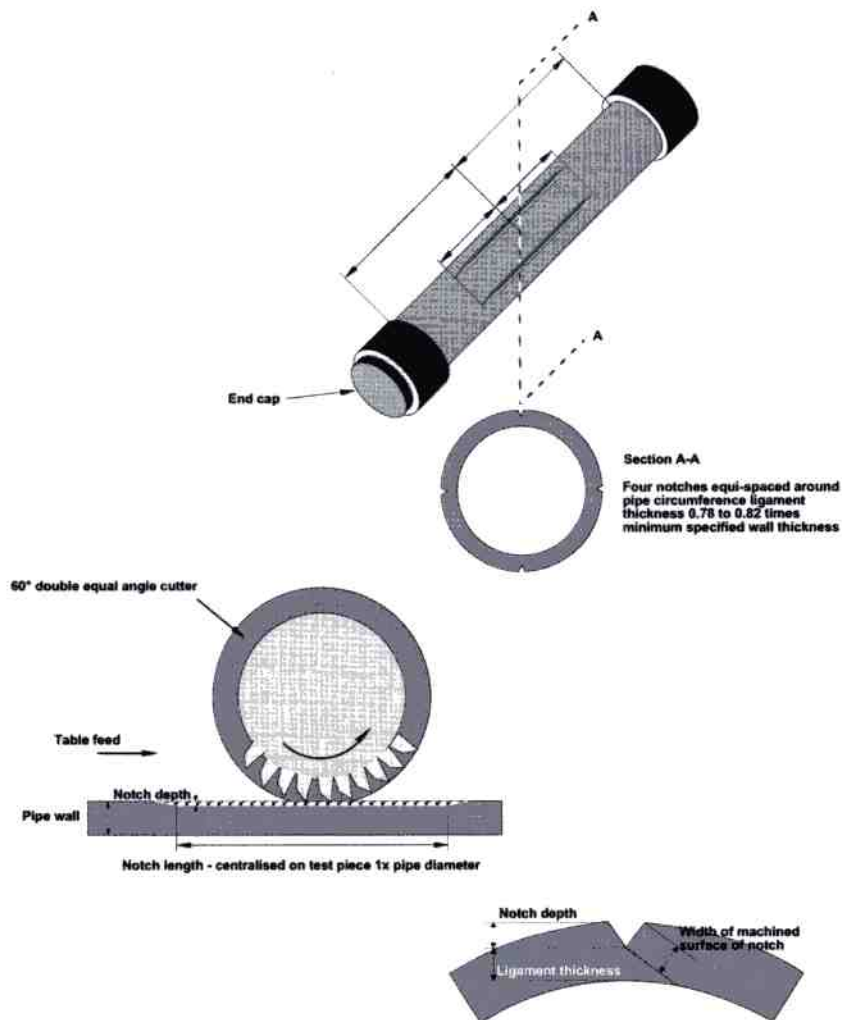


# Bodycote Report

## NOTCH PIPE TESTING

Notch pipe testing according to ISO 13479:1997 of the PE pipe grade P502YE from Korea Petrochemical Ind. CO., Ltd.



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## **NOTCH PIPE TESTING**

### **Notch pipe testing according to ISO 13479:1997 of the PE pipe grade P502YE from Korea Petrochemical Industry Co.**

A notch pipe testing program has been performed on behalf of Korea Petrochemical Industry Co. 3 pipe specimens, 110 x 10 mm, of the PE pipe grade P502YE were notched and pressure tested according to the standard ISO 13479:1997<sup>1</sup>.

The testing conditions were 80°C water/water and 8.0 bar. All pipes have failed and the average failure time is presented in the table below.

<b>Material</b>	<b>Bodycote code</b>	<b>Internal pressure</b>	<b>Average failure time</b>
P502YE	3685	8.0 bar	1 823 h

The pipes were after failure evaluated in accordance with ISO 13479:1997. All failures were located to a notch.

The final results show that the PE pipe grade P502YE passed the requirement of 165 h at 80°C and 8.0 bar as required in ISO 13479:1997 for a PE 80 pipe material.

<sup>1</sup> ISO 13479:1997-Test method for slow crack growth on notched pipes

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2006-05-17

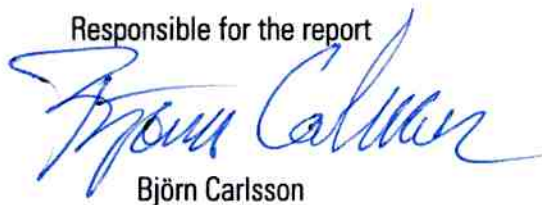
**List of contents**

	<b>Page</b>
<b>1 Investigated pipe material</b>	3
<b>2 Experimental procedure</b>	3
<b>3 Results</b>	4

**Appendices**

A	Investigated pipe material, Table A.1
B	Hydrostatic pressure testing table, Table B.1
B	Measurement information, Table B.2

