A New Approach to High Performance Polyolefin Coatings

by

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Steel Corrosion

- Low Permeability
- Excellent Adhesion to Steel
Coating Systems for Pipelines

Fusion Bonded Epoxy (FBE)

- Low permeability to oxygen
- Excellent Adhesion to Steel
- Excellent Resistance to Cathodic Disbondment
- Low Impact Resistance
- Permeable to moisture
- Tendency to disbond when exposed to HOT & WET conditions for long periods of time
Polyolefins Topcoat

- Low Permeability to Moisture
- High resistant to Impact Damage
- Flexible
- Tough
- Relatively Low Cost (e.g. PE, PP)
Coating Systems for Pipelines

3LPO Coating

Mechanical Properties

Adhesion to Steel

Steel

Copolymer Adhesive

FBE

Polyolefin
Weld Geometry

Pipes with OD > 24” (610 mm)

Cross Section of a Typical Weld on a Pipe
Weld Geometry

Terminology used to describe Weld Geometry:
- Crown
- Toe
- Height
- Undercut
Weld Geometry

- ✔️ Ideal weld shape
- ✗ Square edges
- ✗ Square edges with slight undercut
- ✗ Square edge with severe undercut
- ✗ Severe undercuts both sides and recess on top
Conventional 3LPO Side Extruded Process

Pressing Roller

Extrudate

Weld

Pipe

Ideal Weld Shape
Conventional 3LPO Side Extruded Process

Ideal Weld Shape

Pipe
Conventional 3LPO Side Extruded Process

Ideal Weld Shape
Conventional 3LPO Side Extruded Process

Ideal Weld Shape
Conventional 3LPO Side Extruded Process

Pressing Roller → Extrudate

Weld

High Raised or Square Weld

Pipe
Conventional 3LPO Side Extruded Process

High Raised or Square Weld

The GLOBAL LEADER in Pipe Coating Solutions
Conventional 3LPO Side Extruded Process

High Raised or Square Weld
Conventional 3LPO Side Extruded Process

High Raised or Square Weld

Weld

Pipe
Conventional 3LPO Side Extruded Process

With high raised or square weld …

Void

Pressing roller is NOT Effective!
Conventional 3LPO Side Extruded Process

Water quenching

- Volume Shrinkage
- Hoop Stress
Common Problems:

- Weld Tenting
- Thinning across the top of the weld

Voids
“Graded Structure” PE Coating

Powder Applied PE adhesive and Topcoat

- No distinct interface
- Smooth transition from rigid FBE to much tougher and compliant PE
Advantages:

- Eliminate interlayer adhesion failure
- Provide excellent uniform coverage of the raised weld
- Allow production of lower thickness coatings than is possible with conventional 3LPO coating process
“Graded Structure” PE Coating

Disadvantages:

• More expensive for additional step of polyolefin grinding
• More difficult to apply a thick coating by powder application due to loss of heat transfer
New Approach to Multi-Layer Polyolefin Coatings

- Graded Structure PE Coatings
  - Prevent delamination and loss of adhesion
  - Provide uniform coverage over raised welds

+ Side-Wrap Extruded PE Coatings
  - Attain thick coatings
  - Lower cost
  - Higher throughout
Advantages:

- Allow production of Multi-layer Polyolefin of any thickness with Uniform Thickness at all points
- No Tenting along the edges of welds
New Approach to Multi-Layer Polyolefin Coatings

New Approach Multi-layer PE Coating

VS

Conventional 3LPE Coating

- Application
- Physical Properties
- Coating Effectiveness
The GLOBAL LEADER in Pipe Coating Solutions

Conventional 3LPE Coating

Induction Coil

Sheet Extruder

External Cooling

Coated Pipe

Internal Cooling

FBE Adhesive

PE Adhesive

New Approach Multi-layer PE Coating
Coating Effectiveness
Coating Effectiveness

Conventional 3LPE Coating

![Image of conventional 3LPE coating with weld tenting]

$\frac{t_{\text{weld}}}{t_{\text{body}}} \approx 60-70\%$

New Approach to Multi-layer PE Coating

![Image of new multi-layer PE coating]

161 mls 197 mls 147 mls 172 mls 156 mls

131 mls 211 mls 167 mls

186 mls 201 mls
Coating Effectiveness

New Approach to Multi-layer PE Coating

Fused Polyethylene Powder
Adhesive Interlayer
Coating Effectiveness

Side-Wrapped GSPE on Spiral Weld Pipe (30”)
Coating Effectiveness

Note how well-defined the weld seam is.

Close-Up Showing Excellent Conformance to the Long Seam Weld
Intersection of the Long Seam and the Girth Weld on Double-Jointed Pipe
Physical Properties
Physical Properties

Flexibility Test at -30°C with 4.2°/pd

Conventional 3LPE Coating

New Approach Multi-layer PE Coating
Physical Properties

Rock Impact Test at - 40°C with 22 lb Rock Fell from 2 meters to the tested Coating

Round Rock

Sharp Rock
Physical Properties

Rock Impact Test at -40°C with 22 lb Rock

Conventional 3LPE Coating

New Approach Multi-layer PE Coating
Conclusions

• A new coating system consists of HDPE Side-Wrapped over a “graded structure” PE is introduced.

• This new coating system overcomes the drawbacks of the conventional 3LPE coating.
Conclusions

The new coating system ......

- Provides exceptionally uniform coverage of external welds on both long and spiral welded pipes
- Eliminated “weld tenting”
- Leads to a coating with reduced residual stress
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