

Australia / New Zealand
Standard™

**Ultra High Molecular Weight
Polyethylene (UHMWPE)
pipes for pressure
applications**



PREFACE

This draft standard was prepared by Eugene Lakous of Pipe & Buoy Australia Pty. Ltd. In conjunction with data derived from the Chinese standard QB/T 2668-2008

This revision is consistent with ISO 11542-1, “Plastics – Ultra-high-molecular-weight-polyethylene (PE-UHMW) moulding and extrusion materials –“

Relevant testing and use will be expanded upon within the standard.

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FOREWORD

This manual is based on data derived from the production and use of UHMWPE by the manufacturers accredited to ISO 9001 and 14001. It is in accordance with all known data of UHMWPE characteristics, verified against performance tests by said manufacturers.

Appendices A and B are to be used as supplementary test methodologies that contribute to our knowledge of UHMWPE performance and subsequent expectations of pipe suitability.

Q: Why should Australia use UHMWPE Pipes?

A1. Longer Life

- With a wear resistance 4 to 7 greater than Q235 Steel or HDPE and 2.7 times that of 16Mn Steel under the same operating conditions, UHMWPE Pipe will give you far superior life under most operating conditions.*

A2. Non-Scaling

- Because of its very smooth surface and self lubricating properties UHMWPE Pipe has far superior anti-scaling properties to any other pipeline on the market today.

A3. Less Maintenance Costs, Less Maintenance Time

- The far superior wear resistance of UHMWPE pipe will significantly increase the time between pipe replacements and/or rotations resulting in massive savings in the way of reduced maintenance costs and time.

A4. Less Downtime, Less Lost Production

- The far superior wear resistance of UHMWPE pipe will significantly increase the time between pipe replacements and/or rotations resulting in massive savings in the way of less downtime for maintenance and less loss of plant production time.

A5. Reduced Pumping Costs

- Along with the benefits mentioned above UHMWPE Pipes also offer significant cost savings through increased pumping efficiency.
- With a surface roughness of 0.00022mm UHMWPE Pipe is extremely smooth and has self lubricating properties superior to PTFE (Teflon).
- This means less friction, less pressure loss and greatly reduced energy inputs to deliver the same result.

A6. Chemical and Corrosion Resistance

- With chemical resistance second only to PTFE (Teflon), UHMWPE pipe will offer superior life to other pipeline products in chemically aggressive or corrosive applications under most operating conditions. [*](#)

A7. Extremely High Impact Resistance

- UHMWPE has the highest impact resistance of any plastic. UHMWPE is widely used in the production of Bullet Proof Vests and Bullet Proof Helmets.

A8. Environmentally Friendly

- Base material is colourless, odourless and non-toxic.
- Low Carbon Production Process. The UHMWPE manufacturing process produces only 15% of the carbon dioxide emissions of that of the equivalent amount of steel pipe without discharge of waste water, exhausted gas and waste residue.
- No painting.

STANDARDS AUSTRALIA

Ultra High Molecular Weight Polyethylene (UHMWPE) pipes for pressure applications

1 SCOPE AND APPLICATION

1.1 Scope

This Standard specifies requirements for ultra high molecular weight polyethylene pipes for the conveyance of fluids under pressure and/or solids. Such media includes, but is not restricted to: water, wastewater, brine, slurries, acids, powders, pastes, and abrasive particulates.

Further, this standard specifies UHMWPE pipe classification; referencing raw material distinction, product specification, testing methods, testing regulations, and methods of storage.

1.2 Application

Means for demonstrating compliance with this Standard shall be in accordance with ISO 9001 and 14001, utilising testing referenced in Appendix A and B.

The test requirements may be achieved by alternative test methods if such methods can be shown to provide equal or greater accuracy than those specified herein. In all cases of dispute, the methods specified in this Standard shall be considered the reference test methods.

2 NORMATIVE REFERENCES

The following documents are relevant to the application of this standard. They are all based on ISO standard.

