Centrifuge Operational Adjustments Result in Cost Savings Opportunities at NEORSD

Midwest Biosolids Association, 2nd Annual Conference

Brian Flannagan, NEORSD
Adam Parmenter, HDR

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Agenda

1. NEORSD Background
2. Testing Purpose & Goals
3. Centrifuge Operation Fundamentals
4. Centrifuge Optimization Test Results
5. Next Steps

NEORSD Background

NEORSD – Northeast Ohio Regional Sewer District

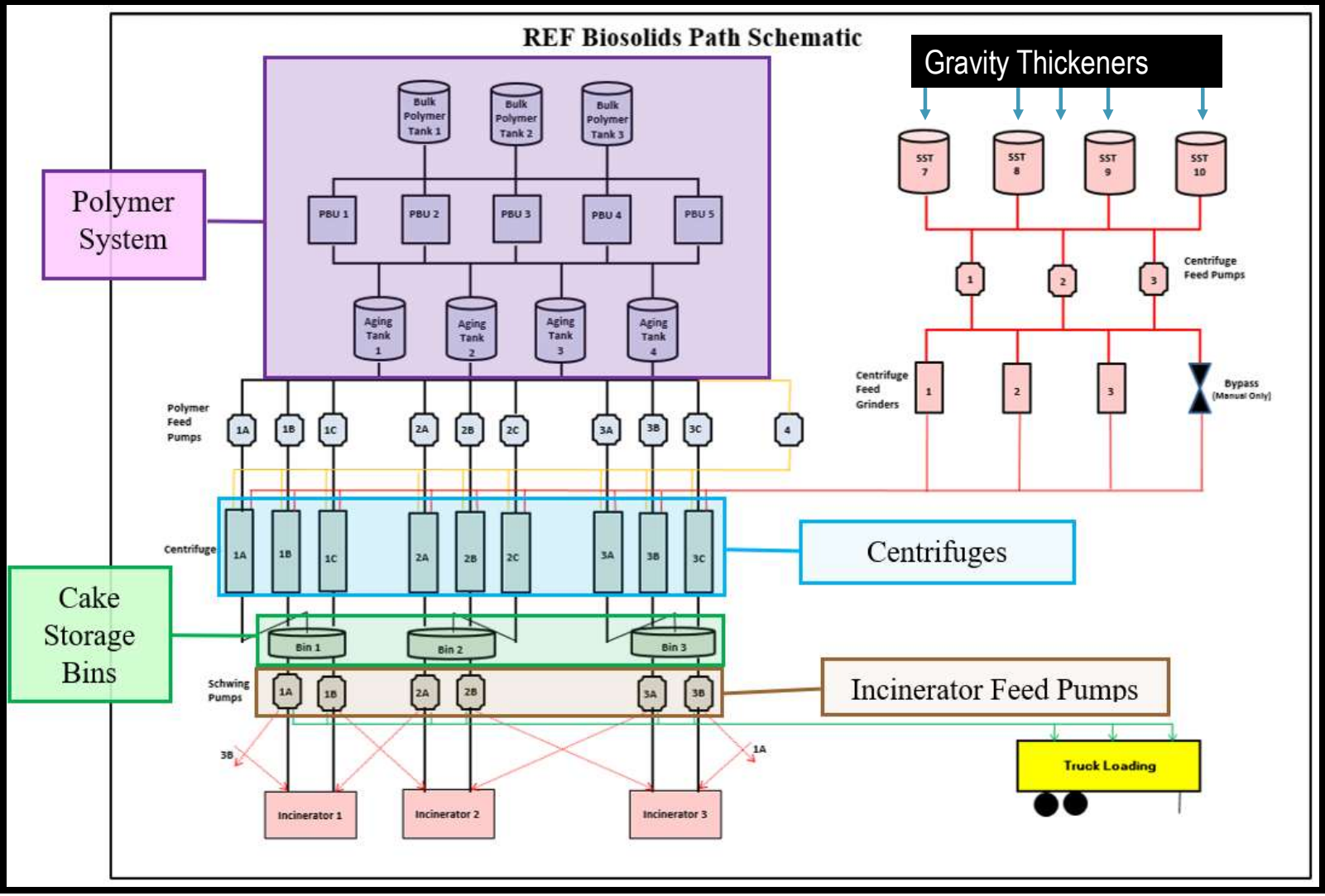
Southerly WWTP is the largest of NEORSD's three wastewater plants

Average daily flow of 120 MGD, Max day 480 MGD (Secondary Treatment)

Centrifuge Dewatering

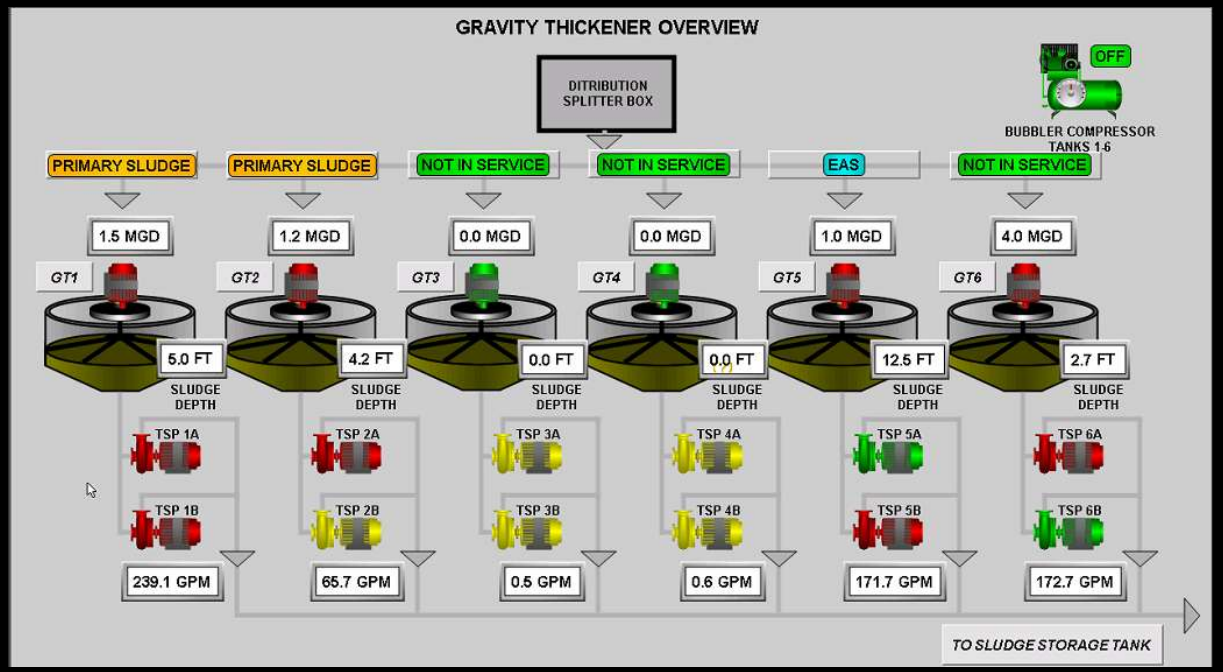
Incineration

Process Flow of Renewable Energy Facility



Gravity Thickener (GT) Operations

- Receives Primary Sludge (PS) & Excess Activated Sludge (EAS)
- GT pumping philosophy has been to keep a <5-foot blanket to maintain a high total solids content.
- Total solids out of GTs up to 6% TS in low flow conditions
- GT Issues in Wet Weather



