In-Situ Pipeline Coatings for Methane Emissions Mitigation and Quantification from Natural Gas Pipelines

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Presentation Outline

- Problem & Approach
- Technical Status
- Key Accomplishments
- Lessons Learned
- Synergy Opportunities
- Project Summary

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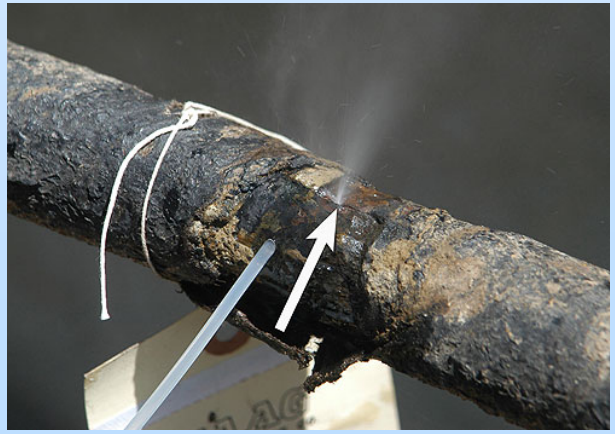
Problem and Approach

- Many methane transport lines are old and in need of retrofit.
- No effective way of long range, cost effective leak detection + protection.
- Macroscopic deposit buildup on the interior of pipelines can cause reductions in transport efficiency.
- Causes both operational losses (increased wear on transport pumps, increased fuel consumption), and product losses (reduced maximum throughput).







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State of the Art

- Nothing – (By far the most common!)
- Mechanical brush pigging
- Chemical cleaning; detergents, solvents, acids
- Internal factory coatings, fusion bond epoxies, etc.
- Inhibition injection
- Corrosion resistant alloys
- Internal liners
- Use of drag reducing agents (DRAs)

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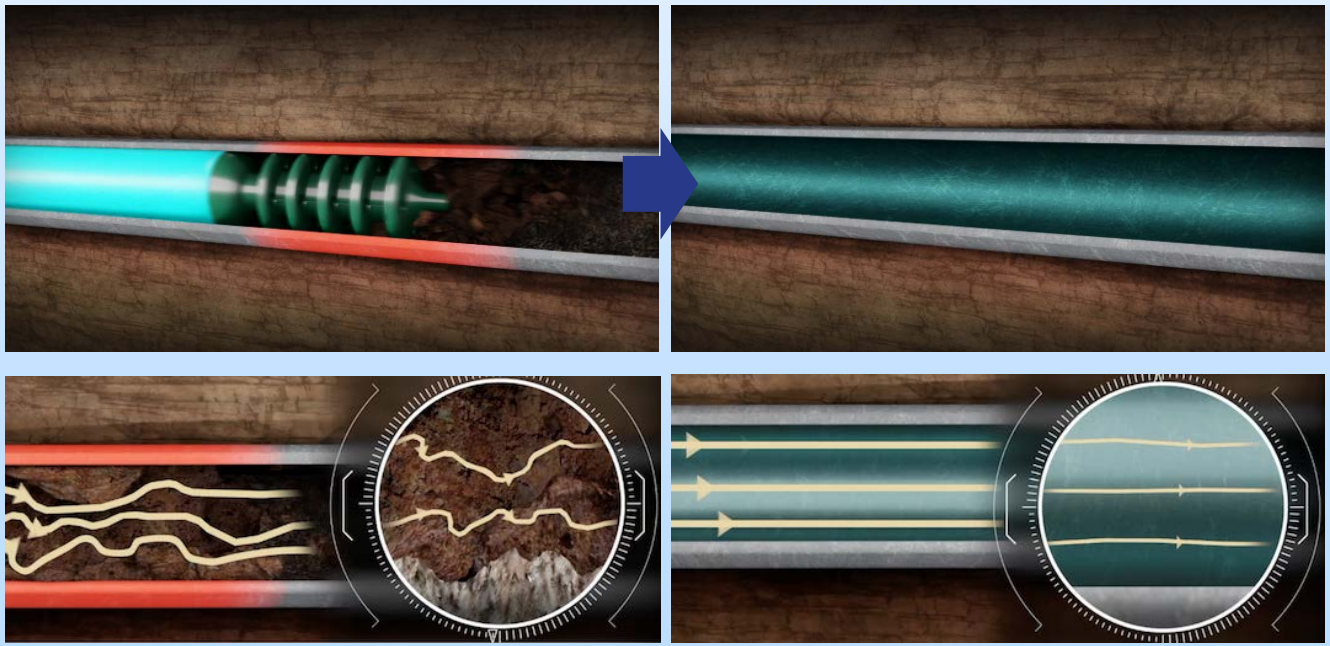
Problem and Approach