Responsible for the report



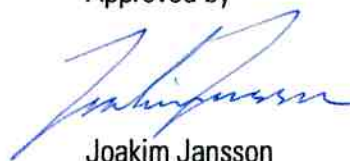
Björn Carlsson

Reviewed by



Karl Bergenlid

Approved by



Joakim Jansson

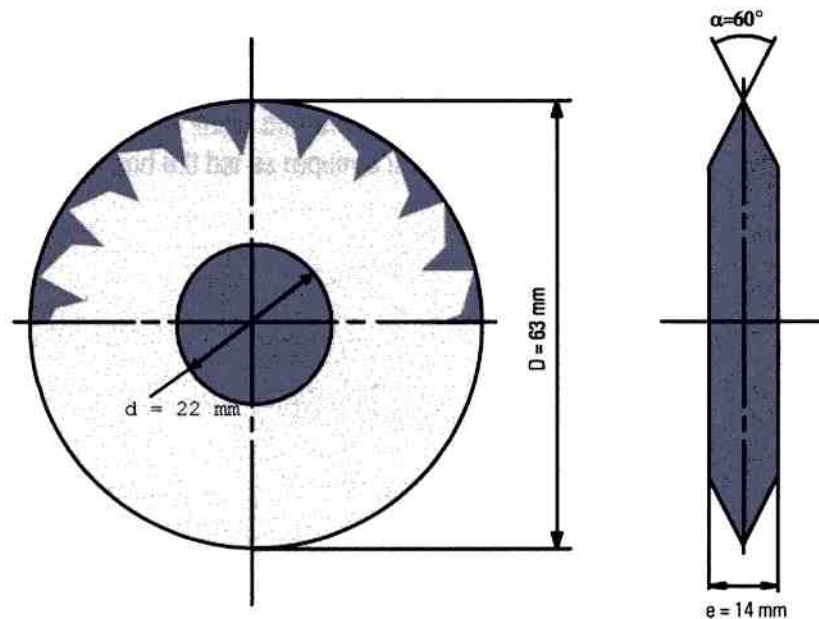
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## 1 Investigated pipe material

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 13479:1997. 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<sup>2</sup> of  $0.010 \pm 0.002 \text{ (mm/rev)/tooth}$ . The accuracy of the notch length<sup>2</sup> is better than  $\pm 1 \text{ mm}$  and the measurement of the machined notch surface<sup>2</sup> is accurate within  $\pm 0.1 \text{ mm}$ .

The pressure testing is carried out with water filled pipes, the outer environment being water at  $80^\circ\text{C}$ . The water used is tap water. The pipes were fitted with Wipex brass fittings. The accuracy for the temperature<sup>2</sup> and the pressure<sup>2</sup> are better than  $\pm 1^\circ\text{C}$  and  $+2/-1\%$ , respectively. The measurements of the wall thickness<sup>2</sup> are accurate within  $\pm 0.02 \text{ mm}$  and the diameters<sup>2</sup> within  $\pm 0.1 \text{ mm}$ .

The general testing conditions follow ISO 1167:1996.

<sup>2</sup> 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.

2006-05-17

### 3 Results

The results are presented in Appendix B, Tables B.1-B.2. The three started pipe specimens of the PE pipe grade P502YE have failed. The average failure time is presented in the table below.

<b>Material</b>	<b>Bodycote code</b>	<b>Internal pressure</b>	<b>Average failure time</b>
P502YE	3685	8.0 bar	1 823 h

All failures were located to a notch, see Table B.1. The pipes were after failure evaluated in accordance with ISO 13479:1997, see Table B.2 for further details.

The final results show that the PE pipe grade P502YE passed the requirement of 165 h at 80°C and 8.0 bar as required in ISO 13479:1997 for a PE 80 pipe material.

2006-05-17

**Table A.1, Investigated pipe material****PE502YE****3685**

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Trade name:	P502YE
Material:	PE
Colour	Yellow
Resin producer:	Korean Petrochemical Ind. Co., Ltd
Pipe producer:	Korean Petrochemical Ind. Co., Ltd
Pipe production date:	n/a
Lot number:	n/a
Pipe dimension:	110 x 10 mm
Pipe marking:	n/a
Consignor:	Korean Petrochemical Ind. Co., Ltd
Arrival date at Bodycote:	2006-01-10
Amount of pipes:	21 x 1.4 m
Bodycote code:	3685

2006-05-17

**Table B.1**

Notch pipe testing at 80°C of the PE pipe grade P502YE using water as the internal and external medium. Bodycote internal code is 3685.

Name of the laboratory:	Bodycote Polymer
Material:	P502YE
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 <sup>1)</sup> (internal code)	Temp °C	Start	t <sup>2)</sup> mm	D <sup>3)</sup> mm	p <sup>4)</sup> bar	<sup>5)</sup> MPa	Failure time h	Failure mode	Remarks
3685-1	80	060119	11.23	109.85	8.04	-	1 859	Mixed	<i>Notch 2</i>
3685-2	80	060119	11.18	109.90	8.04	-	1 789	Mixed	<i>Notch 3</i>
3685-3	80	060119	11.12	109.85	8.04	-	1 820	Mixed	<i>Notch 1</i>

- 1) Internal reference code at Bodycote
- 2) Average wall thickness
- 3) Mean outside diameter
- 4) Internal pressure
- 5) Circumferential stress (hoop stress)

2006-05-17

**Table B.2**

The table below shows the results from the post-test measurements on the notches for the investigated PE pipe grade P502YE from Korean Petrochemical Ind., Co Ltd. Bodycote internal code is 3685.

<b>Pipe</b>	<b>Measured notch depth</b> mm	<b>Relative notch depth<sup>3</sup></b> %	<b>Ligament thickness</b> mm
<b>3685-1</b>			
Notch 1	3.13	28	8.04
<b>Notch 2</b>	3.14	28	8.04
Notch 3	3.26	29	8.04
Notch 4	3.23	29	8.04
<b>3685-2</b>			
Notch 1	3.19	28	8.07
Notch 2	3.14	28	8.08
<b>Notch 3</b>	3.06	28	8.05
Notch 4	3.04	27	8.09
<b>3685-3</b>			
<b>Notch 1</b>	2.97	27	8.07
Notch 2	3.11	28	8.07
Notch 3	3.06	27	8.11
Notch 4	2.96	27	8.11

**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.*

<sup>3</sup> Relative notch depth =  $\frac{\text{notch depth}}{\text{wall thickness}}$