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

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NETL Program Manager: William Fincham

Matthew Nakatsuka

Senior Materials Engineer

Oceanit

U.S. Department of Energy

National Energy Technology Laboratory

Oil & Natural Gas

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Program Overview

- The research effort is focused on developing a cost-effective method of reducing methane emissions from transport pipelines. The DragX treatment solution is able to do so in 3 key ways:
  - **Reduces the need for maintenance**, which requires opening and venting the pipeline.
  - **Reduces the formation of small, non-detectable leaks**, as well as the risk of a large blowout due to corrosion.
  - Reduces the cost, fuel, and wear on pumps due to **reductions in frictional drag**.
- $1.950M DOE Share / $487,500 Participant Share
- 1 October 2016 – 31 August 2021

Technology Background

- Natural gas pipelines are in dire need of replacement in the coming years due to effective end of life.
- Full replacement of lines is extremely costly due to retrenching and downtime.
- Corrosion and deposits in lines result in lost production, reduced throughput and increased wear on pumps.
- Current technologies are only suitable for factory application (fusion bond epoxy), or represent operational expenses (drag reducing agents).






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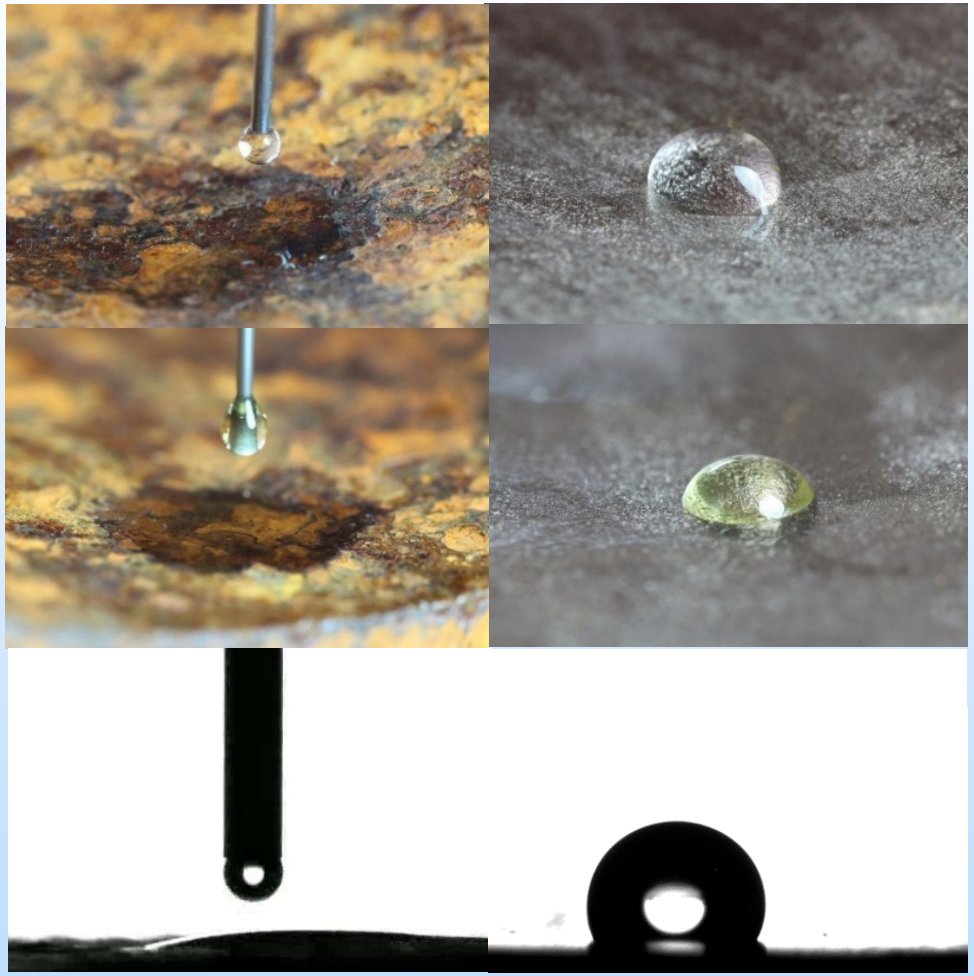
Technology Background

- Develop an omniphobic (water and oil-repellent) **surface treatment** which chemically binds and infiltrates into existing pipeline surface, even if already pitted/corroded.
- Results in low-surface energy (repels fluids) and low-surface roughness (minimizes liquid and gas frictional losses.
- Applicable in-situ via pigging process.
- Water-based with no VOC or hazardous materials



