

NOVEL TECHNOLOGIES FOR WEAR PROTECTION AND MONITORING IN DREDGING

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1. INTRODUCTION

Polymeric Coatings and Linings for Steel Pipe Protection

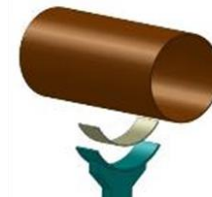
- Steel pipes transporting slurries, e.g. water / sediment mixtures from dredging, are subject to strong wear.
- Polymeric internal coatings provide highly cost-efficient wear protection.
- Desired properties of such coatings are:
 - High degree of corrosion protection and high barrier function (no penetration of product stream components that could reach the pipe wall)
 - Strong adhesion to steel
 - Flow enhancing surface providing low friction
 - Strongest possible abrasion resistance
 - Strongest possible erosion-corrosion resistance
 - Resistance to product stream chemical composition and temperature
 - Option of in-field repair



1. INTRODUCTION

Polymeric Protection for Other Equipment Exposed to Wear

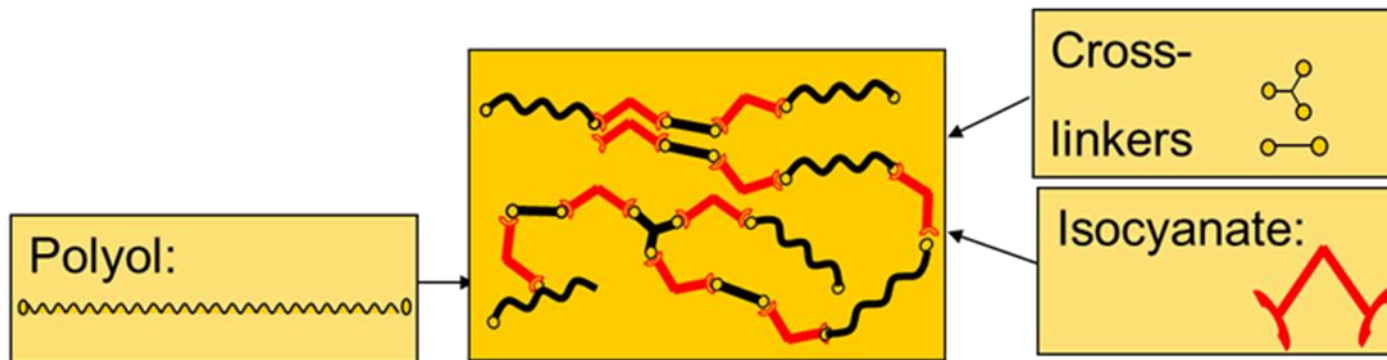
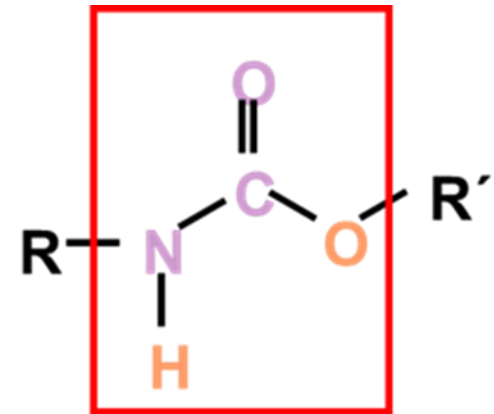
- Generally, the requirements for polymeric protection of equipment surfaces made from steel are quite similar to those for the protection of steel pipelines:
- high barrier function (no penetration of product stream components that could reach the underlying equipment surface);
- High degree of corrosion protection
- Strong adhesion to steel;
- Low surface friction;
- Strongest possible abrasion resistance;
- Strongest possible erosion-corrosion resistance;
- Resistance to chemicals and temperature;
- Option of in-field repair.



1. INTRODUCTION

High-Performance Polyurethane Elastomer Coatings

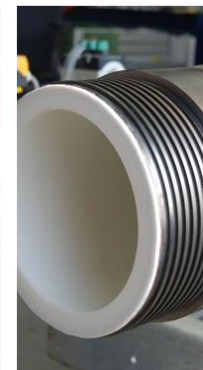
- Polyurethanes – “building-kit synthesis”
- up to 8 different ingredients
- literally millions of combinations possible
- each product has distinct mechanical properties
- high-performance grades can be tailored to application-specific requirements



1. INTRODUCTION

Interior Pipe Coatings made from High-Performance Polyurethane Elastomers

- High degree of corrosion protection and high barrier function (no penetration of product stream components that could reach the pipe wall)
- Strong adhesion to steel
- Flow enhancing surface
- Strongest possible abrasion resistance
- Strongest possible erosion-corrosion resistance



