Implementation of an Automated System for Slurry Viscosity and Density Measurement : Impact on Shell Quality and Labor Efficiency

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Presentation outline

- Problem Statement
- What is the technology?
  - Rheonics SlurrySense
  - Nalco Ecolab 3D TRASAR™ for Slurry Control
- Experimental Procedure
- Characterization of events
- Data Generation LT stability of the sensor
- Results and Trends
- Observations & Conclusions
- Summary and Future Work
- Feedback on Trial
- Acknowledgments

Problem Statement

Investment Casters seek to

- Enhance operational resources
- Reduce costs
- Improve efficiency
- Maintain consistent quality

Case Study

TPM prioritizes **Statistical Process Control**, **Overall Cost**, and **Labor.**

TPM's efforts to improve these have identified **manually slurry consistency testing** as a key area to improve for more efficient **process control**.

Shell Control Solution

rheonics

SRD SlurrySense™
self-cleaning viscosity and density meter

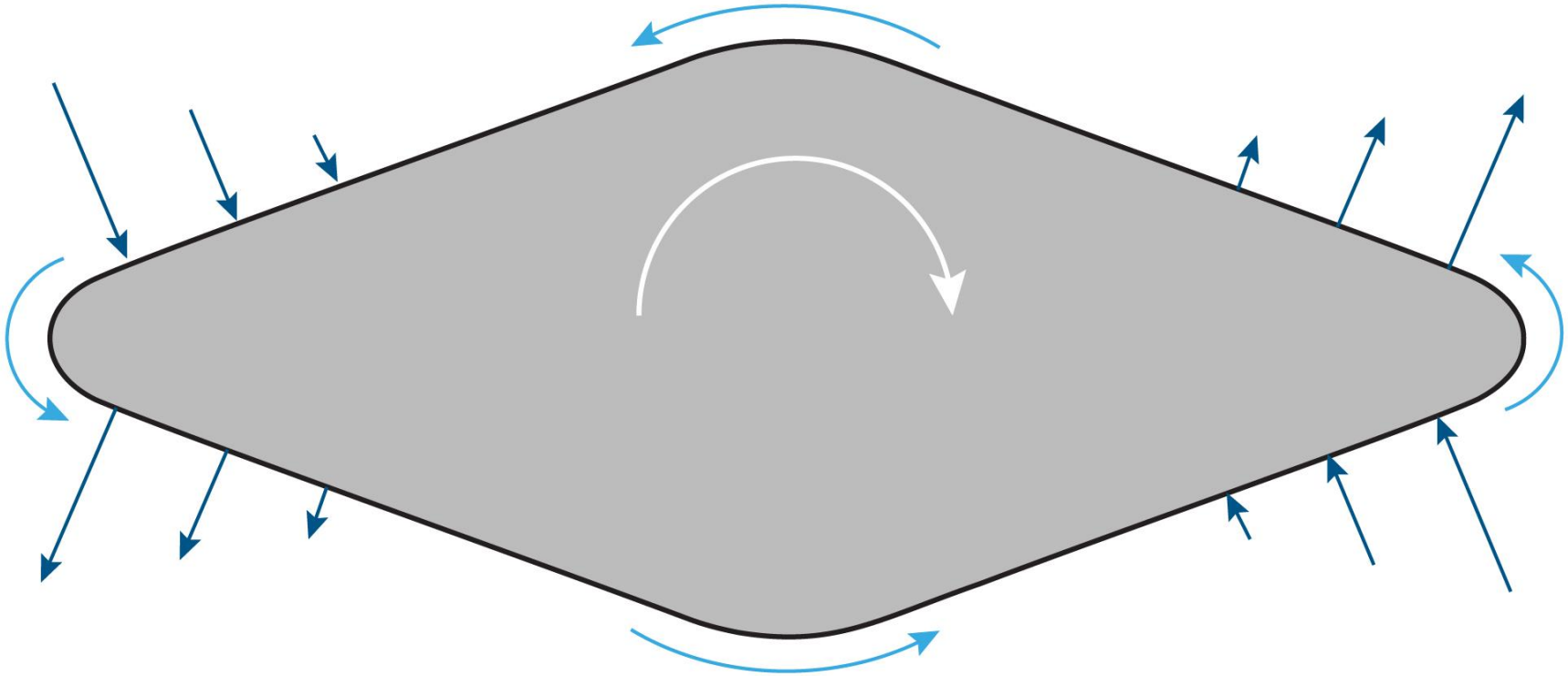
+

NALCO Water

3D TRASAR™ Technology for Slurry Control

Rheonics SRD SlurrySense™

Tip of sensor vibrates at high frequency and very small amplitude

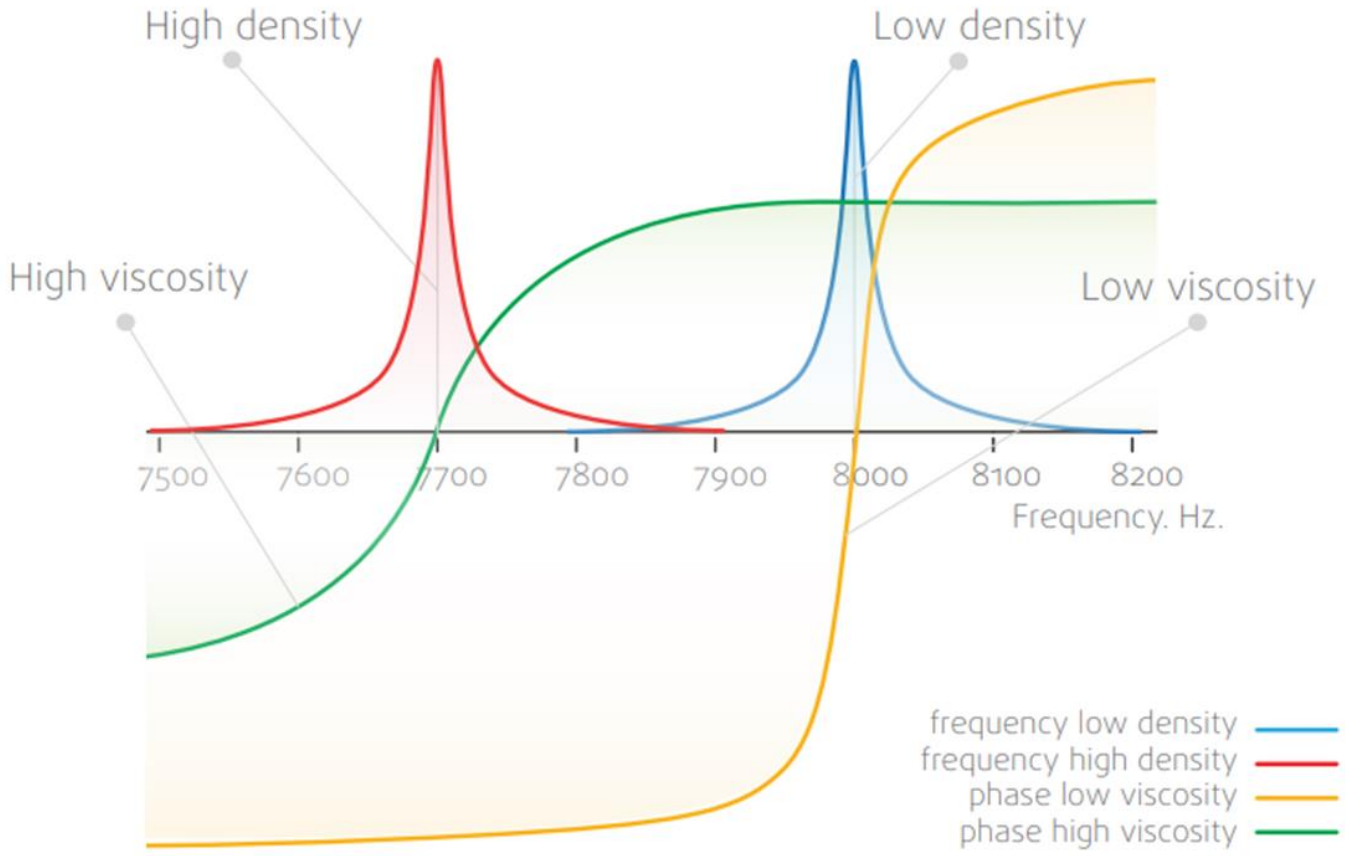


Torsional vibration of SRD tip both **displaces** and **shears** the slurry. These combined forces enable measurement of both **density** and **viscosity** with a single sensor.

Measurement Principle

Raising the **density** of the fluid decreases the SRD's resonance frequency. **Displacement** of the slurry increases the perpendicular force on the tip and lowers its resonant frequency.

Raising the **viscosity** damps the SRD's frequency response, broadening and reducing the amplitude of this resonance curve. **Shearing** of the slurry creates tangential forces on the tip and damps its resonance.

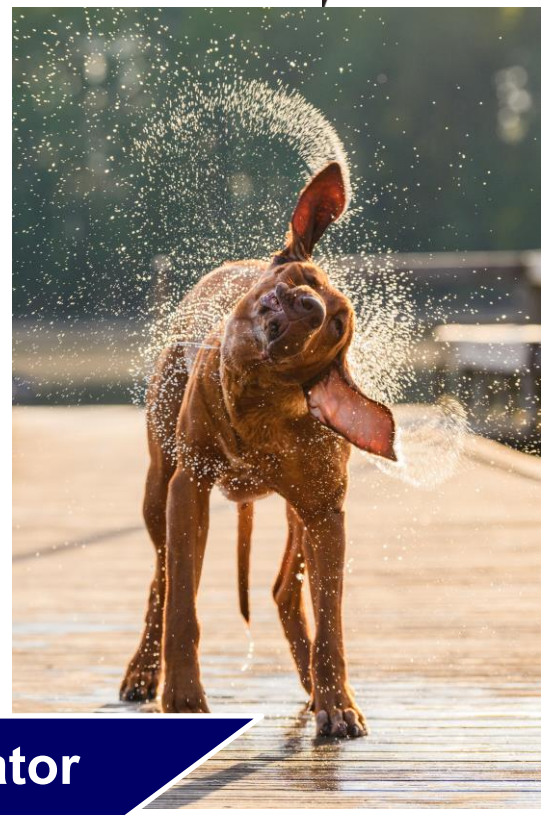


Response of the same resonator immersed in two fluids of different densities and viscosities

