Report No. 2497/11/02

CORROSION
TECHNOLOGY
Dipl.-Ing. Th. HEIM

Expert for corrosion and corrosion protection

dated 25
November 2002

Testing of PUR tar coating

"Corop[?]r TAR 21" in accordance with DIN 30671,

June 1992 Standard version

Interim report

Client: Metallogal-Vertriebs GmbH
Sommerbergweg 28
77815 Bühl (Baden)

Order: Letter dated 20 September 2002

This report contains:

1 cover sheet

4 pages of text

7 tables

Expert Report No. 2591/0S/04

Dated: 10 May 2004

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Test of PUR tar coating "Coropur TAR 21" according to DIN 30671 (June 1992) for normal applications (class N)

Principal:

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1 Introduction

The company Eclatin placed an order with me to test the PUR tar coating "Coropur Tar 21" in accordance with DIN 30671 (June 1992) for normal applications (class N).

For this test, I was provided with coated steel pipe DN 100 and a foil.

The following tests were carried out:

- Coating Thickness
- Holiday Detection
- Impact Resistance
- Indentation Resistance
- Elongation
- Specific Insolation Resistance
- Adhesion
- Cathodic Disbondment

2 Test Results

Table 1 summarises the test conditions and the corresponding requirements. The test results are presented in the actual values column of Table 1.

Coating thickness (4.2.1)

The examination was carried out on three pipes. The coating thickness was determined by non-destructive measurement. The arithmetic mean and standard deviation were calculated from these values. All individual thickness values exceed the required value of 800 µm. The requirement is fulfilled.

Holiday Detection (4.2.2)

The test specimens were exposed to a test voltage of 0.1 kV/µm · 986 µm = 9.9 kV. No holidays were detected. The requirements were fulfilled.

Impact Resistance (4.2.3)

With 30 impacts carried out at a standard impact energy of

E = p - 3 = 0.85 - 3 = 3 N m

no holidays were detected. The requirement is fulfilled.

Indentation Resistance (4.2.4)

Test conditions:

- Test medium: Deionised water
- Pressure: ION/ mm2
- Pressure area: 2.5 mm2
- Test temperature: (70±2)°C

After 48 hours, the penetration depth was (18 ± 1) % of the initial coating thickness. The penetration depth between 24 and 48 hours was (0.5 ± 0.0) % (Table 3). The requirement is fulfilled.

Elongation at break (4.2.6)

Using a PUR tar foil dumbbell specimen No. 3 was produced. At a test speed of 10 mm/min, an elongation at break of (13 ± 1) % was determined (Table 4). This fulfils the requirements.

Specific Insulation Resistance (4.2.7)

4.2.7.1

(at 23°C)

The pipes were mounted in a specially designed test basin.

Test conditions:

- Test medium: 0.1 M NaCl
- Test voltage: 50V
- Test area: 0.1 m2
- Test temperature: (23 ±2)°C

Aft After 100 days of testing, the specific insulation resistance of the three pipes tested was ru= (1.0 ± 0.1)10+8 Qm2• The Tue requirement is fulfilled.
The ratio

$$= \frac{R_{s\ 100\ d}}{Rs\ 10\ d} \geq 0.8$$

also fulfils the standard requirement.

Adhesion Test (4.2.8)

After testing specific insulation resistance, X-cuts with an angle of 30° were made at the intersection point in the coating through to the metal surface. When attempting to lift off the coating with the tip of a knife, no complete loss of adhesion was observed. The requirement is fulfilled.

Cathodic Disbondment (4.2.10)

Test conditions:

- Radius of artificial defect: 6 mm
- Test medium: c NaCl = 0.5 mol/L
- Test temperature: (23 ± 2)°C or (65 ± 2) °C
- Test potential: UH -1.26 V, Ucalometsat. = -1.50 mV
- Test period: 30d resp. 2d

The standard requirements for cathodic disbondment— UT s 12 mm at (23 ± 2)°C and UT ≥ 15 mm at (65 ± 2)°C, are fulfilled. The specimen without artificial defect were free from blisters and showed good adhesion (Table 7).

3 Result

The tested PUR tar coating "Coropur TAR21" fulfils the following requirements:

- Coating thickness
- Holiday Detection
- Impact Resistance
- Indentation Resistance
- Elongation
- Specific Insolation Resistance
- Adhesion
- Cathodic Disbondment

the requirements of DIN 30671 (June 1992) for special applications (class N).

