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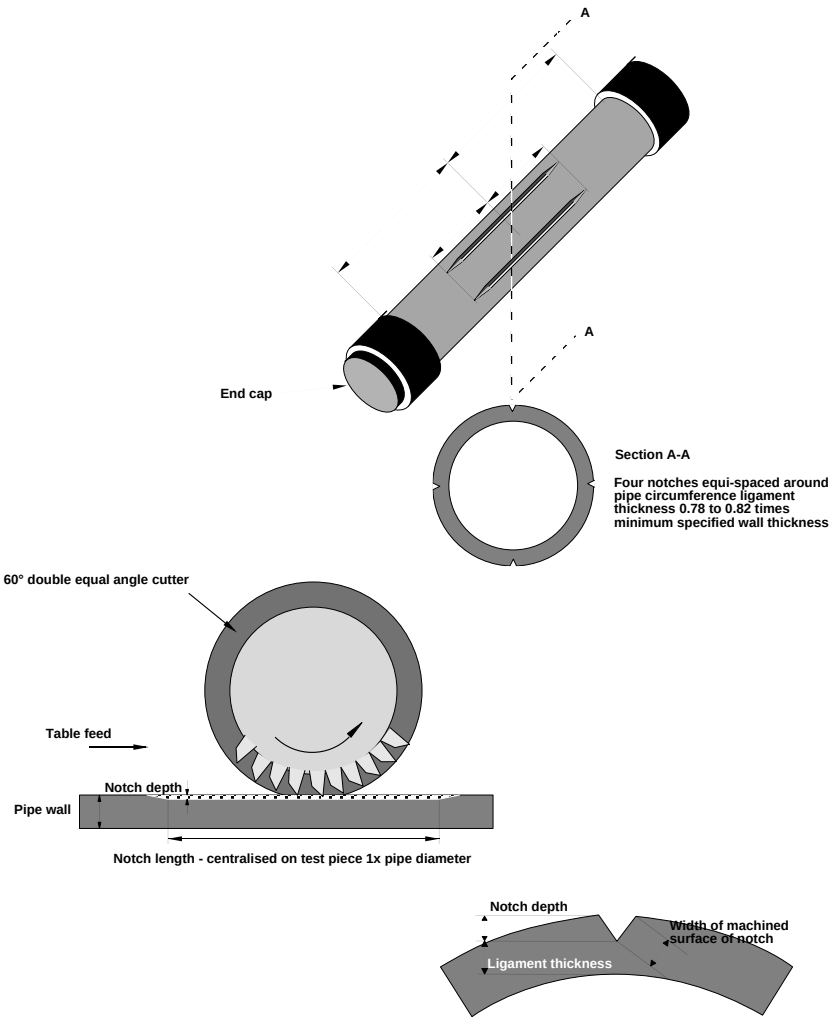
Bodycote Report

NOTCH PIPE TESTING

Notch pipe testing according to ISO 13479:1997 of the PE pipe grade P301E BL from Korea Petrochemical Ind. Co., Ltd.

Joakim Jansson



BODYCOTE POLYMER
SE-611 82 Nyköping, Sweden
Phone +46 155 22 14 73
Fax +46 155 26 31 25
E-mail info@bodycotepolymer.com

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Handled by
Joakim Jansson

Korea Petrochemical Ind. Co., Ltd.
Mr Yoon Boo Hui
Ulsan Plant : R&D Center
178 Bukok – Dong, Nam – ku,
Ulsan city
Korea

NOTCH PIPE TESTING

Notch pipe testing according to ISO 13479:1997 of the PE pipe grade P301E BL from Korea Petrochemical Ind. Co., Ltd.

A notch pipe testing program has been performed on behalf of Korea Petrochemical Ind. Co., Ltd. Three pipe specimens, 110 x 10 mm, of the PE pipe grade P301E BL was notched and pressure tested according to ISO 13479[1].

The testing conditions were 80°C water/water and 8.0 bar. The pipes were after failure evaluated in accordance with ISO 13479. A summary of the results is presented below.