- Utilize an in-situ applied treatment to reduce surface roughness, limit corrosion, deposits, and formation of leaks.
- Scalable to full length of a pipeline.
- Does not require costly trenching and replacement of the line.



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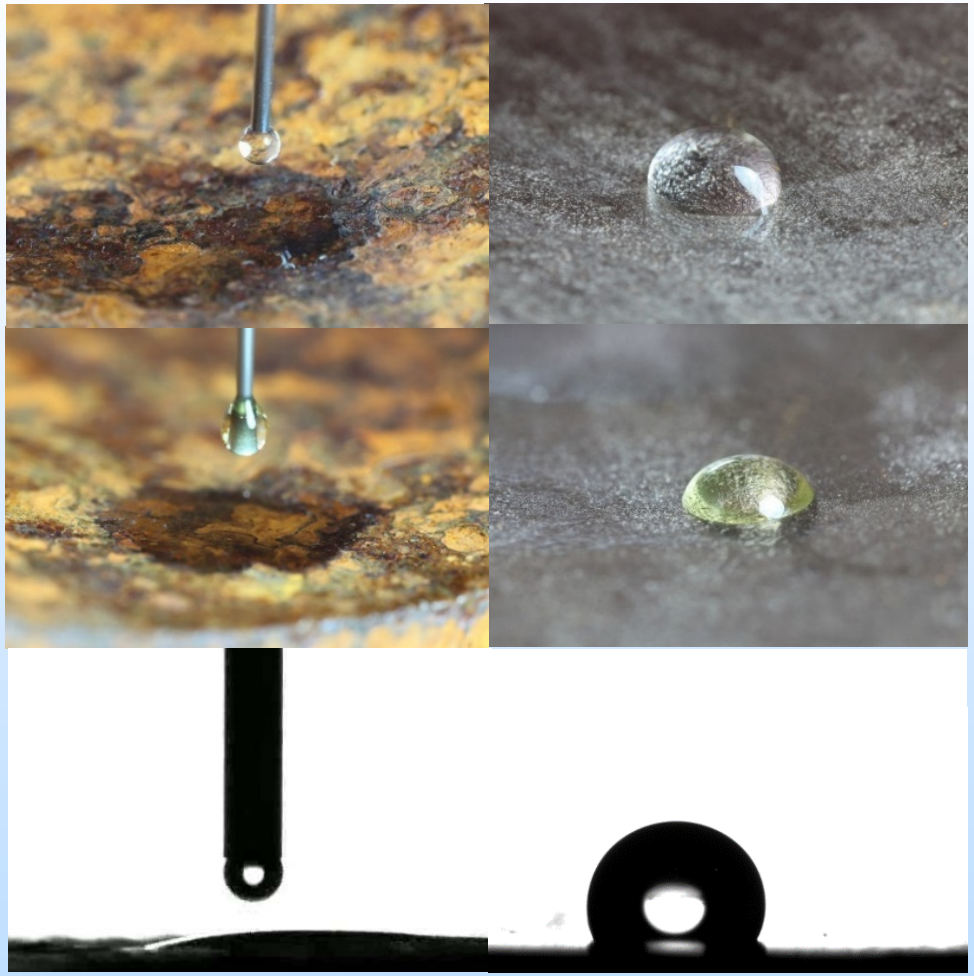
Technical Status – Materials Development

