



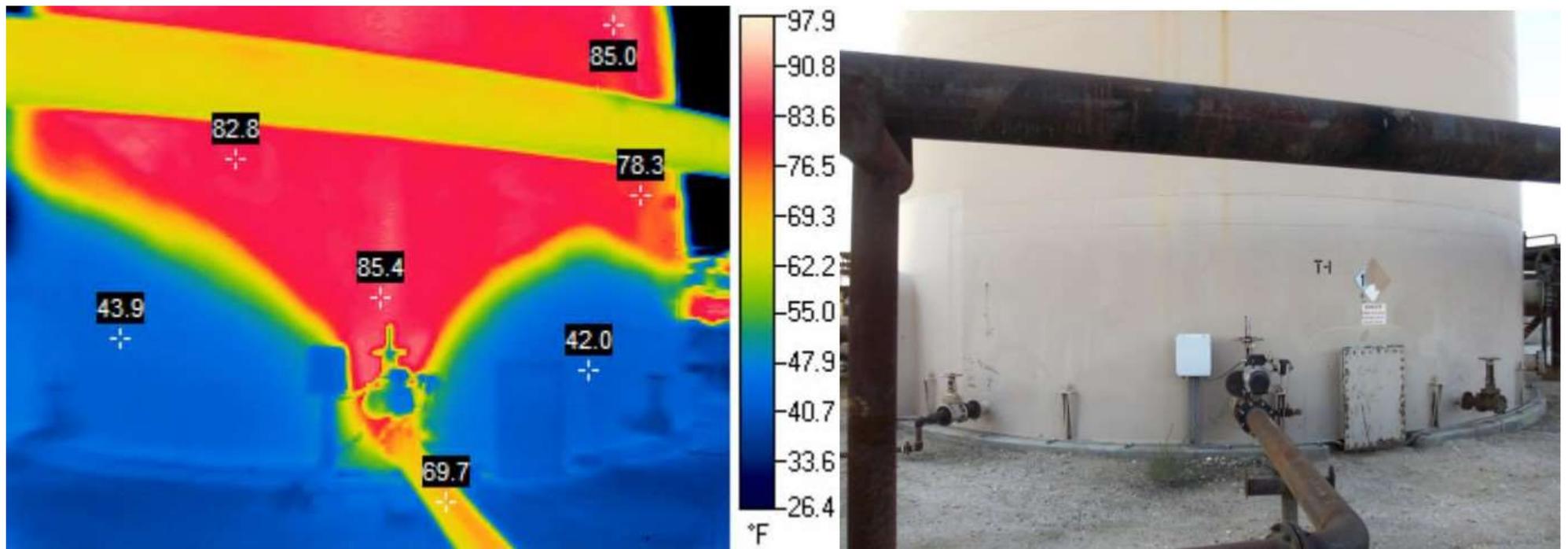
# Solids Accumulation in Produced Water Tanks

Why it's a problem and what you can do about it.

Presenter: Mark Wolf, President Wolf Process

Date: November 17, 2022

# Infrared Image of Solids Accumulation



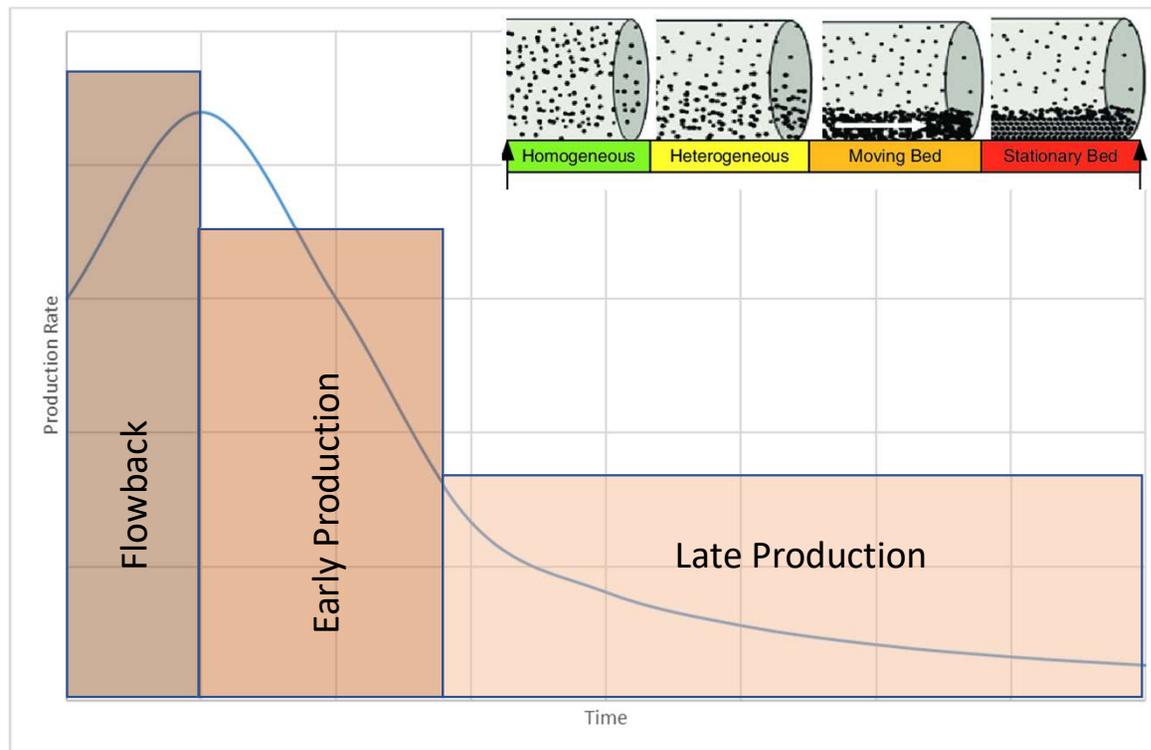
# Source of Solids

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- Formation Solids
- Completion Solids
- Corrosion Products
- Precipitation Products
  - Iron ( $\text{Fe}^{2+}$ ,  $\text{Fe}^{3+}$ )
  - Mineral (Ca, Mg, Ba, Sr, Ra)
- Production Chemicals



