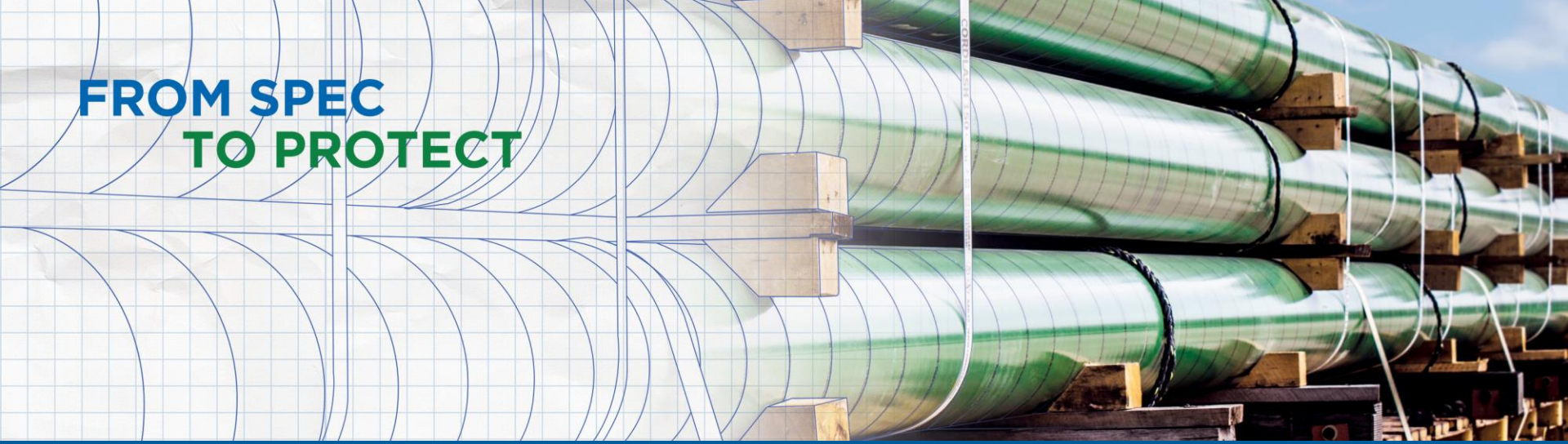


Pipeclad® Flowliner

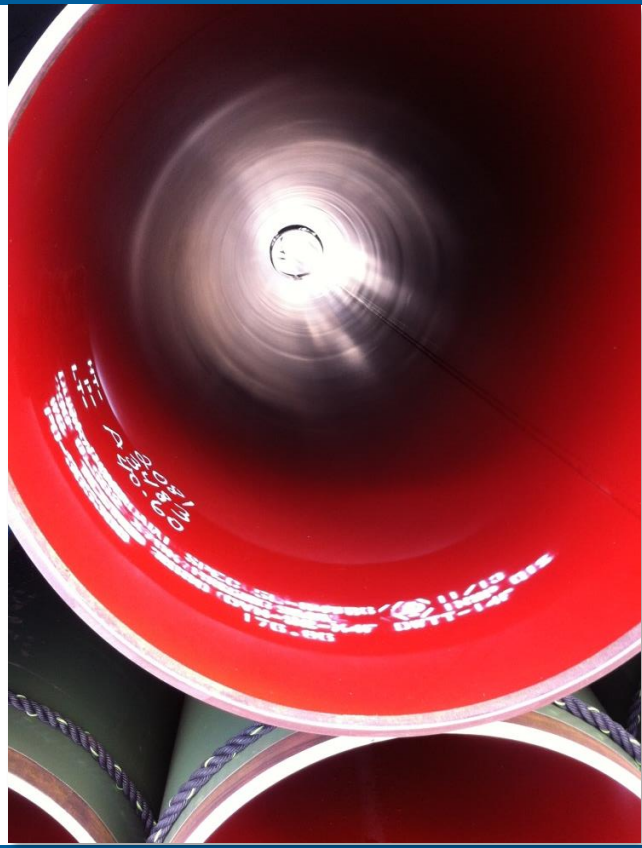
Internal Flow Efficiency Coatings for Natural Gas Transmission: Differentiating Value and Safety

Dr. Jeffrey D. Rogozinski
Global Product Director

SHERWIN-WILLIAMS®

Agenda

- Why use flow efficiency coatings
- Review of data justifying value proposition
  - CAPEX
  - OPEX
  - Safety
- Pipeclad® Flowliner
  - Appendix:
    - ✓ Track record
    - ✓ Select Projects
    - ✓ Testimonials

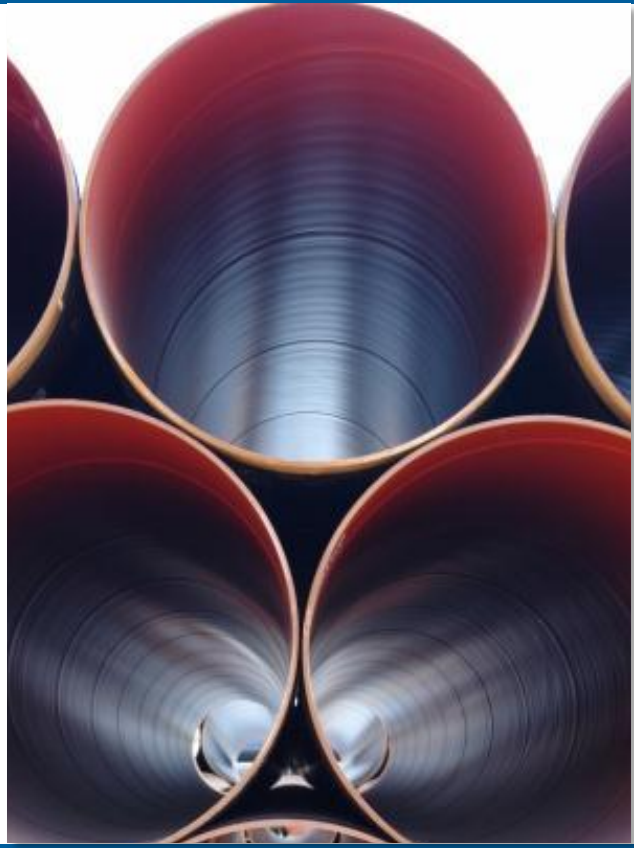


Why Use Flow Efficiency Coatings?

Smoothing the Surface Roughness	**Increased throughput**
Optimized Pre-Commissioning	**Optimal pigging / drying**
Lower OPEX Costs	**Lower compressor station energy costs**
Lower CAPEX Costs	**Reduced number of compressor stations** **Optimized pipeline diameter**
Safety	**Maintain safe levels of odorant** **Reduces pickling requirements**

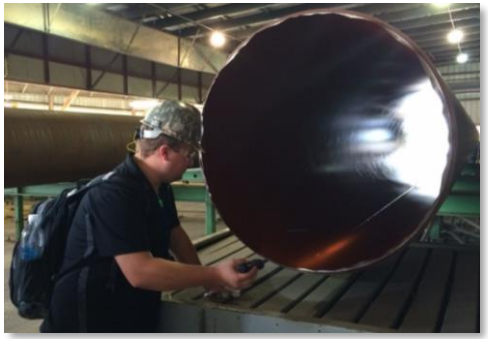
Why Use Flow Efficiency Coatings?