- Nanocomposite material that chemically binds to surface.
- Applicable by in-situ pig batch method
- Requires minimal surface preparation
- Imparts corrosion resistance, water and oil repellency, and low surface roughness.
- Water-dispersible material with no VOC issues.



Untreated **Treated**

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Technical Status – Application Development

- Flowloop formed from 4” diameter, 500’ long, previously weathered transport pipeline.
- Loop contains two 1.5D bends separated by a 10’ length.
- Test spools mechanically cleaned prior to treatment.
- Treatment applied to final thickness of 4mil, applied via compressed dry air.

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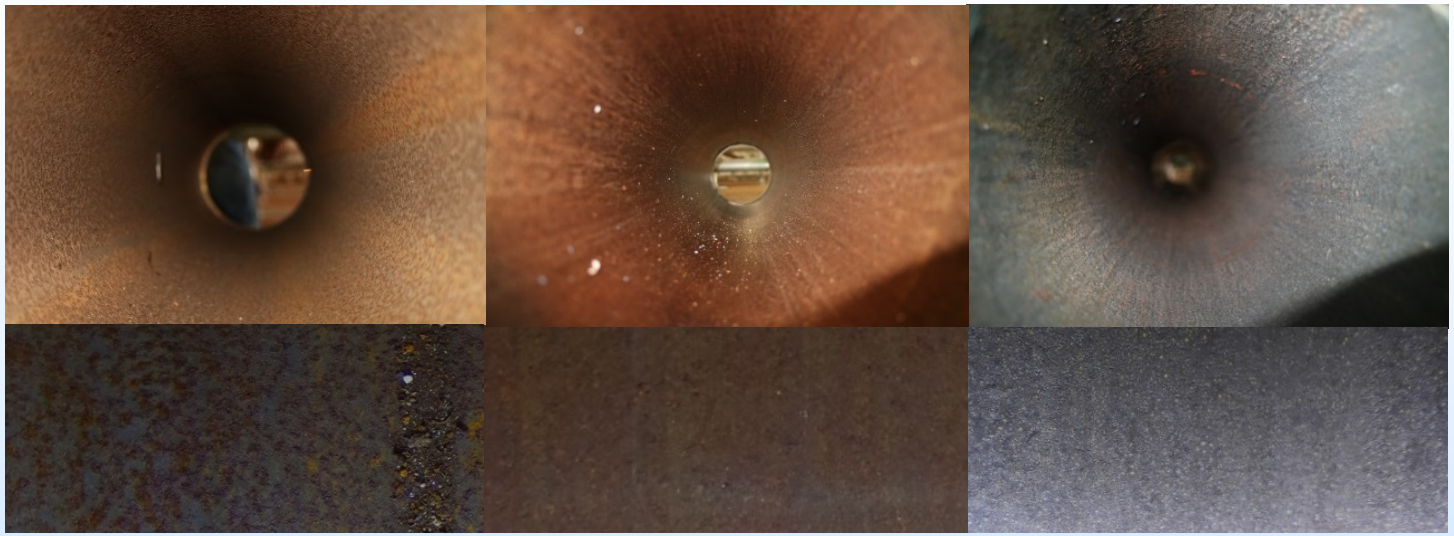
Technical Status – Field Trial Deployment



Untreated Brush Pigged Treated

- Surface roughness reduced to below that of factory new steel surface, and 40-fold vs heavily corroded.

