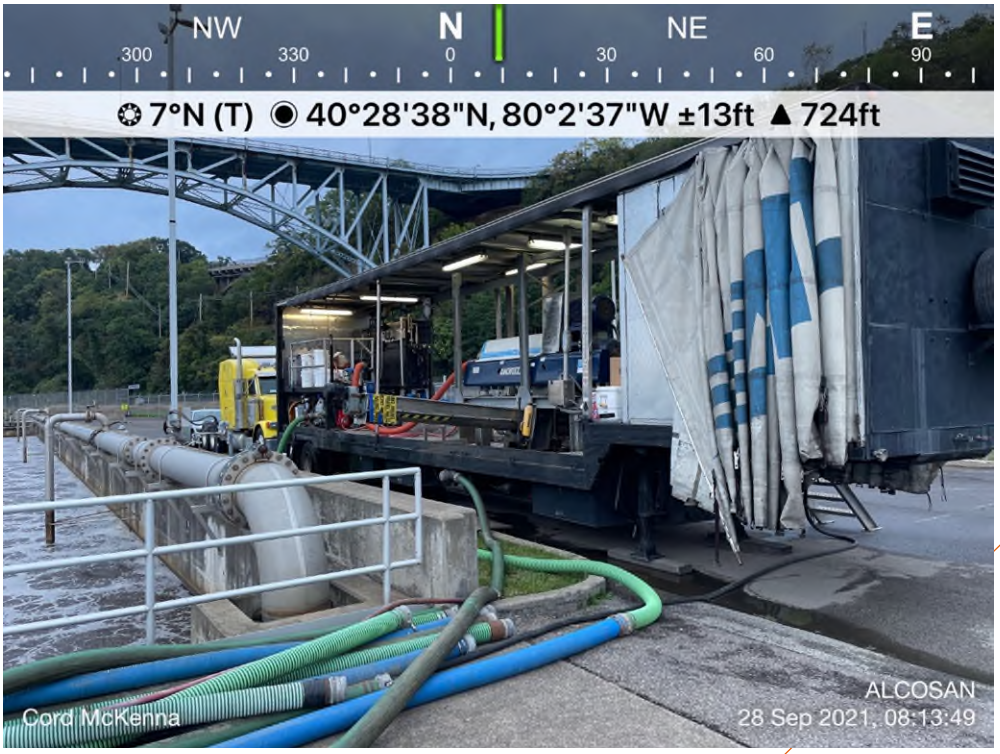
Pilot Photographs

Andritz – Feed line into EA-4 Pass 1 (red)



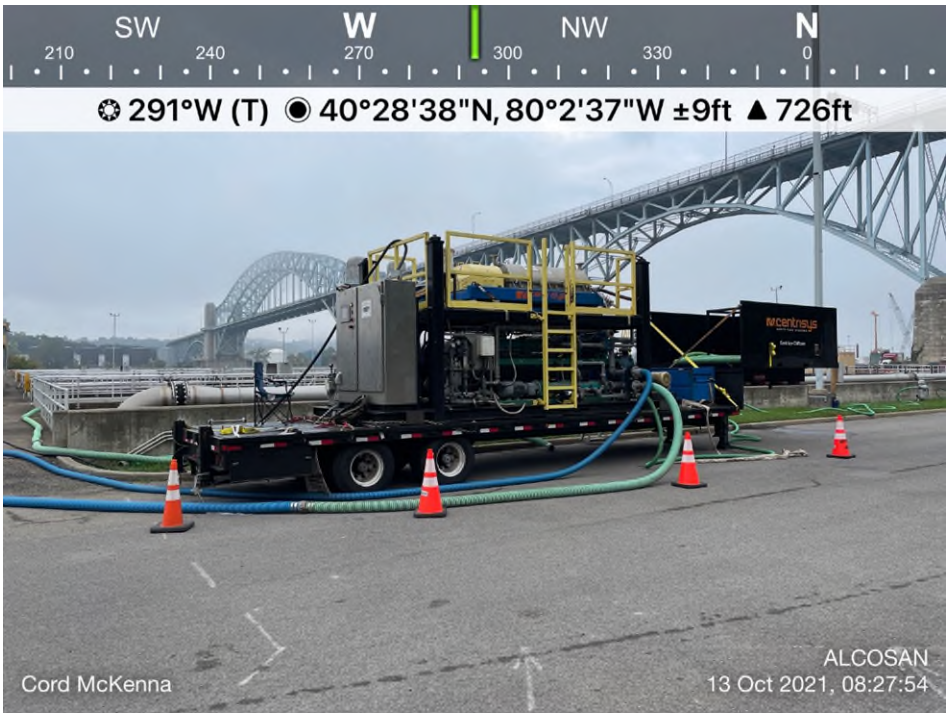
Andritz –Combined Discharge (TWAS + Centrate) line into EA-4 Pass 2 (green)