Untreated **Treated**

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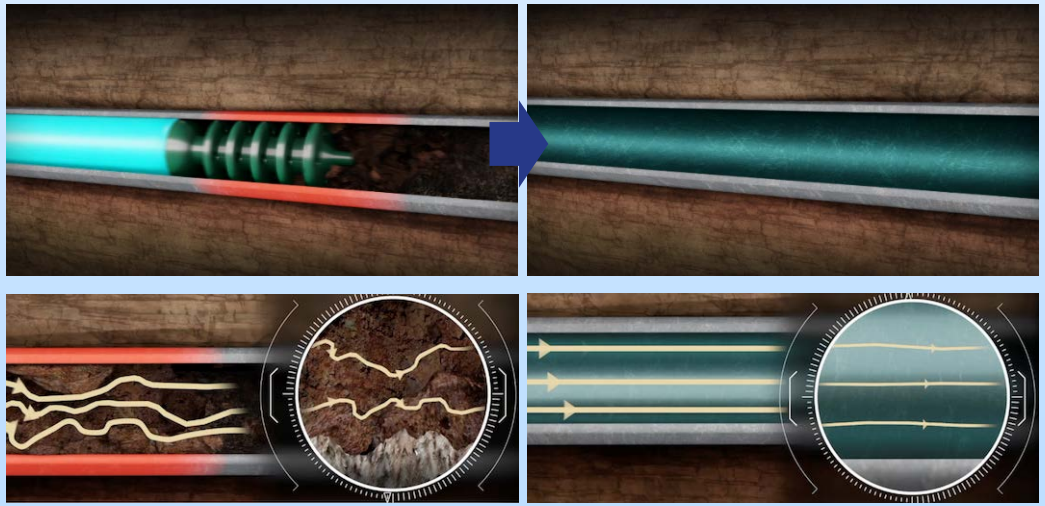
Technology Background

- In-situ pigging process does not require costly trenching and replacement of the line.
- Scalable to full length of a pipeline (10+ miles), and multiple diameters (6 – 30+ inches).
- Complex geometry (90° bends), weld seams, and flanges compatible.
- Compatible with existing pressures/temperatures and gas compositions.



Pipe Before Application

DragX Application

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Project Scope and Technical Approach

Laboratory Development

Key Milestones

- Validation of treatment efficacy at benchtop level.
- Compatibility study of material in simulated conditions.
- Application method refinement.

Industry Subscale Pilot Demonstration

Key Milestones

- Field application on non-operational pipelines.
- Performance validation for in-situ applied treatment.
- Develop inspection criteria and QC processes for in-field deployment.
- Go/No-Go economic viability studies in conjunction with industry partners

Full Deployment & Commercialization

Key Milestones

- Low-risk proof of viability on industry partner operational pipelines.
- In-field performance validation.
- Shipping and application logistics.
- Long-term commercial agreement for deployment and refurbishment.

Current Project Status and Key Performance Benchmarks

Property	Milestone Target	Achieved
Material Durability	Capable of lasting 5-7 years (between mandatory inspections)	Equal to or greater than existing approved flow coat materials for durability, wear and abrasion resistance.
Material Performance - Corrosion	Compatible with existing pipeline conditions and fluids.	Protection against high acid exposure, cleaning solvents and produced water contaminants.
Material Performance – Surface Roughness	Greater than or equal to chemical cleaning of a pipeline (300-400µinch)	Greater than or equal to new commercial steel (100-200µinch)
Material Application	Application to any representative pipeline length > 1000 ft	Applied to production tubing exceeding 2 miles in length.
Efficiency Improvement	10% improvement gains, consistent with aggressive pigging program.	Up to 25% improvement in drag reduction.
Economic Impact	Significant effect on pipeline performance as determined by commercial partner	Throughput increase ranging between 10-50% based on pipeline configuration.

Project Approach

- **The key driver of technology adoption is not preventative protection against corrosion, but improved economic performance.**
- Regularly scheduled maintenance via pigging is rare, so opportunities outside of gas lines alone must be pursued.
- Oceanit has pursued multiple field trials to evaluate key performance metrics.
- Applications on different pipeline sizes and conditions increased logistical experience and provides for process improvements.
- Product-agnostic approach allows for multiple avenues of commercialization post-project.

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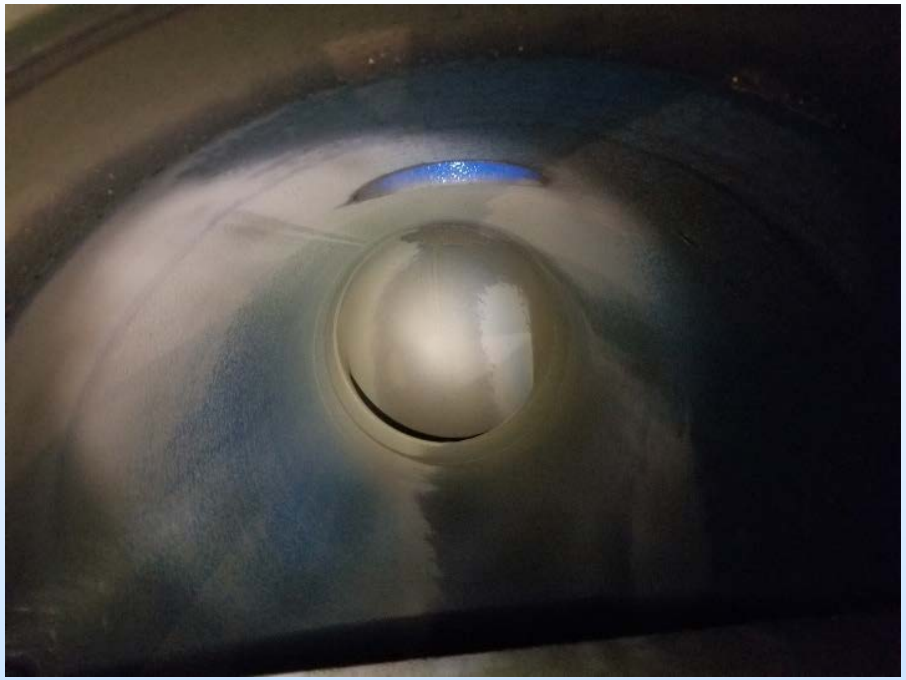
Technical Status – Corrosion Protection

