Solids Accumulation in Produced Water Tanks
Why it’s a problem and what you can do about it.

Presenter: Mark Wolf, President Wolf Process
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Infrared Image of Solids Accumulation
Source of Solids

- Formation Solids
- Completion Solids
- Corrosion Products
- Precipitation Products
  - Iron (Fe$^{2+}$, 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”**

- 70 Mesh (210 micron): 6 seconds
- 140 Mesh (105 micron): 25 seconds
- 200 Mesh (74 micron): 50 seconds
- 270 Mesh (53 micron): 96 seconds
Important Parameters

- Density and type of Solids (Specific Gravity)
  - Sand 165 pounds/ft³ (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?

Solids removal and remediation options.
Manual Tank Cleaning

- 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
HDPE/PEX for sand slurry service

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

Patent Pending
PEX for Oil and Gas

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

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.

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:
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

<table>
<thead>
<tr>
<th></th>
<th>VFU</th>
<th>Straight Pipe</th>
<th>Coiled Pipe</th>
<th>Test Standard</th>
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<tr>
<td>Before Test Wt. (g)</td>
<td>2425.3</td>
<td>496.7</td>
<td>991.3</td>
<td>2037.7</td>
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<td>1005</td>
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<td>Change in Wt. (g)</td>
<td>+20.7</td>
<td>+17.3</td>
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<tr>
<td>% Change</td>
<td>+0.85%</td>
<td>+3.49%</td>
<td>+1.38%</td>
<td>+1.83%</td>
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Free Water Knock Out
Replace Sand Jet with Octopus
No Drawings?.. No Problem
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

\[ \text{Angle of Repose} = 34^\circ \]

- Vert. Tank
- Horiz. Vessel

\[ D = 6r(2y/\tan(34^\circ)) \]

\[ Y = x \cdot \tan 34 \]

\[ X = y/\tan 34 \]
Standard P&ID – Roll Off Collection
QUESTIONS?

Contact info:
Mark Wolf
(281) 796-5357
mark.wolf@wolfprocess.com