# Sand Production Profile Unconventional Well Lateral



## Flowback

- High Sand Rates
- Turbulent mixed flow in lateral
- Larger sand grains

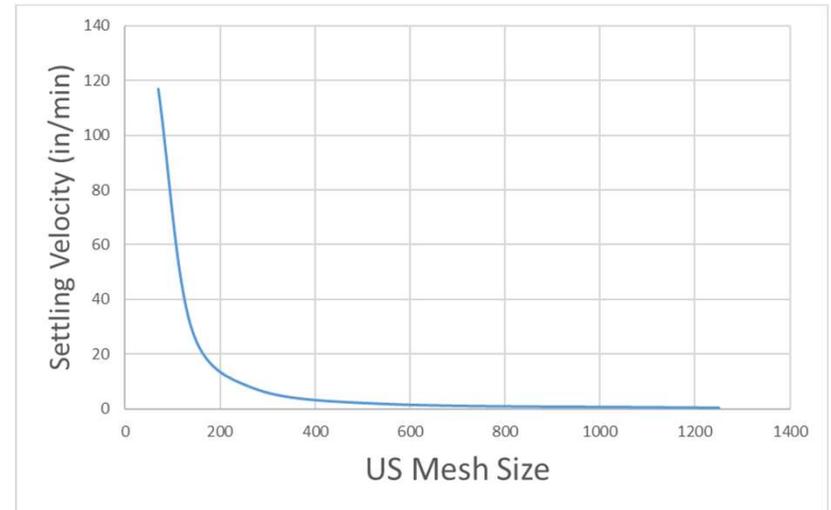
## Early production

- Medium/Intermittent Sand Rates
- Moving Bed
- Sand Slugging

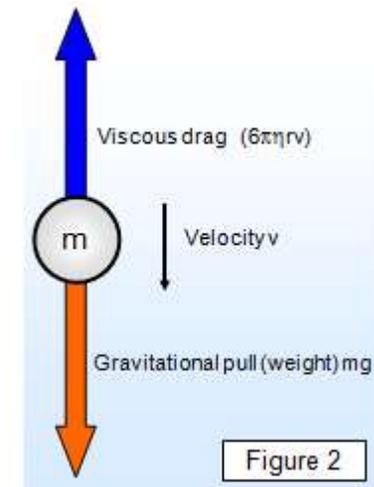
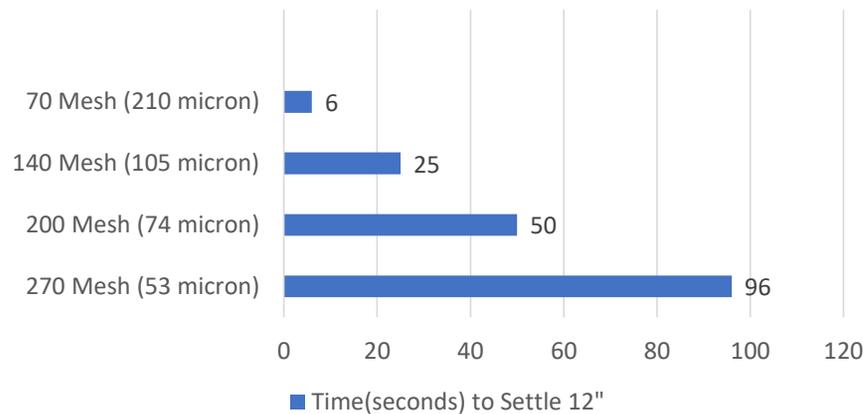
## Late production

- Low/Intermittent Sand Rates
- Stationary Bed/Dune Flow
- Smaller sand grains

# Separation Dynamics (Stokes Law)



Time(seconds) to Settle 12"