Andritz Pilot Centrifuge



Centrisys – Feed line into EA-4 Pass 1 (left) & TWAS Discharge and Centrate line into EA-4 Pass 2 (right)

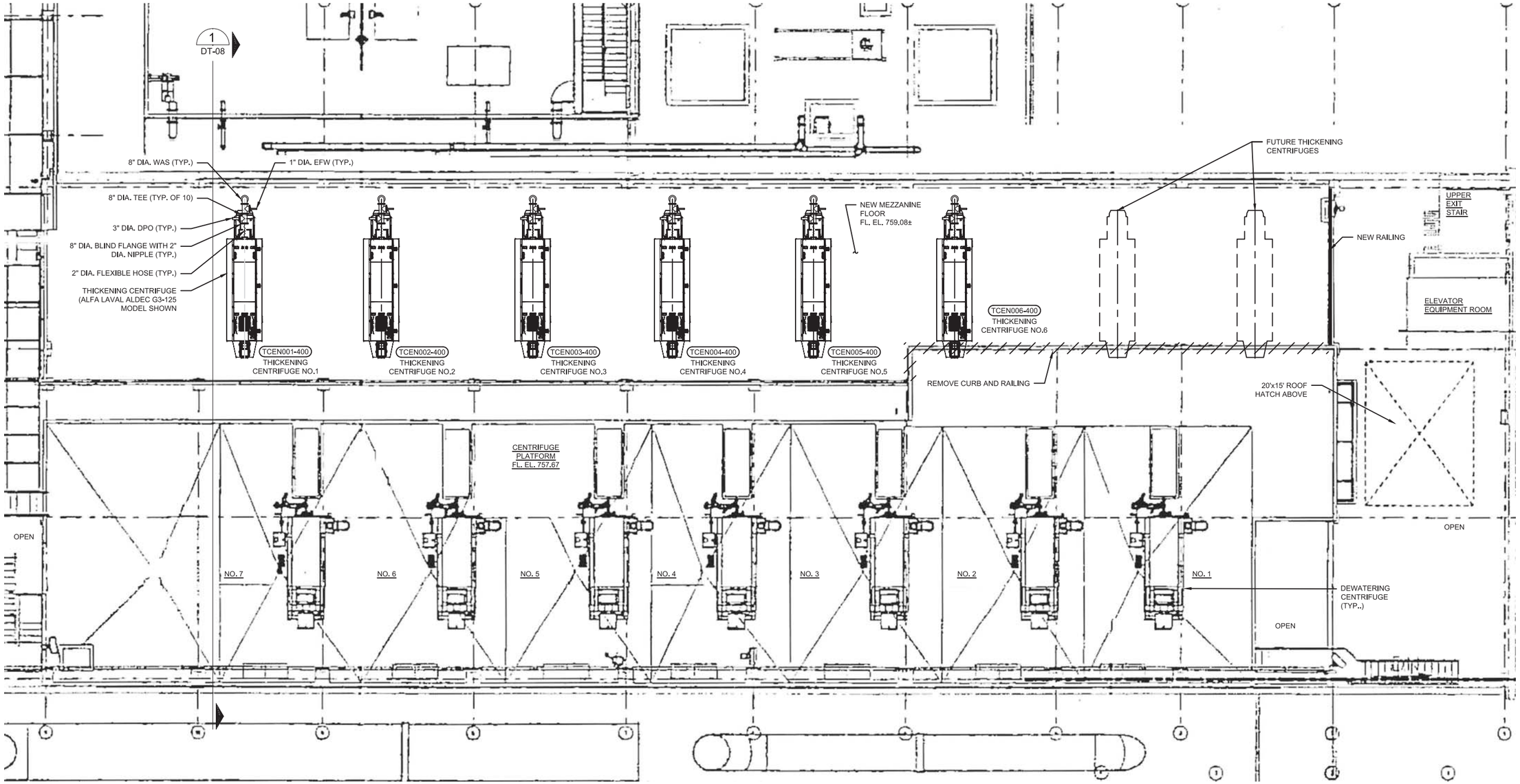
Centrisys THK200 Pilot unit



Samples collected by each vendor after each test run and sent to TestAmerica for analysis