Unprotected Section



DragX

- Application of DragX on flow testing feeder line to simulate pig launcher, diameter 30+ inches, high velocity flows leave line susceptible to erosion near bypass line entry.
- **Protection of carbon steel line from surface oxidation and rust buildup.**
- Long term lifetime to be determined.

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Technical Status – MIC Protection

Typical MIC Damage to Spool

DragX Application after 6 months

- Application on pig launcher spool prior to replacement of heavily pitted launcher susceptible to microbially induced corrosion (MIC).
- DragX applied in extreme conditions (Temperatures below 20° F).
- **No pitting or corrosion found after 6 months of deployment, all sections noted as passed acceptance based on 3rd party UT inspection.**

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Technical Status – Large Scale Deployment and Drag Reduction

- Application on the interior of coiled tubing to reduce required pumping pressure, increase throughput, and increase lifetime (corrosion due to high brine produced water and acidic gas).
- < 4" diameter tube over 1 mile in length, applied in coiled configuration.
- Pre-testing laboratory studies showed optimal protection and chemical compatibility.

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Technical Status – Large Scale Deployment and Drag Reduction

- Utilized modified version of in-situ pigging batch method.
- Application completed over the course of 2 weeks in field.
- Roughly 100 gallons of DragX material fabricated for trial at Oceanit facilities.
- **15% reduction in drag during testing over acid cleaning alone.**

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Technical Status – Extended Deployment and Analysis for Gas Line

Parameter	Value
Gas Flow Rate	300 mmscfd
Pipeline Length	70 miles
Pipeline Diameter	30inch
Pressure Drop in Line	450psi
Surface Roughness (Current)	0.02 in
Surface Roughness (DragX)	0.0001 in
Pipeline Gas	Compressible Methane

- Simulated analysis of improvements due to DragX deployment on a representative methane gas line from industry partner.
- **Case 1: Maintain Pressure Drop, Increase Throughput**
- **Case 2: Maintain Throughput, Reduce Required Inlet Pressure**
- **Case 3: Build a New Line with Reduced Diameter**

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Technical Status – DragX Summarized Benefits

	Case (1) Increase in throughput, based on constant inlet pressure	Case (2) Inlet pressure decrease based on constant production	Case (3) Reduction in pipeline diameter for constant production and inlet pressure
Current (Mid-Life Estimate)	300 MMSCFD	1000psi	30inch
DragX Treatment applied to in-place line	445 MMSCFD	950psi	25.8inch
% Improvement	48%	51%*	14%

*Frictional drag only, other design considerations make up the vast majority of losses.

- Existing planning for deployment as part of future planned activities in project pending line availability and downtime schedule.

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Future Plans and Commercialization

- Performance evaluation test for commercial partner on 20” diameter line.
- Key derisking trial tailored towards partner’s specific internal standards for coatings and liners.
- Parameters to be tested post-application:
  - Adhesion pulloff (ASTM D4541)
  - Abrasion (Modified ASTM D4060)
  - Chemical Resistance (ASTM D6943)
  - Crack Resistance (ASTM D522)

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DragX Effect on Decarbonization

- **Complementary technology** to existing strategies for decarbonization.

Pre-Treatment Post-Treatment

- Can be deployable on **high-risk areas** identified by aerial imaging with a minimum of disruption.

- Drag reduction effect can **compensate for reduced pipeline diameter** stemming from applied structural liners.

- Provides an **economic incentive** for operators to reduce leaks.

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Project Summary

- Key Accomplishments
  - Multiple industry aligned field demonstrations completed to show DragX corrosion protection and improved throughput.
  - Demonstration of economic value as a direct consequence of these trials.
- Next Steps
  - Long term evaluation and recommendations for refurbishment of treatment after use.
  - Full scale commercial deployment on actual in-service lines.
- **Take-Away Message**
  - **DragX balances the need for decarbonization with strong economic incentives for pipeline operators. DOE funding has derisked the technology so it is ready for commercial adoption at the conclusion of the project.**

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