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IMA DRESDEN

Interim Report

"Initial type tests according to DIN EN ISO 21003-2 and DIN CERTCO Certification Program for multilayer plastic pipes PE-RT type II / EVOH / PE-RT type II by Capricorn for dimensions 16 mm and 20 mm"

Short Title: DIN CERTCO D16 and D20

DAkkS Deutsche Akkreditierungsstelle D-PL-13119-02-00

Test Report No.: B581/14.1

Order No.: 302114018

Issued by Department Plastics

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 Specimen:	Multilayer plastic pipes PE-RT/EVOH/PE-RT Dimension 16 x 2,0 mm, 20 x 2,0 mm
Customer:	Capricorn S.A. Ciernie 11 58-160 Świebodzice POLAND
Order no. of the Customer:	Letter from 18 September 2014
Test Specimen received on:	17 September 2014/22 September 2014/07 October 2014/14 October 2014
Test Period:	October 2014 – in process
Person in Charge:	Dipl.-Ing. Matthias Thölert
Distribution List:	1 x Capricorn S.A. 2 x IMA Dresden

Authorized
Dresden, 26 February 2015
IMA Materialforschung und
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1 Task Definition

Capricorn S.A. applied the initial type tests according to DIN EN ISO 21003-2 and DIN CERTCO certification program "Plastic piping and multilayer piping systems for warm floor heating systems and radiation connecting", annex I, clause P-Pipes for multilayer plastic pipes (construction PE-RT type II / EVOH / PE-RT type II) from Capricorn. The pipe tests were carried out on the dimensions 16 x 2,0 mm and 20 x 2,0 mm.

Table 1–1 Table of dimension and SDR

Dimension [mm]	Nominal dimension d_n	Operating pressure [bar]				Dimension group	SDR Basis pipe
		Class 1	Class 2	Class 4	Class 5		
16 x 2,0 mm	16	8	8	8	6	1	9,9 [1)]
20 x 2,0 mm	20	6	6	6	4	1	12,4 [1)]

[1)] In accordance to ISO 17456 clause 5, both dimensions are considered to a similar construction type (SCT), due to the same wall thickness.

2 Requirements

DIN EN ISO 21003-2:2011-07
Multilayer piping systems for hot and cold water installations inside buildings - Part 2: Pipes (ISO 21003-2:2008 + Amd 1:2011); German version EN ISO 21003-2:2008 + A1:2011

DIN CEN ISO/TS 21003-7: 2010-12
Multilayer piping systems for hot and cold water installations inside buildings - Part 7: Guidance for the assessment of conformity (ISO/TS 21003-7:2008 + Amd 1:2010); German version CEN ISO/TS 21003-7:2008 + A1:2010

DIN CERTCO Certification Program "Plastic piping and multilayer piping systems for warm floor heating systems and radiation connecting": 2011-06, annex I, clause P-Pipes for multilayer plastic pipes

DIN 4726:2008-10
Warm water surface heating systems and radiator connecting systems - Plastics piping systems and multilayer piping systems

Table 2–1 Requirements according to DIN CEN ISO/TS 21003-7, Table 6 and DIN CERTCO certification program

Characteristics	Requirements and tests to clause	Test program	Test procedure
Influence on water intended for human consumption	EN ISO 21003-1, 6.2	No indication/declaration.	-
Appearance	EN ISO 21003-2, 6.1	One test per d_n and pressure group.	EN ISO 21003-2, 6.1
Opacity	EN ISO 21003-2, 6.2	No indication/declaration.	-
Dimensions	EN ISO 21003-2, 8.2	One test per d_n and pressure group.	EN ISO 3126
Long-term strength of P-pipes	EN ISO 21003-2, 9.1	One test per pressure group per similar construction type.	ISO 1167
Thermal durability of P-pipes	EN ISO 21003-2, 10.1	One test per similar construction type.	ISO 1167
Delamination of P-pipes	EN ISO 21003-2, 10.2	One test per similar construction type.	EN 12293
Oxygen permeability	EN ISO 21003-2, 13	One test per similar construction type.	ISO 17454
Physical and chemical characteristics	EN ISO 21003-2, 14	One test per similar construction type.	EN ISO 22391-2
Marking	EN ISO 21003-2, 16	One test per d_n and pressure group.	EN ISO 21003-2
Homogeneity	DIN 4726, 4.2	One test per d_n and pressure group.	DIN 4726, 5.2
Bending radius	DIN 4726, 4.3	One test per d_n and pressure group.	DIN 4726, 5.3
Resistance against heat water additives	DIN 4726, 4.5	One test per pressure group.	DIN 4726, 5.5
Instruction leaflet	DIN 4726, 6	Per system.	DIN 4726, 6

3 Specimens

PE-RT/AL/PE-RT pipes, delivered in coils of 30 m length.