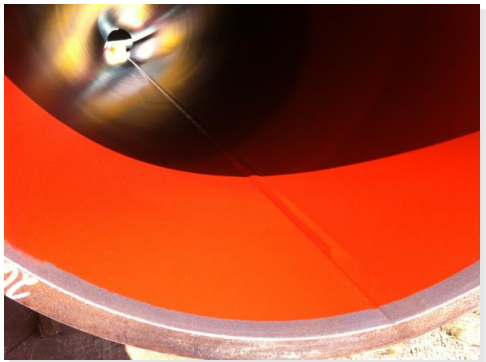
- Corrosion protection in storage
- More environmentally-friendly, CO_2 reduction
- Sealed surface: product purity, less compressor fouling
- Rapid payback

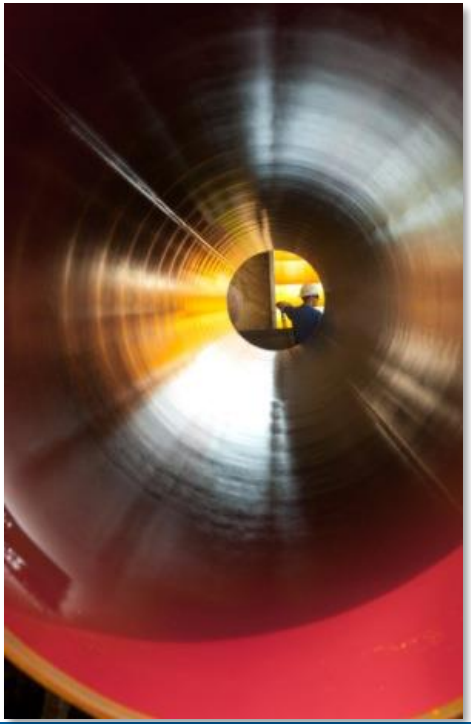


Smooth and Glossy Coating Finish

Pipeclad Flowliner Coating on Inside of Pipe







Smoothness Capability for Coated Pipe

What: Blasted, unpainted substrate
Surface Profile Measurement: R_z=58.788 µm

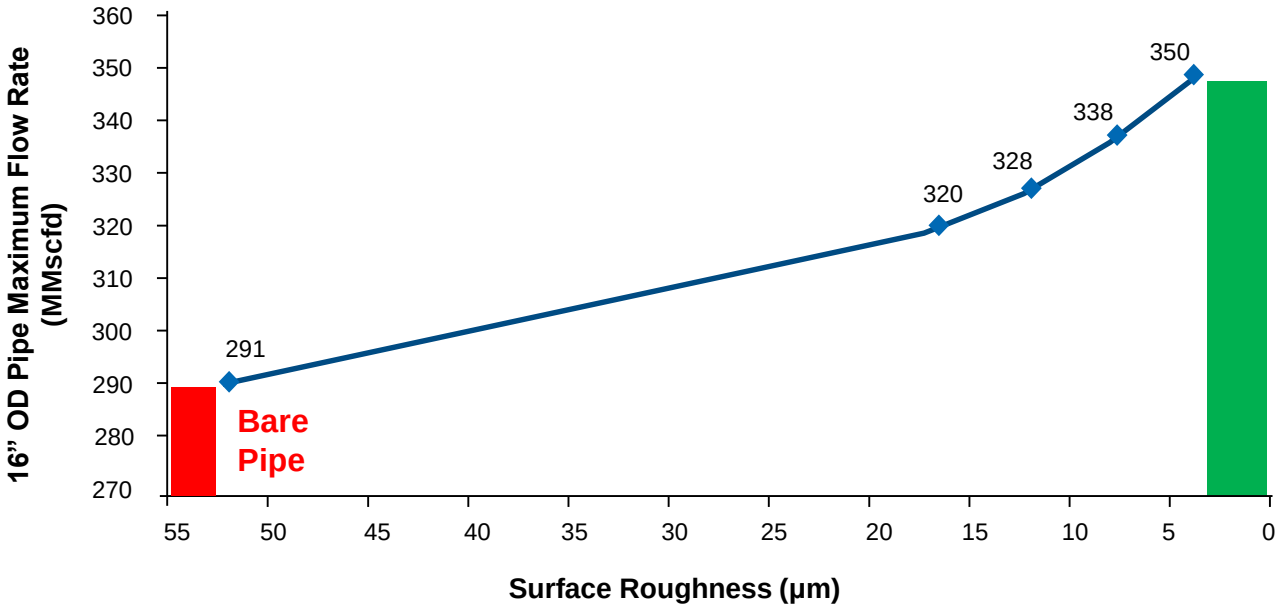
Up to 15% improvement in flow rate with coated pipe

What: Blasted, painted substrate
Surface Profile Measurement: R_z=0.615 µm at **100 micron** DFT

Note: Product smoothness is dependent upon application conditions.

Coated Pipe Maximizes Flow Rate

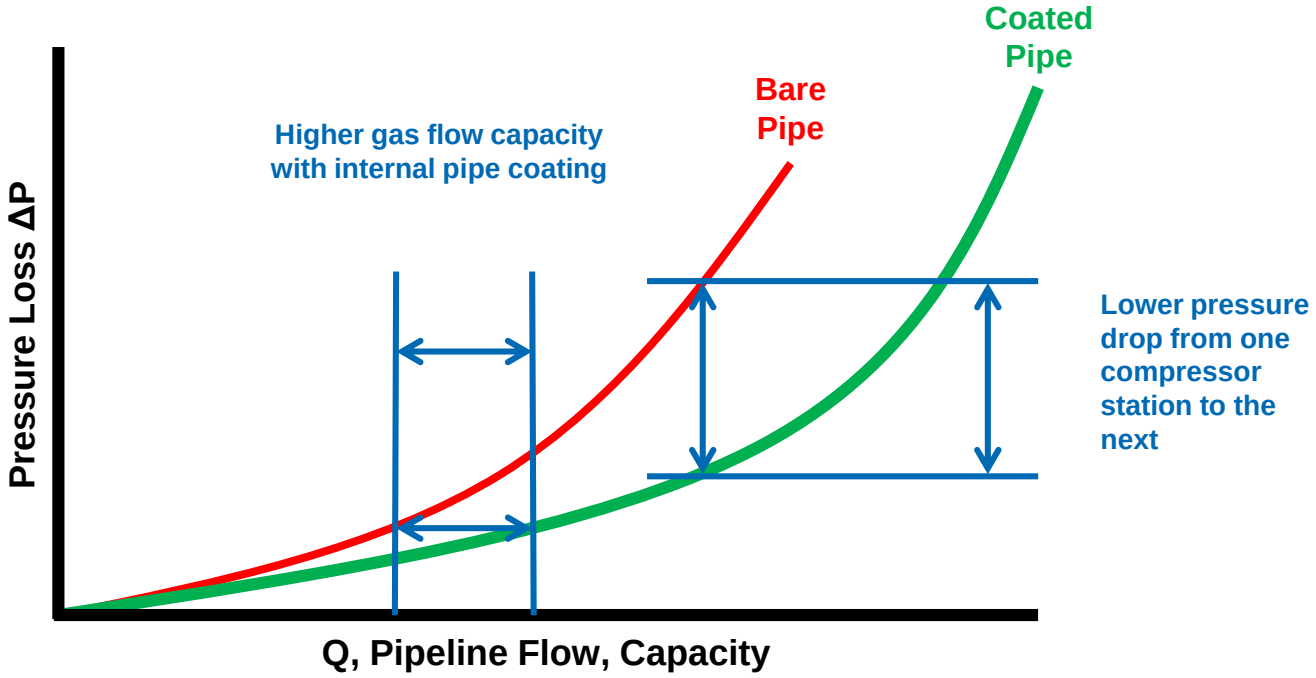
Flowliner Improves Throughput by Making Surfaces Smoother