APPENDIX D

Scale-up Model Footprint Drawings



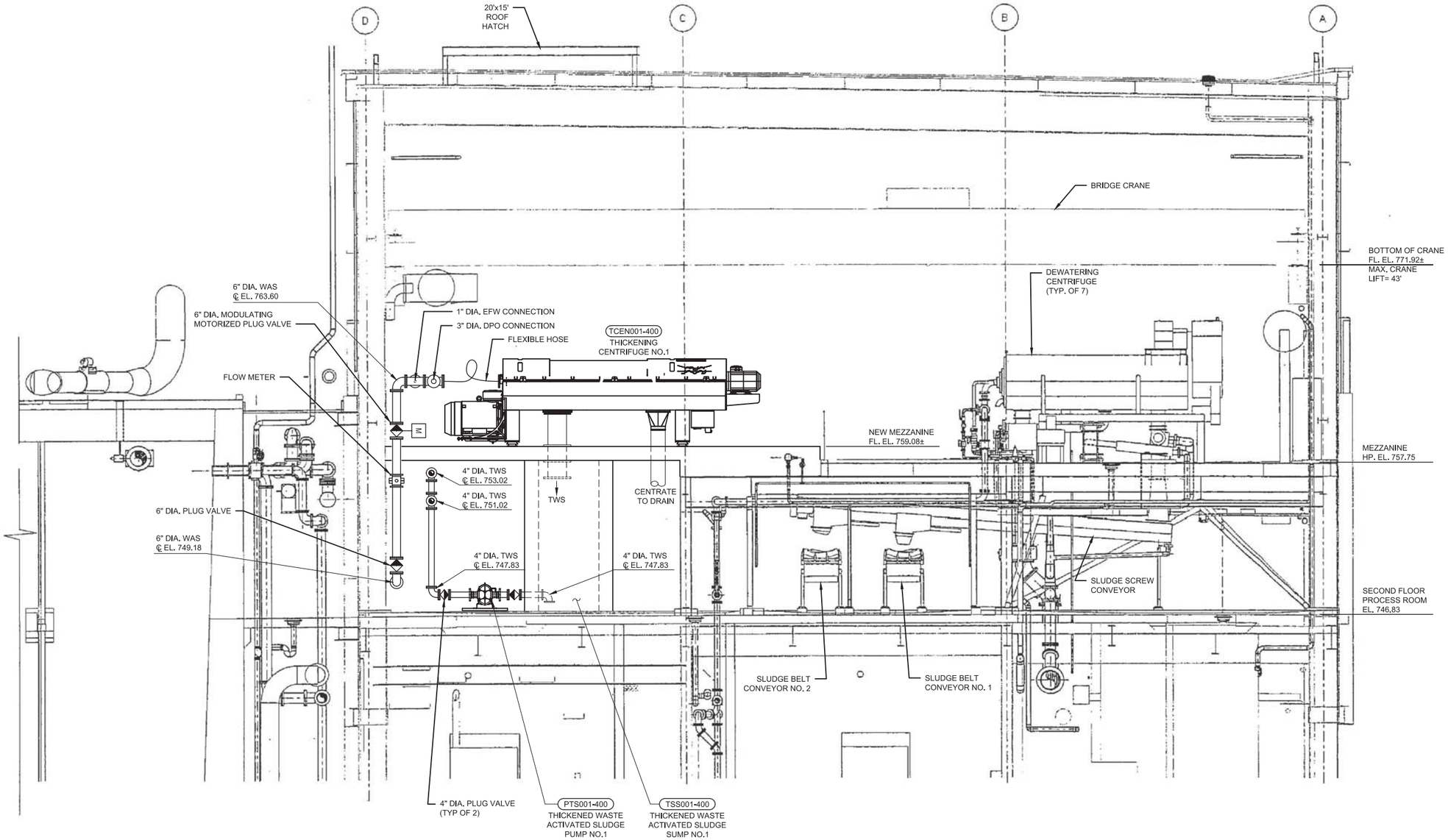
PARTIAL PLAN

SCALE: 1/8"=1'-0"

0 4' 8' 16'

SCALE: 1/8" = 1'-0"

