

C E O C O R 2 0 0 3

European Committee for the Study of Corrosion and Protection
of Pipes

6th International Congress and Technical Exhibition
Italy, May 13 - 16, 2003

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**Pipe Line Coating
Corrosion Protection with Polyurethane Coating Materials**

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Introduction

Within the pipeline protection industry, protective coating systems must meet specific requirements. Only proven and reliable coatings and formulations which meet those extreme chemical and mechanical demands, offer the high performance and long term durable corrosion protection required.

When a pipe fails, the results can be devastating in terms of property damage and financial costs. If the coating fails, owners are faced with the decision of either replacing the pipeline or refurbishing its coating.

Approved polyurethane based coatings - the combination of hardness and flexibility in the coating systems - makes it **the solution** for the entire pipeline network, including field joints, valves, fittings, bends and distribution units.

High Performance Innovative Solutions

The polyurethane coatings chosen by the pipeline owners and/or operators should comply with the pipeline industry's needs that means only high performance polyurethane coatings fulfil e.g. the requirements of the recently passed new **European Standard DIN EN 10290** „Steel tubes and fittings for onshore and offshore pipelines - External liquid applied polyurethane

and polyurethane-modified coatings", or respectively the German DIN Standard 30 671 and 30 677.

The advantages of the performance characteristics of such polyurethane coatings are taken into consideration for the selection of a superior protective coating system. These coatings offer a lot of advantages and some negligible disadvantages compared to alternative systems, however, the major criteria should be to make the right choice, by using a system which offers the overall optimum performance. This includes the flexibility of the coating system such as compatibility, effectivity and efficiency.

The choice of polyurethane coating:

Multi component liquid applied polyurethane based coating provides the following performance:

- single, homogeneously mixed coatings
- fast curing
- high abrasion resistance
- good impact resistance
- excellent chemical resistance
- notable adhesion to steel
- high film thickness in a single coat.

Due to these properties and, compared with alternative systems, no pre- or post-heating procedure is necessary, just one application pass is sufficient for the entire system. The polyurethane coating systems have excellent adhesion to the bare steel pipe substrate as well as to FBE factory coated pipes as a dual system for the corrosion protection of line pipes.

Most of the polyurethane based coatings are available as a two component product. The product is a result of the poly-addition of polyols and iso-cyanate (base and hardener). During the reaction process there are no splitting or deterioration of the molecules. Of the variety resin components available to formulate such a coating system, it is importance to choose and select the correct quality raw materials, in order to achieve a polyurethane system, which produces a high intensity/grade of polymerisation and capacity for resistance against weather, corrosion and chemical influences. In addition, within the oil and gas industry it is required, that the protective coating system should be suitable for simultaneously operated cathodic protective installations.

Only 100 % solids products, means they do not contain any solvent to dissolve, carry or reduce the coating base. Due to it's 100 % solid composition it produces a very fast curing

time, which allows as well for continuous on-line application in the factory with a plural component equipment.

As you are aware, due to the excellent properties of the polyurethane coatings they are used for the industrial application on surfaces as corrosion protection, primer or as a final coating. The high quality of polyurethane systems is even documented and specified within the aviation and automobile industry.

As an example of an approved polyurethane system "PROTEGOL® coating", see "table 1" below, which shows some values required.

| Tests | Specifications | Requirements / Properties |
|------------------------|----------------------------|--|
| Adhesion | ASTM D 4541 | > 8 N/mm ² |
| Cathodic Disbondment | DIN 30 671 | < 12 mm / 30days at RT |
| Application thickness | Info given by manufacturer | Min. 625 µm up to 5 mm in one single layer |
| Curing time touch dry | Info given by manufacturer | At 23° C : 10 min At 90 ° C : < 1 min |
| Hardness | ASTM D 2240 / DIN 5350 | 75 Shore D |
| Impact resistance | DIN 30 671 | > 10 N / mm |
| Indentation Resistance | DIN 30 671 | Max 30% of the initial coating after 48 h |
| Potlife | Info given by manufacturer | 3 seconds up to approx. 3 minutes |
| Surface Preparation | DIN EN 12944-4 | Sa 2 1/2 Blast to Near white |
| Tearing elongation | DIN 50 121 | Min. 5 % elongation |

Table 1: Protegol® requirements / properties

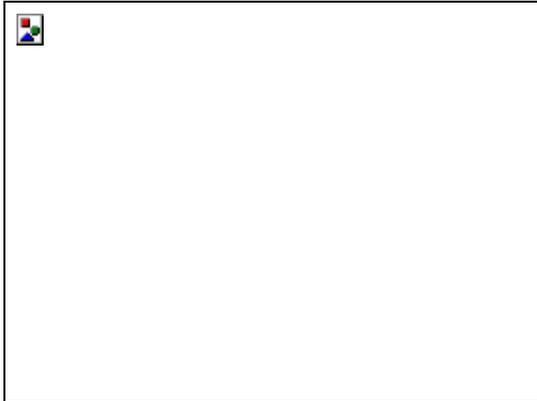
Quality Assurance to stand the test of time:

Polyurethane coatings can be reliably applied on-site. To assure quality performance, areas to be coated must conform to required specifications:

A) Surface preparation:

Surface preparation is the single most important factor for the success or failure of a protective coating. Better cleaning provides better coating performance.