Testing Purpose & Goals

Purpose & Goal of Testing

- Problem:
  - Wet weather events flush thinner sludge through the process and reduce the GTs effectiveness. This impacts normal centrifuge operations.
- Goals:
  - Determine if a consistently thinner sludge to dewatering centrifuges have negative impacts centrifuge operation
  - Secondary Goal of determining additional Operations “Levers to Pull” and Energy Saving opportunities

Centrifuge Thin Sludge Testing Plan

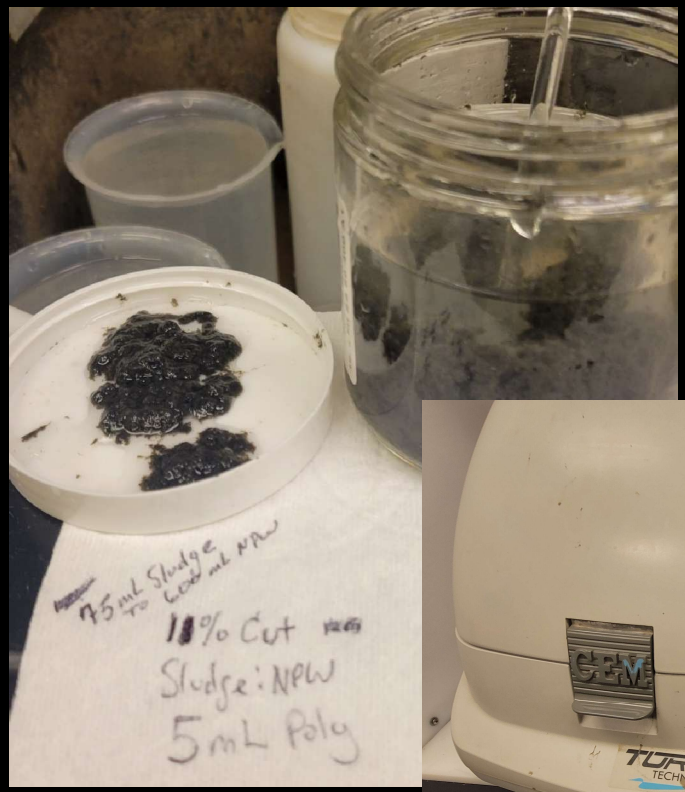
- Simulate a low solids sludge concentration (thin sludge) into a centrifuge, as low as 0.5% TS
- Determine any needed setpoint changes for successful performance

Six Individual Tests

- Test #1 - Thin Sludge, Low Solids Loading Rate (Minimum Flow Rate)
- Test #2 - Thin Sludge, High Solids Loading (Maximum Flow Rate)
- Test #3 - Polymer Reduction Optimization (Cost Saving)
- Test #4 - Centrifuge Higher Bowl Speed (Cake Solids Control)
- Test #5 - Centrifuge Lower Bowl Speed (Energy Savings & Cake Solids Control)
- Test #6 - Centrifuge Lower Torque (Cake Solids Control & Centrate Quality)

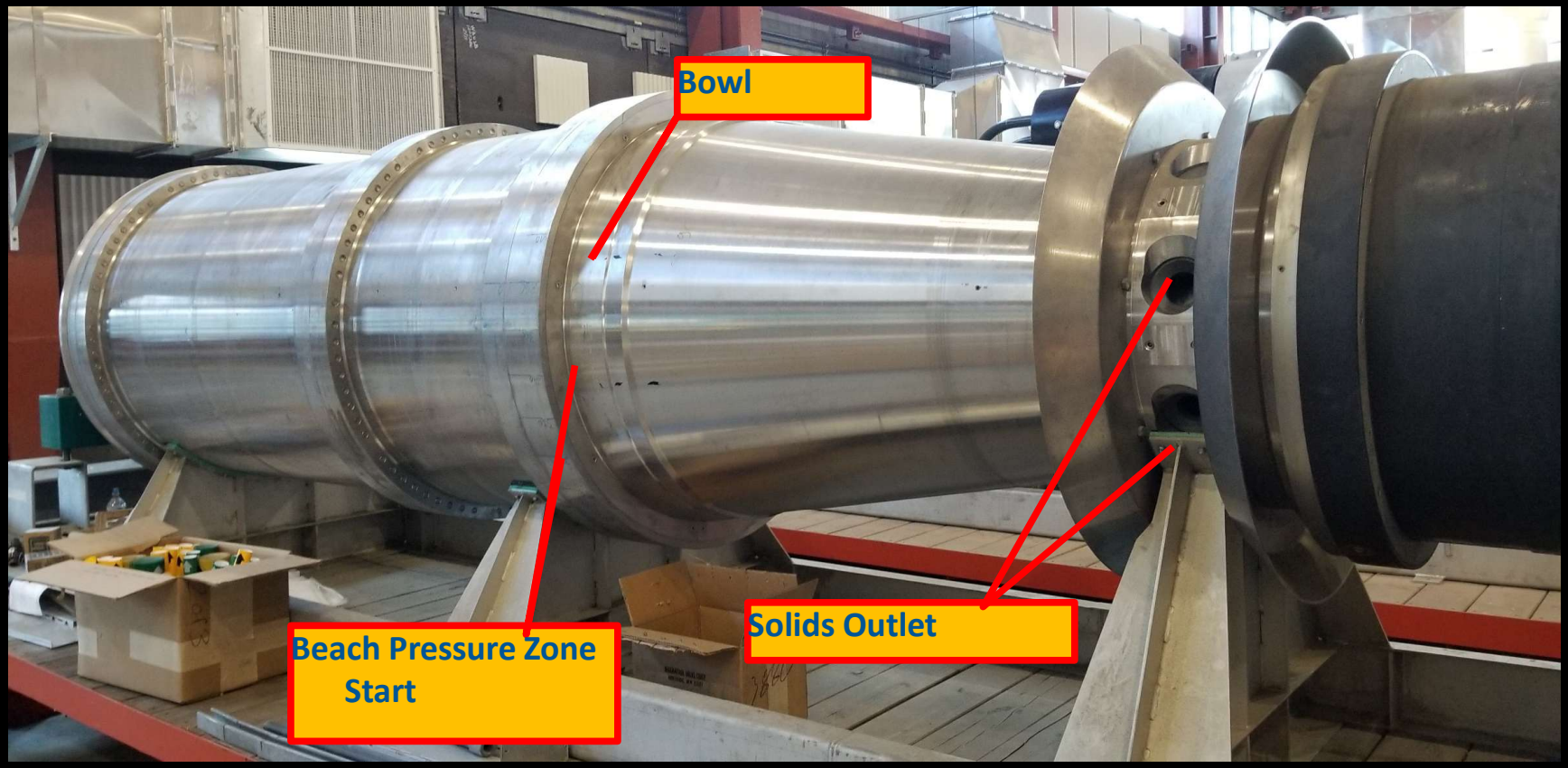
Centrifuge Thin Sludge Testing Setup

- Polymer Jar Testing
  - Confirmed existing polymer creates good floc at as low as 0.5% TS feed solids w/ NPW
  - Small polymer dose increase may be needed at thinner sludge feed rates
- Determine NPW Injection Location Into Centrifuge Feed

