Improved field joint coatings for the challenging pipeline projects with WehoCoat™ and Borcoaat™

Borealis AG
Uponor Infra Ltd
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6. Offshore version of WehoCoat
Borealis at a Glance

- Leading provider of chemical and innovative plastics solutions that create value for society
- More than 50 years of experience
- Unique Borstar® technology to develop polyolefin solutions that are tailored to customers’ needs
- Around 6,400 employees worldwide and customers in over 120 countries
- Ownership 64% IPIC / 36% OMV
- Joint venture in Middle East and Asia: Borouge (Abu Dhabi)
Strong ownership and Oil & Gas industry background
Energy & Infrastructure covers a complete range of solutions

**Energy**
- High Voltage
- Medium Voltage
- Low voltage

**Building Wire**
- Jacketing
- Fiber Optics

**Energy exploration**
- Oil & Gas pipelines

**Infrastructure**
- Drinking Water & Sewage

**Housing solutions**
- Hot & Cold Water Pipe

**Energy storage**
- Capacitor film

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PE and PP for the steel pipe coating processes

Side extrusion-wrapping

Crosshead –hose coating

Multilayer PP offshore
WehoCoat™ Field joint coating technology
In most of our applications we have a clearly wider and better offering than before

- Storm water
- Sewer
- Potable water
- Cable & telecom
- Waste water treatment
- House drainage
- Radon
- Functional piping systems
- Under ground ventilation
- Renovation
- District heating & cooling
- Special constructions
- Marine intakes and outfalls
- Welding, extrusion and blown film technology
Stronger services offering

- Project service
- Technical support
- Customer service
- Special constructions
- Uponor Academy
- Technical Handbook
- The web
- Calculation tools
- Welding services
- Renovation services
- Licensing and franchising
Uponor Infra Ltd, Technology

- Product portfolio
  - Solid wall PO pipe production lines
  - Weholite production lines
  - DH-pipe production lines
  - Flexible PU pre-insulated pipe lines
  - Steel pipe coating lines (SPC)
  - Welding machines
  - Blown film lines, coating and extrusion lamination
  - Franchising & Licensing
Field joints are potential weak points in the corrosion protection systems

Corrosion experts state: “There is a need for compatible, reproducible and cost effective solutions”

Shrink sleeve after soil stress
Corrosion on a pipe joint below the FJC

Continuous improvements of mill applied coatings, but what about field joints?

*Photos courtesy David Norman Associates*
WehoCoat – Borcoat™ System

- Uponor Infra Ltd: Plastics machinery know how and polymer processing
- Borealis: Polymer development and steel pipe coating know-how
- Field Joint (FJ) Coating method based on Hot applied melt film technique - based on PATENTED SOLUTION, WO 2008/ 132279 A1
- Machine rotates around the pipe and applies molten PE or PP material onto the field joint area
WehoCoat – Borcoat™ Joint Design

1. Welded Pipe Joint
2. Steel Pipe
3. Factory Epoxy Coating
4. Factory Adhesive and Top Coat
5. Teknos Infralit EP8064 Powder Epoxy, min 100ym
6. BorcoatME3000FC Top Coat (PE), min 3mm

Top Coat + Adhesive
• A = Overlap Distance Min. 10 mm beyond beveled area

Mill coated
3 layer system

Field joint
2 layer system

PE welding bonds

Epoxy

Steel Pipe

A

1 2 3 4 5 6
Borcoat materials for WehoCoat process

- The field joint system only consists of 2 layers:
  - Fusion bonded epoxy, powder, spray applied
  - Modified PE or PP material, Borcoat ME3000FC or BB5000FC
- Modified PE or PP is a so called “reactive top coat”, i.e. a top coat with ability to
  - React with the epoxy due to functional groups (like adhesive)
  - Perfectly weld to the factory applied coating
  - Acts as a top coat related to mechanical protection
  - Borcoat ME3000FC could be described as “MDPE” class B acc ISO21809-1 related to mechanical strength and protection ability
**WehoCoat Onshore robot – technical data**

Field joint coating for onshore pipe lines with 3L PE/3LPP coating structures

Pipe dimension ranges for the machines:
WehoCoat Onshore 800 (450 – 890 mm)
WehoCoat Onshore 1400 (900 – 1420 mm)

Field joint cut back length: 300 - 450 mm
Field joint coating thickness: 2 – 8 mm

Rotation speed: 1,0-1,2 m/min
Machine length in pipe direction: 0,9-1m
Required space around the pipe: 400 mm
WehoCoat Onshore robot

- Chassis frame with driven rollers
- Induction heating unit
- FBE (Fusion Bonded Epoxy) spraying gun
- Flat die + driven pressure roller
- Temperature measuring sensors
- Hot air blowers for tempering bevel zone