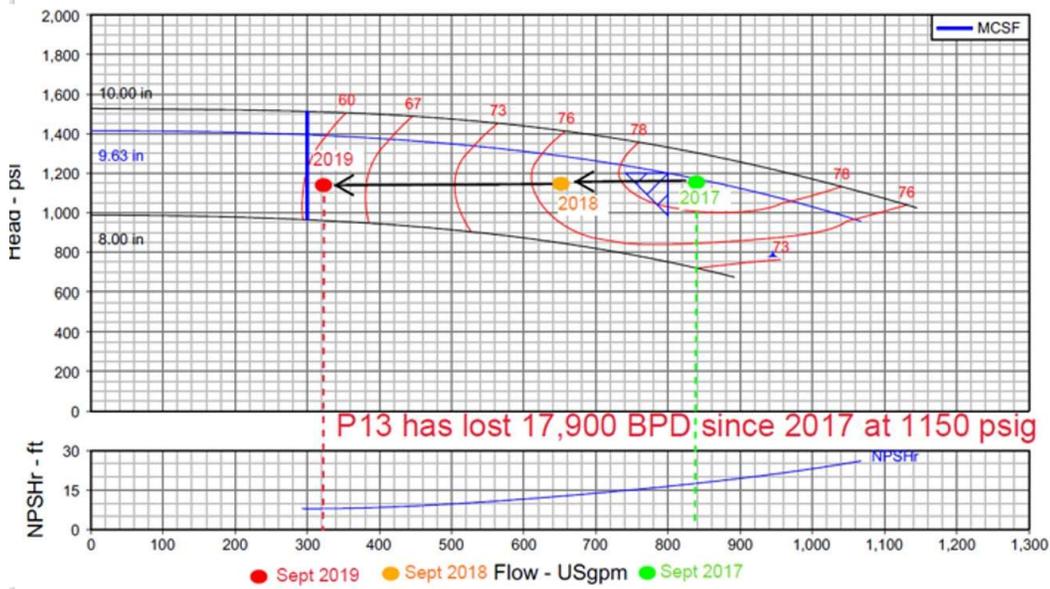
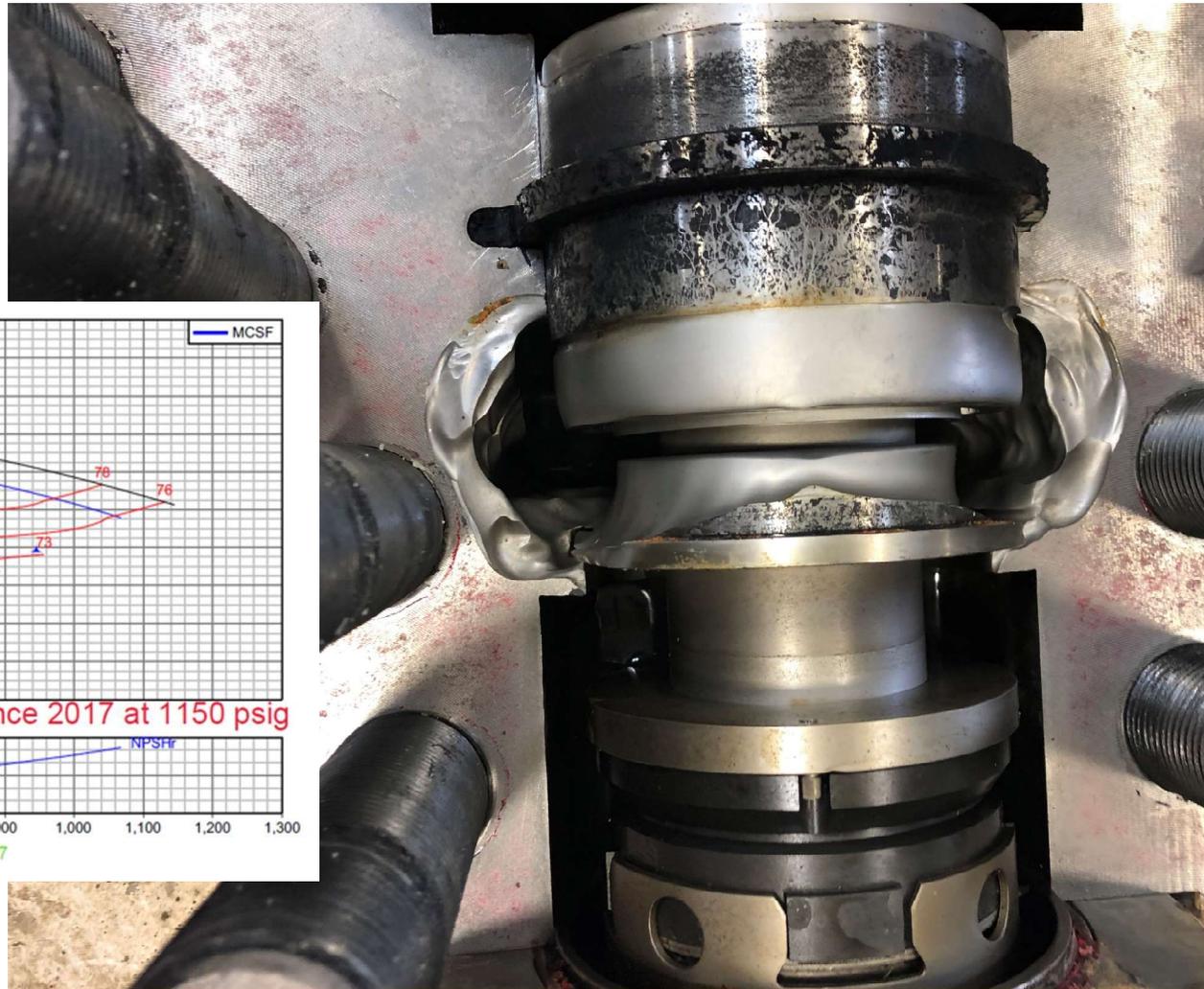


# Important Parameters

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- Density and type of Solids (Specific Gravity)
  - Sand 165 pounds/ft<sup>3</sup> (SG=2.65)
  - Oil wetted iron precipitates ??? (0.9<SG<2.0)
- Size of Solids
  - Settling velocity
  - Impact energy (erosion/corrosion)
- Wettability of solids

# Impact on Injection Pumps





# Impact on Injection and Disposal Wells

- Reduced Injectivity
- Increase pump horsepower
- More frequent acid/cleanout jobs

# What can you do about it?

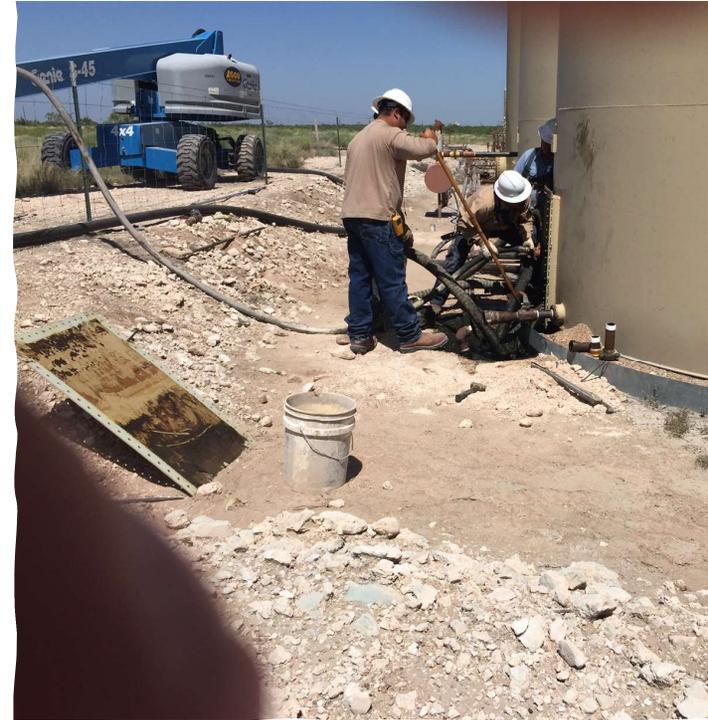
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Solids removal and remediation options.