Self-Cleaning Design Principle

- Slurries can form deposits on the SlurrySense surface, distorting readings
- CleanWave™ technology superimposes vibrations to clean the sensor
- Prevents and clears deposits

Custom Length

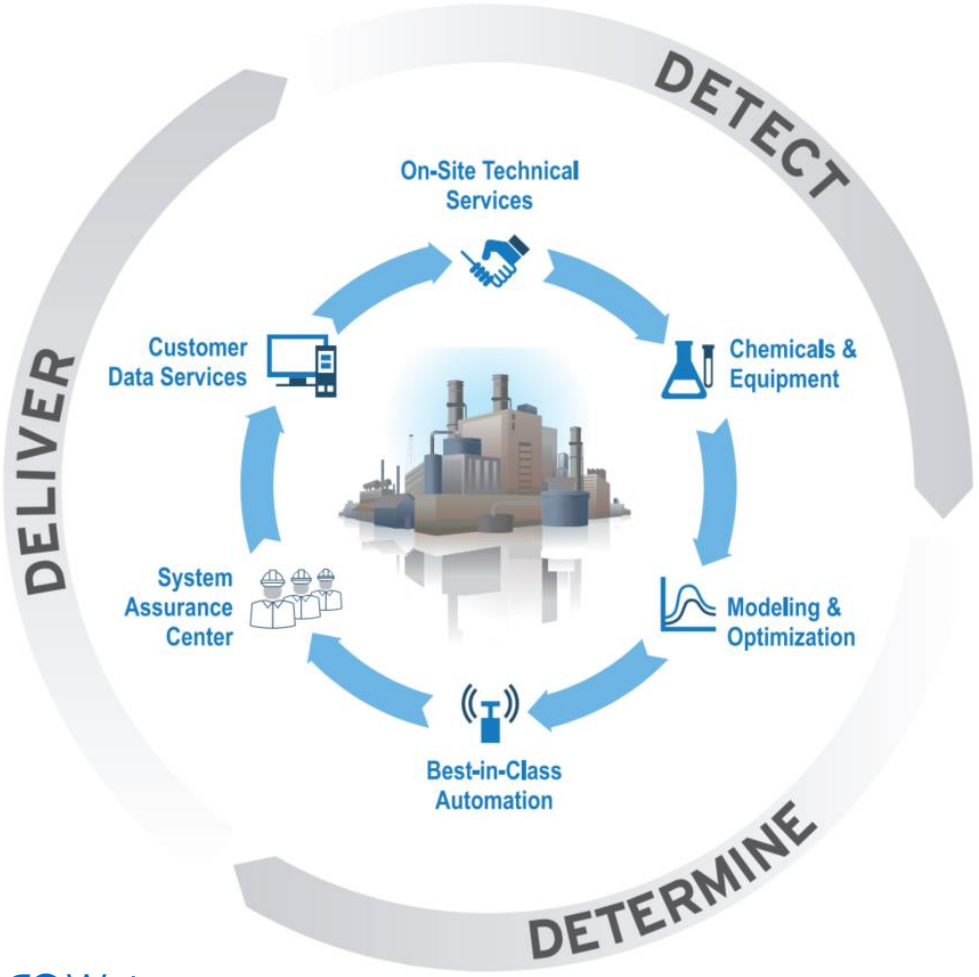


Built-in Vibrator

- High amplitude
- Low frequency

Rheonics SlurrySense

3DTRASAR™ TECHNOLOGY



ACHIEVE YOUR GOALS

With Nalco Water expertise and advanced technology, we help our customers **Minimize Waste** and **Maximize Results** at **Optimized Costs.**

