

**Expert Report N°. 3594a/06/16**

dated: 02.06.2016



Sachverständiger für Korrosionsschutz  
Expert for Corrosion Protection

**Testing**

**Protegol UR Coating 32-60 Systems**

**according to DIN EN 10290,**

**class: B, type: 3**

**final report**

**Client:** TIB Chemicals AG  
Mülheimer Str. 16-22  
68219 Mannheim  
Germany

**Order:** 2061603

**This expert report contains:**

1 cover sheet  
16 pages text, including  
15 tables  
3 figures

# 1 Introduction

The company TIB Chemicals AG placed an order with me for testing of the polyurethane-coating (PUR-coating) **Protegol UR Coating 32-60 Systems** according to EN 10290, class B (thickness 1500 µm); type 3 (service temperature : -20 °C to +80 °C).

For this test I was provided with coated steel plates 300 mm • 300 mm resp. 200 mm x 200 mm and coated flat steel 50 mm • 300 mm • 6 mm, coated steel pipe diameter 100 mm; component A , component B as well as a PUR-foil.

# 2 Test

Tables 1 and 2 summarizes the test conditions and the corresponding requirements. The following tests were performed in line with clause n°. 7.2 to 7.17 of DIN EN 10290. Detail values were present in tables 3 to 15.

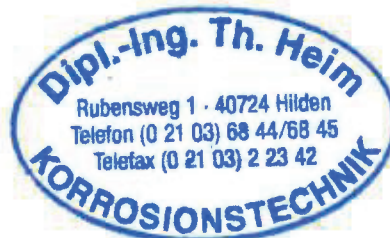
# 3 Result

The tested PUR-coating **Protegol UR Coating 32-60 Systems** fulfills the requirements of EN 10290, class.

Korrosionstechnik Heim



Dipl. Ing. Thomas Heim



## 4 Normative reference

- DIN EN ISO 527-1      Plastics - Determination of tensile properties - Part 1: General principles (ISO 527-1:2012); German version EN ISO 527-1:2012
- DIN EN ISO 527-3      Plastics - Determination of tensile properties - Part 3: Test conditions for films and sheets (ISO 527-3:1995 + Corr 1:1998 + Corr 2:2001) (includes Corrigendum AC:1998 + AC: 2002); German version EN ISO 527-3: 1995 + AC: 1998 + AC: 2002
- DIN EN ISO 868      Plastic and ebonite - Determination of indentation hardness by means of a durometer (Shore hardness) ISO 868: 1985)
- DIN EN ISO 2808      Paints and varnishes - Determination of film thickness (ISO 2808: 1997)
- DIN EN ISO 4624      Paints and varnishes - Pull-off test for adhesion (ISO 4624:2002); German version EN ISO 4624: 2003
- DIN EN ISO 8501-1      Preparation of steel substrates before application of paints and related products - Visual assessment of surface cleanliness - Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coating (ISO 8501-1: 1988)
- DIN EN 10021      General technical delivery requirements for steel and iron products; German version EN 10021: 2006
- DIN EN 10290      Steel tubes and fittings for onshore and offshore pipelines - External liquid applied polyurethane and polyurethane-modified coatings, German version EN 10290: 2002