1. INTRODUCTION

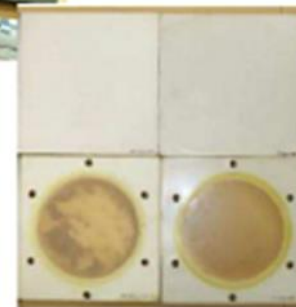
Interior Pipe Coatings made from High-Performance Polyurethane Elastomers

- High degree of corrosion protection and high barrier function (no penetration of product stream components that could reach the pipe wall)
- Relevant test: Atlas Cell Test



$T_{\text{internal (coating)}} = 50^{\circ}\text{C}$
 $T_{\text{external (Stahl)}} = -20^{\circ}\text{C}$ } $\Delta T = 70^{\circ}\text{C}, 17 \text{ Weeks}$

Results: no disbondment, cracks, holes etc.



1. INTRODUCTION

Wear Parts Made From High Performance Polyurethane

For wear parts - as for pipes, high-performance polyurethane elastomers often are ideal wear protection materials, extending useful life multiple times.



2. FIELD EXPERIENCE WITH HIGH PERFORMANCE POLYURETHANE ELASTOMER COATINGS

A typical use of high performance polyurethane elastomers: pipeline inspection



2. FIELD EXPERIENCE WITH HIGH PERFORMANCE POLYURETHANE ELASTOMER COATINGS

2.1 Oil sands tailings and hydrotransport

- Fort McMurray, Alberta, Canada (Athabasca Basin oil sands mines);
 - multi-km pipelines of RoCoat™ non-thermally insulated, internally coated pipes;
 - 24 - 36 inch diameter (610 – 914 mm).
 - flow velocities 3 - 5 m/s;
 - screened rock size up to 5" (12.5 cm);
 - slurry line temperature 45 °C to 65 °C;
 - outside air temperature - 45°C to + 30 °C;
 - occasional flushing with hot water at 95°C.
-
- Straight carbon steel pipe 32" at HT line: useful life 2,500-3,000 hrs w/o rotation;
 - with high-performance elastomer coating: useful life > 30,000 hrs w/o rotation.

3. FIELD JOINING OF INTERNALLY COATED PIPES

2.1 Oil sands tailings and hydrotransport

Proprietary weld joining system

- Requires single in-field weld per joint, faster than conventional butt weld;
- no cooling or re-coating necessary;
- pressure tested up to 3,000 PSI (25,000 kPa).



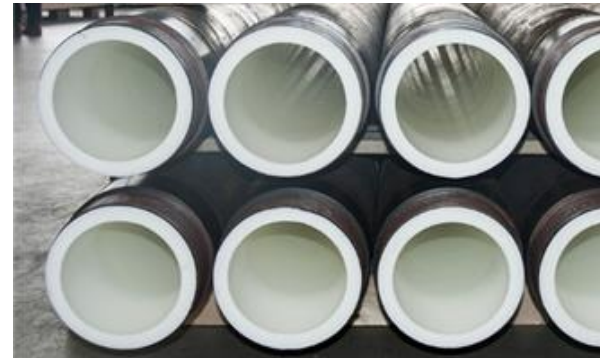
2. FIELD EXPERIENCE WITH HIGH PERFORMANCE POLYURETHANE ELASTOMER COATINGS

2.1 Other cases in mining (synopsis)

Useful life extension by factors ranging up to 15 and more in other applications.

Examples:

- Phosphate slurry (flanged pump station piping covering areas of highest turbulence);
- Shotcrete slick line for vertical transport into underground mine;
- Hydrocyclone runoff at a limestone plant.



2. FIELD EXPERIENCE WITH HIGH PERFORMANCE POLYURETHANE ELASTOMER COATINGS

2.1 Other cases in mining (synopsis)

Phosphate slurry line station piping in Morocco

- Station piping in high-turbulence pump station;
- all pipes flanged for easier exchange / cleaning / repair;
- in operation for 5 years now without need for repair or exchange.



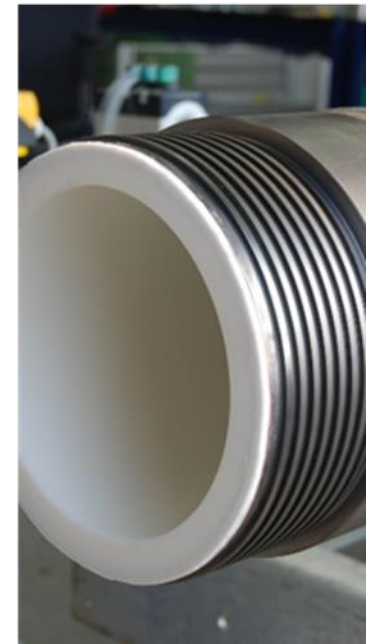
2. FIELD EXPERIENCE WITH HIGH PERFORMANCE POLYURETHANE ELASTOMER COATINGS

2.1 Other cases in mining (synopsis)

Shotcrete

- 203 mm diameter, 380 m long vertical pipe into underground copper mine Portugal;
- pin-and-box connectors;
- coating thickness 12-15 mm.