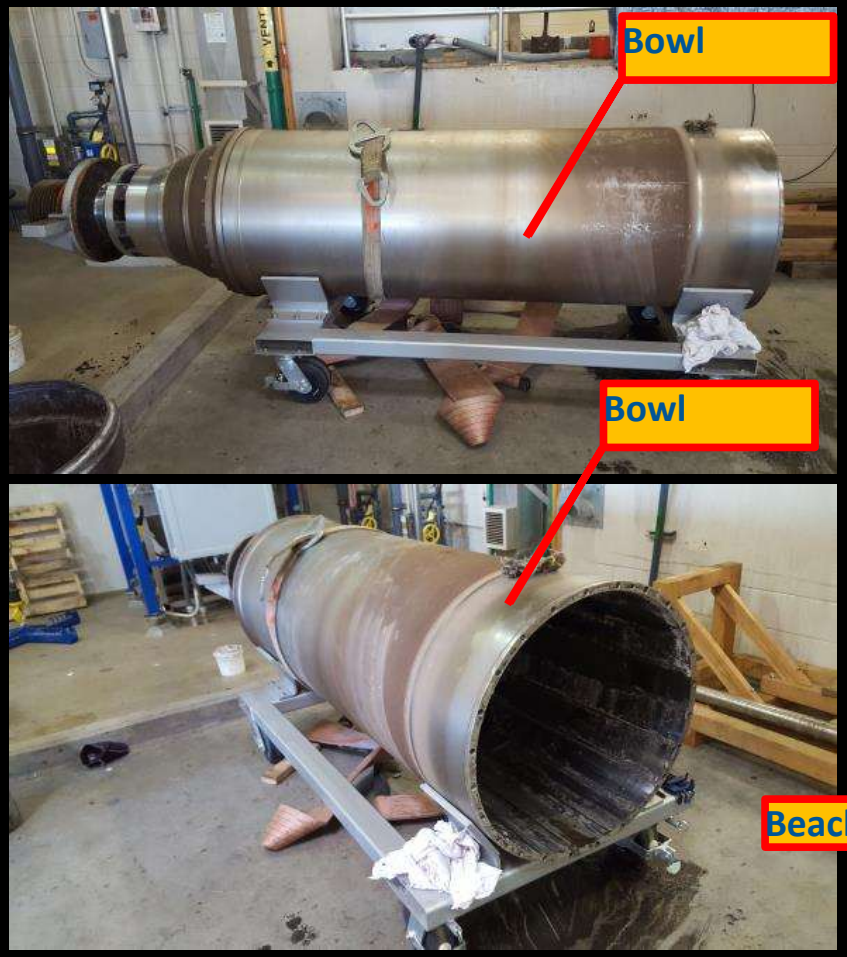


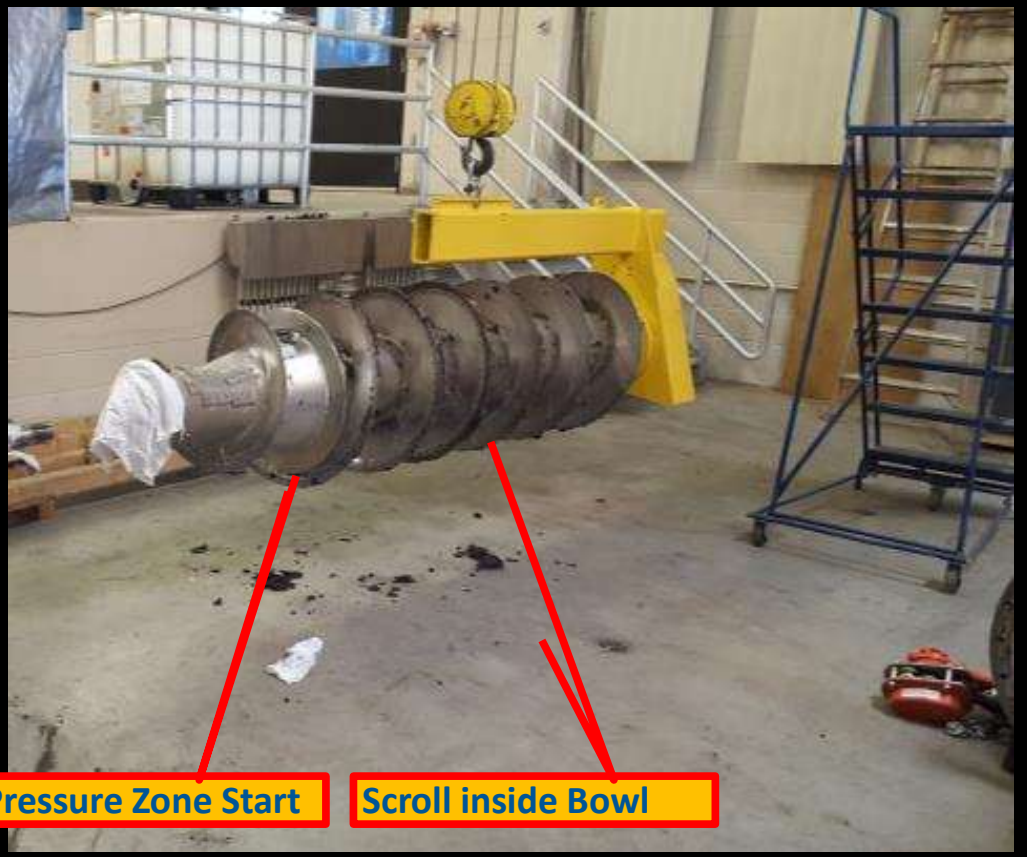
Centrifuge Operation Fundamentals