3D TRASAR™

DETECT system variability and operational problems

DETERMINE proper corrective actions

DELIVER the results that drive optimal performance and savings

3D TRASAR™ Technology for Slurry Control - Monitor

Manual data entry

Platform for analysis that displays key data from multiple sources

Shell System Experts

Mobile Field App

Remote digital services to describe, diagnose and predict

Ecolab Global Intelligence Center

Rheonics SlurrySense™

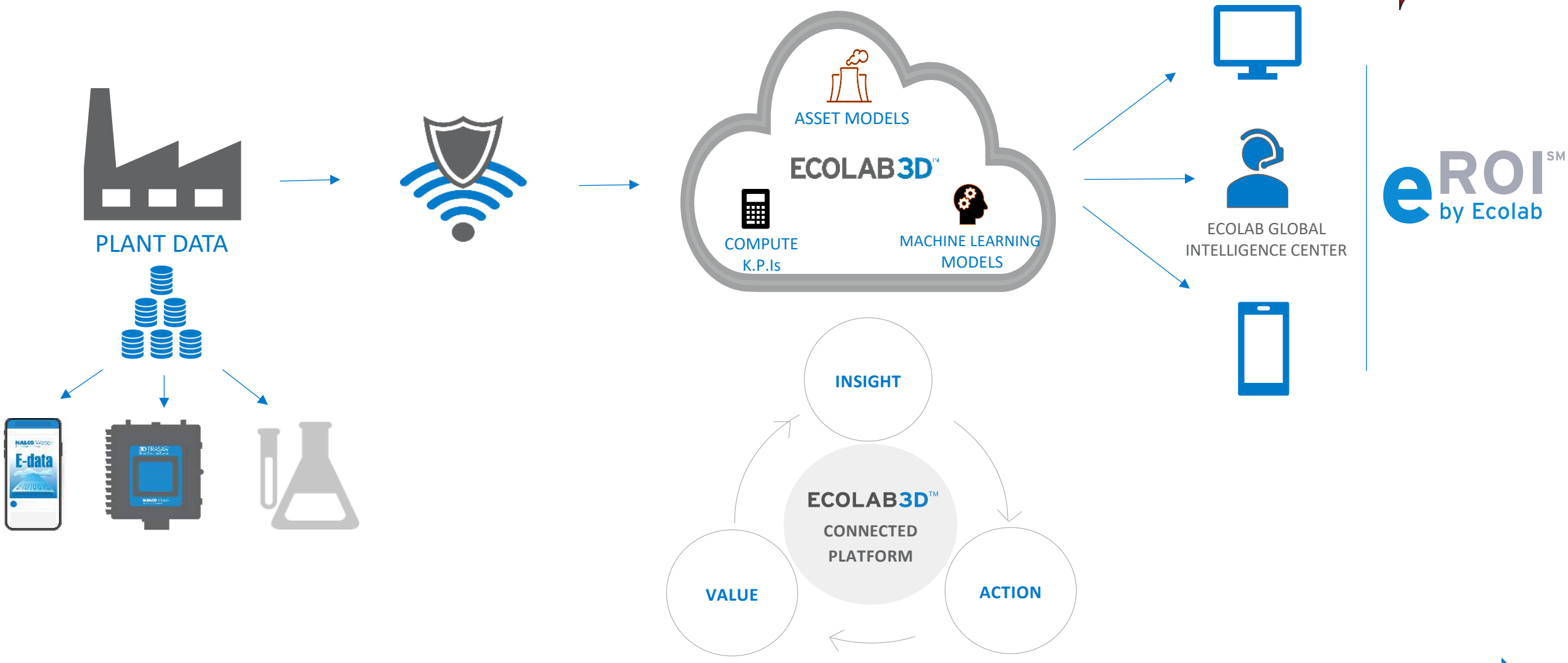
Investment Casting Shell slurry

Measurement of viscosity and density

3D TRASAR™

Data monitoring and control with the alert capability

Transforming Data Into Powerful Insights



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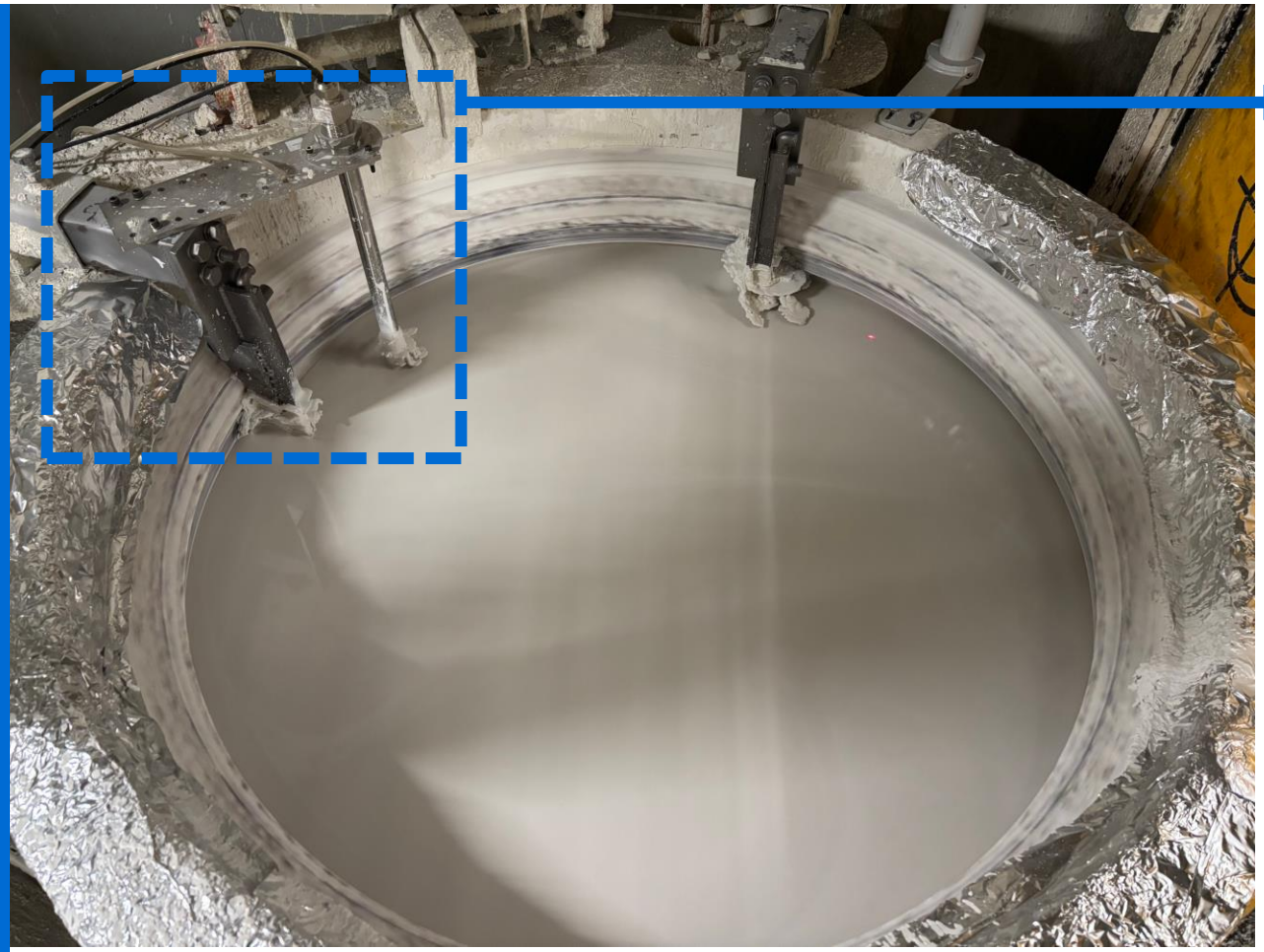
Introduce Texas Precision Metalcraft (TPM) Case Study