Designed by: J. WILLIAMS Drawn by: K. KASPEREK Checked by: B. OLSON	REVISION REV No. / DATE / DESCRIPTION / APPV	ARCADIS ARCADIS, INC 1 SEAGATE #700 TOLEDO, OH 43604 TEL. 419.473.1121 FAX 419.213.1640 www.arcadis.com			ARLETTA SCOTT WILLIAMS EXECUTIVE DIRECTOR, ALCOSAN alcosan allegheny county sanitary authority 3300 PREBLE AVE. PITTSBURGH, PENNSYLVANIA PITTSBURGH, PA 15233 (412) 766 - 4810 www.alcosan.org	ALLEGHENY COUNTY SANITARY AUTHORITY WASTEWATER TREATMENT PLANT PROGRAM MANAGEMENT WAS THICKENING IMPROVEMENTS DT-05 THICKENING-DEWATERING BUILDING MEZZANINE PLAN (EL. 757.67 TO 772.50)	Contract: XXXX CAD File Name: Date: JUNE 2018 Sheet: DT5 OF DT8



SECTION 1 / DT-05
SCALE: 1/4"=1'-0"

0 2' 4' 8'
SCALE: 1/4" = 1'-0"

Designed by: J. WILLIAMS	REVISION			
Drawn by: K. KASPEREK	REV No.	DATE	DESCRIPTION	APPV
Checked by: B. OLSON	1			

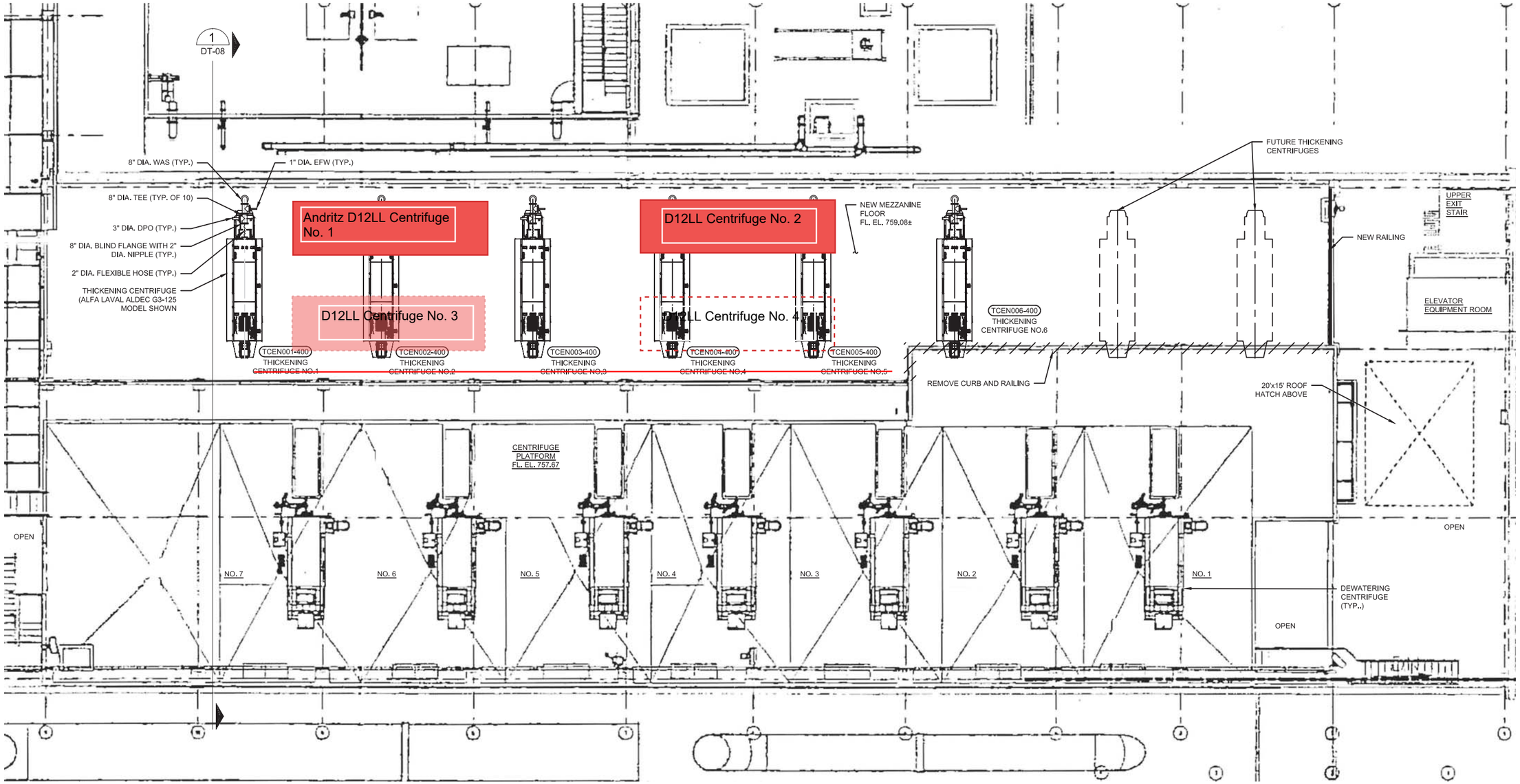
ARCADIS
ARCADIS, INC
1 SEAGATE #700
TOLEDO, OH 43604
TEL. 419.473.1121 FAX 419.213.1640
www.arcadis.com