Material	Average Roughness Value (µinch)
Glass	50
DragX Treated	100-140
Commercial Steel - (New)	180
Steel – Mechanically Brush Pigged	300-400
Steel – After Chemical Treatment	350-700
Steel – After 90 days of weathering	1000-1400
Steel – After 365 days of weathering	> 4000

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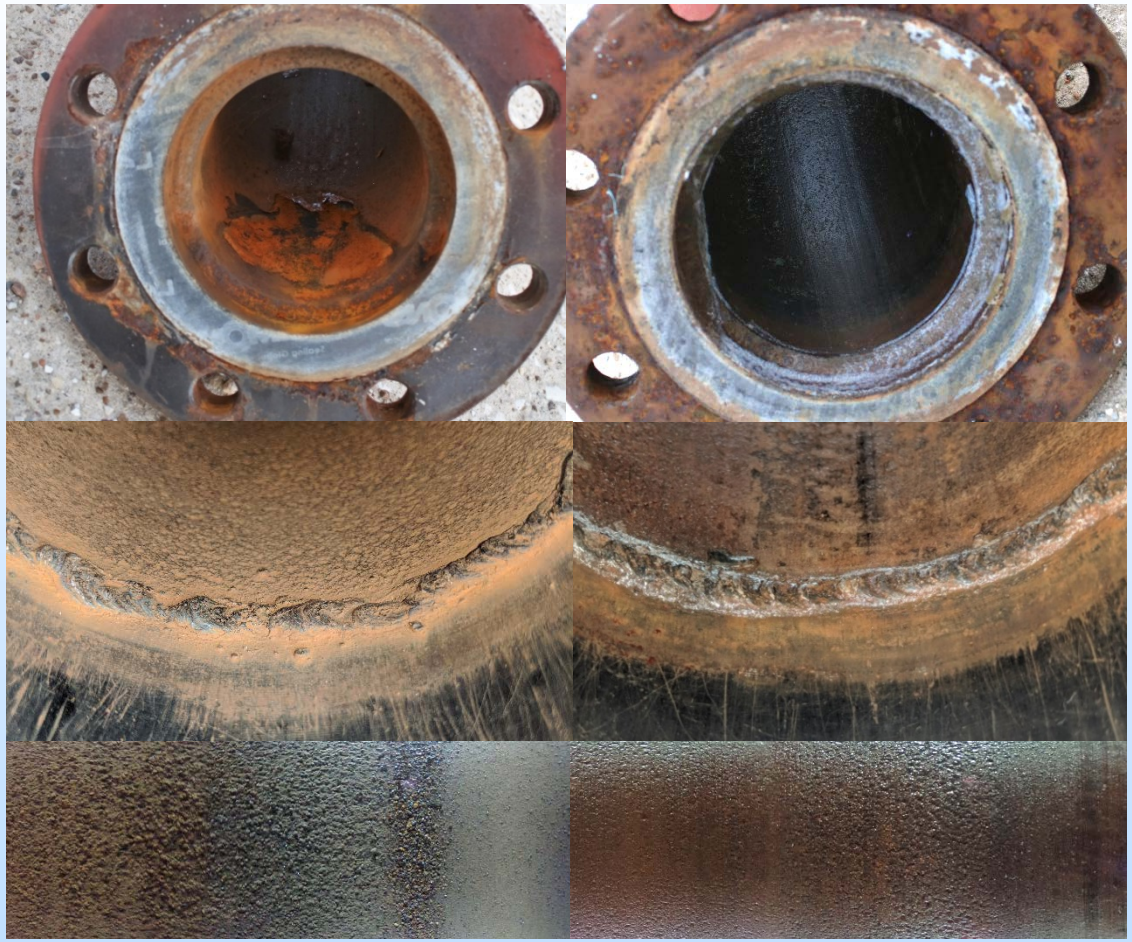
Technical Status – Application to Complex Geometry Pipelines



