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FEDERAL INSTITUTE OF TECHNOLOGY
PLASTICS TECHNOLOGY AND
ENVIRONMENTAL ENGINEERING

Test Report

TGM – VA KU 21864/4

Polypropylene Block-Copolymer (PP-B)
BA 160 E -8229-01

Long-term hydrostatic strength according to
ÖNORM EN ISO 9080
(Translation of German-language test report:
TGM- VA KU 21864/3; 2008-12-02)

Commissioned by:	Borealis Polyolefine GmbH
Address:	4021 Linz/Austria; St.-Peterstrasse 25
Order reached:	23. July 2013
Sign of order:	Dipl.-Ing. Siegfried Liedauer
Receiving of test sample(s):	23. April 2007 (B-3005)
Testing period:	week 17/2007 - week 49/2008
TGM-number:	

As requested by the applicant, pipes made of black

Polypropylene Block-Copolymer (PP-B)

with the designation:

BA 160 E -8229-01

are tested for the purpose of compiling regression curves according to

ÖNORM EN ISO 9080 (1. Oktober 2003)
(ratified German-language copy : March 2003)
Plastics piping and ducting systems –
Determination of the long-term hydrostatic strength of
thermoplastics materials in pipe form by extrapolation

Therefore, the material is classified according to

ÖNORM EN ISO 12162 (1. July 1997)
(ratified German-language copy: June 1995)
Thermoplastics materials for pipes
and fittings for pressure applications -
Classification and designation
and overall service (design) coefficient

Description of the specimen:

On the 23rd of April 2007 the customer delivered a total of 130 sections each 1m long, of pipes with the dimension (32 x 2,9) mm.

Test report:

The pipes were subjected to long-term hydrostatic tests in accordance with ÖNORM EN ISO 1167-1 and -2 (01 07 2006) in each case with a free length of 400 mm, and carried out according to the agreed test conditions at 20, 60 and 80°C.

1. Distribution of the results

The following tables show the temporal distribution of the results and the number of pressure levels for each test temperature according to ÖNORM EN ISO 9080.

Table 1 – Distribution of results and pressure levels according to ÖNORM EN ISO 9080

Test temperature (C°)	Number of pressure levels	Results total	Results > 7.000 h	Results > 9.000 h	Results not taken into account
	Requirement ≥ 5	Requirement ≥ 30	Requirement ≥ 4	Requirement ≥ 1	
20	10	30	5	5	0
60	9	31	8	5	5
80	10	35	4	4	0

2. List of results

The failure results at 20, 60 and 80°C are shown in tables 2 to 4.

Tests without failure are labelled: "***ongoing***".

Tests which were not used for calculation are labelled "***not taken into account***".

Table 2 – Results at 20°C

Test temperature (°C)	Stress (MPa)	Time (h)	Result
20	17,5	121,3	ductile failure
20	17	290,3	ductile failure
20	16,7	399,6	ductile failure
20	16,5	333,8	ductile failure
20	16,5	531,9	ductile failure
20	16,5	457,6	ductile failure
20	16,5	312,8	ductile failure
20	16,5	405,2	ductile failure
20	16,2	665,6	ductile failure
20	16	228,7	ductile failure
20	15,5	1641,4	ductile failure
20	15,5	2151,4	ductile failure
20	15,5	2167,4	ductile failure

Table 2 – continued

Test temperature (°C)	Stress (MPa)	Time (h)	Result
20	15,5	2536,4	ductile failure
20	15,5	3121	ductile failure
20	15	1987,5	ductile failure
20	15	2639,2	ductile failure
20	15	1967	ductile failure
20	15	1304,5	ductile failure
20	15	1170,8	ductile failure
20	14,5	5324	ongoing
20	14,5	5324	ongoing
20	14,5	5324	ongoing
20	14,5	5058,2	ductile failure
20	14,5	5324	ongoing
20	14	12198,1	ongoing
20	14	12198,1	ongoing
20	14	12198,1	ongoing
20	14	12198,1	ongoing
20	14	12890,1	ongoing