- Sensor mounting
- Overlay cup vs sensor
- Data collected before and After (stats)
- TVD for Texas Precision Metalcraft
- Testimonial Voice of Texas Precision Metalcraft
- Conclusions
- Acknowledgements

Sensor mounting

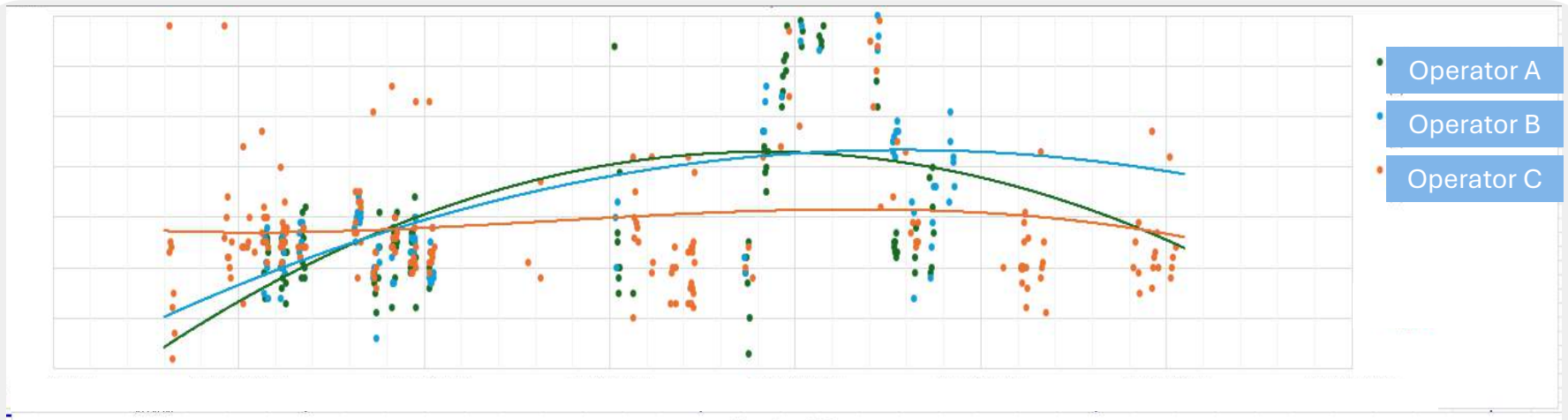


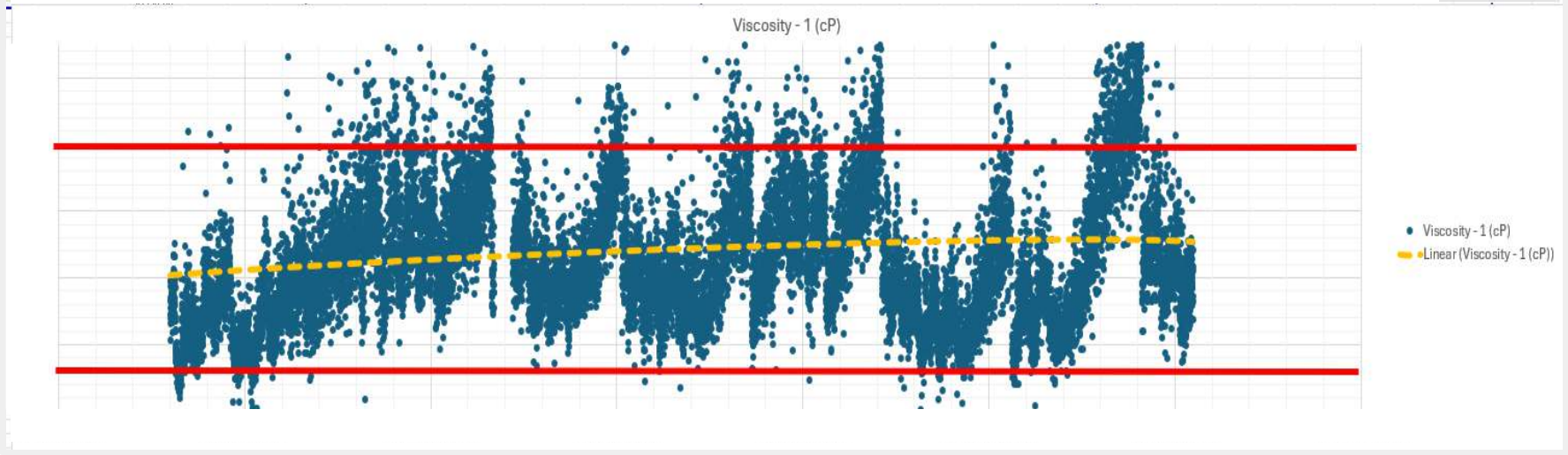
- Rheonics SRD SlurrySense™ with CleanWave technology mounted in the prime tank at Texas Precision Metalcrafts

Viscometer mounted in a tank

Viscometer

Viscosity Overlay





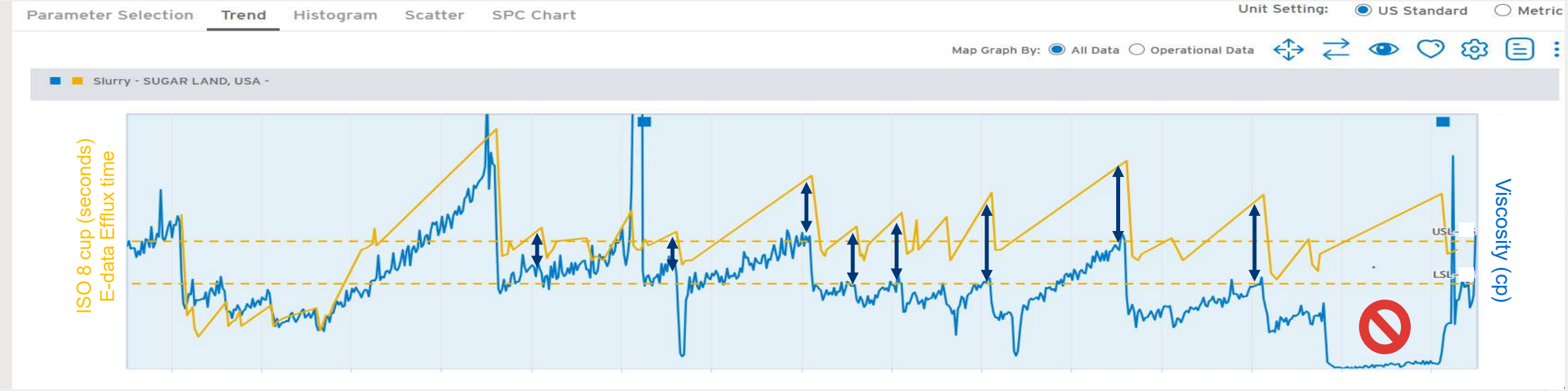
Key Findings

- ❑ Operator A, B, C have the measurement gap
- ❑ Operator C is most experience operator
- ❑ Viscometer, operator C have the similar linear
- ❑ Depending on the operators, ISO 8 cup measurement has the larger variance

Operator-to-Operator variability is high, prone to more error than use of sensor

Week 11-15 at TPM - Monitor

Week 1-5 (Define) | **Week 6-10 (Measure)** | **Week 11-15 (Analyze)**



Stable Trend

- Confirm that the viscosity of the primary slurry is consistent with the ISO 8 efflux time.

Small Gap

- A small discrepancy was observed between the viscometer readings and the ISO 8 efflux time.
- SRD cleaning occurred on 12/12, resulting in notable spikes.