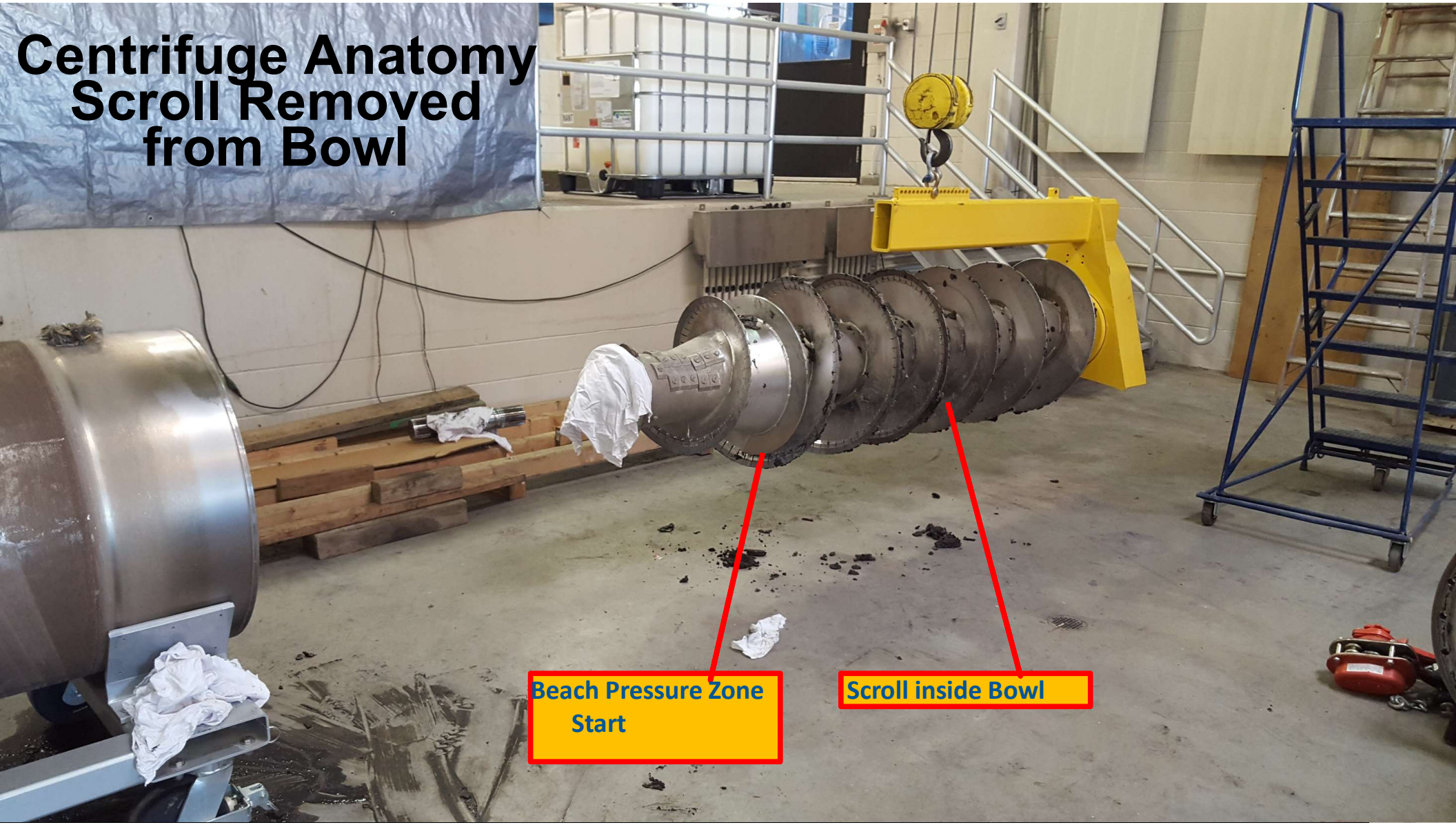
Centrifuge Anatomy



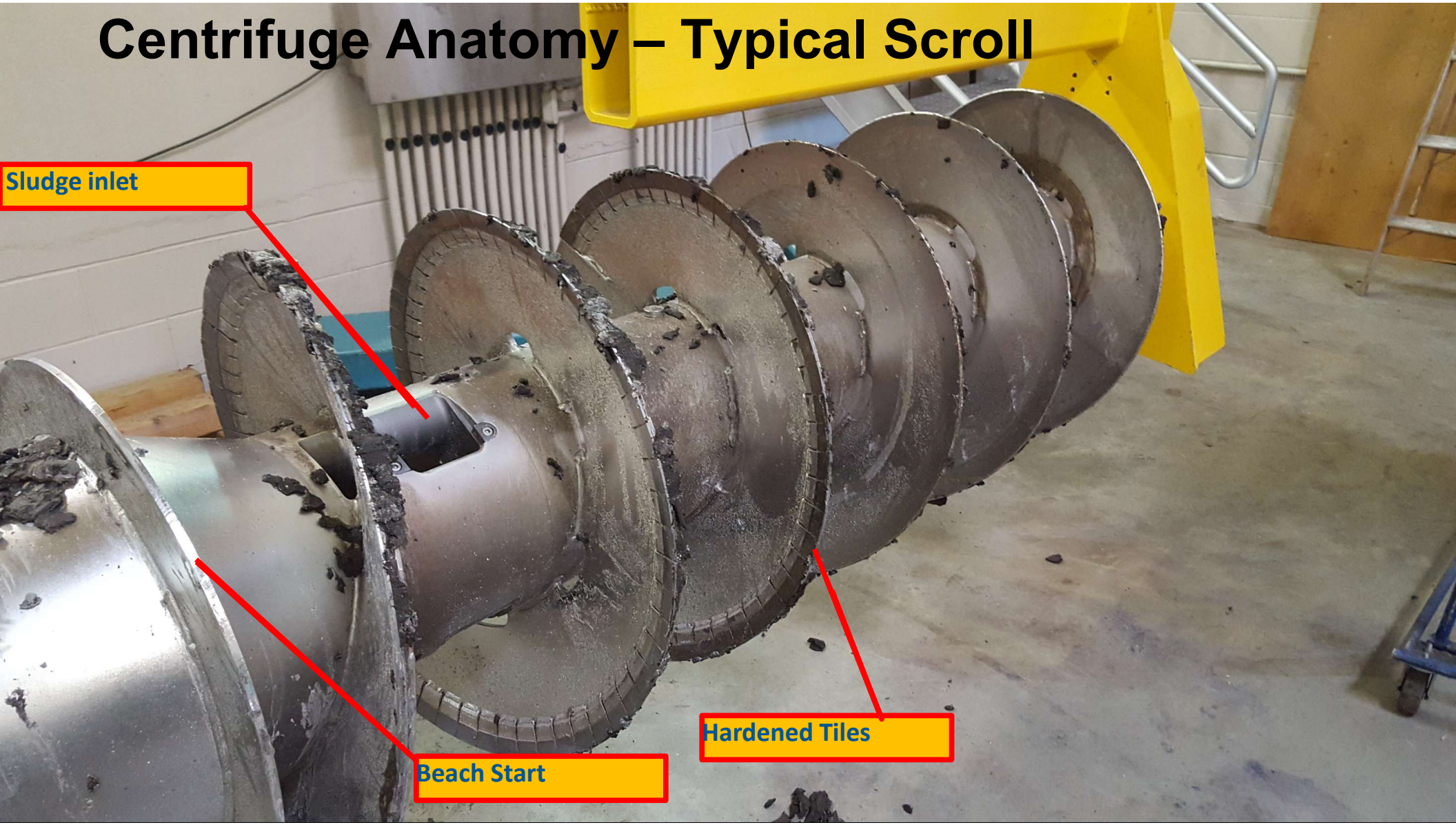
Centrifuge Anatomy Breakdown