Manufacturer: Capricorn S.A.
Cierne 11
58-160 Swiebodzice
Poland

Marking/identification of the test samples (specified by the manufacturer) see table 3-1.

Table 3–1 Characterization of the specimens

d_n	Marking
16	← xxx m → CaPricorn S.A. 16 x 2 5-layer PE-RT TYP II with oxygen barrier according to DIN 4726 / Made in EU / ISO 21003 / class 4-5 / 6 bar / 09/09/14
20	← xxx m → CaPricorn S.A. 20 x 2 5-layer PE-RT TYP II with oxygen barrier according to DIN 4726 / Made in EU / ISO 21003 / class 4-5 / 6 bar / 29/09/14 / ZP-4 / 2014 / RUR
20 [1S]	Without marking.

[1S] Single layer pipe 20 x 2,0 mm.

Table 3–2 Used pipe material

d_n	Characteristics	Type	Material	Supplier	Colour
16 and 20	Inner layer	PE-RT	Dowlex 2388	Dow Chemicals	nature
	Inner adhesive layer	LLDPE	Admer NF468E	Mitsui Chemicals	nature
	EVOH	EVOH	EVAL FP104B	EVAL Europe	nature
	Outer adhesive layer	LLDPE	Admer NF468E	Mitsui Chemicals	nature
	Outer layer	PE-RT	Dowlex 2388	Dow Chemicals	nature
20 [1S]	Single layer pipe	PE-RT	Dowlex 2388	Dow Chemicals	nature

4 Results

4.1 Influence on Water intended for human Consumption

This characteristic was not tested, due to the application for heating.

4.2 Appearance

Test requirements:	DIN EN ISO 21003-2 clause 6.1
Test procedure:	DIN EN ISO 21003-2 clause 6.1
Test sample:	16 / 20 / 20^{1S}
Test date:	27.10.2014
Technician:	E. Biedermann

The pipes were viewed without magnification. The internal and external surfaces of the pipes were smooth, clean and free from any scoring, cavities and other surface defects. The material contained no visible impurities. All pipes/specimens were free of any scratches or deformations. Cavities or other local failures were not visible. The requirements are fulfilled.

4.3 Opacity

This characteristic according to ISO 7686 was not tested. The pipes are not declared as light tight.

4.4 Dimensions

In accordance to DIN EN ISO 21003-2 the dimensions of all pipes were determined.

Test requirements:	DIN EN ISO 21003-2 clause 8.2
Test procedure:	DIN EN ISO 3126: 2005-05
Sample conditioning:	Norm climate (23 ± 2 °C, 50 ± 10 % rel. humidity) acc. to DIN EN ISO 291 class 2; time: 48 h
Test equipment:	Measuring tape UFM 2008/1359; calliper WDM Mitutoyo 369137 Measuring microscope 9 026365 PMK B222-B2
Test date:	27.10.2014 / 10.11.2014
Technician:	E. Biedermann / M. Claus

Table 4–1 Outside diameter

d_n	Outside diameter (over all) Set value [mm]	Outside diameter (over all) Value [mm]	Outside diameter (Basis pipe) Set value [mm]	Outside diameter (Basis pipe) Value [mm]
16	16,0 – 16,3	16,20	15,4 – 15,7	15.40
20	20,0 – 20,3	20,30	19,4 – 19,7	19,40
20^{1S}	20,0 – 20,3	20,05	-	-

Table 4–2 Wall thickness

d_n	Layer	Wall thickness Set value [mm]	Wall thickness Value [mm]
16	Over all	2,0 – 2,3	2,00 – 2,15
	Basis pipe	1,56 – 1,85	1,60 – 1,65
	Adhesive layer (inner)	0,05 – 0,10	0,07
	EVOH layer	0,06 – 0,12	0,10
	Adhesive layer (outer)	0,05 – 0,10	0,07
	Outside layer	0,20 – 0,40	0,20
20	Over all	2,0 – 2,3	2,10 – 2,25
	Basis pipe	1,56 – 1,85	1,65 – 1,70
	Adhesive layer (inner)	0,05 – 0,10	0,08
	EVOH layer	0,06 – 0,12	0,09
	Adhesive layer (outer)	0,05 – 0,10	0,06
	Outside layer	0,20 – 0,40	0,20
20^{1S}	Over all	2,0 – 2,3	2,00 – 2,30

The requirements of DIN EN ISO 21003-2 clause 8.2 are fulfilled.