ARLETTA SCOTT WILLIAMS
EXECUTIVE DIRECTOR, ALCOSAN
alcosan allegheny county sanitary authority
3300 PREBLE AVE.
PITTSBURGH, PENNSYLVANIA
PITTSBURGH, PA 15233
(412) 766 - 4810
www.alcosan.org

ALLEGHENY COUNTY SANITARY AUTHORITY
WASTEWATER TREATMENT PLANT PROGRAM MANAGEMENT
WAS THICKENING IMPROVEMENTS

DT-08
THICKENING-DEWATERING BUILDING SECTION

Contract:	XXXX
CAD File Name:	
Date:	JUNE 2018
Sheet:	



Average Condition, duty + standby

Peak, duty

Peak, duty + standby

Not drawn to scale

PARTIAL PLAN

SCALE: ⅛"=1'-0"

0 4' 8' 16'

SCALE: 1/8" = 1'-0"

Designed by: J. WILLIAMS	REVISION			
Drawn by: K. KASPEREK	REV No.	DATE	DESCRIPTION	APPV
Checked by: B. OLSON	1			

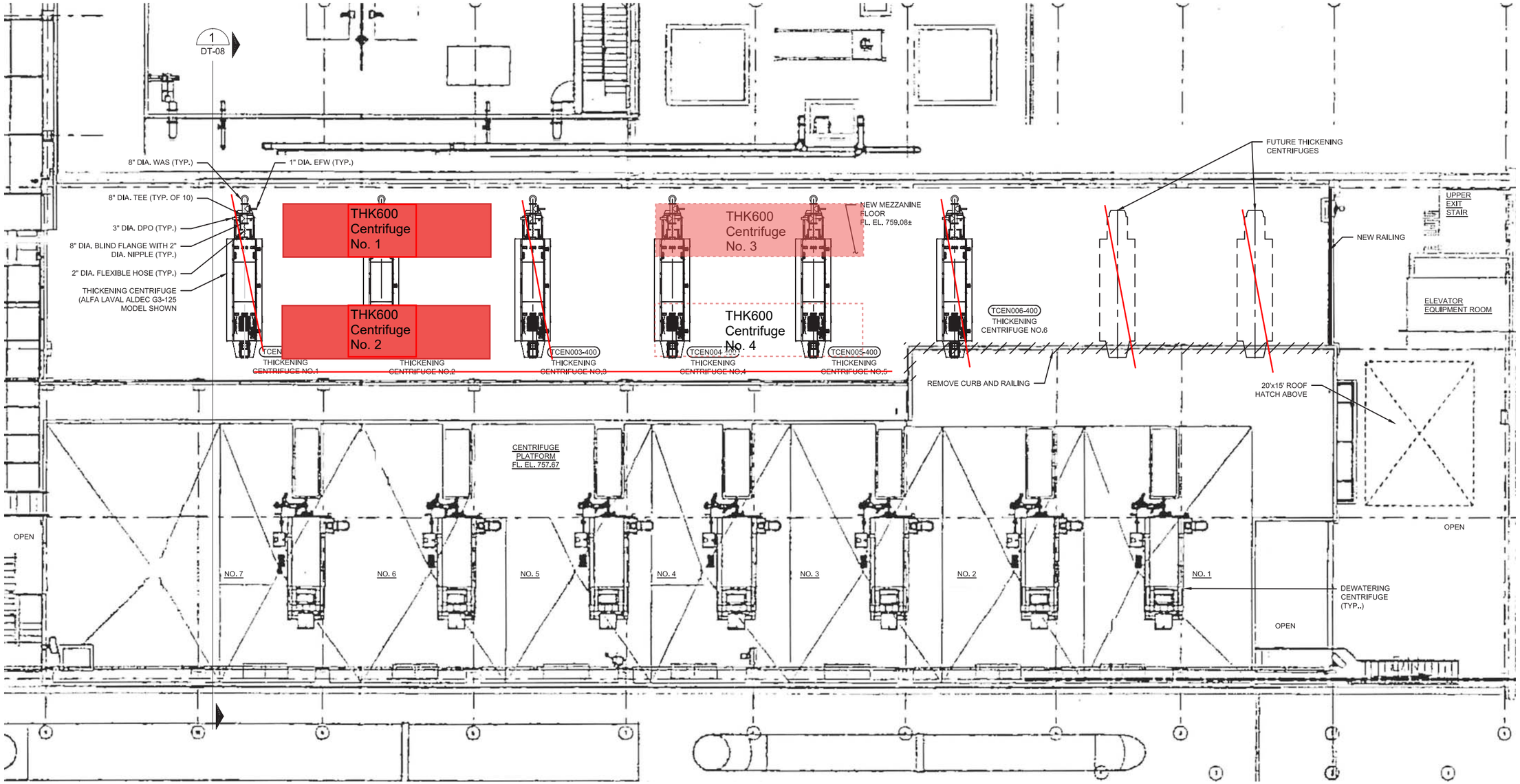
ARCADIS
ARCADIS, INC
1 SEAGATE #700
TOLEDO, OH 43604
TEL. 419.473.1121 FAX 419.213.1640
www.arcadis.com