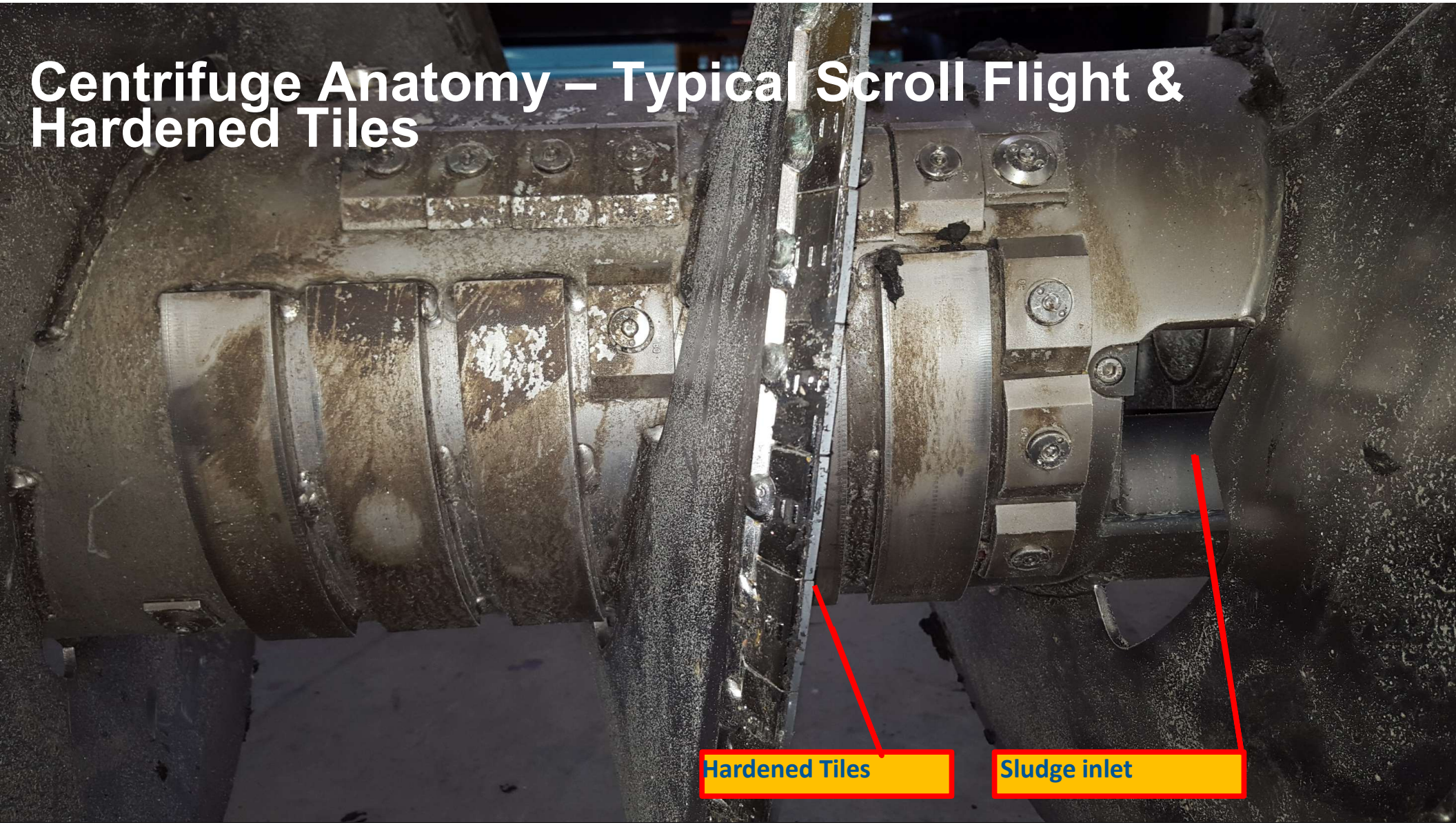



Centrifuge Anatomy
Scroll Removed
from Bowl
Beach Pressure Zone
Start
Scroll inside Bowl

