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Test of the PU-Coating "PROTEGOL(r) UR Coating 32-60 Systems" according to DIN 3476-2 Final Report

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

Order: 2124572

This expert report contains:

1	cover sheet
6	pages text, including
2	tables
4	figures

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1 Introduction

The company TIB Chemicals AG placed an order with me for testing of the PU-coating **"PPROTEGOL(r) UR Coating 32-60 Systems"** according to DIN 3476-2: 05-2019.

For this test I was provided with:

- coated PU flat plates
- coated PU fitting
- PU film

Remark: Following tests for wastewater and drinking water were not carried out, test according to:

§5.2 Performed through the material manufacturer
§6.7 Chemical resistance, for lining of wastewater fittings
§6.8 Abrasion resistance, for lining of wastewater fittings
§6.9 Drinking water ordinance, for the usage of the fittings with potable water

2 Test

The test certificate is according to DIN EN 10204 and ISO 10474.
Tables 1 and 2 summarizes the test conditions and the corresponding requirements. The following tests were performed in line with section N°. § 6.2 to § 6.11 and N°. 7.1.2 to 7.1.9 of DIN 3476-2.

3 Result

The tested PU-coating **"PROTEGOL(r) UR Coating 32-60 Systems"** fulfills the requirements of DIN 3476-2: 05-2019.

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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 598	Ductile iron pipes, fittings, accessories and their joints for sewerage applications - Requirements and test methods; German version EN 598:2007+A1:2009
DIN EN ISO 868	Plastic and ebonite - Determination of indentation hardness by means of a durometer (Shore hardness) (ISO 868:2003); German version EN ISO 868:2003
DIN EN ISO 2808	Paints and varnishes - Determination of film thickness (ISO 2808:2019); German version EN ISO 2808:2019;
DIN EN ISO 4624:	Paints and varnishes - Pull-off test for adhesion (ISO 4624:2016); German version EN ISO 4624:2016
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 8501-1:2007); German version EN ISO 8501-1:2007
DIN EN ISO 8502-3	Preparation of steel substrates before application of paints and related products - Tests for the assessment of surface cleanliness - Part 3: Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method) (ISO 8502-3:2017); German version EN ISO 8502-3:2017
DIN EN 10204	Metallic products - Types of inspection documents, German version EN 10204:1.2005
ISO 10474	Steel and steel products - Inspection documents:07.2013
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
DIN 3476-2	Valves - Requirements and tests - Part 2: Corrosion protection through thermoset thick coatings; 2018-08
DIN 30675-2	External corrosion protection of buried pipes - Part 2: Corrosion protection systems and application for ductile iron pipes; 2019-05

Table 1

DIN 3476-2 (Table A.1, Page 18)						
Properties	**Section**	**Test Condition**		**Section**	**Requirements**	**Actual Value**
Current Testing						
Surface preparation	5.2	Sa 2½; free from dust; grad 2 for PU	roughness R_Z ≥50 µm-	7.1.2	visual inspection DIN EN ISO 8502-3; ISO 4287-1	not carry out
Appearance	5.3	visual	uniform color; smooth appearance; free from defects	7.1.3	visual inspection	pass
Adhesion dolly test	5.4	DIN ISO EN 4624: equipment: PosiTester;	test time ≤90 sec; diameter of dolly: 20 mm; test speed: ≤1 MPa/sec	7.1.4	≥7 MPa	≥14 MPa
Coating thickness	5.5	equipment: digital thickness gauge;	non-destructive measuring	7.1.5	minimum coating thick-ness: ≥1500 µm (for external use); maximum coating thickness: ≤4 mm (PU)	1740 µm 1640 µm 1550 µm
Cross linking about hardness test	5.6	DIN EN ISO 868: hardness shore "D"; equipment: shore hardness tester;	sample dimension: 200 mm x 200 mm; tripod : no; testing time: 1 sec and 15 sec	7.1.6	agreement with reference sample 1 sec: 75 - 85 15 sec: 70 - 80	1 sec: 81 15 sec: 76
Cathodic disbondment	5.8	(23 ± 2) °C 28 d (80 ± 2) °C 2 d equipment: potentiostat, cell, oven, cutting tool	electrolyte: 3 % NaCl; defect (holiday): 6 mm; $U_{H,23°C}$: -1,26 V pH of the electrolyte: 6 to 9; disbondment: 12 measurements	7.1.7	≤10 mm no bubbles ≤15 mm no bubbles	1 mm no bubbles 4 mm no bubbles
Electric holiday detection	5.9	test voltage: 15 kV	-	7.1.8	no pores	pass
Electric or electrolytic holiday detection	5.10	close to DIN EN 10290, annex F; testing the whole fitting	test time: 5 min; test surface: 0,16 m²; electrolyte: 0,1 Mol/L + wetting argent	7.1.9	≥10^{+8} Ωm²	1 10^{+11} Ωm²