ARLETTA SCOTT WILLIAMS
EXECUTIVE DIRECTOR, ALCOSAN
alcosan allegheny county sanitary authority
3300 PREBLE AVE.
PITTSBURGH, PENNSYLVANIA
PITTSBURGH, PA 15233
(412) 766 - 4810
www.alcosan.org

ALLEGHENY COUNTY SANITARY AUTHORITY
WASTEWATER TREATMENT PLANT PROGRAM MANAGEMENT
WAS THICKENING IMPROVEMENTS

DT-05
THICKENING-DEWATERING BUILDING
MEZZANINE PLAN (EL. 757.67 TO 772.50)

Contract: XXXX
CAD File Name:
Date: JUNE 2018
Sheet: DT5 OF DT8



Average Condition, duty + standby

Peak, duty

Peak, duty + standby

Not drawn to scale

PARTIAL PLAN

SCALE: ⅛"=1'-0"

0 4' 8' 16'

SCALE: 1/8" = 1'-0"

Designed by: J. WILLIAMS	REVISION			
Drawn by: K. KASPEREK	REV No.	DATE	DESCRIPTION	APPV
Checked by: B. OLSON	1			

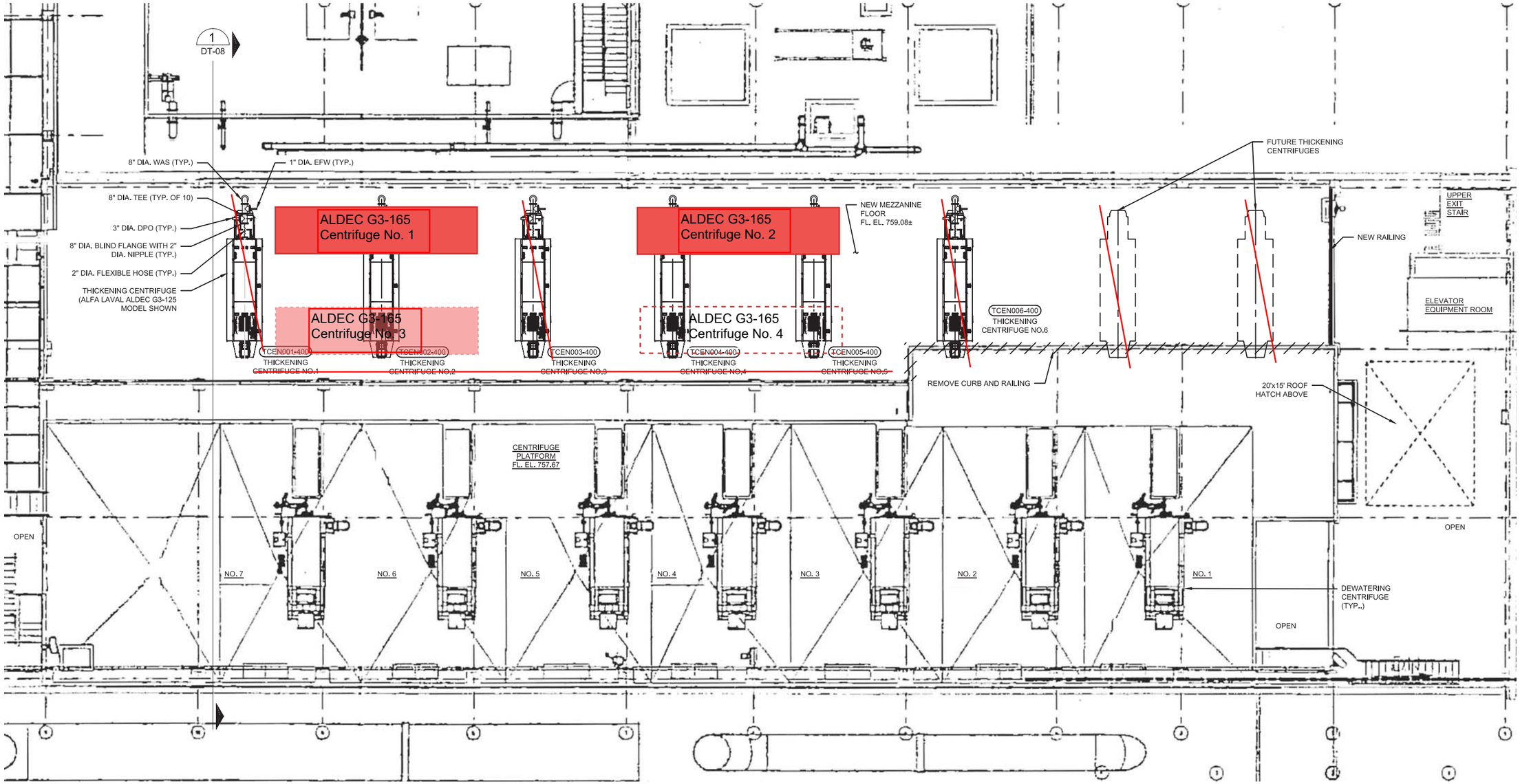
ARCADIS
ARCADIS, INC
1 SEAGATE #700
TOLEDO, OH 43604
TEL. 419.473.1121 FAX 419.213.1640
www.arcadis.com