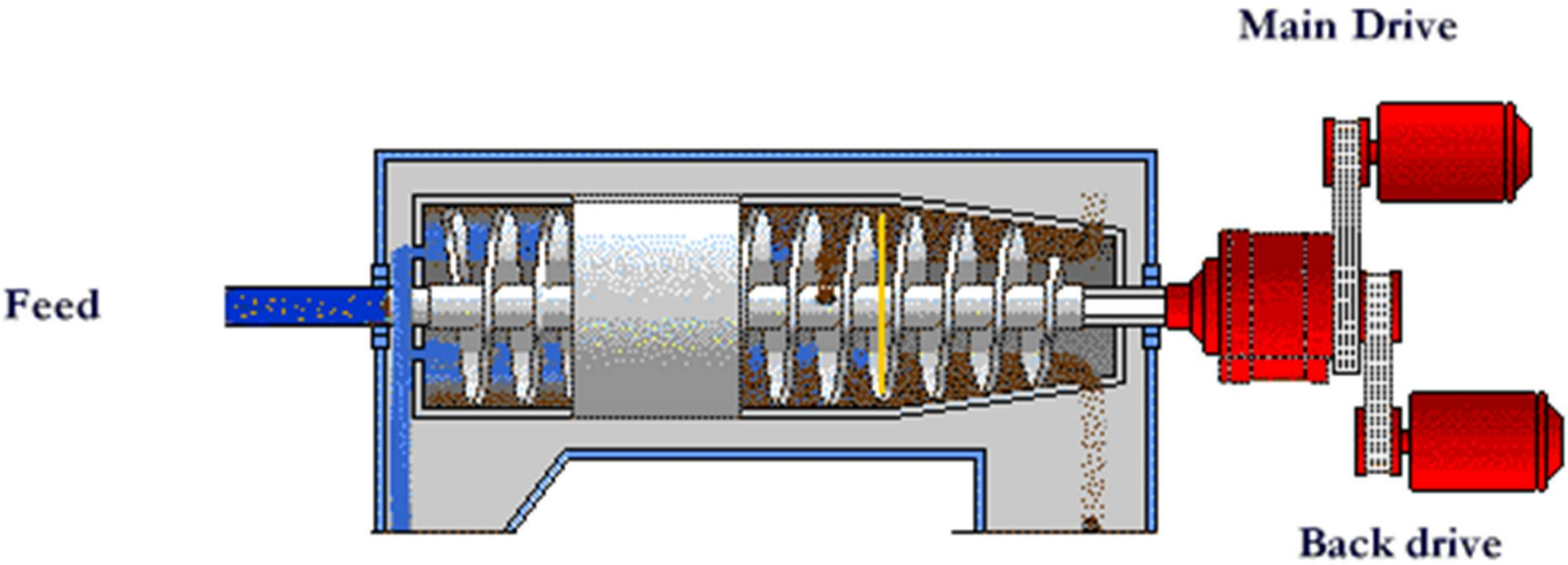
Centrifuge Anatomy – Typical Scroll



Centrifuge Anatomy – Typical Scroll Flight & Hardened Tiles

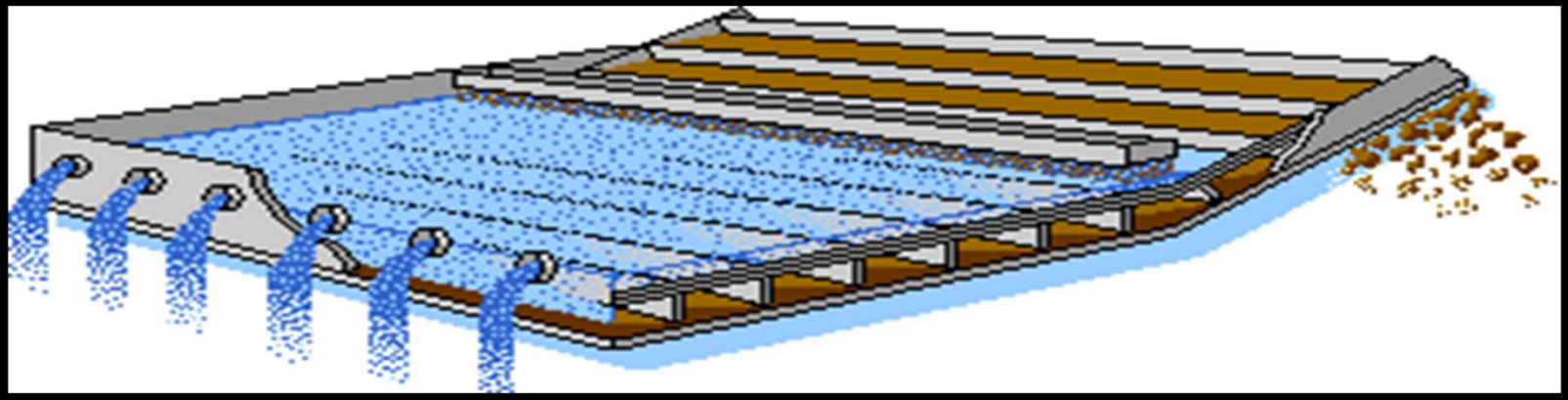


Centrifuge Anatomy

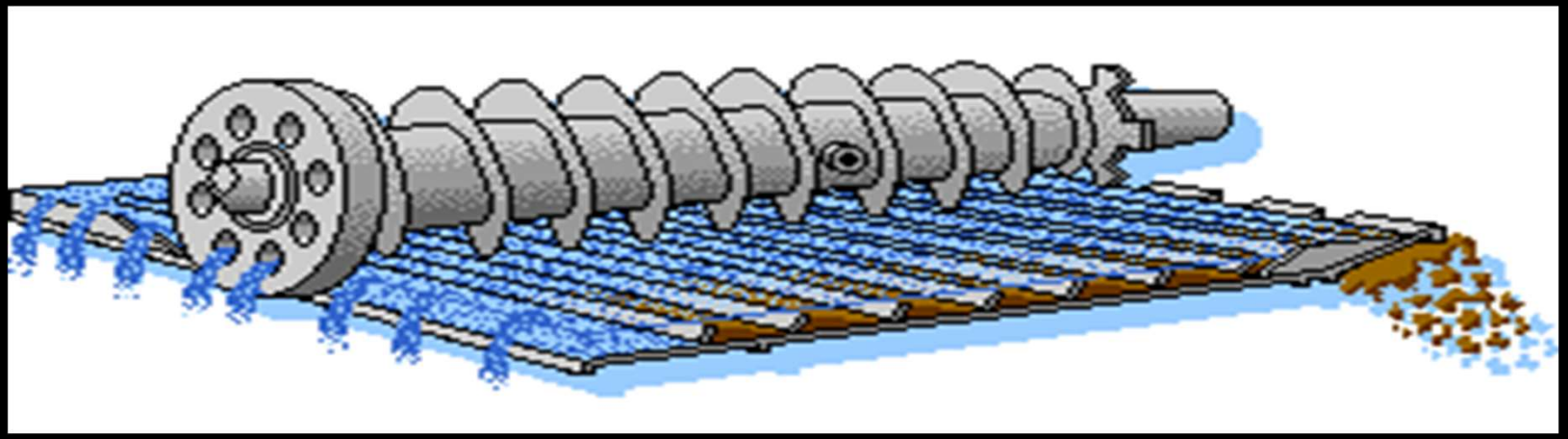


Animations Complements of Alfa-Laval

Centrifuge Anatomy

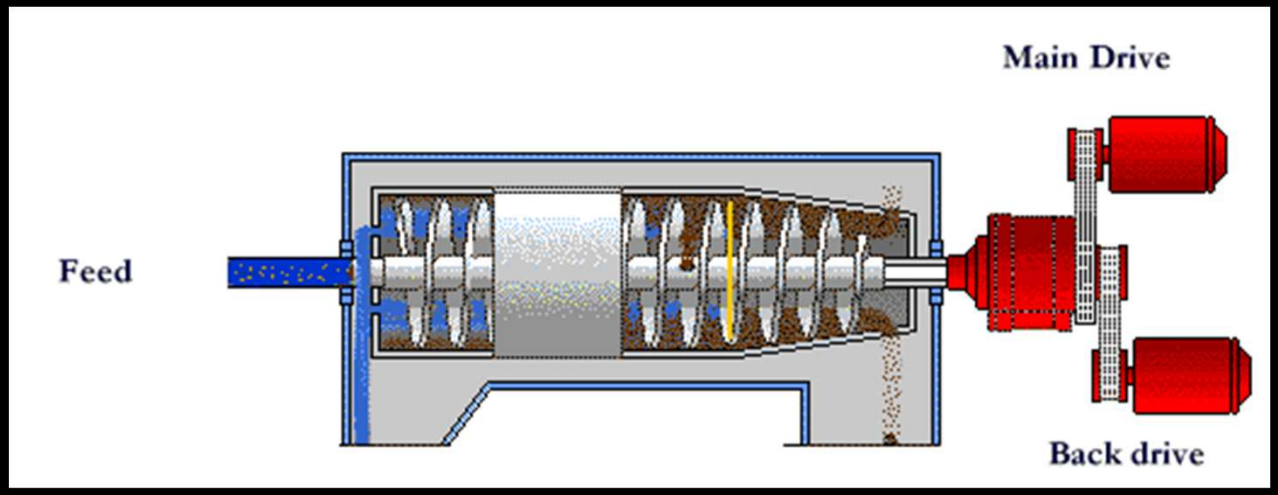


The decanter centrifuge is like a clarifier…..



