

Expert Report N°. 3805a/09/20

Dated: 30.11.2020

Testing
PROTEGOL® UR Coating 32-60
according to
AWWA C222:2018

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

Order N°.: 2128970

This expert report contains:

- 1 cover page
- 6 pages of text, including
- 3 tables
- 3 figures

1 Introduction

The company TIB Chemicals AG ordered me to test PU-coating **PROTEGOL® UR Coating 32-60** in accordance with AWWA C222:2018.

For this test, I was provided with:

- coated flat steel: 300 mm • 300 mm
- coated flat steel: 100 mm • 100 mm
- free PU-film: 300 mm • 300 mm

2 Test

Tables 1 to 3 gives an overview. Detail information were present in tables 4 to 12.

3 Result

The tested PU-coating **PROTEGOL® UR Coating 32-60** fulfills the requirement of AWWA C222:2018.

Korrosionstechnik Heim



Dipl.-Ing. Thomas Heim



4 Standard

- AWWA C222, 2018 Polyurethane Coatings and Linings for Steel Water Pipe and Fittings
- ASTM D149, 2013 Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
- ASTM D522/D
522M, 2017 Standard Test Method for Mandrel Bend Test of Attached Organic Coatings
- ASTM D543, 2014 Standard Test Method for Evaluating the Resistance of Plastics to Chemical Reagents
- ASTM D570, 2010 Standard Test Method for Water Absorption of Plastics
- ASTM D4541, 2017 Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
- ASTM D1186, Standard Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base
replace through ASTM D7091
- ASTM D2240, 2015 Standard Test Method for Rubber Property-Durometer Hardness
- ASTM D4060, 2014 Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
- ASTM D4541, 2009 Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
- ASTM D7091, 2013 Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals

- ASTM G14, 2010 Standard Test Method for Impact Resistance of Pipeline Coatings
- ASTM G62, 2014 Standard Test Methods for Holiday Detection in Pipeline Coatings
- DIN EN or BS EN
60296, 2012 Fluids for Electrotechnical Applications - Unused Mineral Insulating
Oils for Transformers and Switchgear

Table 1

| AWWA C222:2018 | | | | | |
|--|-----------|--|--|---|------|
| Prequalification Requirements of Polyurethane System | | | | | |
| tests | standard | test conditions | requirement | result | pass |
| Cathodic disbondment, Section, 5.2.1 | ASTM G8 | <p>device: potentiostat, cell, cutting tool; diameter of the holiday: 6,4 mm; electrolyte: 1 % NaCl, 1 % Na₂SO₄, 1 % Na₂CO₃; time of experimentation: 30 days; temperature: (23 ± 2) °C testing potential: U_{H, 23°C} = -1,26 V; power supply: potentiostat</p> | <p>radius: <12 mm</p> | 7,34 mm | yes |
| Flexibility, Section, 5.2.2 | ASTM D522 | <p>device: bending tester (principle see figure 2); test method B: cylindrical mandrel test; sample size: 150 mm x 100 mm; steel thickness: ~ 800 µm; bending: 180 °; mandrel diameter: 3 in = 76,2 mm; bending time: 30 sec; specification; temperature: (23 ± 2) °C; inspection: visual</p> | <p>no cracking resp. no delamination</p> | <p>no cracking no delamination</p> | yes |