GB/T 1043-1993	Impact strength determination of rigid materials with the use of a Charpy test - Plastics (ISO 179: 1982)
GB/T 2828.1-2003	Lot Inspection Sampling Plan (ISO 2859-1: 1999)
GB/T 2918-1998	Testing plastic samples. Condition standard, environmentally approved (ISO 6259-3: 1997)
GB/T 6111-2003	Method of testing inner pipe pressure of thermoplastics (ISO 1167: 1996)
GB/T 6671-2001	Thermoplastic pipe longitudinal shrink rate (ISO 2505: 1994)
GB/T 8804.3-2003	Tensile testing of thermoplastic pipe (ISO 6259-3: 1997)
GB/T 8806-1998	Method for testing plastic pipe length (ISO 3126: 1974)
GB/T 17219-1998	Safety standards for drinkable water distribution equipment
GB/T 17391-1998	Method of testing thermal stability of polyethylene pipe (ISO/TR 10837: 1991)
ISO 11542-1:2001	PE-UHMW moulding and extrusion material

3 DEFINITIONS

3.1 Brittle Failure

The type of failure of the materials in pipe form during pressure testing, where the pipe exhibits no plastic deformation visible to the naked eye (normal or corrected vision).

3.2 Co-extruded jacket pipes

A pipe comprising two layers, where the layers are bonded simultaneously in a die head as part of the extrusion process.

3.3 Ductile mode

The type of failure of the material in pipe form during pressure testing, where the pipe exhibits plastic deformation visible to the naked eye (normal or corrected).

3.4 Hoop stress

The stress in a pipe or fitting under pressure acting tangentially to the perimeter of a transverse section.

3.5 Hydrostatic design stress (HDS)

Hoop stress due to internal hydrostatic pressure, which can be applied continuously at a specified temperature, and which is obtained by the application of a design factor to the minimum required strength (MRS)

3.6 Maximum allowable operating pressure (MAOP)

The maximum pressure that can be sustained, with a design factor, by the type or class of pipe for its estimated useful life under the anticipated operating conditions.

3.7 Out-of-roundness (ovality)

The difference between the measured maximum outside diameter and the measured minimum outside diameter in the same cross-section of the pipe.

3.8 Nominal working pressure

Maximum pressure that can be sustained by the class of pipe for its estimated useful life under the expected working conditions.

3.9 Standard dimension ratio

A nominal ratio of the pipe outside diameter to its wall thickness

4 NOMENCLATURE

The following apply to this Standard.

σ_s = stress in MPa

SDR = standard dimensions ratio

$$= \frac{\text{nominal outer diameter}}{\text{nominal thickness}} = \frac{d_n}{e_n}$$

PN = nominal working pressure

P_{PMS} = maximum working pressure

f_1 = temperature reduction factor

f_2 = media reduction factor

d_n = diameter

5 CLASSIFICATION

UHMWPE should be classified into 2 categories based on molecular weight in resin form:

UHMWPE type I and UHMWPE type II

Table 1 material classification

Type	UHMWPE I	UHMWPE II
Molecular weight/ 10^4	≥ 100 , but < 200	≥ 200

5.1 Melting Index

Production of UHMWPE is based on ISO 11542-1: 2001. The melting mass flow rate at 190° C for 21.6 kg of UHMWPE should be less than 0.1 g per 10 minutes.

6 PRODUCT SPECIFICATION

This section will outline basic pipe size requirements by pressure.

6.1 Relationship between nominal working pressure and stress

Formula 1:
$$Pressure = \frac{2\sigma_s}{SDR-1}$$

Tabulated data with reference to SDR is attributable to UHMWPE II

Table 2 Outer Diameter, PN and related thickness

d _n /mm	e _n /mm					
	Standard Size Ratio					
	SDR34.4	SDR 26	SDR 21	SDR 17	SDR 13.6	SDR 11
	PN/MPa					
	0.6	0.8	1.0	1.25	1.6	2.0
63	--	--	--	--	--	5.8
75	--	--	--	--	--	6.8
90	--	--	--	--	6.7	8.2
110	--	--	--	6.6	8.1	10.0
125	--	--	6.0	7.4	9.2	11.4
140	--	--	6.7	8.3	10.3	12.7
160	--	6.2	7.7	9.5	11.8	14.6
180	--	6.9	8.6	10.7	13.3	16.4
200	5.9	7.7	9.6	11.9	14.7	18.2
225	6.6	8.6	10.8	13.4	16.6	20.5
250	7.3	9.6	11.9	14.8	18.4	22.7
280	8.2	10.7	13.4	16.6	20.6	25.4
315	9.2	12.1	15.0	18.7	23.2	28.6
355	10.4	13.6	16.9	21.1	26.1	32.2
400	11.7	15.3	19.1	23.7	29.4	36.3
450	13.2	17.2	21.5	26.7	33.1	40.9
500	14.6	19.1	23.9	29.7	36.8	45.4
560	16.4	21.4	26.7	33.2	41.2	--
630	18.4	24.1	30.0	37.4	--	--
710	20.7	27.2	33.9	42.1	--	--
800	23.3	30.6	38.1	--	--	--