Since degree of surface preparation is critical to performance of coating materials , abrasive blast cleaning to near white of the steel substrate (Sa 2 1/2), and an anchor pattern depths of approximately 50 µm is required. Blasting operations should not be performed during high humidity conditions or on wet surfaces, both cause immediate flash rusting. Even the best coatings may fail when applied over a poorly prepared steel



surface.

| | |
|----------------------------------|--|
| Figure 1: Abrasive Grit Blasting | Courtesy of Pipeline Induction Heat Ltd. (PIH), UK |
|----------------------------------|--|

B) Coating operation:

To avoid, condensation, the temperature of the steel surface should be

at least 3° C above the dew point. The coating must be applied

immediately after blast cleaning, as delayed application is only

permissible, if the original degree of cleanliness has been maintained.

Application is carried out by using a two component equipment, either by

manual or by using an automatic spray machine (see figure 2).



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| Figure 2: Field application of Polyurethane Coating | Courtesy of Pipeline Induction Heat Ltd. (PIH), UK |
|---|--|

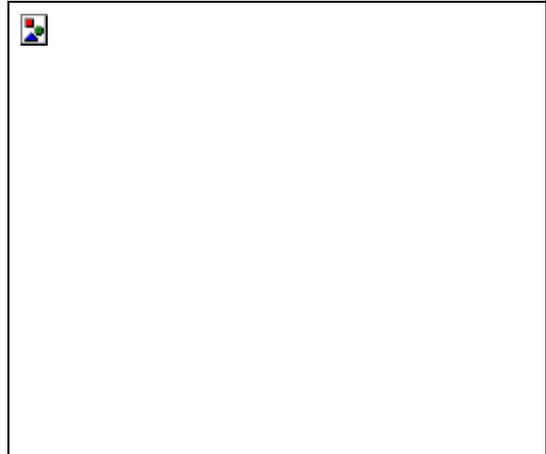
C) Curing and Quality Control:

Fast curing of the applied polyurethane coating, without any post

heating procedures, achieves a pinhole-free single homogenous layer.

Before the pipeline is ready for reinstallation, it is necessary to check the quality of the application.

When visually inspected, the coating should not have blisters, cracks, bubbles mechanical damages. In addition, the coating has to be free of pores (electrostatic holiday testing - 1.000 Volts/100 µm) and the required coating thickness has to be achieved. If repair work is required due to coating imperfections, all defects have to be marked and repaired using e.g. "brush grade" material.



| | |
|---|--|
| Figure 3: Visual Inspection of the girth welded field joint | Courtesy of Pipeline Induction Heat Ltd. (PIH), UK |
|---|--|



Figure 4: Holiday Testing with 25 KV (coating thickness 2,5mm)

After the pipeline / pipesections have been successfully passed the tests, the segments are ready for installation or backfill.

Online field and factory application of Polyurethanes:

Coating Operation in the field:

Line coating equipment is currently in use world-wide for field application, with spray rings designed for two guns on some current projects. Such especially designed equipments can be adjusted to match varying pipe diameters, allowing for a considerable reduction in spray loss as well as to allow for a rather precise adjustment to achieve the requested coating thickness.



Figure 5: Diagram showing the manual

application
of a liquid system in the ditch



Figure 6: Belhole rehabilitation
Mobile application unit

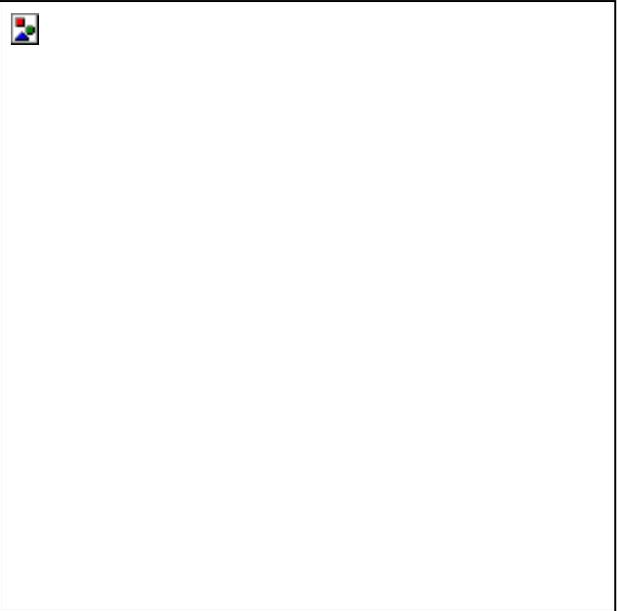


Figure 7: Spray ring in
operation, carried out by Ms.
Colorspol, SK

No primer is required, no other products are involved in the protection system. After the product has been applied it cures within short.

In contrast, the curing time for liquid epoxy coatings depends more on variables, such as ambient and/or surface temperature. The duration can last between 20 minutes on a hot day and several hours on a cold day. Throughout the curing time and the coating is very susceptible to dirt/sand impact and insect damage.