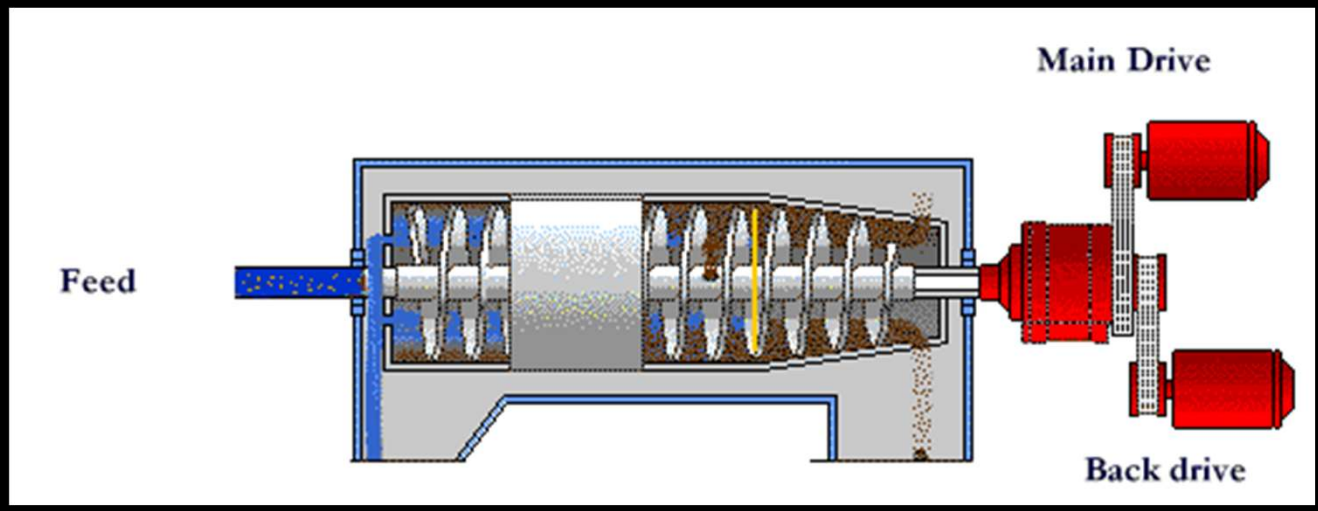
Operational Control – Differential Speed

- Scroll Rotates at a consistent different speed than the bowl
  - Greater speed difference = Faster solids discharged & less residence time
  - Lower speed difference = Higher %TS & longer residence time



Operational Control - Torque

- Scroll Speed Changes Based on Resistance from Solids
- Higher % TS – higher torque
- Allows for Consistent Cake
- Variations in Torque
  - Changes in feed characteristics
  - Polymer dosage



Centrifuge Optimization Test Results

Test #1 - Thin Sludge, Low Solids Loading Rate (Minimum Flow Rate) Findings:

- Stable performance 1,500 lbs/hr (Machine's minimum rated throughput)
- Stable performance at 0.8% TS
- No torque, centrate quality, or cake total solids changes.
- Centrifuge can handle thinner sludge during wet weather events without negative impacts

DATE, TIME, & RUN No.			PROCESS READINGS					LAB RESULTS		CALC'D RESULT
Date	Time	Run Number	Feed Rate gpm	NPW Rate gpm	Feed + NPW gpm	Scroll Differ. (RPM)	Scroll Torque (%)	Feed % TS	Cake % TS	Feed Loading dry lbs/hr
Tuesday, July 30, 2024	12:00	1	135	0	135	2.0	50	3.62	31.52	2445
Tuesday, July 30, 2024	13:15	2	135	50	185	2.0	50	Not Taken	Not Taken	#VALUE!
Tuesday, July 30, 2024	13:50	3	135	100	235	2.0	50	1.47	33.00	1728
Tuesday, July 30, 2024	13:50	4	135	100	235	2.0	50	1.62	Not Taken	1904
Tuesday, July 30, 2024	14:00	5	135	100	235	2.0	50	1.55	Not Taken	1822
Tuesday, July 30, 2024	14:30	6	135	150	285	2.0	50	3.74	Not Taken	2526
Tuesday, July 30, 2024	15:00	7	135	158	293	2.0	50	3.74	34.11	2526
Tuesday, July 30, 2024	15:00	8	135	158	293	2.0	50	1.14	Not Taken	1671
Tuesday, July 30, 2024	15:00	9	135	158	293	2.0	50	0.84	Not Taken	1231
Tuesday, July 30, 2024	15:00	10	135	158	293	2.0	50	1.13	Not Taken	1656
Tuesday, July 30, 2024	16:20	11	100	156	256	2.0	50	1.33	37.42	1703
Tuesday, July 30, 2024	16:20	12	100	156	256	2.0	50	1.20	Not Taken	1537
Tuesday, July 30, 2024	16:20	13	100	156	256	2.0	50	1.18	Not Taken	1511

Test #2 - Thin Sludge and High Solids Loading (Maximum Flow Rate) Findings:

- Stable performance up to 350 GPM Feed (Machine's maximum rated hydraulic throughput)
- Stable performance at as low as 1.8% TS Feed
  - NPW Injection limited lower %TS Feed testing
- No torque, centrate quality, or cake total solids changes.
- Centrifuge can handle thinner sludge during wet weather events without negative impacts at high flow rates

DATE, TIME, & RUN No.			PROCESS READINGS					LAB RESULTS		CALC'D RESULT
Date	Time	Run Number	Feed Rate gpm	NPW Rate gpm	Feed + NPW gpm	Scroll Differ. (RPM)	Scroll Torque (%)	Feed % TS	Cake % TS	Feed Loading dry lbs/hr
Wednesday, July 31, 2024	07:00	1	140	0	140	2.0	50	4.84	35.56	3390
Wednesday, July 31, 2024	07:20	2	185	0	185	2.0	50	4.84	Not Taken	4479
Wednesday, July 31, 2024	10:15	3	185	75	260	2.0	50	2.73	35.78	3551
Wednesday, July 31, 2024	10:15	4	185	75	260	2.0	50	2.71	35.78	3525
Wednesday, July 31, 2024	11:30	5	185	159	344	2.0	50	1.79	39.74	3080
Wednesday, July 31, 2024	11:30	6	185	159	344	2.0	50	1.83	39.74	3149
Wednesday, July 31, 2024	12:15	7	185	159	344	2.0	50	2.04	39.74	3510
Wednesday, July 31, 2024	12:15	8	185	159	344	2.0	50	2.38	39.74	4096

Test #3 - Polymer Reduction Optimization (Cost Saving) Findings:

- Polymer dose was reduced to as low as 5.2 lbs/dt while still maintaining a 95% solids capture rate.
- 30% potential reduction in polymer use possible without compromising performance.