# Manual Tank Cleaning

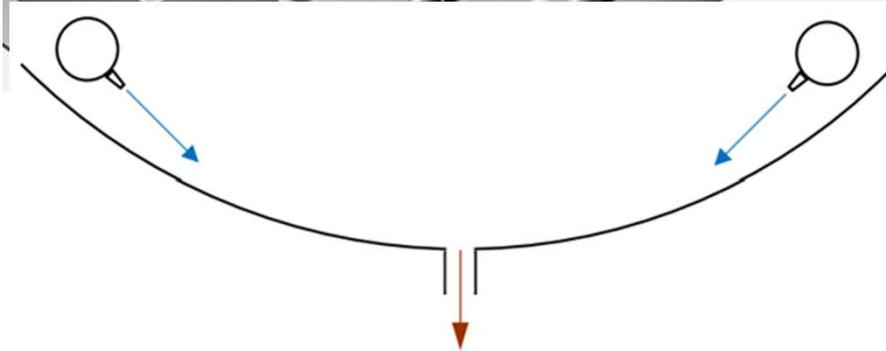
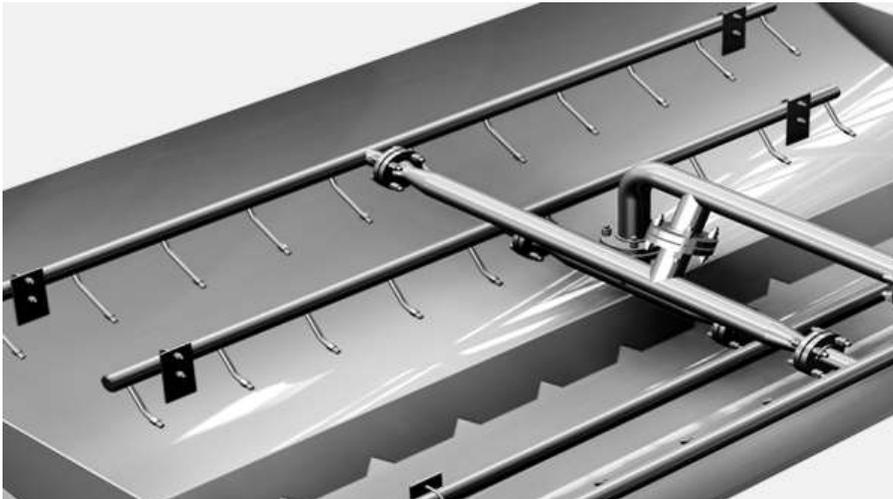
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- Most common
- Facility Down Time/Disruption of Operations
- HSE Risk
  - Confined Space Entry/Hazardous Environment
  - Greater potential for spills
  - Heavy oil contamination of solids
- Manpower Intensive

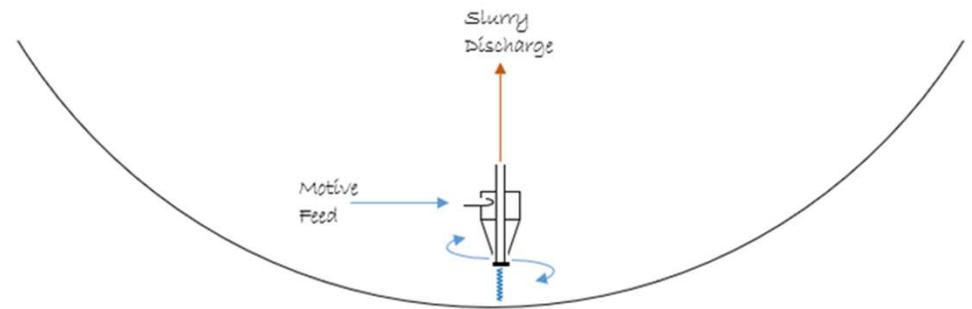


# Online Sand Removal

- Traditional Sand Jetting



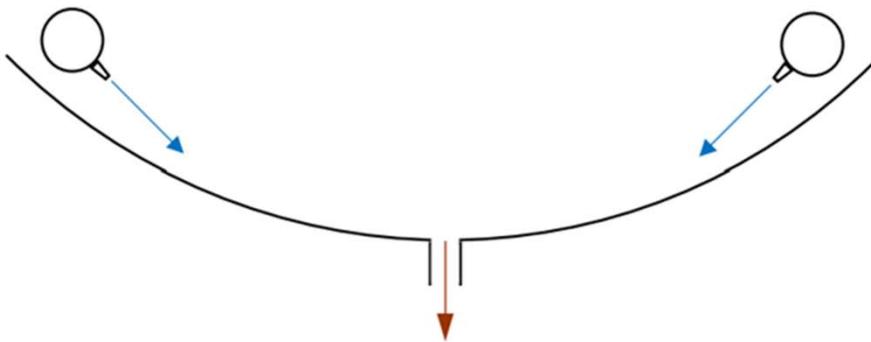
- Cyclonic Jetting



# Online Sand Removal

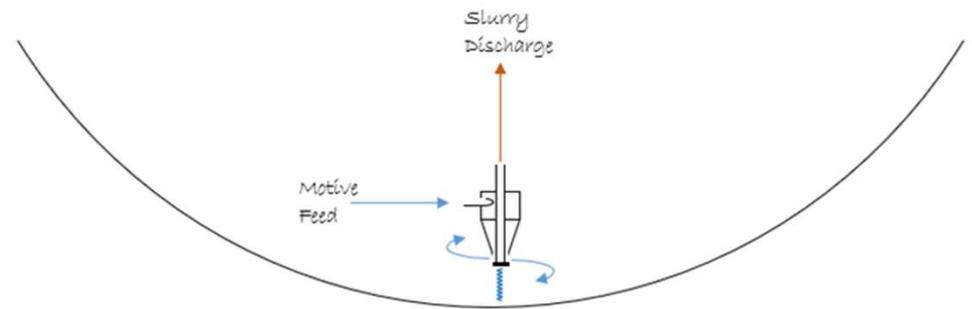
- Traditional Sand Jetting

- Lower Cost internals
- Higher Cost external system
- Higher Energy Use (water volume and pressure)
- Process Upset
- Sand Carryover
- Failure if buried