Source: Development of a New Solvent-Free Flow Efficiency Coating for Natural Gas Pipelines, Rio Pipeline 2005

Benefits of Coating Gas Pipeline Interior

Lower Pressure Drop; Increase Gas Capacity



Supporting Studies

Source	Date	Summary
Oil and Gas Journal	May 1994	NOVA corp, detailed economic justification for large diameter pipe, lower roughness better
Rio Pipeline Conference	October 2005	CAPEX/OPEX savings, smoother is better, solvent free is best
World Pipelines	February 2007	Reduction in MIC, 15% cost savings, storage and installation corrosion mitigation
World Pipelines	April 2007	Optimizing commissioning, drying time, pigging, corrosion, improved flow pattern
World Pipelines	April 2008	Storage benefits, energy costs, lower CO_2, product purity, rapid payback, reduced valve maintenance
World Pipelines	November 2010	Increased flow, increased throughput, lower storage corrosion, lower pumping costs, faster commissioning
World Pipelines	September 2016	Enhanced flow, corrosion protection in storage and pre-commissioning, reduced valve maintenance, lower energy costs, improved roughness
AMI Pipeline Coatings	February 2019	Reduced CAPEX & OPEX, lower CO_2, excellent quantitative analysis

Supporting Studies – Pressure Loss

- **Pressure Loss Model:**
  - Darcy-Weisbach and Colebrook-White equations for transportation of methane gas
- **Key Assumptions:**
  - Linear pipeline, excluding effects of bends, welds, elevation or gas compressibility
  - 2 compressors, 150 km apart
  - 300 km pipeline

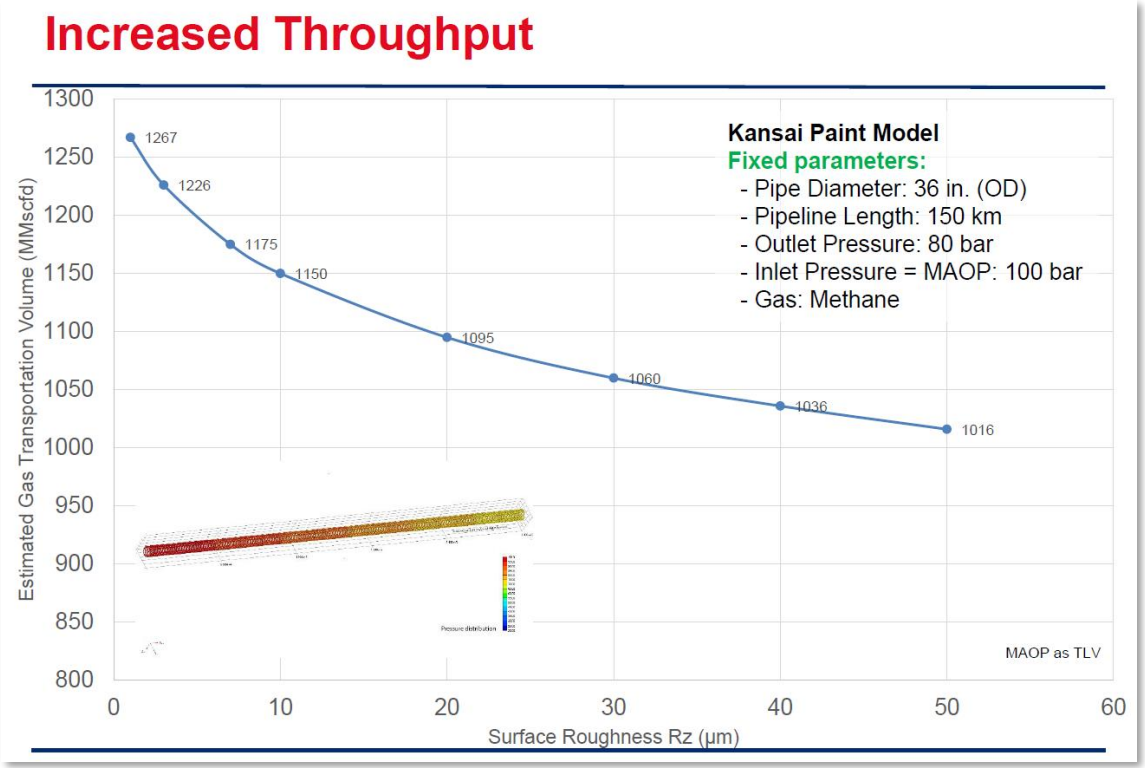
Pressure Drop Summary

Rz (microns)	Type of Surface	Pipe Diameter (in.)	Flow Rate (MMscfd)	Pipeline Length (km)	Inlet Pressure (bar)	Outlet Pressure (bar)	Pressure Drop (bar)
50	Blasted Steel	36	1,060	300	100	**52.3**	**47.7**
10	Low Solids FEC	36	1,060	300	100	**64.7**	**35.3**
7	High Solids FEC	36	1,060	300	100	**66.4**	**33.6**
3	Ultra-High Solids FEC	36	1,060	300	100	**69.2**	**30.8**
1	AlesEpomir PTG Series	36	1,060	300	100	**71.0**	**29.0**

Reduced pressure loss

Pipeline flow performance: State-of-the-art simulation modelling C.J.R. Thomas / AMI Pipeline Coatins 2019, Austria, Vienna, 12-14 February 2019

Supporting Studies – Increased throughput



Pipeline flow performance: State-of-the-art simulation modelling C.J.R. Thomas / AMI Pipeline Coatins 2019, Austria, Vienna, 12-14 February 2019

Supporting Studies – CAPEX & OPEX: Energy Savings

- 300 km pipeline
- 2 compressors to 1
- Energy savings

2 compressors vs. 1 compressor

CAPEX & OPEX Savings

Summary

Rz (µm)	Type of Surface	Pipe Diameter (in.)	Flow Rate (MMscfd)	Pressure at Point B Inlet (bar)	Pressure at Point B Outlet (bar)	Required Pressure Increase (bar)	Comp. Power (kW)	% Power Required	% Energy Saving
50	Blasted Steel	36	1,060	2 x Compressors			17,137	100.0	0.0
10	Low Solids FEC	36	1,060	83.0	97.4	14.4	9,829	57.4	42.6
7	High Solids FEC	36	1,060	83.7	96.8	13.1	8,881	51.8	48.2
3	Ultra-High Solids FEC	36	1,060	85.0	95.7	10.7	7,226	42.2	57.8
1	AlesEpomir PTG Series	36	1,060	85.9	94.9	9.0	6,111	35.7	64.3

