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USt.-IdNr.: DE 155293995

Test Report

"Test of preinsulated bonded pipe DN50/140 mm PUR foam cyclopentaneblown WEHOFOAM manufactured by Uponor Infra Oy"

Short Title: Thermal conductivity (unaged) – DN50/140

Deutsche Akkreditierungsstelle D-PL-13119-02-00

Test Report No.: V002/17.1

Order No.: 402307002

Issued by Department Pipe Systems

Laboratory for Pipe System Testing

Recognised test laboratory of DVGW, DIN CERTCO and DIBt
The recognitions are valid for the test methods stated in the attachments of certificates of approval DVGW LW-BU0023, DIN CERTCO PL121 and DIBt SAC 08

Test Report

Thermal conductivity (unaged) – DN50/140

Test Report No.: V002/17.1

Test Specimen:	Preinsulated bonded pipe, DN50/140 mm
Customer:	Uponor Infra Oy POB 21 65101 Vaasa FINNLAND
Order no. of the Customer:	6636
Test Laboratory:	IMA Materialforschung und Anwendungstechnik Laboratory for Pipe System Testing Wilhelmine-Reichard-Ring 4 01109 Dresden GERMANY
Test Specimen received on:	12 December 2016
Test Period:	December 2016 – March 2017
Person in Charge:	Dipl.-Ing. Matthias Thölert
Distribution List:	1 x Uponor Infra Oy 2 x IMA Dresden

Authorized
Dresden, 17 March 2017
IMA Materialforschung und
Anwendungstechnik GmbH

Dipl.-Ing. Heiko Below
Head of Department Pipe Systems

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1 Task Definition

Uponor Infra Oy commissioned IMA Materialforschung und Anwendungstechnik GmbH with conducting tests on a preinsulated bonded pipe DN50/140 mm in accordance with DIN EN 253 to the characteristics

- cell size (unaged condition),
- foam density (unaged condition),
- compressive strength (unaged condition),
- composition of the gas in the cells of the insulation (unaged condition),
- thermal conductivity (unaged condition).

2 Requirements

DIN EN 253:2015-12
District heating pipes - Preinsulated bonded pipe systems for directly buried hot water networks - Pipe assembly of steel service pipe, polyurethane thermal insulation and outer casing of polyethylene; German version EN 253:2009+A2:2015

Table 2–1 Requirements and tests according to DIN EN 253:2015-12

Characteristics	Requirements acc. to clause	Test methods / remarks
Cell size	4.4.2	5.3.2.1
Compressive strength	4.4.3	5.3.3
Foam density	4.4.4	5.3.4
Composition of the gas in the cells of the insulation	4.5.6 / 4.5.7	Chalmers method
Thermal conductivity in unaged condition	4.5.6	5.4.4

3 Test Specimen

- Preinsulated bonded pipe, DN50/140 mm, manufactured by Uponor Infra Oy,
- Service pipe: steel 60,3 x 2,9 mm P235TR1 EN10217-2,
- Casing pipe: HDPE PE100 140 x 3,0 mm CT,
- Foam system: PUR cyclopentaneblown WEHOFOAM,
- Delivery of the sample material to IMA Dresden: 2016-12-12,
- Storage of the sample material before preparation and test: 72 h at 23 ± 2 °C and 50 ± 10 % R.H.

4 Testing procedure and results

4.1 Cell size (unaged condition)

For determination of the cell size in the radial direction, the PUR foam samples were taken from both ends of the pipe, distributed over the circumference of pipe. According to IMA test specification AA1/11, the sample surfaces were primed and the cell structure, which was examined with the scanning electron microscope, documented. The cell size results from the number of intersections in the range of the gauge length. Three parallel measurements were carried out per test specimen.

Test equipment: Scanning electron microscope EVO MA10 (IMA 9026810)
Specimen dimensions: 25 mm x 20 mm x 10 mm
Specimen number: 2 x 3 items (taken distributed over the circumference, both ends of pipe)
Technician: Ms. Claus

Table 4–1 Requirements and test results – Cell size (unaged condition)

Test parameter	Actual test values				Requirement EN 253
	Specimen 1	Specimen 2	Specimen 3	Average value	
Cell size [mm] Pipe end 1	0,25	0,28	0,31	0,28	≤ 0,5
Cell size [mm] Pipe end 2	0,26	0,30	0,32	0,29	≤ 0,5

4.2 Compressive Strength (unaged condition)

For the determination of the compressive strength of the foam in the radial direction, the test specimens were taken from the both ends of the pipe, distributed over the circumference. The strength test was carried out according to ISO 844.