Untreated Treated

Ability to treat weld seams and flange joints

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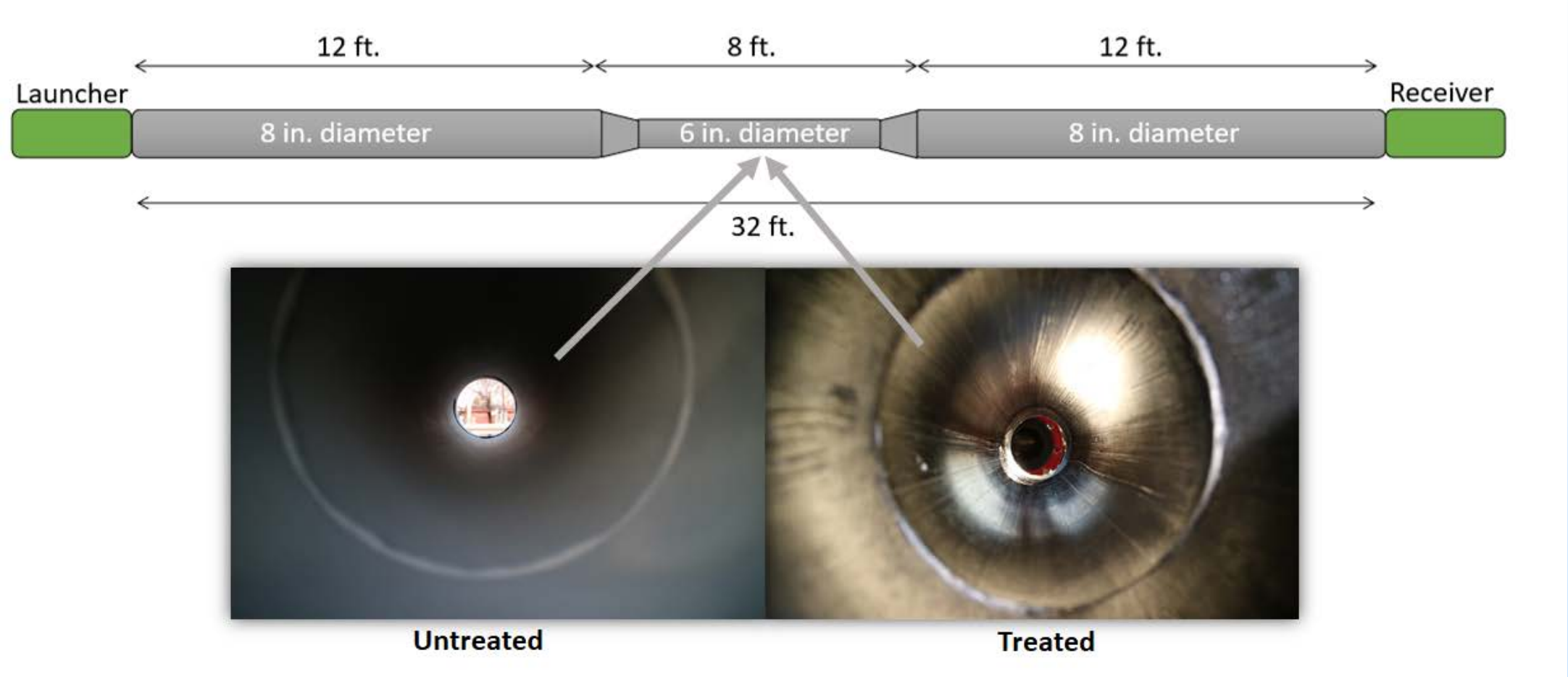
Technical Status – Application to Complex Geometry Pipelines