Pipe Diameter: 36 in. (OD)
Gas: Methane
Flow Rate: 1,060 MMscfd
Inlet Pressure: 100 bar (Point A)
Pipeline Length: 300 km
Compressor Station: 150 km point (Point B)
Delivery Pressure: 80 bar (Point C)
MAOP (Max Allowable): 100 bar

Pipeline flow performance: State-of-the-art simulation modelling C.J.R. Thomas / AMI Pipeline Coatings 2019, Austria, Vienna, 12-14 February 2019

Supporting Studies – OPEX: Compressor Efficiency Improvements

- 300 km pipeline
- Cost savings based on gas cost
- Emission reduction

OPEX and "Green efficiency"

Compressor Station Efficiency Statistics

Rz (µm)	Type of Surface	Natural Gas Consumption (MMscfd)	Natural Gas Consumption (MMscf/year)	Natural Gas Cost (USD/year) USA	EU	Japan	Natural Gas Consumption (MT/year)	CO_2 Emissions (MT/year)
50	Blasted Steel	4.70	1,714	5,141,614	12,854,035	18,852,585	**39,784**	**88,321**
10	Low Solids FEC	2.69	983	2,948,995	7,372,487	10,812,981	**22,818**	**50,657**
7	High Solids FEC	2.43	888	2,664,566	6,661,416	9,770,077	**20,618**	**45,771**
3	Ultra-High Solids FEC	1.98	723	2,168,017	5,420,042	7,949,395	**16,775**	**37,241**
1	AlesEpomir PTG Series	1.67	611	1,833,483	4,583,708	6,722,772	**14,187**	**31,495**

Fuel: Natural Gas

Fuel cost: Natural gas cost is assumed to be USD 3.00/million BTU in USA, USD 7.5/million BTU in EU, USD 11.0/million BTU in Japan

Source: https://pps-net.org/statistics/gas (2015)

Pipe Diameter: 36 in. (OD)
Gas: Methane
Flow Rate: 1,060 MMscfd
Inlet Pressure: 100 bar (Point A)

Pipeline Length: 300 km
Compressor Station: 150 km point (Point B)
Delivery Pressure: 80 bar (Point C)
MAOP (Max Allowable): 100 bar

Pipeline flow performance: State-of-the-art simulation modelling C.J.R. Thomas / AMI Pipeline Coatings 2019, Austria, Vienna, 12-14 February 2019

Supporting Studies – OPEX: # of Compressors Constant, kW & CO_2 Savings

- 3,000 km pipeline
- # compressors constant
- Energy savings
- CO_2 reduction

OPEX and Environmental Impact

Summary

Rz (µm)	Type of Surface	Number of Compressor Stations	Total Compressor Power (kW)	Natural Gas Consumption (MMscf/year)	Natural Gas Cost (USD/year) USA	EU	Japan	CAPEX Reduction (%)	OPEX Reduction (%)	CO_2 Emissions (MT/year)
50	Blasted Steel	22	**300,928**	30,096	90,287,428	225,718,570	331,053,902	0.0	**0.0**	**1,550,927**
10	Low Solids FEC	22	**247,289**	24,731	74,194,119	185,485,297	272,045,102	0.0	**17.8**	**1,274,481**
7	High Solids FEC	22	**239,027**	23,905	71,715,271	179,288,177	262,955,993	0.0	**20.6**	**1,231,901**
3	Ultra-High Solids FEC	22	**223,976**	22,400	67,199,519	167,998,798	246,398,237	0.0	**25.6**	**1,154,331**
1	AlesEpomir PTG Series	22	**213,571**	21,359	64,077,707	160,194,268	234,951,593	0.0	**29.0**	**1,100,705**

Fuel: Natural Gas

Fuel cost: Natural gas cost is assumed to be USD 3.00/million BTU in USA, USD 7.5/million BTU in EU, USD 11.0/million BTU in Japan

Source: https://pps-net.org/statistics/gas (2015)

Pipe Diameter: 36 in. (OD)
Gas: Methane
Flow Rate: 1,060 MMscfd
Pipeline Length: 3,000 km

Pressure at compressor suction side: 80 bar
Pressure at compressor discharge side: 100 bar
Max distance per compressor: 138 km
MAOP (Max Allowable): 100 bar

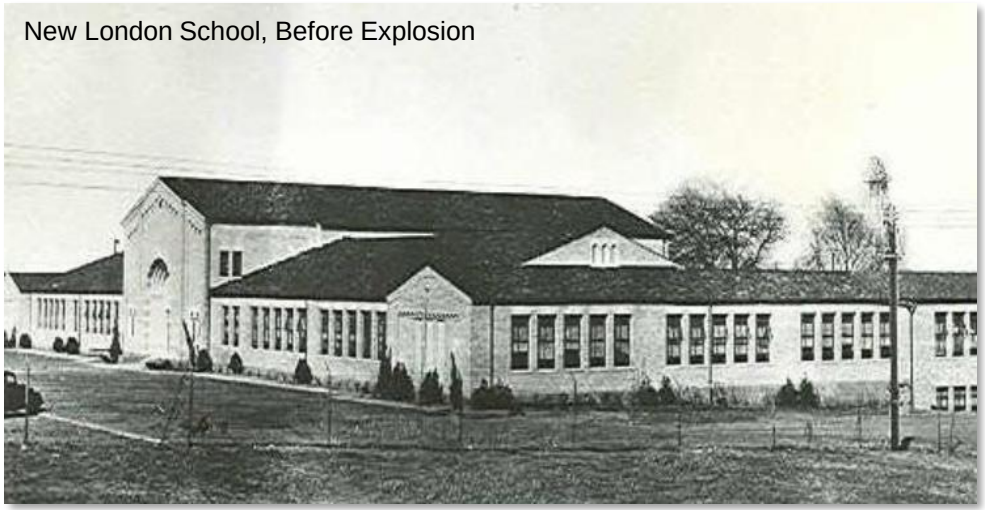
Pipeline flow performance: State-of-the-art simulation modelling C.J.R. Thomas / AMI Pipeline Coatings 2019, Austria, Vienna, 12-14 February 2019

What is the odor of natural gas?

NO ODOR

New London, Texas 1937

- The New London School explosion occurred on March 18, 1937, when a natural gas leak caused an explosion, destroying the London School of New London, Texas.
- The disaster killed more than **295 students and teachers**.
- School had 72 gas fired boilers.


New London School, Before Explosion

New London, Texas 1937

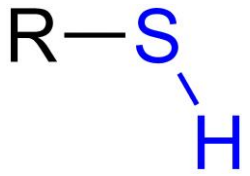
- School board canceled their natural gas contract and had plumbers install a tap into Parade Gasoline company's residual gas line to save money; a common practice as gas was a waste product and flared off.
- **Odorless gas** built up and an electric sander was thought to be ignition source.
- Within weeks of accident, Texas laws passed to **add odorants to natural gas** and practice was widely accepted.