- Cyclonic Jetting

- Higher Cost Internals
- Lower Cost external system
- Lower Energy Use
- No separation disturbance
- No sand carryover
- Recovery from sand slug event





# Issues with Traditional Sand Jetting

- Separation Upsets
- Sand Carryover
- Failure when not operated frequently
- Block Jet Headers
- Vessel Wall Erosion



Blocked Sand Jet Header

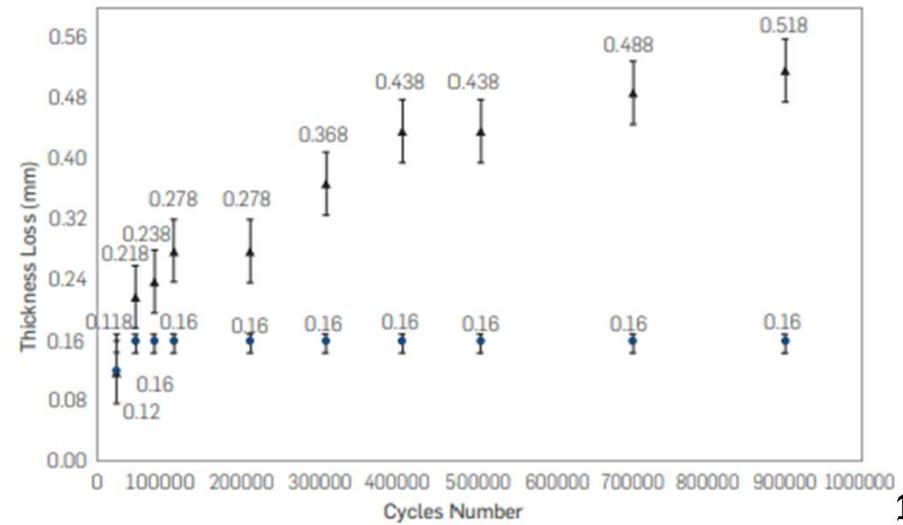


Vessel Wall Erosion

# HDPE/PEX for sand slurry service



▲ X65 carbon steel section ● HDPE section



Reference SPE-209278-MS

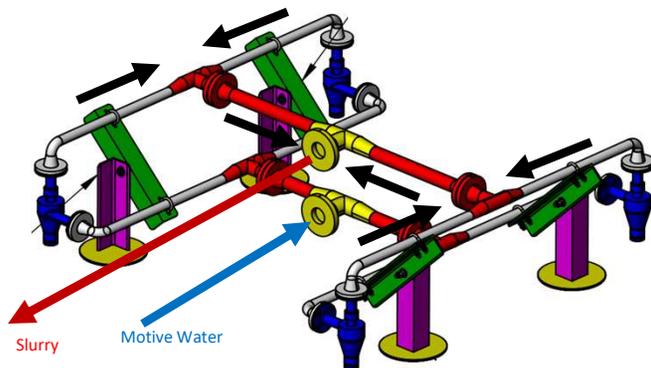


## Cyclonic Jet System in large tank

- Stainless Steel Manifold
- Flexible HDPE Connections

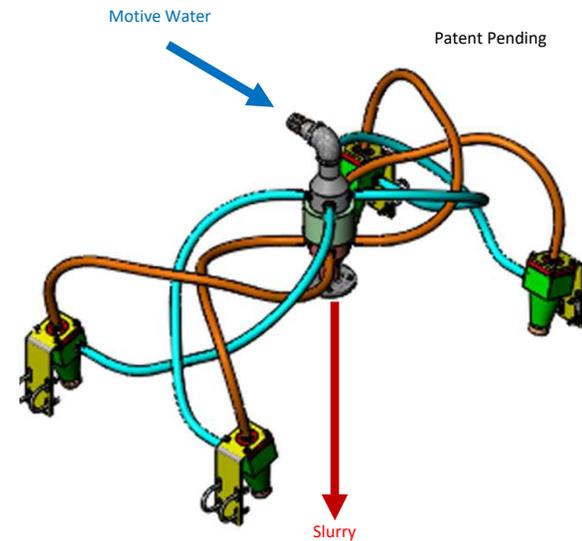


## Reducing Cost of Cyclonic Jetting



### TORE™ OVD – Stainless Steel

- Branched Tee Rigid Pipe
- Custom engineered
- Custom fabricated
- Sharp turns through elbows
- High Potential for galvanic corrosion of steel tanks



### Octopus – UHMW/PEX

- Flexible PEX Pipe
- Standard Design
- Adjustable to fit any pattern
- Smooth turns through bends
- Eliminates galvanic corrosion potential

# PEX for Oil and Gas

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This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.



Designation: F2905/F2905M – 22

## Standard Specification for Crosslinked Polyethylene (PEX) Line Pipe For Oil and Gas Producing Applications<sup>1</sup>

This standard is issued under the fixed designation F2905/F2905M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

### 1. Scope\*

1.1 This specification covers outside diameter controlled, pressure rated, metric-sized and inch-sized black or yellow crosslinked polyethylene (PEX) pipe made in pipe dimension ratios ranging from 6 to 17. Included are requirements and test methods for material, workmanship, dimensions, burst pressure, hydrostatic sustained pressure, stabilizer functionality, bent-pipe hydrostatic pressure, degree of crosslinking, chemical resistance, and minimum operating temperature. Requirements for pipe markings are also given. The pipe covered by this specification is intended for pressure or non-pressure oil and gas producing applications, such as conveying oil, dry or wet gas, gas gathering, multiphase fluids, and non-potable oilfield water. This specification does not cover piping for gas distribution applications.