Ability to treat multi-diameter pipelines

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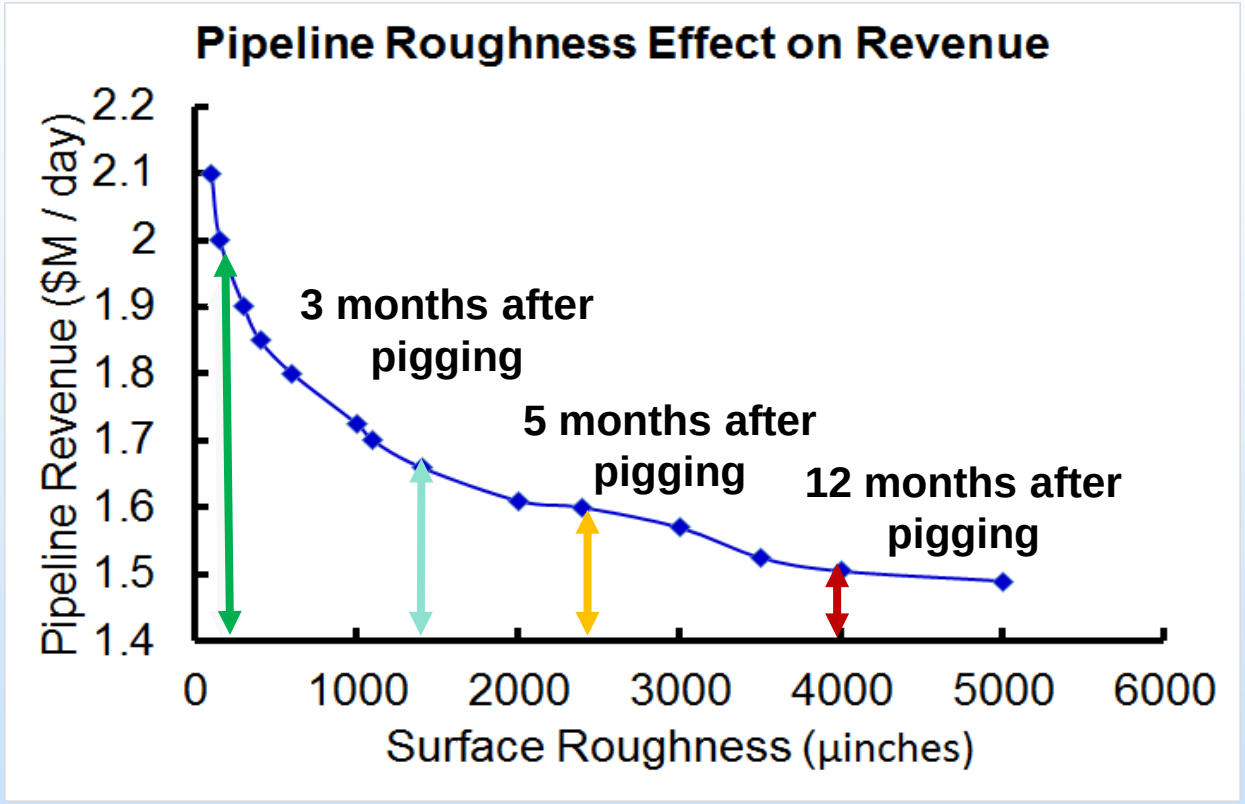
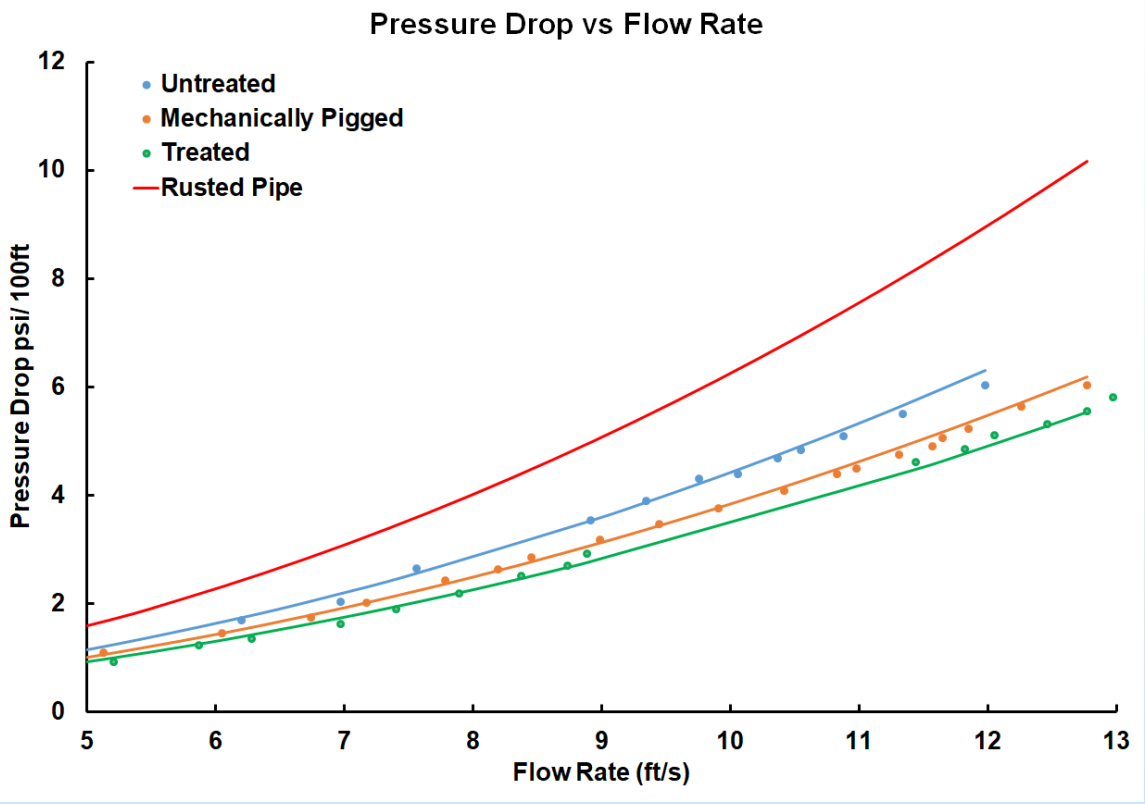
Technical Status – Cost/Benefit Analysis