Table 2

DIN 3476-2 (Table A.2, Page 19)

Properties	Section	Test Condition		Section	Requirements	Actual Value
Functional Test						
Impact resistance	6.2	equipment: impact tester, balance, holiday detector; spherical diameter: 25 mm; number of impacts: 10; correction = no	the tube interior was supported; fall height: 1 m; between two point of impacts: ≥30 mm; load: depending of impact energy; holiday detection: § 7.1.8	7.2.2	5 J/mm no electrical break down	10 J/mm pass
Indentation resistance	6.3	equipment: indentation tester + heating equipment; cylindrical punch diameter: 1,8 mm; test surface: 2,5 mm²	total mass: 2,5 kg; test period: 1 h; 24 hrs and 48 hrs	7.2.3	≤ 30 % of initial coating thickness	16 %
					24 h / 48 h < 0 h / 24 h	1,0 < 1,2
					≤5 % of initial coating thickness	3 %
Degree of curing	6.5	calibration: comparison IR-scans with IR-scans from the manufacturer	component A	7.2.5	the IR-scans (testing material / manufacturer) are equal	figure 1
			component B			figure 2
			cure: A + B			figure 3
			DSC		cure	pass, figure 4
Resistance against thermal ageing in air	6.6 a	number of samples: total 6	sample preparation: bending 3°; convection oven: (110 ± 2) °C; 30 d	7.2.6.1	no electrical break down	pass
			60 d			pass
			90 d			pass
Resistance against thermal ageing in water	6.6 b	samples: 6 blank flanges; electrolyte: dem. water; test time: 7 d;	after ending of 7 d the samples were cooled down to 23 °C and after 2 hrs the pull off adhesion according DIN EN ISO 4624 was carried out	7.2.6.2	adhesion ≥ 6 MPa	7 MPa
Chemical resistance	6.7	-	-	-	DIN EN 598	test not carry out
Abrasion resistance	6.8	-	-	-	DIN EN 598	test not carry out
Material in contact with drinking water	6.9	-	-	-	national hygiene requirement	test not carry out
Specific electrical insulation resistance	6.10	100 d; t: (23 ± 2) °C; equipment: potentiostat, cell, oven, electrolyte $c_{(NaCl)}$: 0,1mol/L; test voltage ≥50 V real 400 V;	test surface: ≥0,03 m² measured each week	7.2.7	$\geq 10^{+8}\ \Omega\ m^2$ I ≥ 0,8	$>4\ 10^{+10}\ \Omega\ m^2$
						pass
		30 d; t: (70 ± 2) °C;		7.2.8	for 1500 µm thickness: $\geq 10^{+5}\ \Omega\ m^2$ no bubbles	$1,2\ 10^{+5}\ \Omega\ m^2$
						pass
Elongation at break	6.11	DIN EN ISO 527-1-3: sample: PU-film; equipment: tensile testing machine	sample size: nº. 5 speed: 50 mm/min	7.2.9	≥10 %	17 %