P.S.: This table $\sigma_s = 10\text{MPa}$

Table 3 Outer Diameter, PN and related thickness

d _n /mm	e _n /mm					
	Standard Size Ratio					
	SDR 27.6	SDR 21	SDR 17	SDR 13.6	SDR 11	SDR 9
	PN/MPa					
	0.6	0.8	1.0	1.25	1.6	2.0
63	--	--	--	--	5.8	7.1
75	--	--	--	--	6.8	8.4
90	--	--	--	6.7	8.2	10.1
110	--	--	6.6	8.1	10.0	12.3
125	--	6.0	7.4	9.2	11.4	14.0
140	--	6.7	8.3	10.3	12.7	15.7
160	5.8	7.7	9.5	11.8	14.3	17.9
180	6.6	8.6	10.7	13.3	16.4	20.1
200	7.3	9.6	11.9	14.7	18.2	22.4
225	9.1	11.9	14.8	18.4	22.7	27.9
250	10.2	13.4	16.6	20.6	25.4	31.3
280	11.4	15.0	18.7	23.2	28.6	35.2
315	11.4	15.0	18.7	23.2	28.6	35.2
355	12.9	16.9	21.1	26.1	32.2	39.7
400	14.5	19.1	23.7	29.4	36.3	
450	16.3	21.5	26.7	33.1	40.9	--
500	18.1	23.9	29.7	36.8	45.4	--
460	20.3	26.7	33.2	41.2	--	--
630	22.8	30.0	37.4	--	--	--
710	25.7	33.9	42.1	--	--	--
800	29.0	38.0	--	--	--	--

P.S.: This table $\sigma_s = 8\text{MPa}$

Table 4 Outer Diameter, PN and related thickness

d _n /mm	e _n /mm					
	Standard Size Ratio					
	SDR 27.6	SDR 21	SDR 17	SDR 13.6	SDR 11	SDR 9
	PN/MPa					
	0.6	0.8	1.0	1.25	1.6	2.0
63	--	--	--	--	5.8	7.1
75	--	--	--	--	6.8	8.4
90	--	--	--	6.7	8.2	10.1
110	--	--	6.6	8.1	10.0	12.3
125	--	--	7.4	9.2	11.4	14.0
140	--	6.4	8.3	10.3	12.7	15.7
160	--	7.3	9.5	11.8	14.6	17.9
180	--	8.2	10.7	13.3	16.4	20.1
200	--	9.1	11.9	14.7	18.2	22.4
225	6.9	10.3	13.4	16.6	20.5	25.2
250	7.7	11.4	14.8	18.4	22.7	27.9
280	8.6	12.8	16.6	20.6	25.4	31.3
315	9.7	14.4	18.7	23.2	28.6	35.2
355	10.9	16.2	21.1	26.1	32.2	39.7
400	12.3	18.2	23.7	29.4	36.3	44.7
450	13.8	20.5	26.7	33.1	40.9	--
500	15.3	22.8	29.7	36.8	45.4	--
460	17.2	25.5	33.2	41.2	--	--
630	19.3	28.7	37.4	46.3--	--	--
710	21.8	32.3	42.1	--	--	--
800	24.5	36.4	--	--	--	--
P.S.: This table $\sigma_s = 6.3\text{MPa}$						

6.2 Pressure reduction factors

The working pressure can be reduced with the use of the following formula:

$$\text{Formula 2: } P_{PMS} = PN * f_1 * f_2$$

The following temperature factors should be only considered in continuous operation. Instantaneous or short-term temperature spikes will not require these factors.

Table 5 Temperature Reduction Factor f_1

Temp t/°C	20	30	40
f_1	1	0.87	0.74

Table 6 Medium Reduction Factor f_2

Medium	Liquid	Paste	Solid Particle/ Other form (Pneumatic)	Abrasive Particulates (Pneumatic)
f_2	1.0	0.8	0.67	<0.4

Please note that a slurry with abrasive solids is not classified into abrasive particulates. It would be in the range between liquid and paste. We are referring to near solids, wholly abrasive, at high flow rates (> 30 m/s).