DATE, TIME, & RUN No.			PROCESS READINGS							POLYMER INFO					LAB RESULTS		CALCULATED RESULTS		
Date	Time	Run Number	Feed Rate gpm	NPW Rate gpm	Feed + NPW gpm	Polymer to Sludge Ratio	Poly Rate gpm	Scroll Differ. (RPM)	Scroll Torque (%)	Neat Poly %active	Intro Point	Dilute Soln %active	Post Dilution gpm	Dilute Soln gpm	Feed % TS	Cake % TS	Feed Loading dry lbs/hr	Solids Recovery %	Polymer Dose active lbs/ton
Wednesday, July 31, 2024	3:15	1	160	0	160	15.50%	24.8	2.0	50	39.0	3B Inlet	0.11	0	24.8	4.63	37.10	3706	100.0	7.4
Wednesday, July 31, 2024	3:25	2	160	0	160	14.75%	23.6	2.0	50	39.0	3B Inlet	0.11	0	23.6	4.63	34.47	3706	97.9	7.0
Wednesday, July 31, 2024	3:35	3	160	0	160	14.25%	22.8	2.0	50	39.0	3B Inlet	0.11	0	22.8	4.63	38.06	3706	97.7	6.8
Wednesday, July 31, 2024	3:45	4	160	0	160	13.00%	20.8	2.0	50	39.0	3B Inlet	0.11	0	20.8	4.63	39.73	3706	97.9	6.2
Wednesday, July 31, 2024	3:55	5	160	0	160	12.00%	19.2	2.0	50	39.0	3B Inlet	0.11	0	19.2	4.63	38.96	3706	96.8	5.7
Wednesday, July 31, 2024	4:05	6	160	0	160	11.00%	17.6	2.0	50	39.0	3B Inlet	0.11	0	17.6	4.63	39.33	3706	95.0	5.2
Wednesday, July 31, 2024	4:15	7	160	0	160	10.00%	16.0	2.0	50	39.0	3B Inlet	0.11	0	16.0	4.63	36.12	3706	89.9	4.8

Test #4 - Centrifuge Higher Bowl Speed (Cake Solids Control) Findings:

- Bowl speed increased from 2300 RPM to 2500 RPM
- No significant operational benefits
- Introduces higher energy consumption and potential additional wear-and-tear issues
- No improvements in cake solids control or performance

DATE, TIME, & RUN No.			PROCESS READINGS				LAB RESULTS			CALC'D RESULTS		Motor Data
Date	Time	Run Number	Feed Rate gpm	Scroll Differ. (RPM)	Scroll Torque (%)	Bowl Speed (RPM)	Feed % TS	Cake % TS	Centrate % TS	Feed Loading dry lbs/hr	Solids Recovery %	Bowl Motor Amps
Thursday, August 1, 2024	9:00	1	160	2.0	50	2300	4.06	39.09	0.06	3250	98.7	49.6
Thursday, August 1, 2024	10:10	2	160	2.0	50	2400	4.06	37.14	0.08	3250	98.2	51.0
Thursday, August 1, 2024	10:20	3	160	2.0	50	2500	4.06	37.75	0.00	3250	100.0	52.5

Test #5 - Centrifuge Lower Bowl Speed (Cake Solids Control & Centrate Quality) Findings:

- The bowl speed was decreased from the standard 2300 RPM to 2000 RPM
- Lower bowl speed maintains desired cake concentration of >28% TS
- An 11-amp energy savings per centrifuge
- Lowering the bowl speed can reduce wear on the centrifuge bearings and extend equipment life

CENTRIFUGE No. 3B													
DATE, TIME, & RUN No.			PROCESS READINGS				LAB RESULTS			CALC'D RESULTS		Motor Data	
Date	Time	Run Number	Feed Rate gpm	Scroll Differ. (RPM)	Scroll Torque (%)	Bowl Speed (RPM)	Feed % TS	Cake % TS	Centrate % TS	Feed Loading dry lbs/hr	Solids Recovery %	Bowl Motor Amps (%)	Bowl Motor Amps (A)
Thursday, August 1, 2024	9:00	1	160	2.0	50	2300	4.06	39.09	0.06	3250	98.7	49.6	149.8
Thursday, August 1, 2024	10:45	1	160	2.0	50	2200	4.06	39.47	0.14	3250	96.9	47.8	144.4
Thursday, August 1, 2024	11:10	2	160	2.0	50	2100	4.06	38.40	0.18	3250	96.0	46.7	141.0
Thursday, August 1, 2024	11:30	3	160	2.0	50	2000	4.06	39.23	0.12	3250	97.3	45.9	138.6
Thursday, August 1, 2024	11:30	4	160	2.0	50	2000	4.06	37.91	0.09	3250	98.0	45.9	138.6

Test #6 - Centrifuge Lower Torque (Cake Solids Control & Centrate Quality)

- Lowered torque from 50% to 42%
- Lowering the torque resulted in a wetter cake which could be useful when cake total solids are too dry for the incinerator

CENTRIFUGE No. 3B											
DATE, TIME, & RUN No.			PROCESS READINGS				LAB RESULTS			CALC'D RESULTS	
Date	Time	Run Number	Feed Rate gpm	Scroll Differ. (RPM)	Scroll Torque (%)	Bowl Speed (RPM)	Feed % TS	Cake % TS	Centrate % TS	Feed Loading dry lbs/hr	Solids Recovery %
Thursday, August 1, 2024	12:30	1	250	2.0	50	2300	4.06	39.09	0.06	5077	98.7
Thursday, August 1, 2024	14:20	2	250	3.0	48	2300	4.06	38.61	0.24	5077	94.7
Thursday, August 1, 2024	14:30	3	250	4.0	46	2300	4.06	36.20	0.20	5077	95.6
Thursday, August 1, 2024	14:45	4	250	4.0	44	2300	4.06	35.29	0.21	5077	95.4
Thursday, August 1, 2024	14:55	5	250	4.0	42	2300	4.06	33.01	0.21	5077	95.4

Next Steps

Conclusion

- Optimization is a Continuous Process
- Understand Performance Links Among Various Parameters
- Maintain Operating Records to Identify Process & Operational Changes
- Take Action!

THANK YOU

Centrifuge Operational Adjustments Result in Cost Savings Opportunities at NEORSD

Brian Flannagan, NEORSD
FlanaganB@neorsd.org

Adam Parmenter, HDR
Adam.Parmenter@hdrinc.com
612-501-2010