- Post-pigging, pressure drop through pipeline is reduced by 25%.
- Strong correlation between directly measured surface roughness and back-calculated roughness.
- **DragX will reduce pressure drop within line by over 50% over heavily corroded/rusted pipeline.**

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Accomplishments to Date

- Optimized physical characteristics of treatment to allow for similar durability to commercially available epoxies while requiring substantially less downtime and applied thickness.
- Imparted hydrophobicity and oleophobicity to highly corroded metal substrates with minimal surface preparation.
- Characterized corrosion resistance and chemical compatibility of DragX treatment under typical natural gas pipelines.
- Developed and optimized application method to apply on pipelines between 2 – 16” in diameter.
- Reduced frictional drag in a treated pipeline by 25%, and 10% over traditional pigging.
- Demonstrated application and refurbishment of complex geometry pipelines.

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Lessons Learned

- **The key driver of technology adoption is not preventative protection against corrosion, but improved economic performance.**
- Regularly scheduled maintenance through pigging is relatively rare and high risk, meaning there is limited opportunities for smart pigging field trials.
- Limited ability to work with crude oil/unprocessed gas due to handling challenges.
- Further testing under high pressure conditions and erosion conditions.

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Synergy Opportunities

– New substrates & fluids, corrosion protection of carbon steel

Pre-Treatment

– New ways to monitor and gain actionable intelligence on pipelines.