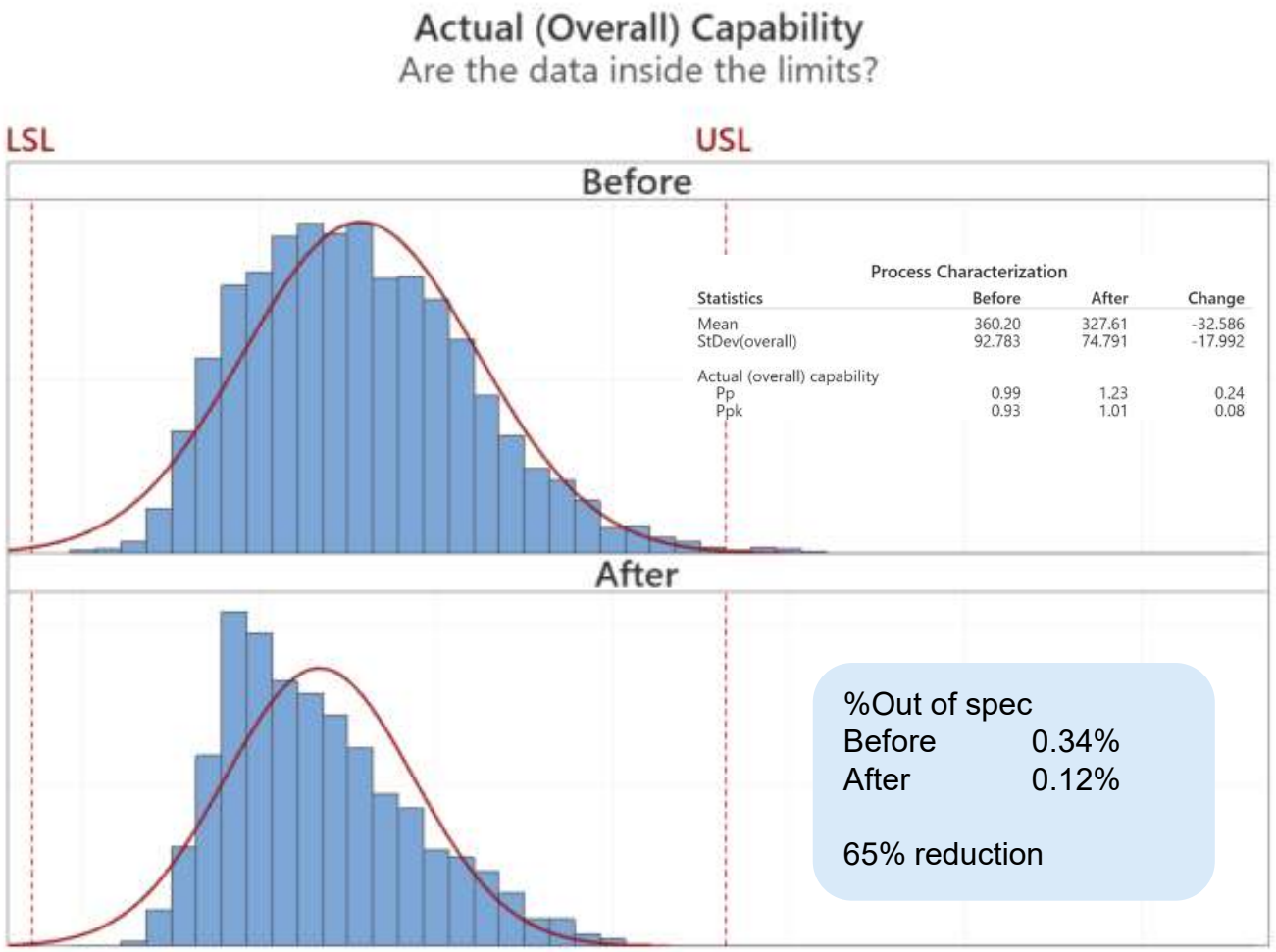
Large Gap

- There is an elevated disparity observed between the ISO 8 efflux time and the viscometer readings.

Abnormal Trend

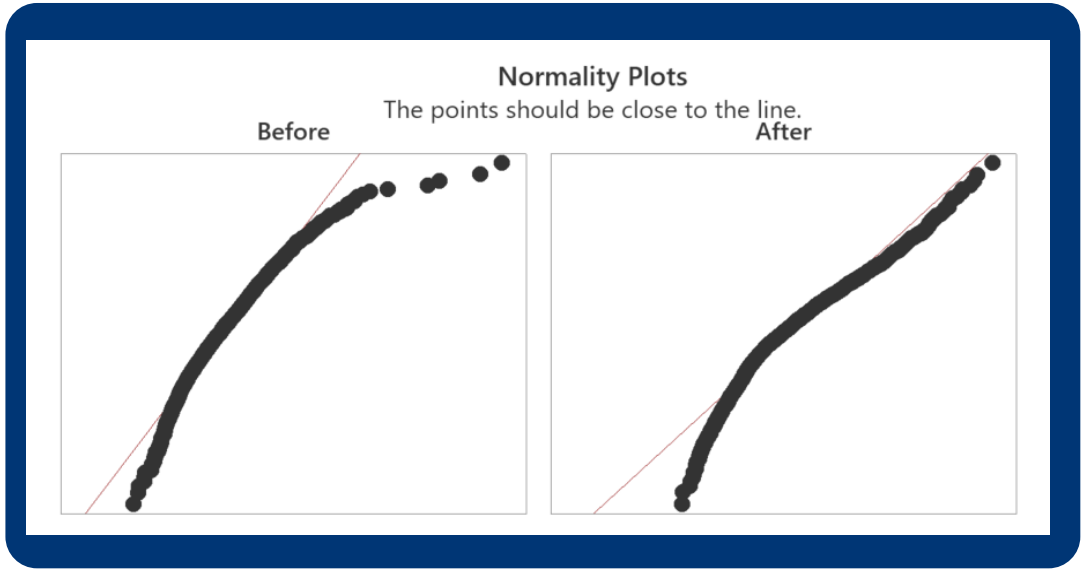
- The ISO 8 cup misread the prime slurry viscosity, showing abnormal readings compared to historical data.
- The ISO 8 cup has been replaced with a new one.