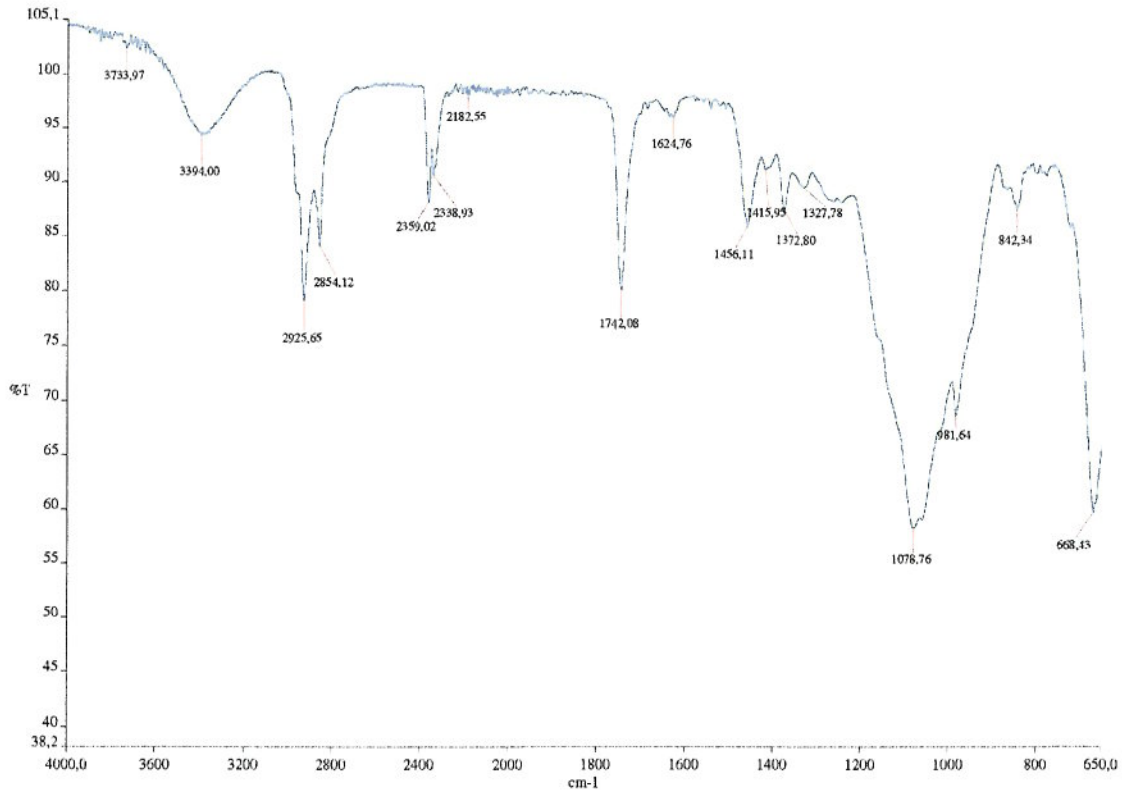

Figure 1, IR scan component A

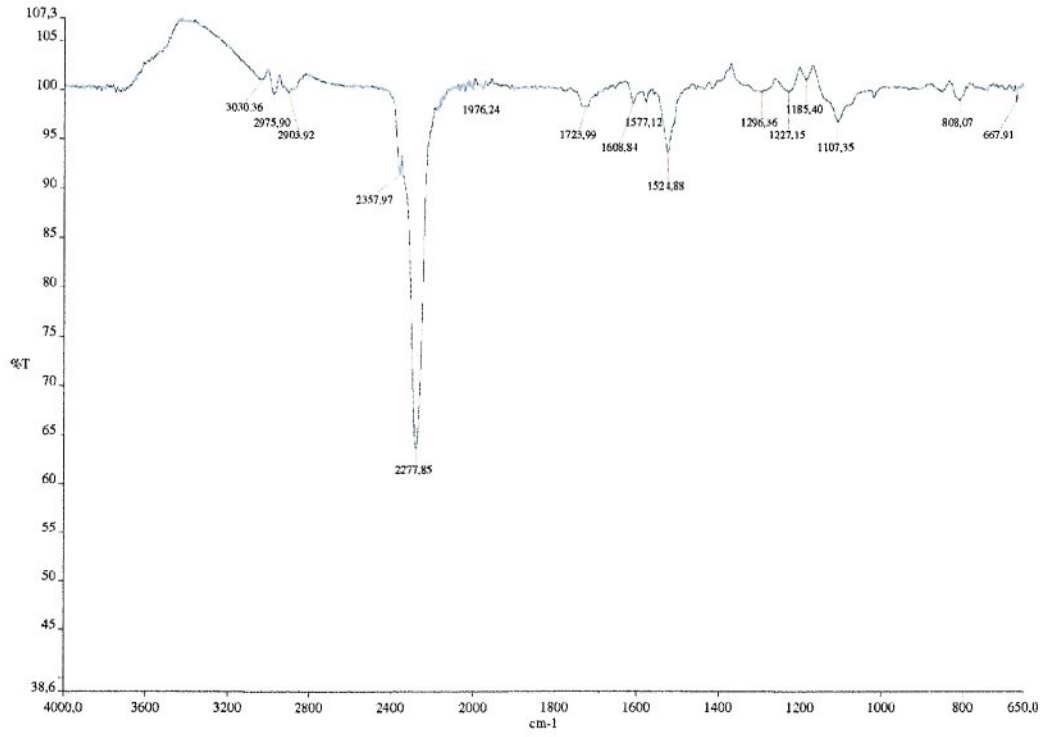