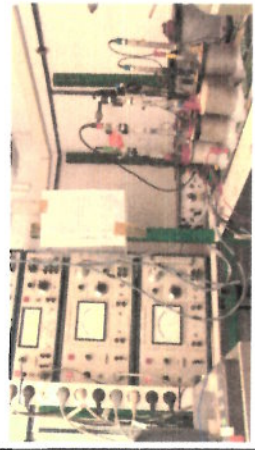


figure 1

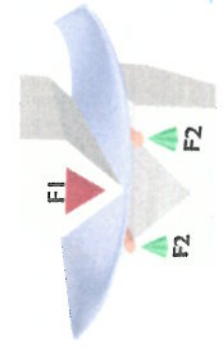


figure 2

Table 2

| AWWA C222:2018 | | | | | |
|--|------------|---|--|-----------------------------------|-----------------------------------|
| Prequalification Requirements of Polyurethane System | | | | | |
| tests | standard | test conditions | requirement | result | pass |
| Impact resistance, Section, 5.2.3 | ASTM G14 | coating thickness: ASTM G 12 replace by ASTM D 7091; holiday detection: ASTM G 62, method B for coating thickness 1 mm; voltage = $7843 \sqrt{\text{coating thickness in mm}}$ in V; temperature: $(23 \pm 2) ^\circ\text{C}$; guide tube: see tables 5; indenter: 15,8 mm; weight: 1361 g; support the samples: yes; number of impacts series: 20; increment in height of drop: 5 cm; distance between impacts: 76 mm; distance from the edge of samples: 38 mm; equation: $m = \left\{ h_o + d \left(\frac{A}{N} \mp \frac{1}{2} \right) \right\} \bullet W = g \text{ cm} = kg \text{ m} = J$ m: impact energy h _o : lowest height at which no holidays occur d: amount of height difference A: per fall high number of non holidays N: number of non holidays W: falling mass | $>75 \text{ in.} \bullet \text{lb} =$ $\geq 8,4 \text{ to } 8,5 \text{ Nm} =$ $\geq 8,5 \text{ J}$ | 9,2 J | yes |
| | | | coating thickness: ASTM G12; number of abrasion cycles (revolutions): 500 and 1000; abrasive rollers were cleaned using compressed air every 100 revolutions | weight loss: $<100 \text{ mg}$ | 500 revolution 1000 revolution |
| Abrasion resistance, Section, 5.2.4 | ASTM D4060 | sample: 100 mm • 100 mm; device: taber abramer; weight placed on: 1 kg; frequency: 1 Hz; temperature: $(23 \pm 2) ^\circ\text{C}$; relative humidity: $(50 \pm 5) \%$ | | | |

Table 3

| AWWA C222:2018 | | | | | |
|--|------------|--|--|-------------------------|------|
| Prequalification Requirements of Polyurethane System | | | | | |
| tests | standard | test conditions | requirement | result | pass |
| Chemical resistance, Section, 5.2.5 | ASTM D543 | temperature: (23 ± 2) °C; reagents: 10% H ₂ SO ₄ ; 30% NaCl; 30% NaOH; #2 diesel fuel; sample: 125 mm • 40 mm | change in mass: <±5 % | max. + 0,24 % | yes |
| | | | change in length: <±5 % | max. - 0,11 % | yes |
| | | | change in width: <±5 % | max. + 0,45 % | yes |
| Dielectric strength, Section, 5.2.6 | ASTM D149 | device: high-voltage system; sample: 80 mm • 80 mm; | individual value >250 V/mil = 10 kV/mm | 31 kV/mm | yes |
| Water absorption, Section, 5.2.7 | ASTM D570 | device: desiccator, exsiccator, balance, thickness gauge, container; sample size: 60 mm • 60 mm; conditioning: 24 h at (50 ± 3) °C; immersion: 24 h at (23 ± 2) °C | electrolyte: distilled water; electrolyte volume: ≥400 ml; the samples are kept at a distance by means of plastic rods; after 24 hrs the samples are dried with a cloth and weighed | 0,42 % | yes |
| Durometer hardness, section, 5.2.8 | ASTM D2240 | device: shore hardness tester; temperature: (23 ± 2) °C; relative humidity: (50 ± 5) %; | shore D: >65 | 1 sec: 78 15 sec: 74 | yes |
| Adhesion, Section, 5.2.9 | ASTM D4541 | device: adhesion tester typ V, automatically; test method: E; test time ≤90 sec; diameter of dolly: 10 mm; speed: demand: 100 psi real: 125 psi temperature: (23 ± 2) °C | >1500 psi = ≥ 10340 kPa = ≥ 10,34 Mpa | 1.937 PSI | yes |



figure 3