Table 3 – Results at 60°C

Test temperature (°C)	Stress (MPa)	Time (h)	Result
60	9	45,4	ductile failure
60	9	29	ductile failure
60	9	30,9	ductile failure
60	8,7	140,7	ductile failure
60	8,5	195,3	ductile failure
60	8,5	134,3	ductile failure

Table 3 – continued

Test temperature (°C)	Stress (MPa)	Time (h)	Result
60	8,5	176,1	ductile failure
60	8,5	214,7	ductile failure
60	8,5	155,9	ductile failure
60	8,5	132,8	ductile failure
60	8	320,9	ductile failure
60	8	381,7	ductile failure
60	8	406,6	ductile failure
60	8	458,8	ductile failure
60	8	471,9	ductile failure
60	7,6	2808,6	ductile failure
60	7,5	1536,6	ductile failure
60	7,5	2894,9	ductile failure
60	7,5	3060,4	ductile failure
60	7,5	3286,3	ductile failure
60	7,5	3593,2	ductile failure
60	7	7684,9	ductile failure
60	7	7959,5	ductile failure
60	7	6279,7	ductile failure
60	7	6573,5	ductile failure
60	7	7723,3	ductile failure
60	6	12172	ongoing
60	6	12172	ongoing
60	6	12172	ongoing
60	6	12172	ongoing
60	6	12172	ongoing
60	5	12996,3	ongoing, not taken into account

Table 3 – continued

Test temperature (°C)	Stress (MPa)	Time (h)	Result
60	5	12996,3	ongoing, not taken into account
60	5	12996,3	ongoing, not taken into account
60	5	12996,3	ongoing, not taken into account
60	5	12996,3	ongoing, not taken into account

Table 4 – Results at 80°C

Test temperature (°C)	Stress (MPa)	Time (h)	Result
80	6,8	39,1	ductile failure
80	6,7	45,1	ductile failure
80	6,7	78,9	ductile failure
80	6,6	34	ductile failure
80	6,5	95,8	ductile failure
80	6	258,1	ductile failure
80	6	341,1	ductile failure
80	6	400,6	ductile failure
80	6	450,6	ductile failure
80	6	461,7	ductile failure
80	6	504,1	ductile failure
80	5,5	780,6	brittle failure
80	5,5	1402	brittle failure
80	5,5	1969,8	brittle failure
80	5,5	2226,2	brittle failure
80	5,5	2226,2	brittle failure
80	5,3	972,1	brittle failure

Table 4 – continued

Test temperature (°C)	Stress (MPa)	Time (h)	Result
80	5,3	1186	brittle failure
80	5,3	2124,2	brittle failure
80	5,3	1046,4	brittle failure
80	5,3	972,1	brittle failure
80	5	4079,8	brittle failure
80	5	4079,8	brittle failure
80	5	4213,8	brittle failure
80	5	3977,4	brittle failure
80	5	4912,4	brittle failure
80	4,5	5350,7	ongoing
80	4,5	5350,7	ongoing
80	4,5	5350,7	ongoing
80	4,5	5350,7	ongoing
80	4,5	5350,7	ongoing
80	4	12174,2	ongoing
80	4	12174,2	ongoing
80	4	12174,2	ongoing
80	4	12174,2	ongoing