Additional external equipment required:
- Truck with articulated crane (1t / outreach 9 m)
- Generator 60 – 250 KVA
- Single screw extruder (outdoor suited)
- Water cooling system
- Air compressor
WehoCoat – Borcoat™ System

- WehoCoat operational Field Package:
  - Tested +40°C in Kuwait and -30°C in Finland
Blast cleaning of the field joint area

Abrasive-non metallic
Rz=50-100ym
SA 2½

Filling of the machine with molten polymer
WehoCoat machine is lifted onto the pipe
Induction heating and automatic FBE application

First induction step 130-150°C
WehoCoat Onshore robot

The surface preparation with sand blasting is done at a separate station

Method overview:

- Induction heating (130 – 150 °C)
- Automatic powder FBE (Fusion Bonded Epoxy) application
- Induction heating (170 – 190 °C)
- Yellow top coat application

Cycle time examples (joint to joint time):

- 500 mm -> 15 - 20 minutes
- 900 mm -> 25 - 35 minutes
- 1420 mm -> 30 - 45 minutes
WehoCoat machine rotates and applies the polymer

Second induction step 170-190°C
The driven roller ensures the even melt distribution and pressure for the welding

Shaped pressure roller possible
Good control of the coating thickness in the FJ area

Left: Mill applied coating 3.47mm

Right: Mill applied coating 2.95mm

Good flow out characteristics of the polymer
No air entrapments
Easy welding to the mill applied coating
WehoCoat Onshore robot

Applications:

Mobile field joint coating for onshore pipelines

Field joint coating for **HDD** (Horizontal Directional Drilling)
Scratch test performance of Borcoat ME3000FC versus shrink sleeves

Scratch test performed with different loads on shrink sleeve (left side), Borcoat HE3450 and Borcoat ME3000FC (right side)
Project details for Gasum pipeline Mäntsälä to Siuntio in Finland

Project details
- Pipeline operator Gasum :(31%Fortum / 24%Finnish state / 20%/EON / 25% Gazprom)
- natural gas pipe DN500, pressure class 80bar
- three layer PE coated
- Project time: September 2010 to April 2011
- Pipeline length~90km
- Sections with horizontal drilling(HDD) with ~1500joints all done with WehoCoat
WehoCoat Robot

Reference Project in Finland at Gasum pipe line project
Many guests at the Mäntsälä project and further machine demonstrations

- Open Grid (EON)
- Shell
- OMV Austria
- Gasum
- Gasunie NL
- GRTgaz France
- ENI Italy
- Fluxys Belgium
- Nabucco AG
- Nord Stream AG
- VNG Verbundnetz
- TIGF France
- VNIIGAZ

- A.Hak
- Rombouts KT
- Saipem
- PIH
- Visser & Smit
- Penspen
- Strojtranspaz
- Argus
- Allseas Engineering
- Denys
- Wood Group
Impact testing of the field joint area during a PQT in presence of gas companies, engineering etc

- Falling weight impact 7J/mm, ~6mm coating, height 1m
- Holiday detection 25kV on impacted area – no failure
WehoCoat – Borcoat™ Peeling test

– Meets requirements as for coated pipes (ISO21809-1/ 23°C>150N/cm)
  – >200N/cm at 23°C on steel surface, on weld, on overlap to mill applied coating
  – >40 N/cm at max operating temp., normally 80°C (PE)
– ISO21809-3 specification for field joints requires only 40N/cm at 23°C...
– ISO21809-1 minimum “Properties of applied coating” are fulfilled as for factory coated steel pipe
Approvals, PPT, PQT etc

- Specification document available for the WehoCoat-Borcoat FJ technology as basis for accreditation
- Third party inspection report:
  - Description of the FJ application
  - Requirements
  - Test methods
  - Test results
- Third party test reports
- We support your certification process!
Future pipeline projects with excellent perspectives for the new WehoCoat system

- Long distance pipeline projects like TANAP
- Challenging projects like onshore section of Galsi on Sardinia for PE coated pipes
- Large diameter oil transmission lines
- European natural gas distribution system
- Gas pipeline projects with PE coating in demanding regions like Canada, Russia etc
- Horizontal drilling sections
WehoCoat Offshore robot

Offshore pipeline field joint coating at the spool base

Field joint coating of offshore pipelines with the WehoCoat placed on the S-lay vessel
WehoCoat Offshore robot

Field joint coating for offshore pipe lines with 3L PE/3LPP structures

Dimension ranges:
WehoCoat Offshore 450 (150 – 450 mm)
WehoCoat Offshore 800 (450 – 820 mm)

Field joint cut back: 300 – 450 mm
Field joint coating thickness: 2 – 8 mm

Cycle time examples for the polymer application:
500mm: 3.5 minutes
800mm: 5 minutes