7 GEOMETRY AND PROPERTIES

This section will outline nominal pipe size geometries and tolerances post extrusion

7.1 Colour

UHMWPE is colourless and odorless; as such the definition of normal or standard is purely reflexive of AS 4130. The pipe will be nominally black, no painting will ever be required. If other colours are required (all are available), it will require an inquiry prior to purchase.

Using white coloured pipe in outdoor locations may be preferred to diminish thermal expansion.

7.2 Appearance

The pipe's inner and outer surface must be glossy (perceived by eye), smooth to the touch without being sunk. It must not have any bubbles or other surface defects affecting the performance of pipe. Pipe cannot contain any contamination of colour or surface, where tails must be cut smoothly across planar, perpendicular axes.

7.3 Diameter rate

Pipe diameter's must match with regulation of maximums and tolerances provided in table 7 and 8.

Table 7

d_n	$d_{em\ min}$	$d_{em\ max}$
63	63.0	63.6
75	75.0	75.7
90	90.0	90.9
110	110.0	111.0
125	125.0	126.2

140	140.0	141.3
160	160.0	161.5
180	180.0	181.7
200	200.0	201.8
225	225.0	227.1
250	250.0	252.3
280	280.0	282.6
315	315.0	317.9
355	355.0	358.2
400	400.0	403.6
450	450.0	454.1
500	500.0	504.5
560	560.0	565.0
630	630.0	635.7
710	710.0	716.4
800	800.0	807.2

Table 8 Thickness Tolerance

$e_{y \min}$		Tolerance t_y	$e_{y \min}$		Tolerance t_y	$e_{y \min}$		Tolerance t_y
>	\leq		>	\leq		>	\leq	
5.3	6.0	0.9	22.5	23.0	4.5	37.0	37.5	7.4
6.0	6.6	1.0	23.0	23.5	4.6	37.5	38.0	7.5
6.6	7.3	1.1	23.5	24.0	4.7	38.0	38.5	7.6
7.3	8.0	1.2	24.0	24.5	4.8	38.5	39.0	7.7
8.0	8.6	1.3	24.5	25.0	4.9	39.0	39.5	7.8
8.6	9.3	1.4	25.0	25.5	5.0	39.5	40.0	7.9
9.3	10.0	1.5	25.5	26.0	5.1	40.0	40.5	8.0
10.0	10.6	1.6	26.0	26.5	5.2	40.5	41.0	8.1
10.6	11.3	1.7	26.5	27.0	5.3	41.0	41.5	8.2
11.3	12.0	1.8	27.0	27.5	5.4	41.5	42.0	8.3
12.0	12.6	1.9	27.5	28.0	5.5	42.0	42.5	8.4
12.6	13.3	2.0	28.0	28.5	5.6	42.5	43.0	8.5
13.3	14.0	2.1	28.5	29.0	5.7	43.0	43.5	8.6
14.0	14.6	2.2	29.0	29.5	5.8	43.5	44.0	8.7
14.6	15.3	2.3	29.5	30.0	5.9	44.0	44.5	8.8

15.3	16.0	2.4	30.0	30.5	6.0	44.5	45.0	8.9
16.0	16.5	3.2	30.5	31.0	6.1	45.0	45.5	9.0
16.5	17.0	3.3	31.0	31.5	6.2	45.5	46.0	9.1
17.0	17.5	3.4	31.5	32.0	6.3	46.0	46.5	9.2
17.5	18.0	3.5	32.0	32.5	6.4	46.5	47.0	9.3
18.0	18.5	3.6	32.5	33.0	6.5	47.0	47.5	9.4
18.5	19.0	3.7	33.0	33.5	6.6	47.5	48.0	9.5
19.0	19.5	3.8	33.5	34.0	6.7	48.0	48.5	9.6
19.5	20.0	3.9	34.0	34.5	6.8	48.5	49.0	9.7
20.0	20.5	4.0	34.5	35.0	6.9	49.0	49.5	9.8
20.5	21.0	4.1	35.0	35.5	7.0	49.5	50.0	9.9
21.0	21.5	4.2	35.5	36.0	7.1	50.0	50.5	10.0
21.5	22.0	4.3	36.0	36.5	7.2			
22.0	22.5	4.4	36.5	37.0	7.3			

7.4 Hoop Stress

Pipe's Hoop stress must match with Table 9

Table 9

Num.	Project	Hoop Stress/MPa at $\sigma_s = 10\text{MPa}/8\text{MPa}$	Hoop Stress/MPa at $\sigma_s = 6.3\text{MPa}$	Requirement
1	20°C intensity (100h)	12.4	9.0	Not Break,not leak
2	80°C Intensity (165h)	5.5	4.6	Not Break,not leak
3	80°C Intensity (1000h)	5.0	4.0	Not Break,not leak

7.5 Mechanical Properties

The physical and mechanical properties of UHMWPE pipe must match with Table 10.