New London School, After Explosion

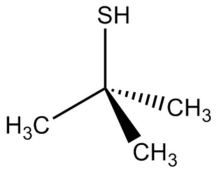
Safety – What are the Odorants in Natural Gas?

Generally thiols (sulfur analogs of alcohols)

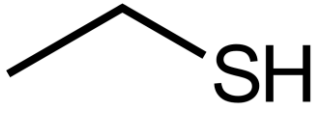
- Often called **mercaptans** - Latin for *mercurium captan* “capturing mercury.”
- Smell like **rotten eggs, skunk or garlic** (e.g. skunky beer exposed to UV light “Heineken”)
- Can smell at **part per billion**



T-butyl mercaptan for natural gas

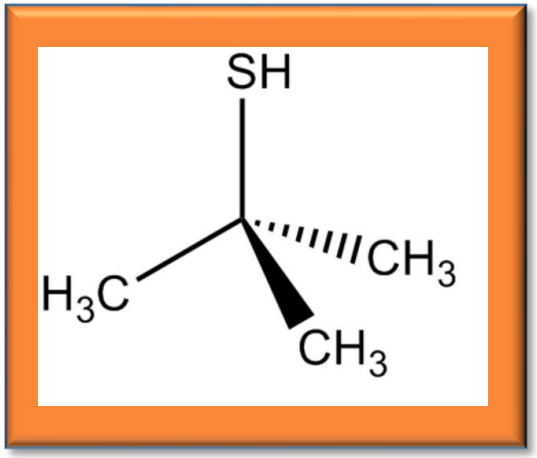


Ethanethiol in liquefied petroleum gas (LPG, propane)



Safety –
What are the Interactions of Odorants and Steel Pipe?

- Metal ion complexation with thiolates
- With metal ions, thiolates behave as ligands to form transition metal thiolate complexes
- The pipe itself can “absorb” the odorant
- This is especially problematic in smaller diameter, longer pipes such as **distribution lines**
- Safety issue if the gas has no odor when delivered to customer.



Atlanta Gas and Light, Southern Company

What is the remedy right now?

- Pickle the lines with mercaptan (saturation)

What is a better option?

2017:
- Studied pickling of lines
- Need to pickle lines at commissioning

Tested:
- 50,000 ft of 8-inch pipe
- Pickling cost = $75,000 not counting 3 weeks downtime
- Coating cost = $40,000 up front, not to mention not having to pickle every 18-36 months
- No odorant loss

Currently:
- Coating all of their pipe with Pipeclad® Flowliner

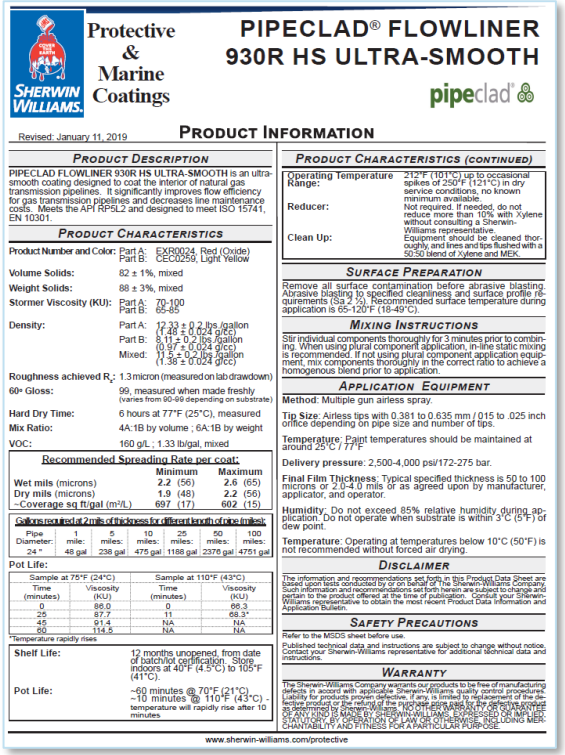
Pipeclad Flowliner 930R Family

Pipeclad Flowliner 930R HS Ultrasmooth

- 82% volume solids (HAPS free available)
- 4:1 ratio

Pipeclad Flowliner 930R SF

- 100% volume solids
- 3:1 ratio



Protective & Marine Coatings

PIPECLAD® FLOWLINER 930R HS ULTRA-SMOOTH

pipeclad®

Revised: January 11, 2019

PRODUCT INFORMATION

PRODUCT DESCRIPTION

PIPECLAD FLOWLINER 930R HS ULTRA-SMOOTH is an ultra-smooth coating designed to coat the interior of natural gas transmission pipelines. It significantly improves flow efficiency for gas transmission pipelines and decreases line maintenance costs. Meets the API RP5L2 and designed to meet ISO 15741, EN 10301.

PRODUCT CHARACTERISTICS

Product Number and Color:	Part A: EXR0024, Red (Oxide) Part B: CEC0259, Light Yellow
Volume Solids:	82 ± 1%, mixed
Weight Solids:	88 ± 3%, mixed
Stormer Viscosity (KU):	Part A: 70-100 Part B: 65-85
Density:	Part A: 12.33 ± 0.2 lbs./gallon (1.48 ± 0.024 g/cc) Part B: 8.11 ± 0.2 lbs./gallon (0.97 ± 0.024 g/cc) Mixed: 11.5 ± 0.2 lbs./gallon (1.36 ± 0.024 g/cc)
Roughness achieved R_z:	1.3 micron (measured on lab drawdown)
60° Gloss:	99, measured when made freshly (varies from 90-99 depending on substrate)
Hard Dry Time:	6 hours at 77°F (25°C), measured
Mix Ratio:	4A:1B by volume ; 6A:1B by weight
VOC:	160 g/L ; 1.33 lb/gal, mixed

Recommended Spreading Rate per coat:

	Minimum	Maximum
Wet mils (microns)	2.2 (56)	2.6 (65)
Dry mils (microns)	1.9 (48)	2.2 (56)
~Coverage sq ft/gal (m²/L)	697 (17)	602 (15)

Gallons required/mile of thickness for different inch of pipe miles:

Pipe Diameter:	1 mile:	5 miles:	10 miles:	25 miles:	50 miles:	100 miles:
24 "	48 gal	238 gal	475 gal	1188 gal	2376 gal	4751 gal

Pot Life:

Sample at 75°F (24°C) Time (minutes)	Viscosity (KU)	Sample at 110°F (43°C) Time (minutes)	Viscosity (KU)
0	86.0	0	66.3
25	87.7	11	88.3*
45	91.4	NA	NA
60	114.5	NA	NA

*Temperature rapidly rises

Shelf Life:	12 months unopened, from date of batch/lot certification. Store indoors at 40°F (4.5°C) to 105°F (41°C).
Pot Life:	~60 minutes @ 70°F (21°C) ~10 minutes @ 110°F (43°C) - temperature will rapidly rise after 10 minutes

PRODUCT CHARACTERISTICS (CONTINUED)

Operating Temperature Range:	212°F (101°C) up to occasional spikes of 250°F (121°C) in dry service conditions, no known minimum available.
Reducer:	Not required. If needed, do not reduce more than 10% with Xylene without consulting a Sherwin-Williams representative.
Clean Up:	Equipment should be cleaned thoroughly, and lines and tips flushed with a 50:50 blend of Xylene and MEK.