4.5 Long-term strength of P-pipes

The Long-term strength shall be tested in accordance with ISO 17456, procedure I – calculation method for determination of the long-term hydrostatic pressure strength of multilayer P-pipes. The control tests shall be performed at 95 °C for 8.760 h in accordance with ISO 21003-1.

Additional hydrostatic pressure tests for the strength at 3,7 and 3,6 MPa were performed.

Requirements:	Tests on one dimension per pressure group and similar construction
Test conditions:	According to ISO 17456; 95 °C and 8.760 h
Test equipment:	Test basins No.: 205-215: PMK B122/1-25 B2 Pressure stations No.: 1-250, PMK B122/ii B2
Number of samples:	Three per test dimension
Test environment:	Water in air
Test period:	30.10.2013 – in process (8.760 h tests)
Technician:	D. Juhrs

Table 4–3 Parameter and result – Long-term strength

d_n		Outside diameter [mm]	Wall thickness [mm]	Stress value [MPa]	Pressure [bar]	Test pressure [bar]	Test duration [h]	Test result [h]
16	Overall	16,22	2,01	3,7	10,5	10,50 [2]	> 165	> 165
16	Overall	16,22	2,01	3,6	10,18	9,72 [1]	> 1.000	> 1.000
	EVOH	15,70	0,10	3,6	0,46			
16	Overall	16,22	2,01	3,51	9,93	9,48 [1]	> 8.760	In process.
	EVOH	15,70	0,10	3,51	0,45			
20	Overall	20,28	2,08	3,7	8,46	8,46 [2]	> 165	> 165
20	Overall	20,28	2,08	3,6	8,23	7,90 [1]	> 1.000	> 1.000
	EVOH	19,64	0,09	3,6	0,33			
20	Overall	20,28	2,08	3,51	8,02	7,70 [1]	> 8.760	In process.
	EVOH	19,64	0,09	3,51	0,32			

[1] Pressure less the oxygen barrier layer/pipe (EVOH)
[2] Pressure including the oxygen barrier layer/pipe (EVOH)

The tests are not finished at the time of the report creation date. The current testing period is approximately 2.500 hours.

4.6 Thermal durability of P-pipes

Tests were carried out on a single layer pipe in accordance with DIN EN ISO 1167-1 and DIN EN ISO 1167-2. Test parameters are in accordance with DIN EN ISO 22391-2, table 10 and DIN EN ISO 21003-2, clause 10.1.

Test requirements:	Test temperature: 110 °C Stress value PE-RT: 2,3 MPa Test time: 8.760 h
Test conditions:	ISO 1167-1/-2
Number of samples:	Three

Table 4–4 Result – Thermal durability

d_n		Outside diameter [mm]	Wall thickness [mm]	Stress value [MPa]	Test pressure [bar]	Test duration [h]	Test result [h]
20 [1S]	Overall	20,05	2,01	2,3	5,13	> 8.760	In Process.

The tests are not finished at the time of the report creation date. The current testing period is approximately 2.500 hours.

4.7 Delamination of P-pipes

According to the requirements of "one test piece per similar construction type" dimensions 16 was tested. The delamination was evaluated within the system pressure for dimension 16 with a pressure of 6 bar.

Test requirements:	No delamination of the layers
Test procedure:	EN 12293
Test equipment:	Temperature cycling device TWPA PMK B198-B2
Test date:	Start: 13.01.2015 – End: in process (16 x 2,0)
Technician:	E. Biedermann

Table 4–5 Parameter – Delamination of P-pipes

d_n	Test arrangement	Bending radius branch C	Prestress [MPa]	Test time [min]		Test temperature [°C]		Pressure value [bar]	No. of Cycles
				cold	warm	cold	warm		
16	flexible pipes	6 x d_n	2,6	30^{+2}		$20^{\pm 5}$	$95^{\pm 2}$	$6^{+0,2/-0,1}$	≥ 5,000
				15^{+1}	15^{+1}				

Table 4–6 Result – Delamination of P-pipes

d_n	Tensile Force [N]	No. of Cycles
16	229	In process.

The tests are not finished at the time of the report creation date. The current testing period is approximately 1.950 cycles.

4.8 Oxygen permeability

For application classes 4 and 5 the tests were performed at laboratory MPA NRW (accredited laboratory).

Requirement:	EN ISO 21003-2, clause 13
Test conditions	40 °C and 80 °C in reference to class 4 and 5

Table 4–7 Result - Oxygen permeability

d_n	Used material	Application class	Requirement Set value [mg/m² d]	Result Value [mg/m² d]
16 [1)]	Dowlex 2388 Admer NF468E EVAL FP104B	4	≤ 0,32	In process.
		5	≤ 3,6	In process.