1.2 This specification also includes requirements for joints made between PEX pipe and polyethylene electrofusion fittings (specified in Specifications [F1055](#) or [F3373](#)). Fittings to be used with PEX pipe manufactured to this Specification are in Specification [F2829/F2829M](#). Installation considerations are in [Appendix X3](#).

be used for metric sized pipe, and metric sized fittings should not be used for IPS inch sized pipe.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

### 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

- [D618 Practice for Conditioning Plastics for Testing](#)
- [D792 Test Methods for Density and Specific Gravity \(Relative Density\) of Plastics by Displacement](#)
- [D1505 Test Method for Density of Plastics by the Density-Gradient Technique](#)
- [D1598 Test Method for Time-to-Failure of Plastic Pipe](#)

# Erosion Testing



1" DR11 HDPE Coiled to 17" Diameter



1" DR11 HDPE Straight Pipe



1" HDPE Vortex Fluidizing Unit (VFU)

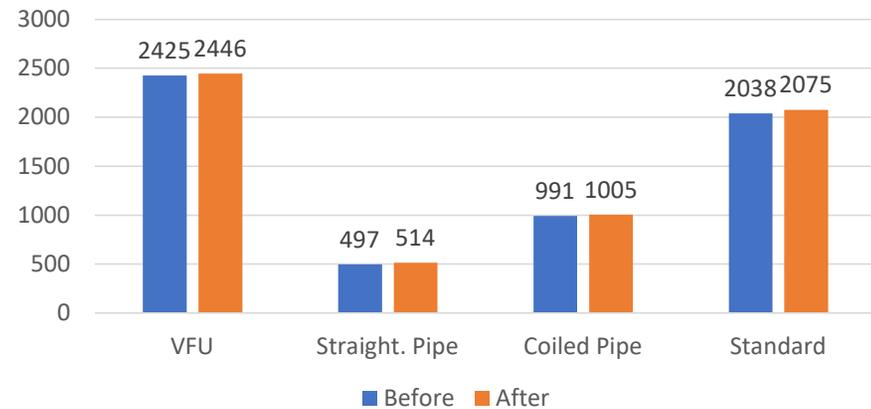


# Erosion Testing

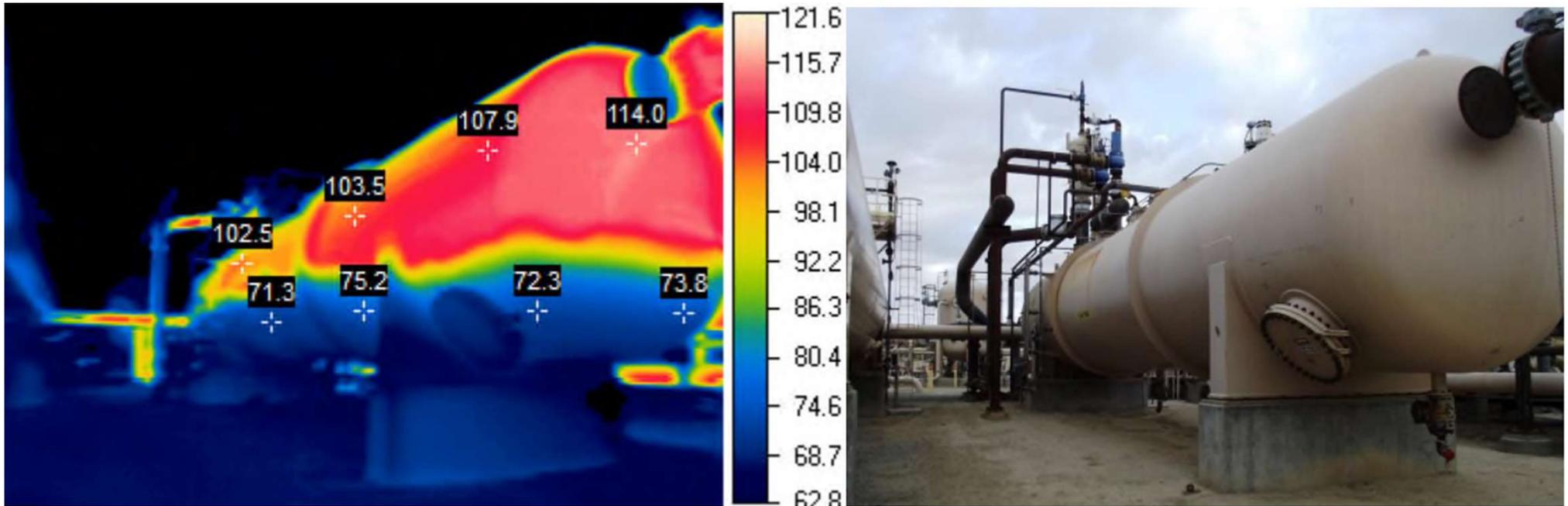
- 5805 Minutes Run Time
- Simulated 11 Years-2 Months Service Life
- 40/70 Mesh Sand (210-420 micron)
- Sand Concentration 1.4% -18.9%
- Velocity 5.7-14.1 ft/s (Average 10 ft/s)