ARLETTA SCOTT WILLIAMS
EXECUTIVE DIRECTOR, ALCOSAN
alcosan allegheny county sanitary authority
3300 PREBLE AVE.
PITTSBURGH, PENNSYLVANIA
PITTSBURGH, PA 15233
(412) 766 - 4810
www.alcosan.org

ALLEGHENY COUNTY SANITARY AUTHORITY
WASTEWATER TREATMENT PLANT PROGRAM MANAGEMENT
WAS THICKENING IMPROVEMENTS

DT-05
THICKENING-DEWATERING BUILDING
MEZZANINE PLAN (EL. 757.67 TO 772.50)

Contract: XXXX
CAD File Name:
Date: JUNE 2018
Sheet: DT5 OF DT8



Average Condition, duty + standby

Peak, duty

Peak, duty + standby

Not drawn to scale

PARTIAL PLAN

SCALE: ⅛"=1'-0"

0 4' 8' 16'

SCALE: 1/8" = 1'-0"

Designed by: J. WILLIAMS Drawn by: K. KASPEREK Checked by: B. OLSON	REVISION REV No. / DATE / DESCRIPTION / APPV	ARCADIS, INC 1 SEAGATE #700 TOLEDO, OH 43604 TEL. 419.473.1121 FAX 419.213.1640 www.arcadis.com		ARLETTA SCOTT WILLIAMS EXECUTIVE DIRECTOR, ALCOSAN alcosan allegheny county sanitary authority 3300 PREBLE AVE. PITTSBURGH, PENNSYLVANIA PITTSBURGH, PA 15233 (412) 766 - 4810 www.alcosan.org

ALLEGHENY COUNTY SANITARY AUTHORITY
WASTEWATER TREATMENT PLANT PROGRAM MANAGEMENT
WAS THICKENING IMPROVEMENTS

DT-05
THICKENING-DEWATERING BUILDING
MEZZANINE PLAN (EL. 757.67 TO 772.50)

Contract: XXXX
CAD File Name:
Date: JUNE 2018
Sheet: DT5 OF DT8

APPENDIX E

Vendor Recommendation Forms

ALCOSAN WAS Thickening Pilot Vendor Recommendation Form

Design Basis:

- Two existing WAS streams operate at the following combined capacities:
  - 1,000-1,200 gpm (normal)
  - 2400-3200 gpm (high)
  - 3,600 gpm (maximum)
- Desired thickening performance levels – 4-6% TS
- Capture rate of > 90-95%; preferably > 95%

Based on pilot testing results, please provide scaled up model performance and operating results in the table below for ***one unit***.