Table 1

## DIN EN 10 290, Class B, Type 3

Properties	Clause	Test Condition	Requirements	Actual Value	Table
Dry film thickness	7.2	sample: coated PUR-steel plate 300 mm x 300 mm; non-destructive measuring per sample; 12 measurements	class B: 1500 µm	1700 µm 1600 µm 1800 µm 2000 µm 1800 µm	3
Hardness Shore "D"	7.3	DIN EN ISO 868, equipment: shore hardness tester; sample: coated PUR-steel plate test temperature: (23 ± 2) °C	sample dimension: 200 mm x 200 mm; tripod : no; testing time: 1 sec and 15 sec	82	4
Appearance and continuity	7.4	visual	uniform color, smooth appearance and free from defects	73	-
Cut back	7.5	-	(150 ± 20) mm	not occur	-
Holiday detection	7.6	sample: coated PUR-steel plate 300 mm x 300 mm ; testing voltage: 8V / µm; max	(23 ± 2) °C	no pores	-
Impact resistance	7.7	sample: coated steel pipe diameter 100 mm; spherical diameter: 25 mm; number of impacts: 10; correction k = 0,85; the tube interior was supported; height: 1 m; between two point of impacts: ≥ 50 mm; holiday detection see clause 7.6	(23 ± 2) °C	5 J/mm	5
		max. impact energy	(23 ± 2) °C	12 J/mm	
		max. impact energy	(-5 ± 3) °C	3 J/mm	
Adhesion test: Resistance to removal	7.8	sample: coated PUR-steel plate 300 mm x 300 mm; X-shaped cuts	(23 ± 2) °C	4 J/mm	6
		cuts: thought the coating to the metall surface; angle: ~ 30°	(80 ± 2) °C	rating: 1	
		conditions: 4 hours at 80 °C in air	(23 ± 2) °C	rating: 1	
Adhesion test: Pull-off method	7.9	DIN ISO EN 4624: sample: coated PUR-steel plate 200 mm x 200 mm; equipment: PosiTester;	(23 ± 2) °C	> 23 N/mm <sup>2</sup>	7
		test time ≤ 90 sec; diameter of dolly: 10 mm; speed: ≤ 1 MPa/sec	(80 ± 2) °C	> 11 N/mm <sup>2</sup>	
Cathodic disbondment	7.10	sample: coated PUR-steel plate 300 mm x 300 mm; device: potentiostat, cell, oven	(60 ± 2) °C	0,9 mm	8
		2d; (60 ± 2) °C	(23 ± 2) °C	1,1 mm	
		28d; (23 ± 2) °C	(23 ± 2) °C	1,7 mm	
Specific electrical insulation resistance	7.11	sample: coated PUR-steel plate 300 mm x 300 mm; electrolyte c <sub>NaCl</sub> : 0,1 mol/L; test voltage ≥ 50 V real 400 V;	10 <sup>-7</sup> Ω m <sup>2</sup>	2,1 mm	9
		100 d; (23 ± 2) °C	$\frac{R_{S100}}{R_{S70}} \geq 0,8$	4,6 10 <sup>-8</sup> Ωm <sup>2</sup>	
		30 d; (80 ± 2) °C	$\frac{R_{S100}}{R_{S70}}$	$\frac{R_{S100}}{R_{S70}} = 1$	
			(180 ± 2) °C	3,2 10 <sup>-7</sup> Ωm <sup>2</sup>	10

Table 2

Properties		Clause		Test Condition		Requirements		Actual Value		Table	
Adhesion test after immersion in tap water	7.12	sample: coated steel plate 200 mm x 200 mm; pre-testing: holiday detection see clause 7.6 + adhesion test see clause 7.8; ageing: 100 hrs in tap water test temperature: (80 ± 2) °C; drying at t:(23 ± 2) °C; adhesion test (resistance to removal)	for information:  holiday detection	no pores	11	adhesion test: resistance to removal	rating: 1	11	no pores	11	
Indentation resistance	7.13	equipment: indentation tester; sample dimension: PUR-film <10 mm x <10mm; cylindrical punch diameter: 1,8 mm; surface: 2,5 mm <sup>2</sup>	(23 ± 2) °C indentation: ≤ 0,2 mm	0,07 mm	12	total mass: 2,5 kg test period: 24 hrs	≤ 30 % of initial coating thickness	9 %	0,07 mm	12	
Thermal ageing	7.14	sample dimension: coated PUR steel plate 200 mm x 200 mm; pre-testing: holiday detection see clause 7.6; equipment: oven	testing: 100 days; ageing temperature: (100 ± 2) °C after ageing: holiday detection see clause 7.6 + adhesion test see clause 7.8	type 3	13	for information: 1) holiday detection 2) EN 4624	no pores	no pores	13		
Flexibility	7.15	equipment: bending tester; coated steel flat steel; sample size: 50 mm • 300 mm • 6 mm mandrel diameter D: t(1-S) / S; S: taken from table K.1 of EN 10290; arc length: (225 ± 25) mm; support gap: M + 2t + 4 mm; t = chord length across the mandrel arc; M = chord length of the steel plate; speed: 25 mm/ min; test time after bending: 1 min resp. 24 hrs; holiday detection see clause 7.6	(23 ± 2) °C S: 0,010 mandrel diameter: 594 mm	pass: no cracks, no disbondment no pinholes	14	pass: no cracks, no disbondment no pinholes	no cracks, no disbondment no pinholes	14	pass: no cracks, no disbondment no pinholes		
Infra-red scan	7.16	sample: PUR-film; IR-scan; little NaCl plates	acceptable comparison with reference scan by the purchaser	A	figure 1	identical	figure 2	figure 3	figure 1		
Elongation	7.17	EN ISO 527-1-3; sample: PUR-film; equipment: tensile testing machine	sample size: n° 5 speed: 50 mm/min	≥ 10 %	15	16 %	15	15	16 %		

\* During bending, peaking (point at which a gap occurs between the mandrel and the panel) may be observed at the center of the panel. In this case, the area of the panel where the gap exceeds 0.25 mm shall be disregarded in evaluating the test results. This area shall not exceed 25 % of the mandrel area.