Material	Bodycote code	Internal pressure	Requirements	
			Average failure times >165 h	Remaining ligament thickness[2]
P301E BL	3911	8.0 bar	**1 405 h**	**OK**

The final results show that the PE pipe grade P301E BL pass the requirement of 165 h at 80°C and 8.0 bar as required in ISO 13479 for a PE 80 pipe material.

[1] *ISO 13479:1997- Polyolefin pipes for the conveyance of fluids -- Determination of resistance to crack propagation -- Test method for slow crack growth on notched pipes (notch test)*

[2] *The remaining ligament thickness should be 0.78-0.82 times the nominal wall thickness*

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Responsible for the report

Björn Carlsson
TECHNICIAN

Reviewed by

Jonathan Rabiei
PROJECT MANAGER

Approved by

Joakim Jansson
PROJECT MANAGER

1 Investigated pipe material

The characteristics and code of the investigated material is presented in Appendix A, Table A.1.

2 Experimental procedure

All tests have been performed at Bodycote Polymer. The pipes were notched according to ISO 13479. The cutter is a V-cutter conforming to ISO 6108, for dimensions see Figure 1 below.

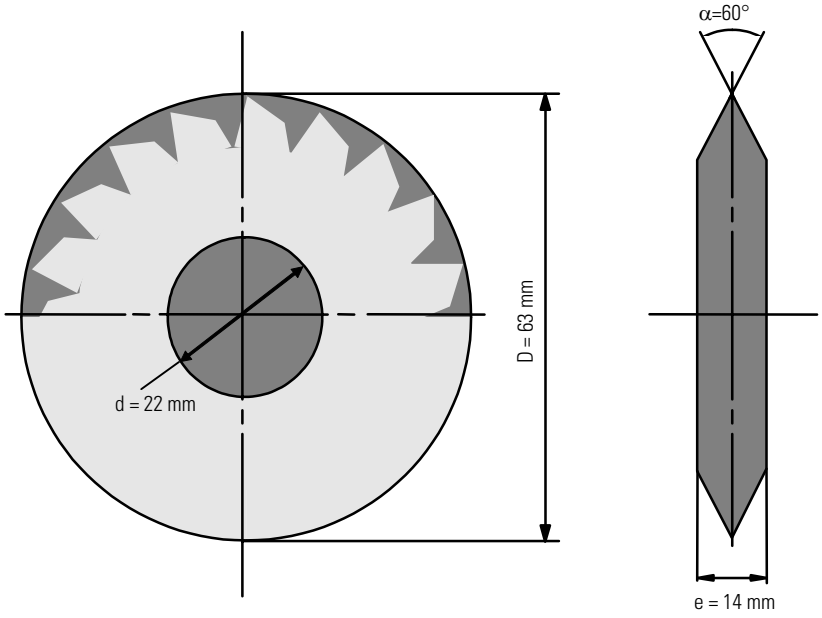

Figure 1
Dimensions for the V-cutter, Double equal angle cutters with plain bore and key drive

The notch cutter has 20 teeth and is rotating at 765 rpm with a transverse speed of 158 mm/min giving a cutting rate[3] of 0.010 ±0.002 (mm/rev)/tooth. The accuracy of the notch length[3] is better than ±1 mm and the measurement of the machined notch surface[3] is accurate within ±0.1 mm.

The pressure testing is carried out with water filled pipes, the outer environment being water at 80°C. The water used is tap water. The pipes were fitted with Wipex brass fittings. The accuracy for the temperature[3] and the pressure[3] are better than ±1°C and +2/-1%, respectively. The measurements of the wall thickness[3] are accurate within ±0.02 mm and the diameters[3] within ±0.1 mm.

The general testing conditions follow ISO 1167:2006.

[3] The expanded uncertainty of measurement has been calculated as the standard uncertainty of measurement multiplied by the coverage factor K=2, which for a normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with EA Publication EA-4/02 and is documented at Bodycote Polymer.