Test equipment: Material testing machine FPZ 100 (IMA 9023842)
Slide gauge Mahr (IMA 102 3011)
Specimen dimensions: 30 mm x 30 mm x 20 mm
Number of specimen: 2 x 3 items (taken distributed over the circumference, both ends of pipe)
Technician: Mr. Schillig

Table 4–2 Requirements and test results – Compressive strength (unaged condition)

Test parameter	Test individual values				Requirement EN 253
	Specimen 1	Specimen 2	Specimen 3	Average value	
Compressive strength [MPa] Pipe end 1	0,29	0,32	0,29	0,30	≥ 0,3
Compressive strength [MPa] Pipe end 2	0,28	0,31	0,30	0,30	≥ 0,3

4.3 Foam density (unaged condition)

For the determination of the foam density, the test specimens were taken from both ends of the pipe, distributed over the circumference. The density measurement was carried out according to ISO 845.

Test equipment:	Electronic analytical balance (IMA 9904 286) Slide gauge Mahr (IMA 102 3011)
Specimen dimensions:	30 mm x 30 mm x 20 mm
Specimen number:	2 x 3 items (taken distributed over the circumference, both ends of pipe)
Technician:	Mr. Lehmann

Table 4–3 Requirements and test results – Foam density (unaged condition)

Test parameter	Test individual values				Requirement EN 253
	Specimen 1	Specimen 2	Specimen 3	Average value	
Foam density [kg/m³] Pipe end 1	56,2	60,0	56,5	57,6	≥ 55
Foam density [kg/m³] Pipe end 2	56,0	58,1	55,4	56,5	≥ 55

4.4 Composition of the gas in the cells of the insulation (unaged condition)

The stipulation of the cell gas content was implemented in a sub-order instruction through the BASF Schwarzheide, according to Chalmers-procedure. The result is documented in the test report 905017711604, which was available to IMA Dresden.

Table 4–4 Test results – Composition of the gas in the cells (unaged condition)

Result from test report number: 905017711604	Pressure [kPa]	Oxygen [Vol%]	Nitrogen [Vol%]	Carbondioxide [Vol%]	n-Pentane [Vol%]	Cyclopentane [Vol%]
Measurement 1	108	0,0	0,0	55,6	3,6	40,8
Measurement 2	108	0,0	0,0	53,5	3,4	43,1
Measurement 3	110	0,0	0,0	54,6	3,4	42,0
Average value	109	0,0	0,0	54,5	3,5	42,0

4.5 Thermal conductivity (unaged condition)

The determination of thermal conductivity (unaged condition) at the preinsulated pipe DN50/140 mm was carried out based on EN 253:2015 and ISO 8497.

Test equipment:	Test-equipment for determination of thermal conductivity on pre-insulated pipes according to EN 253:2015, Annex F Manufacturer: IMA Dresden / PMK B98-B2
Temperature measurement:	2 x 6 thermocouples
End apparatus:	calibrated endcaps; correction according to van Rinsum
Steel service pipe.	D_{S1} = 54,28 mm, D_{S2} = 60,41 mm, T = 3,06 mm
Thermal insulation:	PUR cyclopentaneblown WEHOFOAM
PE- Casing pipe:	D_{C3} = 133,75 mm, D_{C4} = 141,00 mm; e_{PE} = 3,62 mm
Number of measurements:	3
Technician:	Mr. Lehmann

Table 4–5 Test results – Thermal conductivity (unaged condition)

Heat flow - rate ϕ [W]	**Temperature hot | cold sample surface**		**Difference in temperature sample surface**	**Mean temperature of sample**	**Thermal conductivity of PUR-foam**
	$\overline{T_1}$ [°C]	$\overline{T_4}$ [°C]	$\overline{T_1} - \overline{T_4}$ [K]	T_m [°C]	λ_{PUR} [W/(m·K)]
18,77	72,83	25,95	46,88	49,49	0,0243
19,57	74,50	26,16	48,34	50,43	0,0245
19,91	75,22	26,38	48,84	50,90	0,0247
λ_{50} = 0,0244 W/(m*K)					

5 Summary

The test results documented in this test report verify that the tested characteristics

- cell size (unaged condition),
- foam density (unaged condition),
- compressive strength (unaged condition),
- composition of the gas in the cells of the insulation (unaged condition),
- axial shear strength in unaged condition,
- thermal conductivity (unaged condition)

of the pre-insulated pipe DN50/140 mm with PUR rigid foam system cyclopentaneblown WEHOFOAM meet the requirements of DIN EN 253:2015-12.

Reviewed

Dipl.-Ing. Heiko Below
Laboratory for Pipe Systems

Created

Dipl.-Ing. Matthias Thölert
Person in Charge