[1)]... MPA NRW test in process

4.9 Physical and chemical characteristics

The determination of the physical and chemical characteristics was performed on dimension 20 x 2,0 mm in accordance with DIN EN ISO 21003-2, clause 14.

Test requirements:	DIN EN ISO 22391-2, table 10 Longitudinal reversion: ISO 2505 Melt mass-flow rate (MFR): ISO 1133-1 (Thermal durability – see clause 4.6)
Test equipment:	compartment drier UT6200 PMK B26-B2, calliper Mitutoyo 1600912 Analytical balance B223-B2, CEAST MMF 7026 B190-B2
Test date:	15.12.2014 / 27.11.2014
Technician:	M. Lasch

Table 4–8 Parameter and result – Longitudinal reversion

d_n	No. of sample	Test temperature [°C]	Test duration [h]	Shrinking rate Set value [%]	Shrinking rate Value [%]	Remark
20	1	110	1	≤ 2	1,44	The requirements are fulfilled
20	2			≤ 2	1,43	
20	3			≤ 2	1,54	

Table 4–9 Parameter and result - MFR

d_n	No. of sample	Test temperature [°C]	Test duration [min]	Test weight [kg]	MFR Variance Set value [%]	MFR Variance Value [%]	Remark
20	1	190	10	5	≤ 30	8,3	The requirements are fulfilled
20	2				≤ 30	7,6	
20	3				≤ 30	9,5	

4.10 Marking

The test samples were at least marked with the following information:

- manufacturer´s name / trademark,
- number of standard ISO 21003,
- nominal dimension,
- composition of the pipes,
- application class with design pressure,
- manufacturer´s information (only dimension 20).

To the market launch following required marking shall be complemented:

- DIN CERTCO registration number,
- manufacturer´s information for dimension 16.

Traceability of the used materials and the pipe characteristics is insured; see table 3-1 and table 3-2.

4.11 Homogeneity

According to the requirements “one test per d_n and pressure group” dimensions 16 and 20 were tested.

Test requirement: DIN 4726 clause 4.2 - Cross sectional area of inhomogeneities ≤ 0.02 mm²
Test procedure: DIN 4726 clause 5.2
Test equipment: Microscope Axiolab 9 905 457
Test date: In process.

Table 4–10 Result - Homogeneity

d_n	Result	Remark
16	In process.	-
20	In process.	-

4.12 Bending radius

According to the requirements “one test per d_n and pressure group” all dimensions 16 and 20 were tested.

Test requirement: DIN 4726 clause 4.3 - No permanent damage because of bending
Test procedure: DIN 4726 clause 5.3
Test equipment: Templates 5 x d_n
Test date: 13.10.2014
Technician: Z. Mravik

Table 4–11 Parameter and result - Bending radius

d_n	Bending radius 5 x d_n [mm]	Result	Remark
16	80	No permanent damage.	The requirements are fulfilled.
20	100	No permanent damage.	The requirements are fulfilled.

4.13 Resistance against heat water additives

According to the requirements “one d_n per pressure group” dimension 16 x 2.0 mm was tested.

Test requirement: DIN 4726 clause 4.5 - No crack initiation
Test procedure: DIN 4726 clause 5.5
Test equipment: Pressure station PMK B122/ii-B2
Microscope MM1-200 / PMK B222-B2
Specification of heat water additives: Sentinel X 100
Concentration of heat water additives: 2 %
Technician: D. Juhrs

Table 4–12 Parameter and result – Resistance against heat water additives

d_n	No. of specimen	Stress [MPa]	Pressure [bar]	Test temperature [°C]	Test time [h]	Result	Remark
16	1	3,6	9,72	95	> 1,000	In process.	-

The test is not finished at the time of the report creation date. The current testing period is approximately 490 hours.

4.14 Instruction leaflet

Test requirements: DIN 4726 clause 6, indication to DIN 4726 clauses 4.4, 4.5, 4.6, 6a – 6c, 7
Test procedure: DIN 4726 clause 6

The instruction leaflet for the system Capricorn shall handed over to IMA.

5 Summary

All past tests fulfil the requirements according to DIN EN ISO 21003-2 and DIN CERTCO certification program.

To the date of report creation following tests are in process:

- long-term strength of P-pipes, clause 4.5,
- thermal durability, clause 4.6,
- delamination of P-pipes, clause 4.7,
- oxygen permeability, clause 4.8
- homogeneity, clause 4.11,
- resistance against heat water additives, clause 4.13
- instruction leaflet, clause 4.14.

Reviewed

Signed Dietze

Dipl. Ing. (BA) Carsten Dietze
Pipe System Test

Created

Signed Thölert

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