# Erosion Test Results

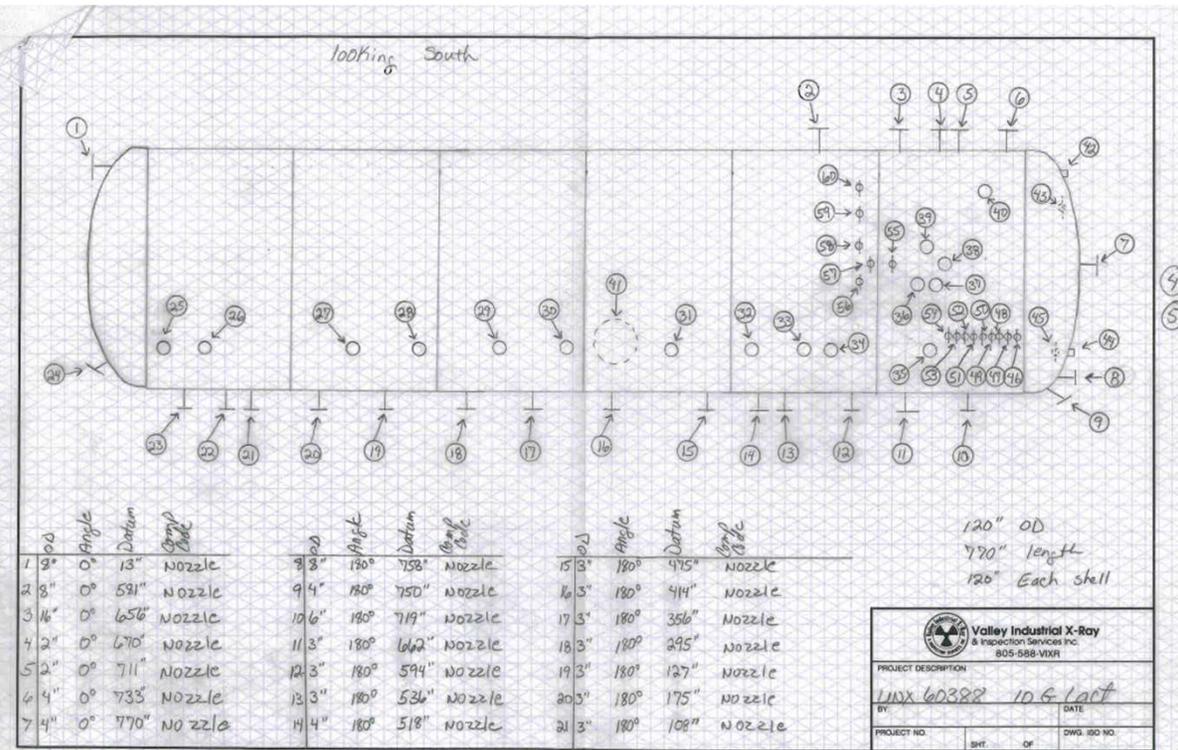


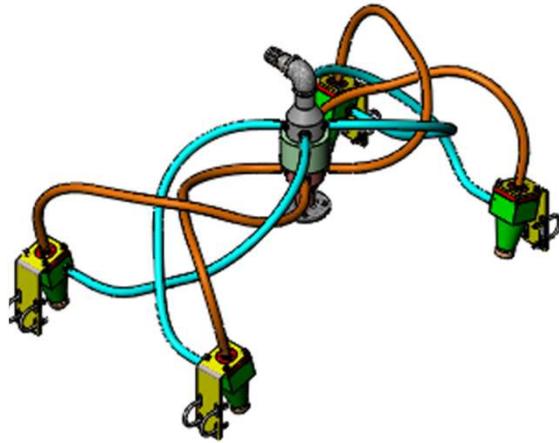
	VFU	Straight Pipe	Coiled Pipe	Test Standard
Before Test Wt.(g)	2425.3	496.7	991.3	2037.7
After Test Wt.(g)	2446	514	1005	2075
Change in Wt. (g)	+20.7	+17.3	+13.7	+37.3
% Change	+0.85%	+3.49%	+1.38%	+1.83%



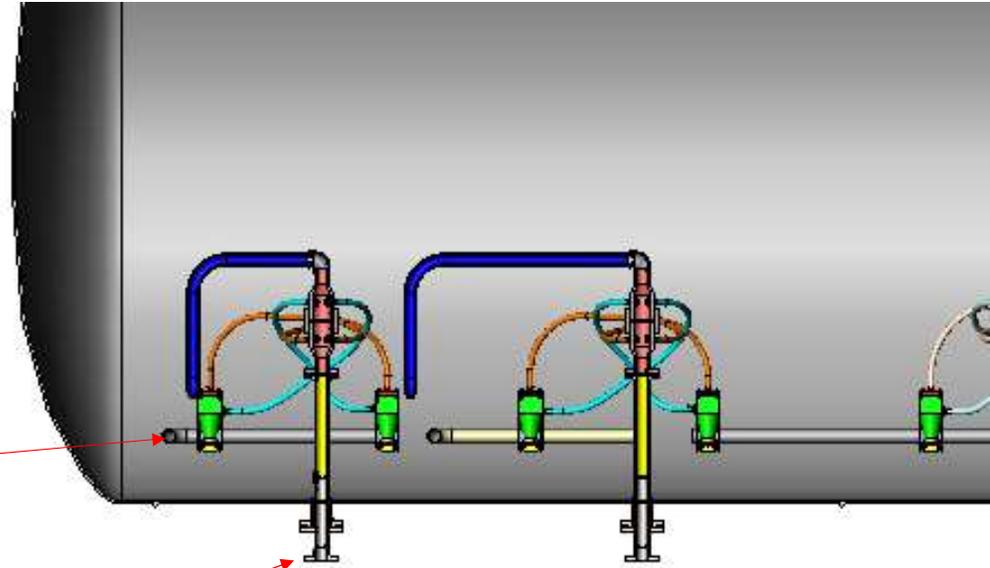
Free Water Knock Out  
Replace Sand Jet with Octopus

# No Drawings?.. No Problem





4 Way Octopus Manifold  
Patent Pending



Existing jet  
piping

Adaptor Spool

## Retrofit Plan

- Remove Sand Pans
- Install Adaptor Spools for Motive feed and Slurry Outlet/Hub Support
- Attach fluidizers to existing sand jet headers
- Field fit 1" and 2" connecting lines with no glue/no clamp PEX-A Expansion fittings.