Recommend Model	ANDRITZ ***D12LL***
Model Capacity (gpm)	1400 gpm
G Volume	6610 m³ / 1,746,177 gal
Surface Area (sq. in)	9345.7 sq in (Liquid Surface Area at Discharge Height)
Total Installed HP (HP)	500 Main Drive / 75 HP Secondary Drive
Footprint (L"xW"xH")	326" x 85" x 93" Note: Dry weight of unit ≈ 55,000 lbs.
Budget Price (per unit)	$ 1,875,000.00 (ex-works Arlington, TX excludes Field Services)
Lead Time (weeks)	60 to 70 weeks after receipt of Approved Submittals

Parameters	***600 gpm, no polymer***	***600 gpm, w/ polymer***	***1,200 gpm, no polymer***	***1,200 gpm, w/ polymer***
Polymer (active lbs/DT)	N/A	3±1	N/A	3±1
Thickened sludge (%TS)	5-6	6-7	4-5	6-7
Capture rate (%)	93-95	>95	93-95	>95
Operating power (kW/gpm)	0.30	0.32	0.48	0.50

Vendor Recommendation for required number of units:

Three 3 Duty, One (1) Standby

ALCOSAN WAS Thickening Pilot Vendor Recommendation Form

Design Basis:

- Two existing WAS streams operate at the following combined capacities:
  - 1,000-1,200 gpm (normal)
  - 2400-3200 gpm (high)
  - 3,600 gpm (maximum)
- Desired thickening performance levels – 4-6% TS
- Capture rate of > 90-95%; preferably > 95%

Based on pilot testing results, please provide scaled up model performance and operating results in the table below for ***one unit***.

Recommend Model	CENTRISYS ***THK600***
Model Capacity (gpm)	1200 gpm
G Volume	647,000 G-gallons
Surface Area (sq. in)	3,715.2
Total Installed HP (HP)	225 HP
Footprint (L"xW"xH")	285 x 61 x 76
Budget Price (per unit)	$797,800
Lead Time (weeks)	30-32 weeks after receipt of drawings approval

Parameters	***600 gpm, no polymer***	***600 gpm, w/ polymer***	***1,200 gpm, no polymer***	***1,200 gpm, w/ polymer***
Polymer (Active lbs/DT)	N/A	0-1	N/A	1-1.5
Thickened sludge (%TS)	6%	6%	6%	6%
Capture rate (%)	>95%	>95%	>90%	>95%
Operating power (kW/gpm)	0.098	0.07	0.1	0.07

Vendor Recommendation for required number of units:

3 Duty, 1 Standby

ALCOSAN WAS Thickening Pilot Vendor Recommendation Form

Design Basis:

- Two existing WAS streams operate at the following combined capacities:
  - 1,000-1,200 gpm (normal)
  - 2400-3200 gpm (high)
  - 3,600 gpm (maximum)
- Desired thickening performance levels – 4-6% TS
- Capture rate of > 90-95%; preferably > 95%

Based on pilot testing results, please provide scaled up model performance and operating results in the table below for ***one unit***.

Recommend Model	ALFA LAVAL ***ALDEC G3-165***
Model Capacity (gpm)	1200
G Volume	4,744 m^3
Surface Area (sq. in)	11,117 sq. in.
Total Installed HP (HP)	340 HP
Footprint (L"xW"xH")	341.4" x 80.7" x 88.5"
Budget Price (per unit)	$997,000.00
Lead Time (weeks)	40 weeks from release to manufacturing

Parameters	***600 gpm, no polymer***	***600 gpm, w/ polymer***	***1,200 gpm, no polymer***	***1,200 gpm, w/ polymer***
Polymer (Active lbs/DT)	N/A	5-6	N/A	5-6
Thickened sludge (%TS)	4 - 6	4 - 6	N/A	4 - 6
Capture rate (%)	85%	90 - 95%	N/A	90 - 95%
Operating power (kW/gpm)	0.30	0.31	N/A	0.23

Vendor Recommendation for required number of units:

3 Duty, 1 Standby. Two ALDEC G3-165 units (with polymer) will handle your normal and high flows listed above and the single standby unit will cover the maximum you have listed above when needed. A single unit without polymer will not be sufficient to cover your needs. One unit will be a true backup.

Arcadis U.S., Inc.

6041 Wallace Road Extension

Suite 300

Wexford, Pennsylvania 15090

Tel 724 742 9180

Fax 724 742 9189

www.arcadis.com