Figure 2, IR scan component B

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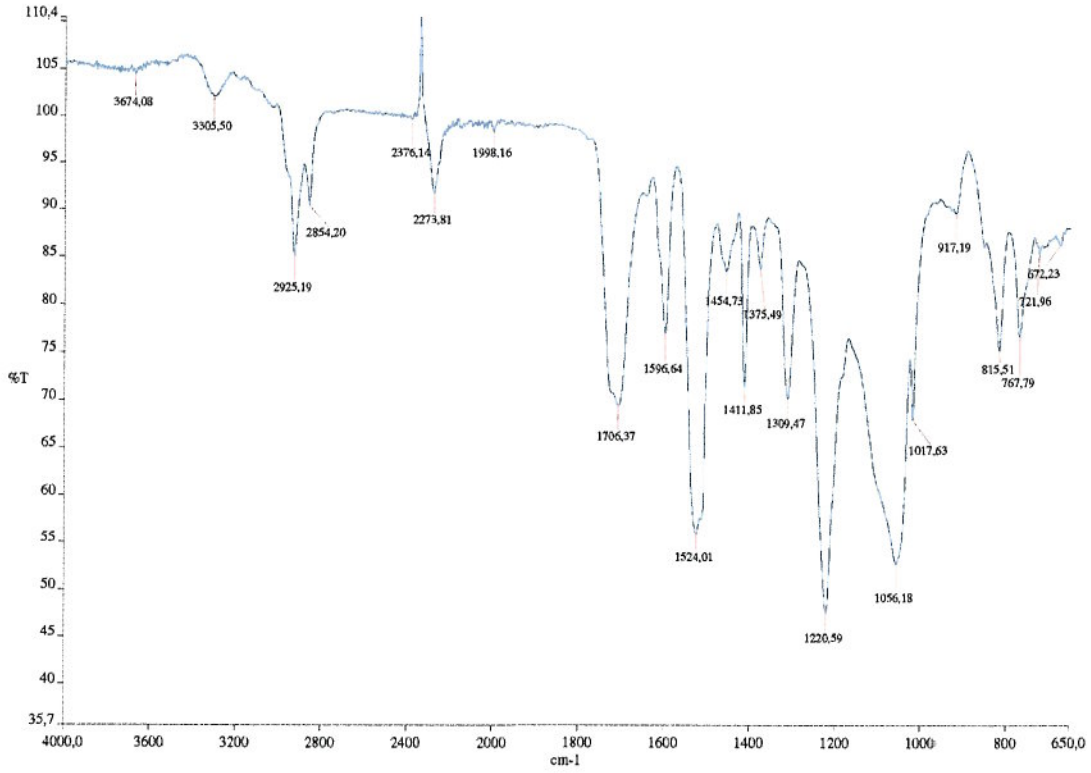