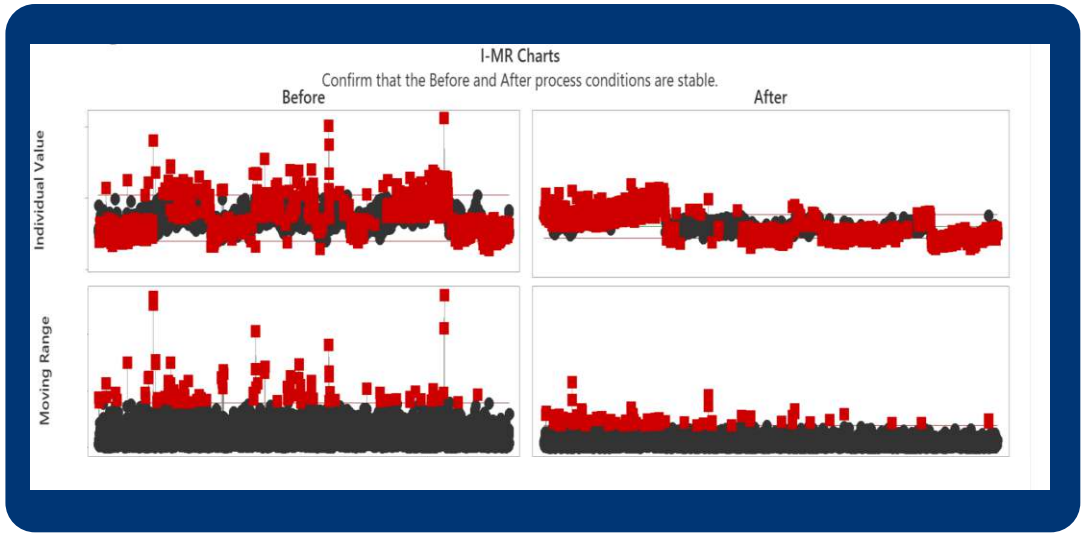
Capability Comparison before/after



%Out of spec
Before 0.34%
After 0.12%

65% reduction





NALCO Water **Process capability increased after implementation of monitor & notify, % out of spec reduced by 65%**

eROI Calculation Total Value Delivered – TPM

LABOR PRODUCTIVITY

Viscosity measurement Labor Reallocated

200 hrs

PRODUCTIVITY

Robot Downtime Improvement

5%

PRODUCTIVITY

Efficiency improvement to data access

95 %

PRODUCTIVITY

Robot operational cost Saving

$6600

PROFITABILITY

Revenue loss saving with robot downtime

1000 trees

COSTS

Labor reduction

$5,000

RELIABILITY

Viscosity data additional visibility

102,720

HUMAN HEALTH & SAFETY

Risk reduction of fall injury

1.86%

RAW MATERIAL OPTIMIZATION

Slurry life extension

$8300

PRODUCT QUALITY

Improve slurry consistency

65%

RELIABILITY

Data accuracy improvement

95%

PRODUCT QUALITY

Improvement of process control (PpK)

0.08

WASTE

Prime disposal

$25000

TOTAL VALUE DELIVERED

Summary and Future work

- **The Shell Control technology has demonstrated:**
  - Synergy between Rheonics SlurrySense & Ecolab's 3D TRASAR™ controller and ECOLAB3D digital platform
  - More consistent measurement than using viscosity cup measurements
  - Improves process control and reduces slurry variability
- **Future work:**
  - Optimize process control leveraging the automation dosage system through the relay on 3D TRASAR controller
  - Enhance control of slurry viscosity and density in other Slurry Tanks

Chart 1: Prior to Control – Slurry Fluctuations & Spikes

Chart 2: After Automatic Dosing Control – Slurry Consistency & Stability

Automated Slurry Monitoring significantly reduced variability, transforming an unstable and inconsistent process into a stable, controlled, and predictable trend!

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Voice from TPM, Q&A

- *In traditional viscosity testing, variability by operator to operator, as well as for the same operator over different days can be a concern for getting measurements that can be "trusted".*

- *Utilizing the sensor reduces/eliminates interruptions to the operator's and the robot's productivity. There is also a safety improvement as the operator is not entering the "robot movement" zone and is not using a ladder to access the slurry tank.*

- *The sensor has proven to give consistent viscosity results in a reliable and predictable time frame. This has increased the "trust" in the numbers allowing automated water dosing adds to be implemented.*

Acknowledgement

rheonics

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