# Install Flange Adapters





Installation Complete

Design  
Adaptability



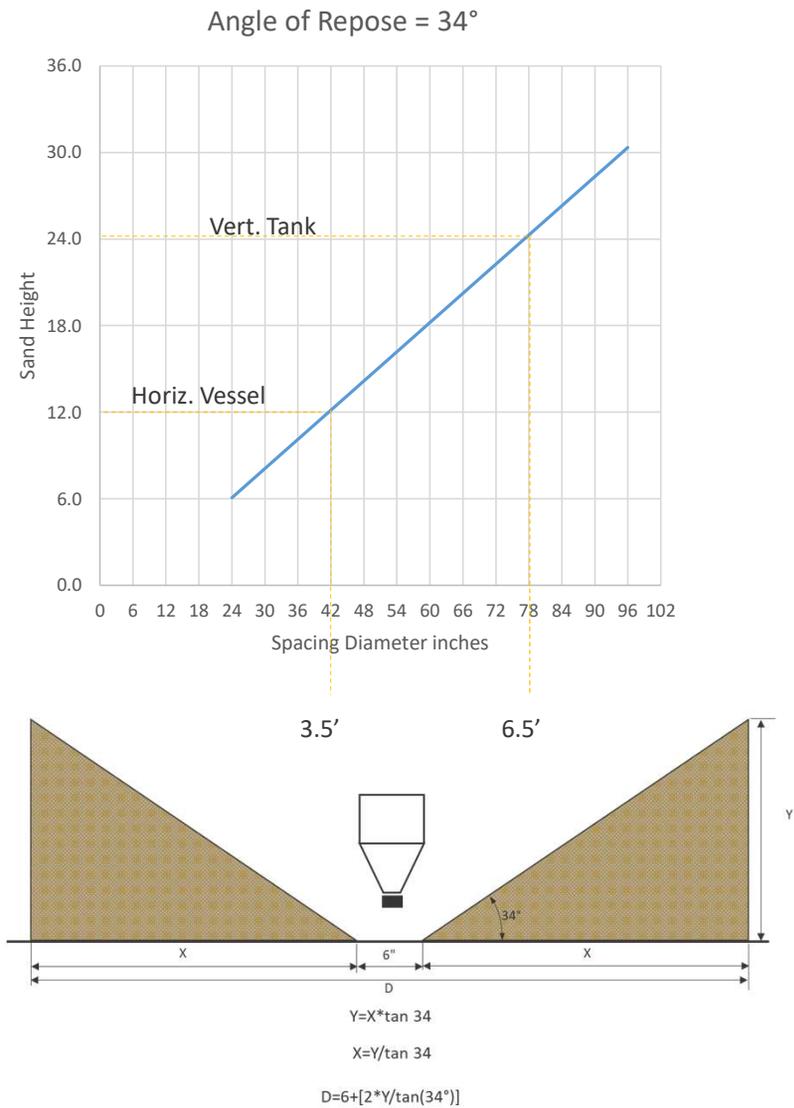
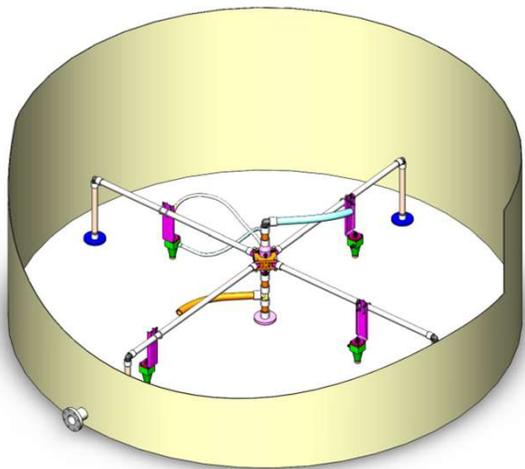
Hub Offset



Hub Centered

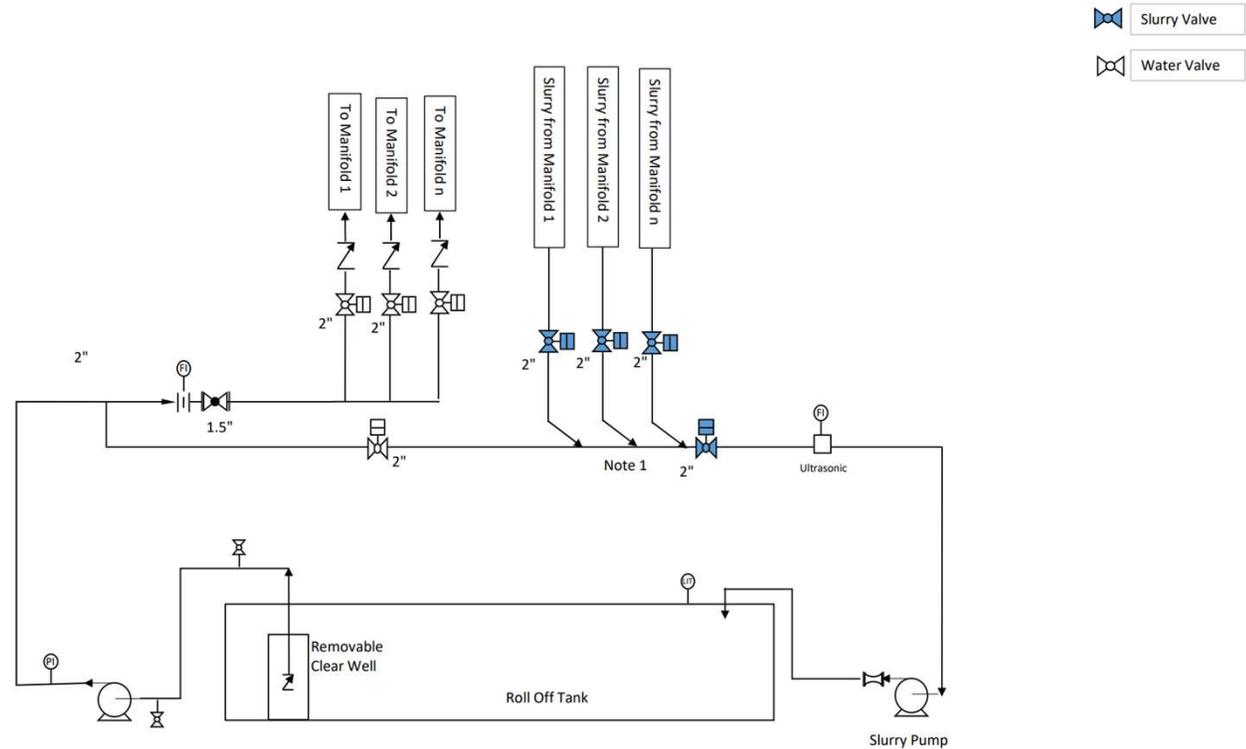
# Tank Design

- Larger Spacing
- Lower available head
- Protect Inlet and Outlet Nozzles



# Standard P&ID – Roll Off Collection

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QUESTIONS?

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