Pipe diameter 6-18” machine is exclusive for Shawcor Bredero
WehoCoat Offshore robot

Includes:
• Adjustable chassis according to different pipe sizes
• Flat die + pressure roller
• Temperature measuring sensors
• Hot air blowers for tempering bevel zone

Requires the following equipment:
• Surface treatment (sand blasting)
• Induction heating
• FBE Application equipment
• Powder adhesive application guns
• Electrical lifting devices
• Extruder
WehoCoat Offshore robot

Method overview for 3L:

• The surface preparation with sand blasting is done at a separate station
• The induction heating, then FBE and then powder adhesive application
• Pipe travelles further to next station
• The top coat application is made with the WehoCoat robot
Conclusion

- Wehocoat -Borcoat™ process gives excellent repeatability from joint to joint
- The field joint method has proven outdoor suitability
- Polymer welded bonds between mill applied coating and field joint material allows:
  - High water tables
  - River crossings
  - Swamp areas
  - Offshore applications (S-lay)
- Life Time Cost savings for pipe line:
  - Competitive Field Joint Installation cost for larger projects
  - Longer life time for the whole pipeline
  - Piece of mind for the Oil & Gas companies

A chain is as strong as it’s weakest link!
For more questions please contact:
Patrick Jansson, Daniel Egle, Uponor Infra Ltd
Norbert Jansen, Thomas Stark, Dmitri Fedotov, Borealis
Date: 15.03.2014

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Backup slides

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**WehoCoat – Borcoat™ System**

**WehoCoat Machinery Package consists of:**

1. Extruder for polymer melting and charging of cylinder
2. WehoCoat Robot for application of polymer onto FJ area
3. Inductive heating, coil integrated to the WehoCoat Robot
4. Power and control unit for inductive heating
5. Main electrical cabinet for system control and power supply
6. Epoxy powder spray equipment
7. 400V electrical power, 40 kVA
# External Polyethylene field joint coating systems for 3LPE coated line pipe

<table>
<thead>
<tr>
<th>Tests</th>
<th>Samples</th>
<th>Requirement</th>
<th>Result</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual appearance 2.1</td>
<td>Directly on the pipe</td>
<td>No blisters etc.</td>
<td>Requirement met</td>
<td></td>
</tr>
<tr>
<td>Total coating thickness 2.2</td>
<td>Directly on the pipe</td>
<td>Upon definition</td>
<td>Requirement met</td>
<td>Table 11</td>
</tr>
<tr>
<td>Thickness of the FBE layer 2.3</td>
<td>Directly on the pipe</td>
<td>Upon definition</td>
<td>Requirement met</td>
<td>Table 9</td>
</tr>
<tr>
<td>Holiday test 2.4</td>
<td>Directly on the pipe</td>
<td>10 kV/mm</td>
<td>No holidays</td>
<td></td>
</tr>
<tr>
<td>Adhesion test 2.5</td>
<td>Ambient temperature (23°C to 37°C)</td>
<td>Adhesion to steel</td>
<td>Directly on the pipe, performed during the application trials</td>
<td>≥29*</td>
</tr>
<tr>
<td></td>
<td>80°C</td>
<td>Adhesion over the weld-seam</td>
<td>&gt;15 N/mm</td>
<td>≥29*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adhesion to factory coating</td>
<td></td>
<td>≥29</td>
</tr>
<tr>
<td>Impact 2.6</td>
<td>30 J and 40 J</td>
<td>Directly on the pipe</td>
<td>15 J No holiday</td>
<td>Requirement met</td>
</tr>
</tbody>
</table>

* no peeling but elongation in the test stripe
## External Polyethylene field joint coating systems for 3LPE coated line pipe