Corrosion Technology Heim

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Dipl. Ing. Th. Heim

DIN 30 671, N

Test Method		Test Condition		Requirements		Actual Value	
Coating Thickness	5.3	non-dcs1 measuring	4.2.1	N: 800 µm		(974% 69) J1Dl (986±55)µm	IC table2
Holiday Detection	5.4	high voltage test 0.01 lcV per µm coating thickness	C'1 4	no electrical breakdown		pused	-
Impact Resistance	5.5	30 impacts, (23±2 °C. impact energy E cp . 3) Nm	3	DN 10 — 0 0.85		pas	-
				no electrical breakdown; E•3Nm			
Indentation Resistance	6	arca: 2.5m, weighs 2.5 kg, pres: 10NI mnr. (70:1:2)°C,	4	after 48 h tbe penetrate depth bc max. 30% of tbe initial C09bna thiclmes		(18±1)%	C Hc 3
				between 24 hours and 48 hours penetration depth 5 % of the initial coating thk-ncs	sbaU bc	(0.5%0.0)%	
Elongation	8 .n	duml>-bcl specimen N".3 y:lOmm/ sect: (23 + 2)"C	6 4	210%		(13±1)%	se tabec4
Specific Insulation Resistance	9 .n	c(NaCl t•0.1 mol/L, A U2SO 2 0.03 m1	4.2.7.1	(22) "C lO d	2 IO..Cm2 cn:0.8	(1.0% O.l)IO+aclm2 0.9; 0.8	IC Table 5
Adhesion	10	after testing of specific coating resistance: qualitative examination-+ V-shaped cuts into tbe coGina	8	(23:t:2)"C lOOd	DO complete los ofldbesio	pux.d	-
Cathodic Disbondment	12 .n	c(NaCJ) : 0.5 mol/L, 9-6, ß'n: -1500 mV, c rc at 30 d. (65 : 2rc ai 2d	10		average disbondment Uvinm.m	average disbondment U_T mmm	se Table 7
				(23 :t:2 rc J()d	12mm	6.0 mm 4. 6 n (S,6 ±0.6)m	
					Yes, 5 YEARS	passed	
						passed	
					no blisters		
				(65 ±2)"C a	15mm	2.6m 2 6 mm (2.9±0.5)	
					Jesl,51A	p a s	
					no blisters	passed	

Coating thickness

Position of Values	Coating thickness in µm										
N°. 1											
12	837	**996**	100	1001	983	957	903	861	775	806	1001
	838	889	957	970	1003	899	989	956	965	911	1006
15	956	901	1025	937	968	968	944	958	915	871	992
	834	973	**994**	1082	1092	1106	1087	1013	1058	1027	1016
18	1031	1018	1044	942	**994**	896	877	813	**844**	913	**990**
	1051	973	1006	958	959	980	953	911	937	1018	982
21	989	1034	1070	1020	975	1058	1018	953	1046	1058	961
	1023	1027	1094	1044	1043	1001	1025	963	1013	987	1001
Arithmetic average and (975 ± 67) No. 2											
12	1032	1034	1006	1025	1053	950	946	1018	1026	980	970
	1056	995	1035	1056	1032	1023	946	931	947	1003	992
15	1084	1011	932	973	977	875	901	949	1065	1049	1013
	1015	963	887	1018	968	1070	1068	994	999	1042	931
18	1051	992	943	987	963	1050	973	968	970	978	946
	1003	1013	951	1003	933	933	1077	1025	1068	1084	1018
21	1006	1075	859	992	958	963	889	953	912	931	913
	968	1077	923	942	996	1053	890	915	901	956	906
Arithmetic average and (986 ± 55) No. 3											
12	1120	1142	1125	1084	1049	1051	1082	1042	932	961	980
	931	1070	965	1018	1025		912	918	894	934	920
15	987	875	885		903	973	1025	989	937	889	968
	1112	857	901	920	930	**944** 930	931	957	1061	1115	1109
18	975	895	877	**992** 1032	1039	931	934	873	937	1046	984
	930	911	853	1001		811	868	844	970	963	918
21**	975	925	849	951	958	856	961	984	913	973	911
	942	1015	937	1001	**906** 859	899	1008	914	911	887	889
Arithmetic average and (959 ± 73)											

Expert Report No. 2591/05/04 Table 3

Indentation Resistance

No	between 24 and 48 hours Indentation depth m %	Arithmetic Average and Standard Deviation in -y.
1	0,5	0,5 ± 0,0
2	0,5	
3	0,5	
4	0,5	
	after 48 h: Indentation Depth in %	
1	17	18 ± 1
2	18	
3	18	
4	19	

Expert Report No. 2591/051.04 Table 4

Elongation		
N°	Individual Values in‘	arithmetic mean and standard deviation
1	12	13±1
2	13	
3	13	
4	14	
5	12	
6	13	
7	13	
8	12	
9	14	
10	12	

Expert Report No. 2591/05/04 Table S

Specific Insolation Resistance

No	Specific Insolation Resistance in O - m2			(x · = ___! ◆ 0'8 ru70
	Individual Values		arithmetic average and standard deviation after 100 d	
	70d	100		
	(23 ± 2) ·c			
1	1. 3 10+3	1 · 1 1o+s	(1.0 ± 0.1) 10+8	0
2	1.2 10+3	1.0 10+3		0
3	1. 1 0+3	1 · o 10+ 8		0

Expert Report No. 2591/05/04 Table 6

Cathodic disbondment

N°	Test Conditions			Disbondment Uy in mm								arithmetic average	aritbmetic averageud standard deviation
1	2d, 24h (6 mA/cm²)		0.9	2.5	3	1	3	3	3	3,S	2	2.6	2.9± 0.5
2			1	3	3	2.5	2.5	2	3	2.5	2.5	2.6	
3			0.9	2.5	3.5	3.S	4	3.S	4.5	4	3.5	3.6	
4			without damage										
1	30d, 24h (2 mA/cm²)	no	1	6	6	5	9	4	7	6	5	6	5.6 ± 0.6
2			1	9	5	5	5	7	6	4	7	6	
3			1	8	4	5	4	4	4	4	5	4.8	
4			without damage										