The extremely short curing time allows a pipe to be inspected and buried within „minutes“ after application.

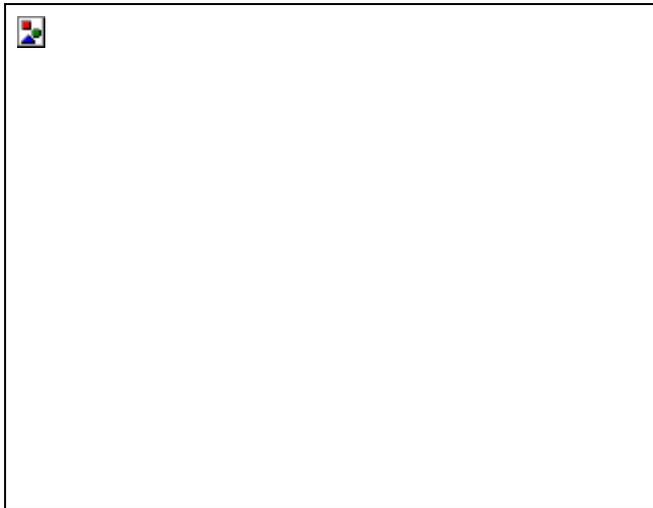
Several hundred miles were refurbished with two component polyurethane systems in different jobs throughout the world on pipelines varying from 20 to 48 inch OD. The objective, after all, is to rehabilitate pipeline „sections“ at measurably lower costs than that of new constructions and at the same time to maintain a set schedule that minimises“out-of-service“ time, on the condition that the required procedures during application are correct.

Implementation of a plural component spray equipment for on-line production

Polyurethane coating systems are not necessarily restricted to manual application, e.g. for field joints, bends, fittings, valves etc. .

In recent years polyurethanes such as Protegol have appeared in many international coating specifications as an optional line pipe coating.

Within Europe as a direct example in Switzerland - a polyurethane product was chosen as the protective coating for the new type of storage facility for natural gas to replace the above ground conventional spherical tanks. This extraordinary designed sized underground tank was the first of its kind constructed in Europe, the tank storage facility itself consists of nine pipes laid parallel, in total a length



of 2,18 km with a diameter of 2,50 m (98 inch).

Figure 8: Aerial View: Gas reservoir Zürich, Ch

The performance characteristics of this coating were taken into consideration to select a superior protective coating system, which was applied on-line in the factory.

PROTEGOL® was, and is, the state-of-the-art coating system as the storage facility is built like a huge diameter pipeline cut into parallel sections.

Another perfect example was realised in 2001 when Protegol was selected for a pipeline project in the Gas field of Hassi R`Mel, Algeria by Ms. SONATRACH. The coating specification required a minimum dry film thickness (dft) of 1.000 µm (1,0 mm) for 12 m sections of the 36 inch OD pipes. This contract was awarded to Trouvay Cauvain, France, the main contractor. The work for pipe fabrication and coating application was awarded to Dong Yang Steel Pipe Co. Ltd, Seoul, Korea.

The external coating of the spiral saw pipe had to be carried out in the production facility, where 3 layer polyethylene normally is put on, by means the coating process in particular

- speed of production / rate of feed had to be maintained. In a short period, the required two component equipment to carry out the continuous application of the liquid system was integrated.

When compared with other alternative systems such as two component epoxy coatings, the application of the polyurethans offer the advantage of easy application with a varying dry film thickness in a single spray pass;

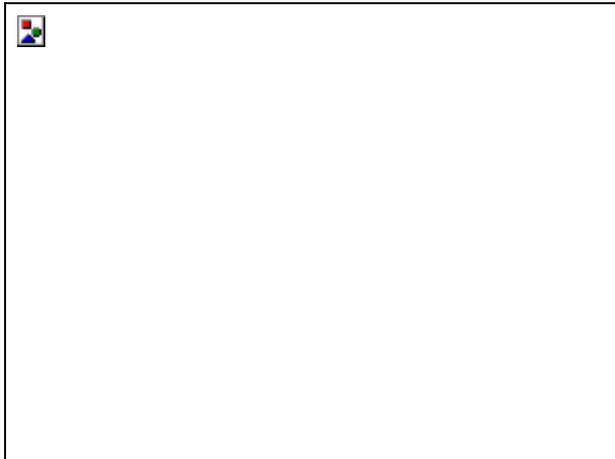


Figure 9: Spray cabin: Fixed Spray gun for continuous application



Figure 10: Online Coated Pipe - Cooling procedure at DYSP, Korea; PROTEGOL® 32-10

Polyurethane coatings comply with the pipeline industry`s need for long lasting, highly effective corrosion protection in the gas and oil, water and waste water industry.

This technology allows for reliable application on site and in the factory - results that guarantee durable corrosion protection.

Goldschmidt TIB GmbH, Mannheim, has more than 30 years experience in the manufacturing and marketing of PROTEGOL® corrosion protection coatings, based on liquid epoxies and polyurethanes for the gas, oil and water industry.

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