3. Mathematic knee detection:

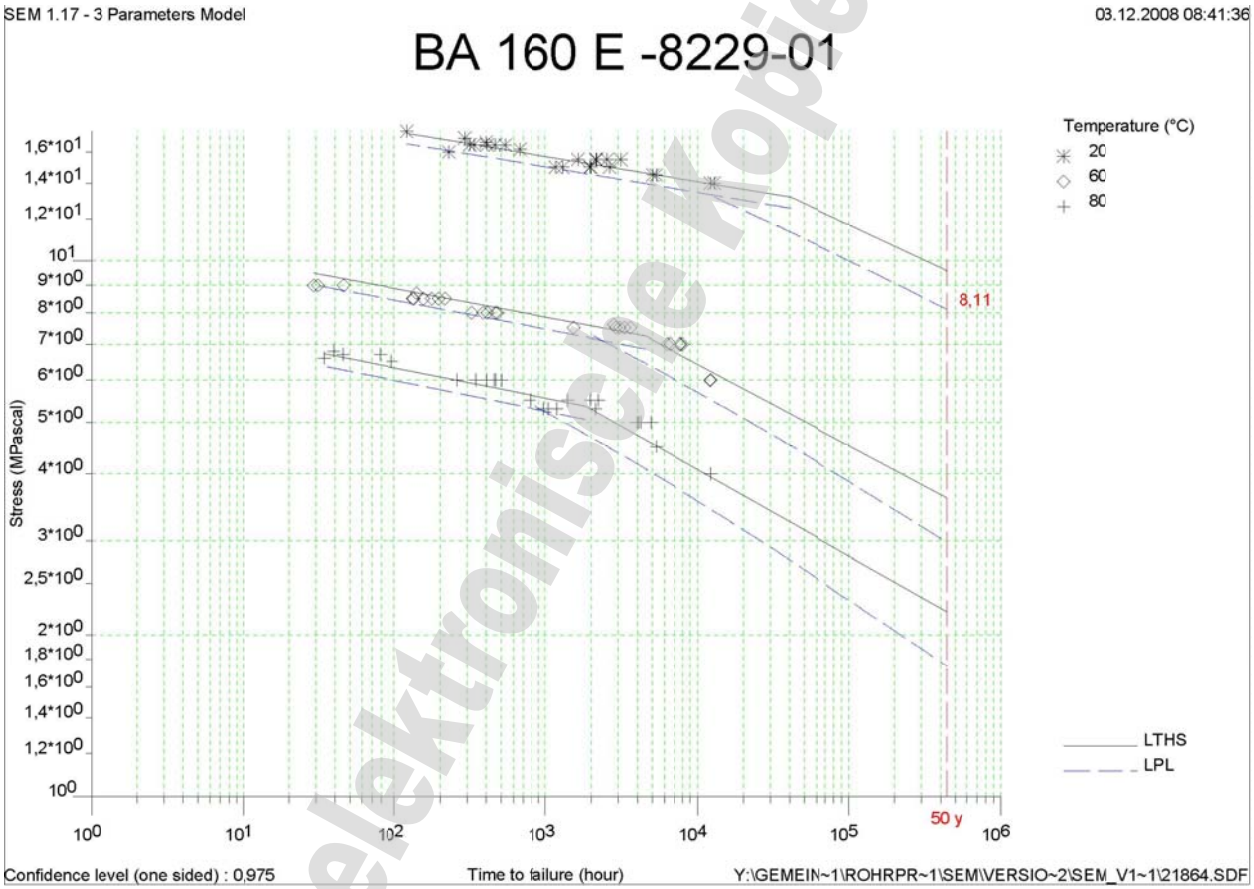
SEM Software Version 1.17 of Becetel vzw; B-9090 Melle was used for the calculation. This software package complies with the specifications of the EN ISO 9080 (ratified German-language copy: March 2003). It has been tested and approved by the WG10 of ISO/TC 138/SC 5 (formerly AHG SEM).