Table 10

Num.	Project		Target			
			UHMWPE I		UHMWPE II	
1	Oxidation Induction time (200°C)/min		≥ 20		≥ 20	
2	Tensile Stress	Tensile Yield Stress/MPa	20		≥ 22	
		Elongation/%	≥250		≥220	
3	Charpy notched	23°C	Sample 1	≥30	Sample 1	≥60

	impact strength (kJ/m ²)		Sample 2	≥90	Sample 2	≥140
		-40°C	Sample 1	≥20	Sample 1	≥50
			Sample 2	≥50	Sample 2	≥100
4	Mortar worn rates		≤0.40		≤0.30	
5	Longitudinal shrinkage rates		≤3		≤3	

7 TESTING METHODS

This section will outline testing methods used as common practice for UHMWPE validation.

7.1 Environmental requirements

In addition to matching with aforementioned standards, all testing must take place at 23 ± 2 °C with a Humidity of $50 \pm 5\%$

7.2 Colour and Shape

To be confirmed as adherent to section 6 via the naked eye (or with prescription eyewear).

7.3 Diameter rates and tolerances

These rates and tolerances are currently based on GB/T 8806.

7.4 HDS and hoop stress

Based on GB/T 6111-2003. Tested on water.

7.5 Oxidation induction time

Based on GB/T 17391-1998 testing. All samples must be taken from inner surface of pipe

7.6 Tensile strength

Based on GB/T 8804.3-2003 testing.

7.7 Charpy double notched impact strength test

Based on Appendix A

7.8 Mortar wear rates

Based on Appendix B

7.9 Oxidation induction time

Based on GB/T 17391-1998 testing. All samples must be taken from inner surface of pipe

7.5 Longitudinal shrinkage rates

Based on GB/T 6671-2001 testing. At revised temperature of is $110 \pm 2^{\circ}\text{C}$

8 TESTING REGULATIONS

All product must pass factory quality control and have certification guaranteeing such.

8.1 Batching and sampling

The total weight of each batch is to not exceed 50t. Further, if the production of said batch of UHMWPE exceeds 30 days, it cannot be considered to be within the same batch as pipes manufacturer herewith.

Sampling is to be conducted based on GB/T 2828.1-2003 using the sampling plan Table 11

Table 11 Sampling plan

Batch Qty (N)	Sample Qty (n)	Acceptable Qty (Ac)	Refuse Qty (Re)
<25	2	0	1
26~150	8	1	2
151~280	13	2	3
281~500	20	3	4
501~1200	32	5	6
1201~3200	50	7	8
3201~10.000	80	10	11

8.2 Factory inspection

Factory inspection is to include samples for hydrostatic testing, charpy testing and tensile yield testing as previously indicated.

The grouping of these inspections are to be determined nominally through size by Table 12.

Table 12 size group and outer diameter of pipe

Group	1	2	3
Outer Diameter	63~225	>225~630	>630~800

9 MARKING AND STORAGE

9.1 Marking

All pipe should be marked with the following as a minimum:

- Name of firm/trademark (permanent mark);
- Name of product, type, size specification;
- Production date;
- PN;
- The number of standard.

9.2 Storage and transportation

Pipe must not be tossed when loading or unloading. Further, if using a forklift, it must be held from either end and lifted at the centre. Forks may not be used down the length of pipe. Further, the pipe must not be contaminated by any oil or chemical.

During storage, pipe must be kept away from heat and should be housed indoors away from UV exposure. Pipe should not be stored at heights above 2m for the safety of personnel.