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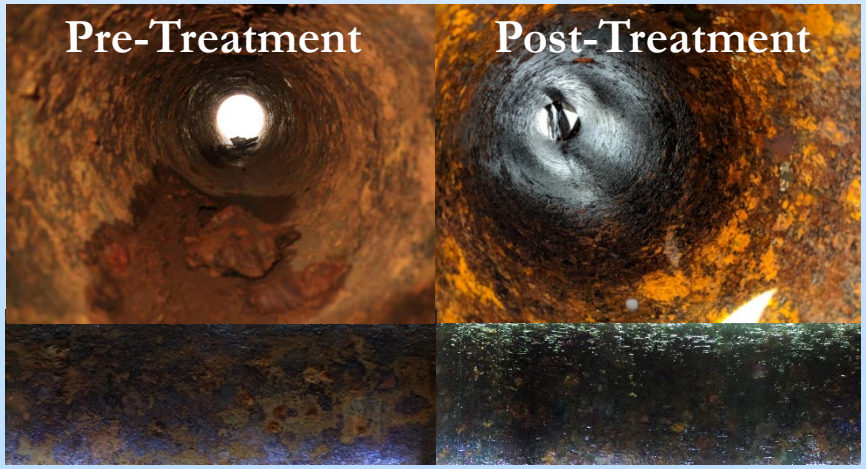
Field Demonstration Opportunities

New and Existing Pipelines

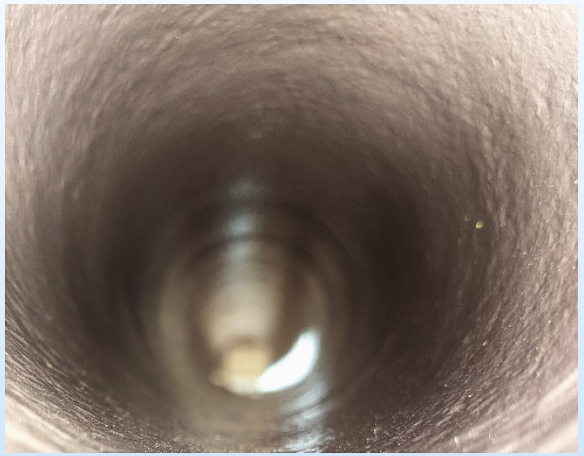
Existing Line Refurbishment

Water Lines

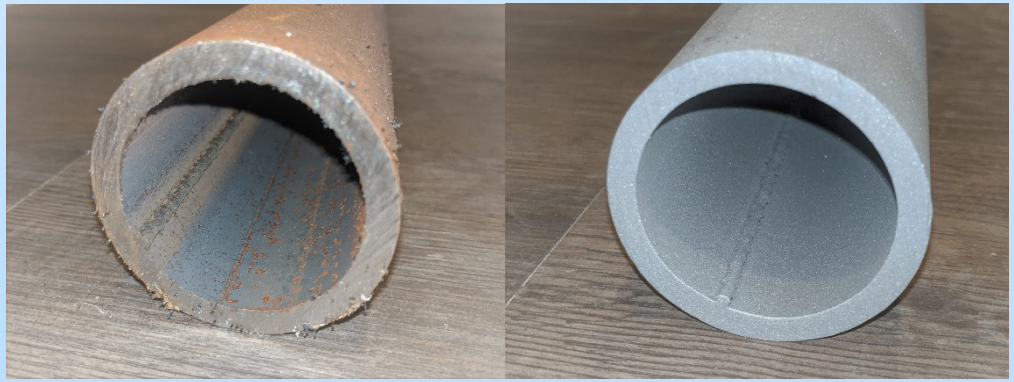


Oil-and-Gas Adjacent Fields

Fracking Tubing



Coiled Tubing



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Project Summary

- Key Findings
  - Ease of deployment and short downtime is highly attractive to operators.
  - Ability to add economic value is the key driver of early stage adoption.
- Next Steps
  - Key targeted field trials in different verticals to demonstrate economic value.
  - Additional scale up and long term value analysis
- **Take-Away Message**
  - **DragX is able to balance the key interests of operators, producers, and the public at large, reducing maintenance costs, enhancing safety, and improving product throughput.**

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