- Uncoated pipes lasted approx. 2 months;
- excessive wear by steel fibers in concrete;
- coated pipes in operation for more than 2 years now.



2. FIELD EXPERIENCE WITH HIGH PERFORMANCE POLYURETHANE ELASTOMER COATINGS

2.1 Other cases in mining (synopsis)

Limestone

Original Solution:

- Lifetime of prior spool 3 months
- Required time for replacement 16 hours
- Repair jobs per spool 8 times before replacement
- Repair time 8 hours each
- Flow rate 270 to/hr

With RoCoat 3000™ Coating:

- Availability of test spool 100%
- Operation time (still in operation) 21 months
- Saved repair time 600 hours approx.

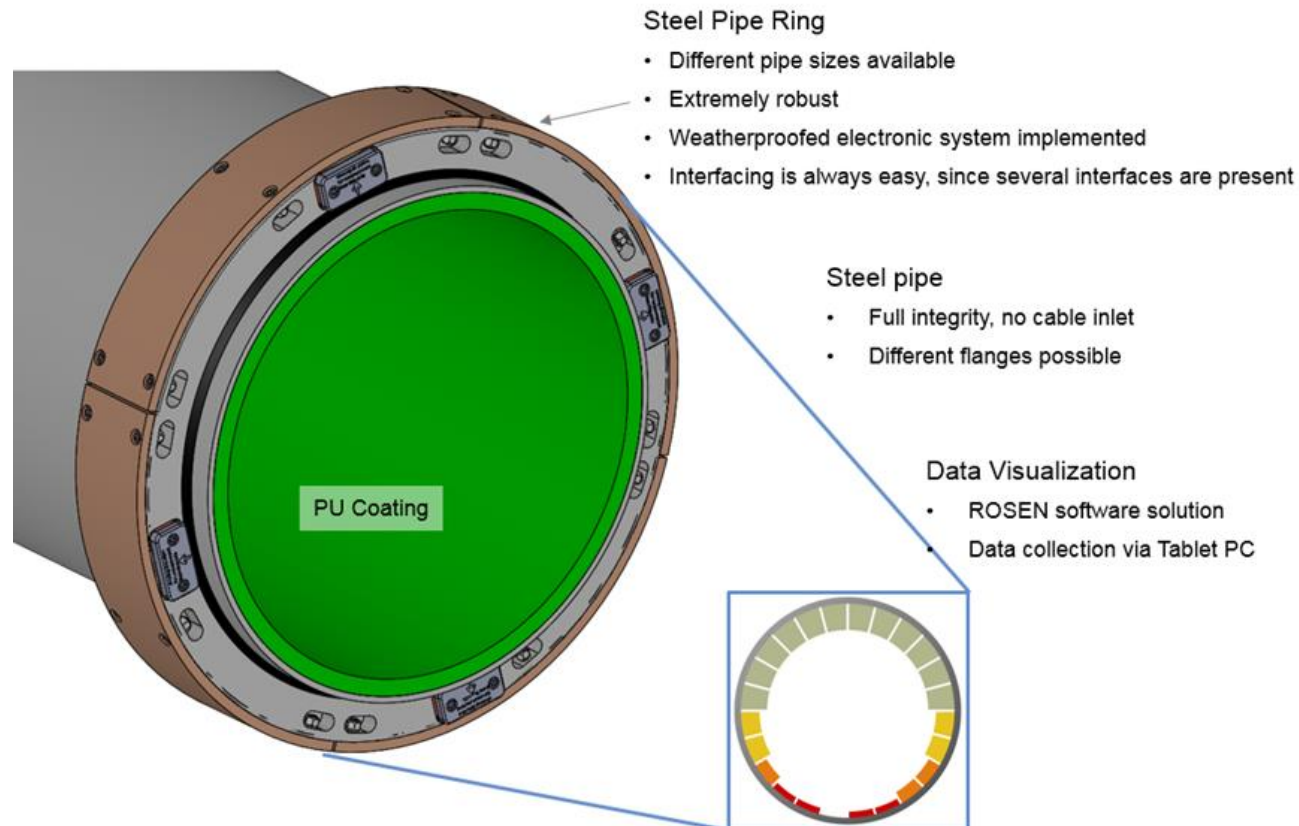
- **Lifetime Extension** **Factor 7+ (spool still in operation)**



3. INTELLIGENT COATINGS PROVIDING WEAR MONITORING

Is continuous wear monitoring of polymeric internal coatings possible?