SURFACE PREPARATION

Remove all surface contamination before abrasive blasting. Abrasive blasting to specified cleanliness and surface profile requirements (Sa 2 ½). Recommended surface temperature during application is 65-120°F (18-49°C).

MIXING INSTRUCTIONS

Stir individual components thoroughly for 3 minutes prior to combining. When using plural component application, in-line static mixing is recommended. If not using plural component application equipment, mix components thoroughly in the correct ratio to achieve a homogenous blend prior to application.

APPLICATION EQUIPMENT

Method: Multiple gun airless spray.

Tip Size: Airless tips with 0.381 to 0.635 mm / 015 to .025 inch orifice depending on pipe size and number of tips.

Temperature: Paint temperatures should be maintained at around 25°C / 77°F.

Delivery pressure: 2,500-4,000 psi/172-275 bar.

Final Film Thickness: Typical specified thickness is 50 to 100 microns or 2.0-4.0 mils or as agreed upon by manufacturer, applicator, and operator.

Humidity: Do not exceed 85% relative humidity during application. Do not operate when substrate is within 3°C (5°F) of dew point.

Temperature: Operating at temperatures below 10°C (50°F) is not recommended without forced air drying.

DISCLAIMER

The information and recommendations set forth in this Product Data Sheet are based upon tests conducted by or on behalf of The Sherwin-Williams Company. Such information and recommendations set forth herein are subject to change and supplement without notice effected at the time of publication. Consult your Sherwin-Williams representative to obtain the most recent Product Data Information and Application Bulletin.

SAFETY PRECAUTIONS

Refer to the MSDS sheet before use.

Published technical data and instructions are subject to change without notice. Contact your Sherwin-Williams representative for additional technical data and instructions.

WARRANTY

The Sherwin-Williams Company warrants our products to be free of manufacturing defects in accord with applicable Sherwin-Williams quality control procedures. Liability for products proven defective, if any, is limited to replacement of the defective product or the refund of the purchase price paid by the customer for the defective product. SHERWIN-WILLIAMS MAKES NO OTHER WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, STATUTORY, BY OPERATION OF LAW OR OTHERWISE, INCLUDING MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

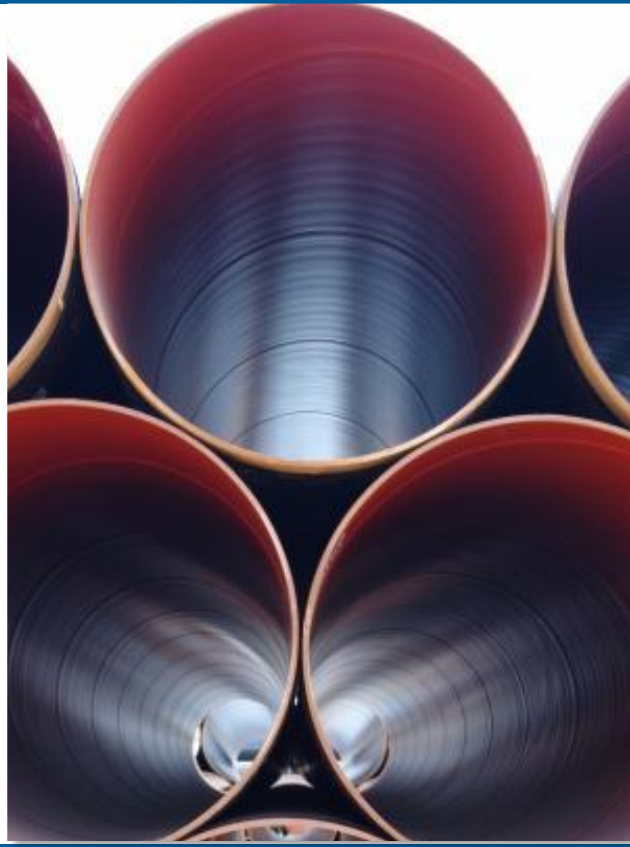
www.sherwin-williams.com/protective

Why Use Flow Efficiency Coatings?

Smoothing the Surface Roughness	**Increased throughput**
Optimized Pre-Commissioning	**Optimal pigging / drying**
Lower OPEX Costs	**Lower compressor station energy costs**
Lower CAPEX Costs	**Reduced number of compressor stations** **Optimized pipeline diameter**
Safety	**Maintain safe levels of odorant** **Reduces pickling requirements**

Why Use Flow Efficiency Coatings?

- Corrosion protection in storage
- More environmentally-friendly, CO_2 reduction
- Sealed surface: product purity, less compressor fouling
- Rapid payback



Appendix

Conformity to:

- Standards
- Specifications

At work in the field:

- Select projects
- Track record
- Testimonials
- Recommendations

Conforms to API RP 5L2 Standard

Tests	API RP 5L2 Acceptance Criteria	Test Method	Test Results	Status
Salt Spray	No blistering and ≤0.125 inch of coating removed in any direction from scribe with pull by clear plastic tape	Appendix B API RP 5L2	No blistering and no coating removed in any direction from scribe with pull by clear plastic tape (2.2 mils)	Pass
Water Immersion	No blistering over 0.25 inch from edges	100% immersion in saturated $CaCO_3$/ distilled water solution, 21 days 77±2°F	No visible blistering (2.1 mils)	Pass
Methanol and Water Mixture (1:1 by Volume)	No blistering over 0.25 inch from edges	100% immersion in mixture, 5 days 77±2°F	No visible blistering (1.9 mils)	Pass
Stripping	Coating shall flake off and produce powdery particles when rolled	Appendix C API RP 5L2	Coating flaked and powdered when rolled (2.0 mils)	Pass
Bend	No visual flaking, adhesion loss, or cracking at ≥0.5 inch diameter	ASTM D 522	No visible flaking, adhesion loss, or cracking at ≥0.5 inch diameter (2.1 mils)	Pass
Adhesion	No material lifting other than cuttings	Appendix D API RP 5L2	No material lifted other than cuttings (2.0 mils)	Pass
Hardness	≥94 Buchholz @ 77±2°F	DIN 53 153	Average Buchholzhardness of 106 (2.0 mils)	Pass
Gas Blistering	No blistering	1200±100psi 24hrs., 77±10°F	No visible blistering (2.1 mils)	Pass
Abrasion	≥23 coefficient of abrasion	ASTM D 968 Method A	223 coefficient of abrasion (2.0 mils)	Pass
Hydraulic Blistering	No blistering	2400±500psi 24hrs., 77±10°F	No visible blistering (2.1 mils)	Pass