Appendix A

Charpy double notched impact strength testing method

A.1 Scope

This appendix it to show how to test UHMWPE pipes using Charpy double notched impact strength testing method

A.2 Equipment

Notched impact strength testing device as dictated by GB/T 1043-1993 standard

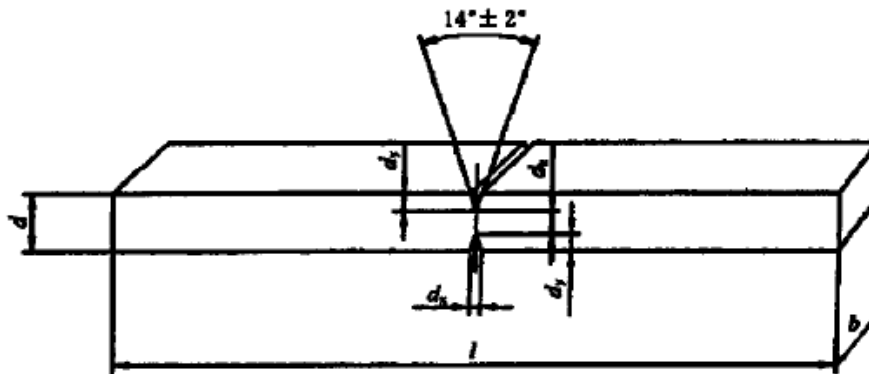
A.3 Sampling

A.3.1 Sampling Shape

Sampling surface must smooth, without bubbles or cracks. Further, it cannot be stratified or appear damaged in any way to the naked eye.

A.3.2 Sampling forms and size

Based on ISO 11542-2: 1998; please see picture A.1 for form and table A.1, 2 for notch depth requirements



Picture A.1 Sampling forms

Table A.1 Sampling type, size

Sampling Type	Length (l)		Width (b)		Thickness (d)		Space of support
	Base size	Tolerance	Base size	Tolerance	Base size	Tolerance	
1	80	±2	10	±0.5	4	±0.5	60
2	120	±2	15	±0.5	10	±0.5	70

P.S.: wall thickness smaller than 12mm use the sampling type 1

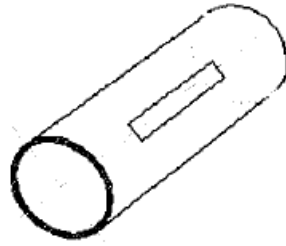
Table A.2 Sampling notch depth

Sampling type 1	Sampling type 2
1	1.3±0.1
2	3±0.1

A.3.3 Sampling preparation

A.3.3.1 Example

The sample must be cut at parallel with the direction with pipe's main axis, see picture A.2.



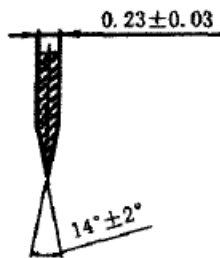
Picture A.2 Sampling method

A.3.3.2 sample and notch preparation

A.3.3.2.1 sample and notch can be processed at milling machine or other specific machining machine. Cutter must not be angled, please see picture A.3.

A.3.3.2.2 It is recommended that the cutter tip line speed is 90m/min - 185m/min, with a feed rate of 10mm/min~130mm/min.

A.3.3.2.3 The cutter's sharpness must be checked, the shape must be consistent with this standard.



Picture A.3 Machining cutter

A.3.4 Sample quantity

Every group sample must not less than 10.

A.4 Charpy double notched impact strength test

A.4.1 Conditions

The samples must be taken at $23 \pm 2^\circ\text{C}$, and used within 24 hours. GB/T 2668-2004

A.4.2 Testing

Based on GB/T 1043-1993 testing.

A.5 Calculating results

A.5.1 To calculate the impact strength α_k (kJ/m²), please use formula A.1 below.

Formula A.1:

$$\alpha_k = \frac{A_k}{b * d_k} * 10^3$$

A_k ----impact energy taken by notch (J);

b ----sample width (mm);

d_k ----notch remaining thickness(mm).

A.5.2 The final result should be an average value derived from the 10 samples

Appendix B

Mortar wear rates testing method

B.1 Scope

This appendix will provide a method for testing UHMWPE pipe mortar worn rates. A test which offers objective results to UHMWPE's supremacy against heavy wear.

B.2 Process

Place a sample of pipe into a vessel with particulates. Spin the sample for a pre-determined time. Check the samples revised size and weight post duress. Comparison against original based on volume provides index.