→ Instrumentation Spools



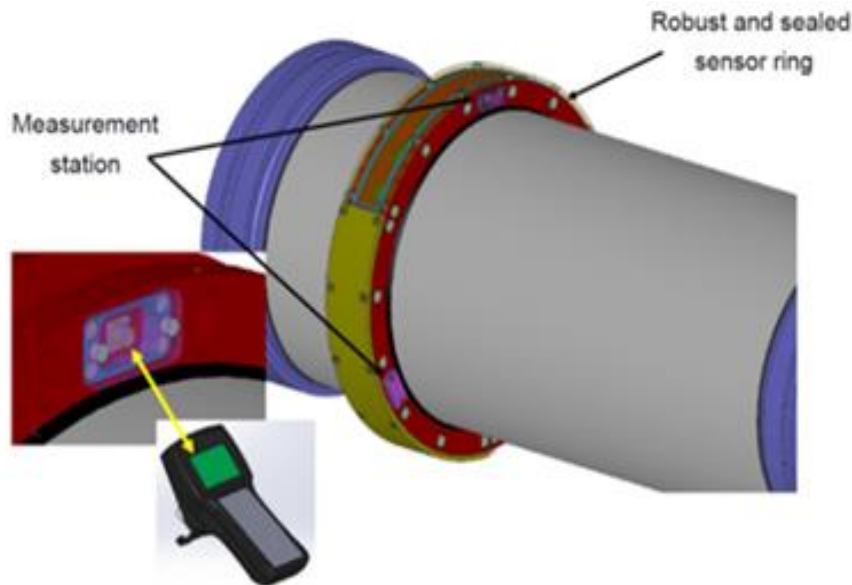
3. INTELLIGENT COATINGS PROVIDING WEAR MONITORING

Is continuous wear monitoring of polymeric internal coatings possible?

→ Instrumentation Spools

→ no preventive shutdowns for wear measurement required

→ 25% or more maintenance cost savings possible



4. HIGH PERFORMANCE POLYURETHANE ELASTOMERS FOR DREDGING

The need for wear protection in dredging depends on

- the individual dredging equipment used and on
 - the actual project.
-
- Single pipes or short lines on a ship may suffer from extreme wear
 - internal wear protection can significantly extend maintenance intervals.
 - Cost of maintenance down time higher than cost difference between internally coated pipe and standard carbon steel pipe.
 - Use of High Performance Polyurethane Elastomer coated pipes will
 - further reduce maintenance cost,
 - increase life time of pipes even more than metallic solutions.

4. HIGH PERFORMANCE POLYURETHANE ELASTOMERS FOR DREDGING

Laboratory Results

- Abrasion tests ASTM G 75; ASTM B 611; ISO 53516; ISO 598; ASTM D 4060/7
- Adhesion tests EN 10290; ASTM D 4541
- Flexibility, bending, gouge tests
 - CSA Z254.20-10, clause 12.11;
 - CSA Z245.20-10, section 12.15
- Cold wall effect: Atlas Cell Test
- Slurry Jet Test (NRC, Ottawa, Canada)
- Hot water immersion adhesion test ASTM D 870; EN 10290
- Various other tests
- Detailed data available from ROSEN
- Test according to Mens and deGee [Mens, deGee, 1991]:
 - results exceeding these of alloys and overlays by a factor of more than 2 and these of carbon steel by a factor of approximately 30.

4. HIGH PERFORMANCE POLYURETHANE ELASTOMERS FOR DREDGING

Ongoing Field Trials Dredging

- Quartz sand dredge
 - continuous operation on a lake in Germany, slurry with 30% water content
 - wear issues at 4 and 8 o'clock position
 - likely sliding bed formation at the bottom
 - RoCoat test spools showed no wear after two and a half years
 - still in operation to the full satisfaction of the operator.
- On-board piping test on a large dredge in progress.

5. CONCLUSIONS

- Internal pipe coatings made from High Performance Polyurethane Elastomers can extend the useful life of slurry pipes by a factor of 10 or higher compared to carbon steel.
- In oil sands tailings and hydrotransport, this cost saving effect has been proven in multi-mile lines for more than half a decade.
- In other mining applications (e.g., phosphates, shotcrete, limestone), similar results have been achieved.



5. CONCLUSIONS

- Intelligent internal elastomer coatings enable operators to monitor coating wear and hence to schedule maintenance much more efficiently, translating into savings of approx. 25-35 % of maintenance cost.
- Lab tests and field trials running since more than 2 ½ years indicate that in dredging applications, intelligent High Performance Polyurethane Elastomer coatings can generate significant savings for dredge operators.



We like to thank the organizers for giving us the opportunity to present.

And we like to thank you for your attention!

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