Conforms to ISO 15741 & EN 10301 Standards

Tests	ISO 15741/EN 10301 Acceptance Criteria	Test Method	Test Results	Pass/Fail
Non-volatile Matter by Mass	Meets manufacturer specifications	ISO 3251	Part A = 83.2% Part B = 68.1% Mixed = 86.5%	Pass
Non-volatile Matter by Volume (ISO 15471 Only)	Meets manufacturer specifications	ISO 3233	66.20%	Pass
Viscosity	Meets manufacturer specifications	ISO 2431	654 cP (75KU)	Pass
Density	Meets manufacturer specifications	ISO 2811	Part A = 1.67 g/mL Part B = 0.99 g/mL	Pass
Ash	Meets manufacturer specifications	ISO 15741 Annex A	Part A = 56.4%	Pass
Dry Film Thickness	60 µm to 100 µm	ISO 15741 Annex B	Average = 3.6 mils (90.2 µm)	Pass
Adhesion	ISO ratings of ≤1	ISO 2409	ISO ratings of #0 (no coating removed)	Pass
Buchholz Hardness	Hardness value of 94 or greater	ISO 2815	Buchholz hardness = 134	Pass
Resistance to Natural Salt Spray	Samples free from deterioration, blisters, cracking or staining	ISO 7253	No blistering, cracking or staining	Pass
Resistance to Artificial Aging	Maximum crack length after bending of 13mm from small end of mandrel	ISO 15741/EN 10301	No cracks or disbondment	Pass

Conforms to ISO 15741 & EN 10301 Standards

Tests	ISO 15741/EN 10301 Acceptance Criteria	Test Method	Test Results	Pass/Fail
Bend Test	Maximum crack length of 13mm from small end of mandrel	ISO 6860	No cracks or disbondment	Pass
Resistance to Gas Pressure Variations	No blistering, ISO adhesion, ISO adhesion ratings of ≤1	ISO 15741/EN 10301 Annex C	No blistering ISO adhesion ratings of #0	Pass
Resistance to Water Immersion	No blistering or softening	ISO 2812 - 2	No blistering or softening	Pass
Resistance to Chemicals – Cyclohexane	No blistering or softening, ISO adhesion ratings of ≤1	ISO 2812-1	No blistering or softening	Pass
Resistance to Chemicals – Diethylene Glycol in Water	No blistering or softening, ISO adhesion ratings of ≤1	ISO 2812-1	No blistering, ISO adhesion ratings of #0	Pass
Resistance to Chemicals – Hexane	No blistering or softening, ISO adhesion ratings of ≤1	ISO 2812-1	No blistering or softening, ISO adhesion ratings of #0	Pass
Resistance to Chemicals – Methanol	No blistering or softening, ISO adhesion ratings of ≤1	ISO 2812-1	No blistering or softening, ISO adhesion ratings of #0	Pass
Resistance to Chemicals – Toluene	No blistering or softening, ISO adhesion ratings of ≤1	ISO 2812-1	No blistering or softening, ISO adhesion ratings of #0	Pass
Resistance to Chemicals – Lubricating Oil	No blistering or softening, ISO adhesion ratings of ≤1	ISO 2812-1	No blistering or softening, ISO adhesion ratings of #0	Pass
Resistance to Hydraulic Blistering	No blistering, ISO adhesion, ISO adhesion ratings of ≤1	ISO 15741 Annex D	No blistering or softening, ISO adhesion ratings of #0	Pass

Pipeclad Flowliner Meets End User Specifications

Gas Company and Project Specifications

Pipeclad Flowliner

At work in the field…

Ruby Pipeline

Scope: Largest 2010 pipeline in U.S.
Pipe Coated: 675 miles (~1,086 km)
Diameter: 42-inch pipe

Coatings:
- Pipeclad® 2000 FBE
- Pipeclad® 2040 ARO
- Pipeclad® Flowliner Liquid

elpaso KINDER MORGAN

Challenges:
- Pipeline exposed to difficult elements (rock/rivers/etc.)
- Used low-VOC Flowliner to meet environmental constraints

Results:
- Delivered products 100% on time with no quality problems for 14 months at 5 different applicators
- Improved plant application of FBE by applying internal coating before external coating

Questar Pipeline

Scope: 2010 pipeline in U.S.
Pipe Coated: 45 miles (~73 km)
Diameter: 36-inch pipe

Coatings:
- Pipeclad® 2000 FBE
- Pipeclad® Flowliner Liquid

QUESTAR®

Challenges:
- Extreme flexibility needed for undulating terrain

Results:
- Met or exceeded all customer expectations

Green River, Wyoming construction site with Pipeclad 2000 & Flowliner

TransCanada Project

Scope: Multi-year pipeline installation in the U.S.
Pipe Coated: 477 miles (768 km)
Diameter: 30- to 48-inch pipe

Coatings:
- Pipeclad® 2000 FBE
- Pipeclad® Flowliner Liquid

TransCanada
In business to deliver

Challenges:
- Cold weather application and installation

Results:
- Met or exceeded all customer expectations

Coated pipe unloaded at Parkway

NET Mexico Pipeline

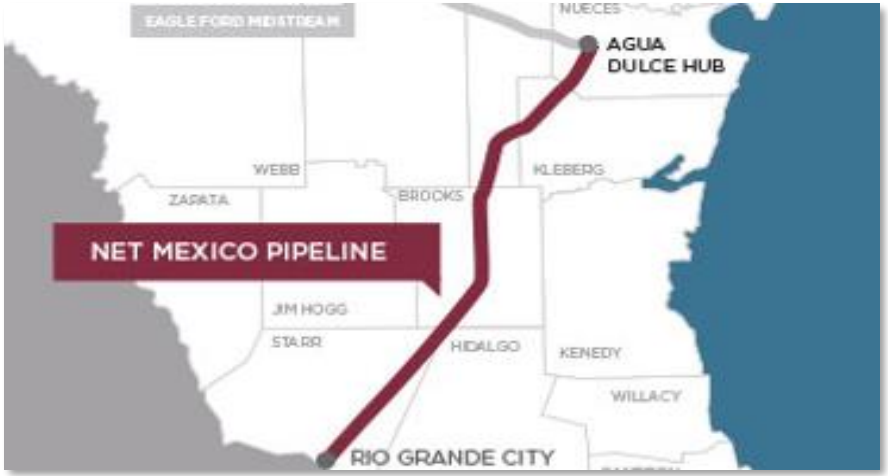
Scope: Major 2014 pipeline in the U.S.
Pipe Coated: 124 miles (200 km)
Diameter: 42- and 48-inch pipe

Coatings:
- Pipeclad® Flowliner 930R UHS

NET MIDSTREAM

Challenges:
- Rz value needed to be 2 microns or less
- Needed easy-to-apply product with technical support

Results:
- Rz value, product performance and technical support exceeded customer expectations



Williams Project

Scope: 2013-2014 pipeline in the U.S.)
Pipe Coated: 255 miles (362 km)
Diameter: 24-, 26- and 42-inch pipe

Coatings:
- Pipeclad® 2000 FBE
- Pipeclad® 2040 ARO
- Pipeclad® Flowliner Liquid

Challenges:
- Constitution Pipeline and Virginia Southside Expansion required strict coating deadlines
- Portion of Rockaway Delivery Lateral pipe lay consisted of HDD onshore drill to run to offshore exit point

Results:
- Delivered products 100% on time with no quality problems
- Improved ease of application by having technical support present for different applicator project start-ups
- Met or exceeded all customer expectations

Information:
- Project includes Virginia Southside Expansion, Constitution Pipeline, Rockaway Lateral Project and Liedy Southeast Expansion