Figure 3, IR scan cure A + B

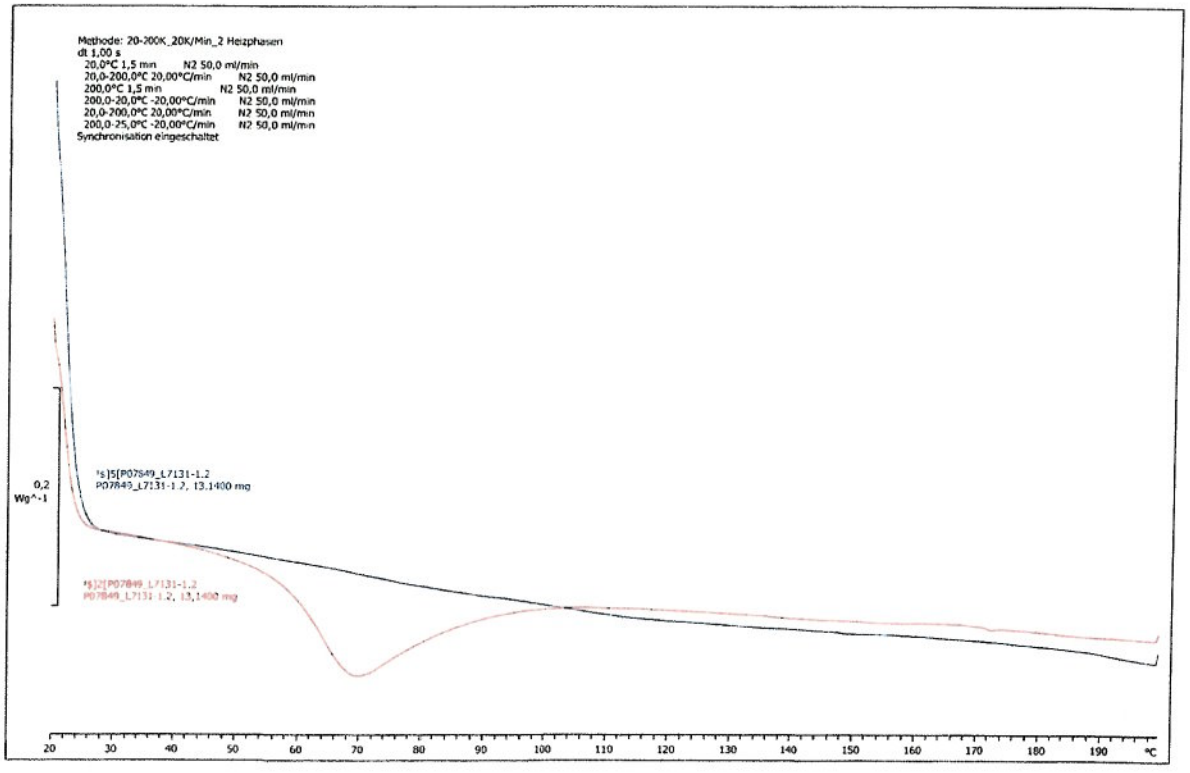

Figure 4, DSC scan A + B