B.3 Material and reagents

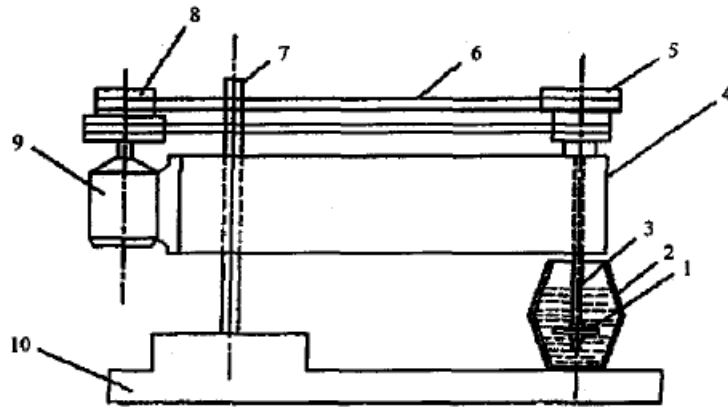
B.3.1 Quartz sand: $\text{SiO}_2 \geq 99\%$; $\text{Fe}_2\text{O}_3 \leq 0.2\%$; heat resistance $> 1600^\circ\text{C}$; granularity: $450\mu\text{m} - 900\mu\text{m}$.

B.3.2 Particulates: combined from quartz sand and water with 3:2 scale

B.3.3 Acetone: analyzed alcohol.

B.4 Equipment

B.4.1 mortar worn testing machine: RPM $(669 \pm 30)\text{r}/\text{min}$, see picture B.1.



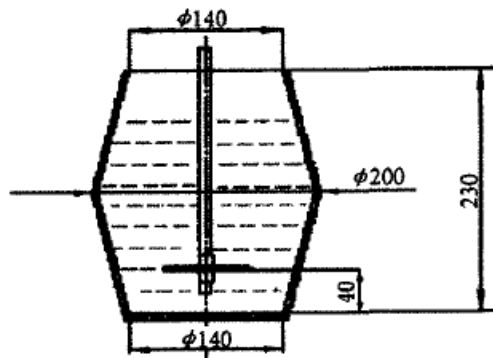
1-sample; 2-vessel; 3-impeller;

4-working deck; 5-pulleys; 6-belt;

7-lifting guide; 8-pulleys; 9-motor; 10-base plate of machine

Picture B.1 mortar worn testing machine schematic diagram

B.4.2 Special clamps and mortar vessels, see picture B.2



Picture B.2 special clamps and center of mortar vessels schematic diagram

B.4.4 Scale: accurate to 0.1mg

B.4.5 Electric blast blower: 0°C - 300 °C.

B.4.6 Blower.

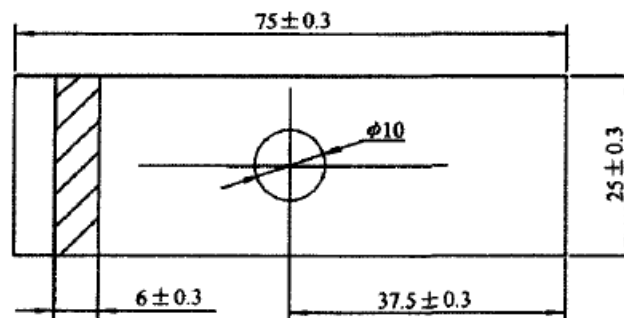
B.4.7 Ultrasonic cleaner

B5 Sampling preparation

B.5.1 Samples taken at a consistent size 76mm X 26mm X 7mm from pipe sections parallel to flow.

B.5.2 Polish the surface with sandpaper until very smooth

B.5.3 Use a minimum of 3 samples per test.



Picture B.3 Sample size

B.6 Method

B.6.1 Flush sample with pure water, using the ultrasonic cleaner wash for 20 min.

B.6.2 Immerse sample in acetone for 20 min.

B.6.3 After immersing sample, dry at 50 deg C for 1 hr.

B.6.4 Use scale to weigh sample before wearing

B.6.5 Put sample into clamps, as per picture B.2, for four hours.

B.6.6 Take out worn out sample, use ultrasonic cleaner wash 20min, then flush with pure water.

B.6.7 Then use acetone solution immerse 20 min.

B.6.8 After immersing dry using the blower ,at 50°C for 1h. Let the material cool to room temperature.

B.6.9 Weigh worn out sample quality, then calculate wear rate.

B.7 Test Result

Wear rates, as a percentage, are to be calculated via B.1:

$$\text{Wear rates} = \frac{m_1 - m_2}{m_1} \times 100 \dots\dots\dots (\text{B.1})$$

m_1 ----quality before worn out (mg);

m_2 ----quality after worn out (mg).

The final rate is to be an average of the three samples used.