<table>
<thead>
<tr>
<th>Tests</th>
<th>Samples</th>
<th>Requirement</th>
<th>Result</th>
<th>Annex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indentation 2.7</td>
<td>indentation pressure: 10N/mm²</td>
<td>3 field joints: (100 x 100) mm</td>
<td>≤0,2 mm</td>
<td>0,12 mm</td>
</tr>
<tr>
<td>23°C</td>
<td></td>
<td>≤0,6 mm</td>
<td>0,29 mm</td>
<td></td>
</tr>
<tr>
<td>80°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peel strength after hot water soak test 2.8</td>
<td>adhesion to steel (FJ coating / steel) (length 200, width 100) mm</td>
<td>3 field joints</td>
<td>&gt;48 N/mm</td>
<td></td>
</tr>
<tr>
<td>28 days 80°C tap water</td>
<td>adhesion to factory coating</td>
<td>@ 23°C</td>
<td>&gt;24 N/mm</td>
<td></td>
</tr>
<tr>
<td>Peel strength after immersion test 2.9</td>
<td>100 days 80°C tap water</td>
<td>adhesion to steel (FJ coating / steel) (length 200 x width 100) mm</td>
<td>&gt;57 N/mm</td>
<td></td>
</tr>
<tr>
<td>100 days 80°C tap water</td>
<td>adhesion to factory coating</td>
<td>@ 23°C</td>
<td>&gt;11 N/mm</td>
<td></td>
</tr>
<tr>
<td>Cathodic disbonding 2.10</td>
<td>disbondment to steel</td>
<td>3 field joints</td>
<td>≤7 mm</td>
<td>3,1 mm</td>
</tr>
<tr>
<td>23°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-1,5 V, 28 days</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-1,5 V, 28 days</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>80°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-1,5 V, 28 days</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 samples = (100 x 100) mm</td>
<td></td>
<td>≤10 mm</td>
<td>5,7 mm</td>
<td></td>
</tr>
<tr>
<td>12 samples</td>
<td></td>
<td>≤20 mm</td>
<td>14 mm</td>
<td></td>
</tr>
<tr>
<td>Annex 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>WehoCoat Onshore 800</td>
<td>WehoCoat Onshore 1400</td>
<td>WehoCoat Offshore 450</td>
<td>WehoCoat Offshore 800</td>
</tr>
<tr>
<td>------------------</td>
<td>----------------------</td>
<td>-----------------------</td>
<td>-----------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Mobile FJC</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HDD</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spool base</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Tie-in</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Vessel</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Double Joint</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Quad joint</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
ISO21809-3 for Field Joint coatings shows a long list of solutions...

Table 1 — FJC types

<table>
<thead>
<tr>
<th>Code</th>
<th>Clause</th>
<th>Type of field joint coating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td>10</td>
<td>Hot-applied bituminous tapes</td>
</tr>
<tr>
<td>1B</td>
<td></td>
<td>Petrolatum tapes</td>
</tr>
<tr>
<td>1C</td>
<td></td>
<td>Wax tapes</td>
</tr>
<tr>
<td>1D</td>
<td></td>
<td>Cold-applied polymeric tapes</td>
</tr>
<tr>
<td>2A</td>
<td>11</td>
<td>Heat-shrinkable materials, polyethylene-based</td>
</tr>
<tr>
<td>2B</td>
<td></td>
<td>Heat-shrinkable materials, polyethylene-based, applied over a liquid or fusion-bonded epoxy layer</td>
</tr>
<tr>
<td>2C</td>
<td></td>
<td>Heat-shrinkable materials, polypropylene-based, applied over a liquid or fusion-bonded epoxy layer</td>
</tr>
<tr>
<td>3A</td>
<td>12</td>
<td>Single-layer fusion-bonded epoxy powder</td>
</tr>
<tr>
<td>3B</td>
<td></td>
<td>Two-layer fusion-bonded epoxy powder</td>
</tr>
<tr>
<td>4A</td>
<td></td>
<td>Liquid epoxy or derivatives</td>
</tr>
<tr>
<td>4B</td>
<td></td>
<td>Liquid polyurethane or derivatives</td>
</tr>
<tr>
<td>4C</td>
<td>13</td>
<td>Fibre-reinforced epoxy</td>
</tr>
<tr>
<td>4D</td>
<td></td>
<td>Fibre-reinforced vinylester</td>
</tr>
<tr>
<td>4E</td>
<td></td>
<td>Cast polyurethane</td>
</tr>
<tr>
<td>5A</td>
<td>14</td>
<td>Flame-sprayed polypropylene powder applied over an epoxy layer</td>
</tr>
<tr>
<td>5B</td>
<td></td>
<td>Polypropylene tapes/sheets hot-applied over an epoxy layer</td>
</tr>
<tr>
<td>5C</td>
<td></td>
<td>Injection-moulded polypropylene over an epoxy layer</td>
</tr>
<tr>
<td>5D</td>
<td></td>
<td>Flame-sprayed polyethylene powder applied over an epoxy layer</td>
</tr>
<tr>
<td>5E</td>
<td></td>
<td>Polyethylene tapes/sheets hot-applied over an epoxy layer</td>
</tr>
<tr>
<td>6</td>
<td>15</td>
<td>Thermal spray aluminium (TSA)</td>
</tr>
<tr>
<td>7</td>
<td>16</td>
<td>Hot-applied microcrystalline wax coatings</td>
</tr>
<tr>
<td>8A</td>
<td>17</td>
<td>Elastomeric coatings, polychloroprene-based</td>
</tr>
<tr>
<td>8B</td>
<td></td>
<td>Elastomeric coatings, EPDM-based</td>
</tr>
</tbody>
</table>