Coated pipe for Rockaway Lateral Pipeline

Pipeclad Flowliner

A proven track record…

Pipeclad Flowliner: Proven Track Record

Valspar Product	Project Name	Location	Pipe Length	Diameter	Year
Pipeclad Flowliner	UGI Utilities	North America	11 miles	24”	2017
Pipeclad Flowliner	Atlantic Coast P/L	North America	550 miles	36”	2016
Pipeclad Flowliner	Kinder Morgan (Triad Expansion)	North America	7 miles	36”	2016
Pipeclad Flowliner	Kinder Morgan (Susquehanna West)	North America	8 miles	36”	2016
Pipeclad Flowliner	Spectra Energy	North America	255 miles	36”	2016
Pipeclad Flowliner	CFE/Enbridge	India	168 miles	36”	2016
Pipeclad Flowliner	Spectra Energy	North America	465 miles	36”	2016
Pipeclad Flowliner	NextEra	North America	126 miles	30” & 36”	2016
Pipeclad Flowliner	Dominion	North America	30 miles	20” & 30”	2016
Pipeclad Flowliner	Energy Transfer	North America	800 miles	24”, 30”, 36” & 42”	2015
Pipeclad Flowliner	Williams	North America	8 miles	36”	2015

Pipeclad Flowliner: Proven Track Record

Valspar Product	Project Name	Location	Pipe Length	Diameter	Year
Pipeclad Flowliner	Spectra Energy	North America	73 miles	30”	2014
Pipeclad Flowliner	Boardwalk	North America	74 miles	24-30”	2014
Pipeclad Flowliner	Williams	North America	100 miles	24”	2014
Pipeclad Flowliner	NET Midstream	North America	.5 miles	48”	2013
Pipeclad Flowliner	NET Midstream	North America	124 miles	42”	2013
Pipeclad Flowliner	Williams	North America	5 miles	26”	2013
Pipeclad Flowliner	Williams	North America	120 miles	24”	2013
Pipeclad Flowliner	Shell	North America	90 miles	16”	2012
Pipeclad Flowliner	GAIL	India	100 miles	20”	2011
Pipeclad Flowliner	Bison (TCPL)	North America	303 miles	30”	2010
Pipeclad Flowliner	Fayetteville Express	North America	185 miles	42”	2010

Pipeclad Flowliner: Proven Track Record

Valspar Product	Project Name	Location	Pipe Length	Diameter	Year
Pipeclad Flowliner	Ruby	North America	675 miles	42”	2010
Pipeclad Flowliner	Haynesville Extension	North America	249 miles	30-36”	2009
Pipeclad Flowliner	Boardwalk	North America	100 miles	36”	2008
Pipeclad Flowliner	Cheniere	North America	241 miles	42”	2008
Pipeclad Flowliner	Trinidad (Amaco)	Trinidad	105 miles	24”	2005
Pipeclad Flowliner	Alliance Pipeline	North America	2,300 miles	36”	2000
Pipeclad Flowliner	Kinder Morgan	North America	221 miles	36”	1998
Pipeclad Flowliner	Sempra	North America	38 miles	36”	1996
Pipeclad Flowliner	Anadarko	North America	58 miles	20”	1994
Pipeclad Flowliner	Gulf South	North America	130 miles	42”	1993
Pipeclad Flowliner	A to C (ARKLA)	North America	275 miles	36”	1992

Pipeclad Flowliner: Proven Track Record

Valspar Product	Project Name	Location	Pipe Length	Diameter	Year
Pipeclad Flowliner	Northern Natural	North America	50 miles	30”	1986
Pipeclad Flowliner	Texas Gas	North America	192 miles	42”	1985
Pipeclad Flowliner	Northern Borders	North America	100 miles	30”	1982
Pipeclad Flowliner	Northwest Pipeline	North America	250 miles	36-42”	1981
Pipeclad Flowliner	Trailblazer	North America	420 miles	42”	1981

Testimonial

3,719-kilometer natural gas pipeline completed in 2000 connecting Canada to U.S.

“As one of the newest pipeline systems, Alliance is also one of the most efficient. Our internally-coated pipeline and high-efficiency combustion turbines result in significantly lower greenhouse gas emissions than a conventional pipeline system.”

Testimonial

NET MIDSTREAM

“NET Mexico chose Valspar Flowliner 930R UHS for internal coating of the 42” OD pipe because it had proven to produce a very low surface roughness.”

—Jordan Hunter, Pipeline Construction Manager

200-kilometer natural gas pipeline completed in December 2014 to transport gas from 9 interconnects in Texas, U.S.

End User Contacts

End User	Contact Name	Title	Phone	E-mail
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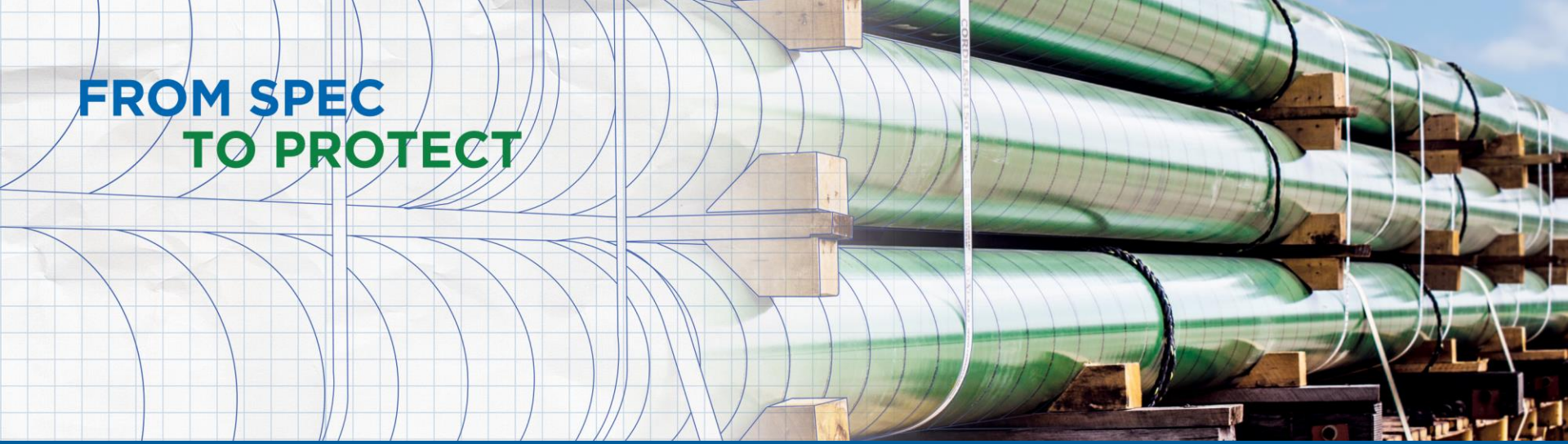
“Powered by Pipeclad®” Informational Series

“Powered by Pipeclad®” Technology Discussion Topics

- High Operating Temperature (HOT) Fusion Bonded Epoxy Coatings for Onshore and Offshore Applications
- Moisture Resistant Overcoats: Advances in Damage Tolerance and Barrier Properties
- Effects of UV Exposure and Risk Mitigation
- Internal Flow Efficiency Coatings for Natural Gas Transmission; Differentiating Value and Safety



THANK YOU

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