4. Regression of the stress rupture data:

4.1. Estimation: (see Picture 1)

4.1.1. Model used:

$$\lg t = c_1 + \frac{c_2}{T} + \frac{c_4 \cdot \lg \sigma}{T}$$



Picture 1: Graphical presentation of the results of the SEM analysis

4.1.2. Type A failure:

Residual variance:	0,040922
Number of points:	62
Number of parameters:	3
Number of degrees of freedom:	59

Table 5 – Estimated parameters for type A failure

Parameter	Value	Standard error	*t*-value	Probability (> I *t* I)
c_1	-43,771	1,932	-22,654	0,000
c_2	21138,269	904,679	23,365	0,000
c_4	-6210,070	287,765	-21,580	0,000

Test of fit of model: Probability [F(18;41) > 11,022] = 0,000

4.1.3. Type B failure:

Residual variance: 0,024203

Number of points: 34

Number of parameters: 3

Number of degrees of freedom: 31

Table 6 – Estimated parameters for type B failure

Parameter	Value	Standard error	*t*-value	probability (> I *t* I)
c_1	-17,550	1,637	-10,724	0,000
c_2	8943,032	694,509	12,877	0,000
c_4	-2184,770	209,068	-10,450	0,000

Test of fit of model: Probability [F(4;27) > 13,864] = 0,000

4.2. Prediction:

4.2.1 General:

Predicted values of strength are given in tables 7 to 10.

The extrapolation limits are given in table 11.

4.2.2 Type A failure:

Table 7 – Predicted values of strength for type A failure

Temperature °C	Time (h)					
	1	10	100	1.000	10.000	100.000
	σ_{LTHS} (MPa)					
20	21,759	19,518	17,508	15,704	14,087	B
60	11,368	10,047	8,880	7,848	B	B
80	8,217	7,209	6,324	5,548	B	B
	σ_{LPL} confidence level (one-sided) = 0,975 (MPa)					
20	20,642	18,598	16,729	15,017	13,450	B
60	10,750	9,537	8,442	7,453	B	B
80	7,751	6,822	5,990	5,245	B	B

Table 8 – Predicted values of strength for type A failure

Temperature °C	Time (years)			
	0,5	1	10	50
	σ_{LTHS} (MPa)			
20	14,647	14,175	B	B
60	7,250	B	B	B
80	B	B	B	B
	σ_{LCL} confidence level (one-sided) = 0,975 (MPa)			
20	13,996	13,537	B	B
60	6,872	B	B	B
80	B	B	B	B

4.2.3 Type B failure:

Table 9 – Predicted values of strength for type B failure

Temperature °C	Time (h)					
	1	10	100	1.000	10.000	100.000
	σ_{LTHS} (MPa)					
60	A	A	A	A	6,417	4,517
80	A	A	A	A	4,074	2,808
	σ_{LPL} confidence level (one-sided) = 0,975 (MPa)					
60	A	A	A	A	5,694	3,871
80	A	A	A	A	3,559	2,327

Table 10 – Predicted values of strength for type B failure

Temperature °C	Time (years)			
	0,5	1	10	50
	σ_{LTHS} (MPa)			
60	A	6,547	4,609	3,606
80	4,656	4,162	2,869	2,212
	σ_{LCL} confidence level (one-sided) = 0,975 (MPa)			
60	A	5,814	3,962	2,977
80	4,109	3,644	2,387	1,752

4.2.4 Extrapolation time:

Table 11 – Extrapolation time for T_t = 80°C, t_{max} = 10328 h

T (°C)	ΔT (°C)	k_e	t_e (h)	t_e (years)
20	60	100	876000,00	100
60	20	6	61970,60	7,07

Summary:

The report shows that the long-term hydrostatic strength was determined according to

ÖNORM EN ISO 9080

on pipes made of black

Polypropylene Block-Copolymer (PP-B)

BA 160 E – 8229 – 01

of the applicant.

For this material a long-term strength (lower confidence level) for 50 years at 20°C in water was identified:

σ_{LCL} = 8,11 MPa

and therefore can be classified according to

ÖNORM EN ISO 12162

with the following minimum required strength (MPa)

MRS 8

as

PP-B 80.

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The present report

is including

13 Pages 0 Appendix(es) (with 0 pages)

Offical in charge: AR Ing. Stefan Büchinger Vienna, 16. September 2013

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