3 Results

The results are presented in Appendix B, Tables B.1-B.2. The three started pipe specimens of the PE pipe grade P301E BL have been tested until failure. A summary of the results is presented below.

Material	Bodycote code	Internal pressure	Requirements	
			Average failure times >165 h	Remaining ligament thickness[4]
P301E BL	3911	8.0 bar	**1 405h**	**OK**

The pipes were after failure evaluated in accordance with ISO 13479, see Table B.2 for further details.

The final results show that the PE pipe grade P301E BL pass the requirement of 165 h at 80°C and 8.0 bar as required in ISO 13479 for a PE 80 pipe material.

[4] *The remaining ligament thickness should be 0.78-0.82 times the nominal wall thickness*

Table A.1, *Investigated pipe material*

Trade name:	P301E BL
Material:	PE
Colour:	Black
Resin producer:	Korea Petrochemical Ind. Co., Ltd.
Pipe producer:	Korea Petrochemical Ind. Co., Ltd.
Pipe production date:	n/a
Lot number:	n/a
Pipe dimension:	110 x 10 mm
Pipe marking:	unmarked
Consignor:	Korea Petrochemical Ind. Co., Ltd.
Arrival date at Bodycote:	2007-02-12
Amount of pipes:	5 x 1.4 m
Bodycote code:	3911

Table B.1

Notch pipe testing at 80°C of the PE pipe grade P301E BL using water as the internal and external medium. Bodycote internal code is 3911.

Name of the laboratory:	Bodycote Polymer
Material:	P301E BL
Test method:	ISO 13479:1997
Nominal dimension:	110 x 10 mm
Pipe length (total/free):	580/440 mm
Fittings:	Wipex brass fittings (Type A)
Internal medium/External medium:	Tap water/Tap water
Conditioning time:	24 h
Responsible for the testing:	Björn Carlsson

Specimen[1] (internal code)	Temp	Start date[2]	Reg. date[3]	t[4]	D[5]	p[6]	σ[7]	Failure time	Failure mode	Remarks
	°C	yymmdd	yymmdd	mm	mm	bar	MPa	h		
3911-1	80	070301	070425	10.78	110.10	8.0	-	1 307	Mixed	*Notch 4*
3911-2	80	070301	070502	10.62	110.10	8.0	-	1 451	Mixed	*Notch 2*
3911-3	80	070301	070502	10.77	110.10	8.0	-	1 457	Mixed	*Notch 2*

1) Internal reference code at Bodycote
2) Date when the test began
3) Registration date for the failure/termination
4) Average wall thickness
5) Mean outside diameter
6) Internal pressure
7) Circumferential stress (hoop stress)

Table B.2

The table below shows the results from the post-test measurements on the notches for the investigated PE pipe grade P301E BL. Bodycote internal code is 3911.

Pipe	Measured notch depth	Relative notch depth[5]	Ligament thickness
	mm	%	mm
3911-1			
Notch 1	2.56	24	8.08
Notch 2	2.58	24	8.09
Notch 3	2.87	26	8.11
Notch 4	2.74	25	8.07
3911-2			
Notch 1	2.33	22	8.09
Notch 2	2.53	24	8.09
Notch 3	2.67	25	8.14
Notch 4	2.53	24	8.09
3911-3			
Notch 1	2.86	26	8.13
Notch 2	2.71	25	8.12
Notch 3	2.50	23	8.13
Notch 4	2.49	23	8.15

Notes

- *The bold text indicates in which notch the failure occurred.*
- *The ligament thickness should be within 7.8 and 8.2 mm for a 110 x 10 mm pipe. The given value refers to the ligament thickness at the notch.*
- *Complete documentation of the notch measurements is stored at Bodycote Polymer.*

[5] $\text{Relative notch depth} = \frac{\text{notch depth}}{\text{wall thickness}}$

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Bodycote Polymer · SE-611 82 Nyköping · Sweden
Phone +46 155 22 14 76 · Fax +46 155 26 31 25
www.bodycotepolymer.com · info@bodycotepolymer.com

Bodycote POLYMER