SPECIFICATION FOR HIGH DENSITY POLYETHYLENE (HDPE) PIPE & FITTINGS

SPECIFICATION SAJ PS / HDPE / 001

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QUALITY ASSURANCE DEPARTMENT
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This specification is applicable to High Density Polyethylene (HDPE) Pipe for water supply systems and shall conform to the relevant standards listed below:

MS 1058: Part 1: 2005	Polyethylene (PE) Piping System for Water Supply Part 1: General (Fourth Revision)
MS 1058: Part 2: 2005	Polyethylene (PE) Piping System for Water Supply – Part 2: Pipes (Fourth Revision)
MS 1058: Part 3: 2006	Polyethylene (PE) Piping System for Water Supply – Part 3: General (Fourth Revision)
JKR 20200-0053-99	JKR Tender Specification for Polyethylene (PE) Pipe Systems for Water Supply
BS EN 12201-3: 2011+A1:2012	Plastics Piping System for Water Supply and for Drainage and Sewerage Under Pressure
ISO 1133	Plastics – Determination of melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics – Part 1: Standard method
EN 728	Plastics piping and ducting system. Polyolefin pipes and fittings. Determination of oxidation induction time
EN 921	Plastics piping system. Thermoplastics pipes. Determination of resistance to internal pressure at constant temperature.

MATERIAL SPECIFICATION FOR HIGH DENSITY POLYETHYLENE (HDPE) PIPE & FITTINGS

1.0 GENERAL

1.1 This specification is applicable to High Density Polyethylene Pipe for water supply systems and shall conform to MS 1058: Part 1: 2005, MS 1058: Part 2: 2005 and MS 1058: Part 3: 2006, BS EN 12201-3: 2011 and JKR Standard Specification JKR 20200-0053-99.

1.2 These specifications will provide necessary information on the product dimension and requirements for the supply of pipes only.

2.0 MATERIAL

2.1 The High Density Polyethylene (HDPE) Pipe shall be made from base polymer and shall conform to the requirements as specified in MS 1058 Part 1: 2005.

2.2 The base polymer shall be a single grade of polyethylene, PE 100 with a derived density greater than 0.93g/cm^3 tested at 20°C.

2.3 No rework material is allowed to be used for the manufacture of the pipes.

2.4 No additives that can contribute to toxic hazard, impair the fabrication of properties and chemical and physical properties in particular to long term mechanical and strength is allowed.

3.0 COLOUR

3.1 The colour of the pipes shall be black with blue stripes. The material for stripes shall be of the same type of resin as used in the compound for the pipe.

4.0 CLASSIFICATION AND DIMENSION OF PIPES

4.1 All High Density Polyethylene (HDPE) Pipes must be from class PE 100 and minimum strength at 20°C with

4.1.1 Nominal Pressure (PN) 16 and Standard Dimensions Ratio (SDR) 11 shall be use for main pipes sizes from 63mm and above.

4.1.2 Nominal Pressure (PN) 20 and Standard Dimensions Ratio (SDR) 9 shall be use for communication pipes sizes 50mm and below.

4.2 Wall thickness and nominal diameter of PE 100 are given in the table below.

Table 1: Diameter and wall thickness for PE100, PN16 (SDR 11) and PN20 (SDR 9) pipe series

Nominal Diameter for PE Pipes (mm)	PN 16		PN20		Outside Diameter (mm)
	Wall thickness (mm)		Wall thickness (mm)		
	Min	Max	Min	Max	
16	-	-	2.0	2.3	16
20	2.0	2.3	2.3	2.7	20
25	2.3	2.7	3.0	3.4	25
32	3.0	3.4	3.6	4.1	32
40	3.7	4.2	4.5	5.1	40
50	4.6	5.2	5.6	6.3	50
63	5.8	6.5	7.1	8.0	63
75	6.8	7.6	8.4	9.4	75
90	8.2	9.2	10.1	11.3	90
110	10.0	11.1	12.3	13.7	110
125	11.4	12.7	14.0	15.6	125
160	14.6	16.2	17.9	19.8	160
180	16.4	18.2	20.1	22.3	180
200	18.2	20.2	22.4	24.8	200
225	20.5	22.7	25.2	27.9	225
250	22.7	25.1	27.9	30.8	250
280	25.4	28.1	31.3	34.6	280
315	28.6	31.6	35.2	38.9	315
355	32.2	35.6	39.7	43.8	355
400	36.3	40.1	44.7	49.3	400
450	40.9	45.1	50.3	55.5	450
500	45.4	50.1	55.8	61.5	500
560	50.8	56.0	-	-	560
630	57.2	63.1	-	-	630

5.0 TOLERANCE

5.1 The tolerance for wall thickness is determined by the difference between the wall thickness and the nominal wall thickness.

6.0 LENGTH

6.1 The required length of HDPE pipes in coil for nominal diameter 90 mm and below will be 100 m.

6.2 The standard length of HDPE pipes for nominal diameter 110 mm and above shall be 6m, 9 m and 12m.

7.0 APPEARANCE

7.1 The internal diameter and external surfaces of pipes must be smooth, clean and free from scoring, cavities and other surface defects which may affect pipe performance.

7.2 The ends of pipe shall be cut cleanly and square to the axis of the pipe.

7.3 Appearance shall be checked at the point of manufacture.

8.0 TESTING REQUIREMENTS

The pipe suppliers shall, as and when requested by the purchasers, furnish results carried out in accordance with requirements of MS 1058: 2005.

8.1 Physical Characteristics

8.1.1 Melt Mass-Flow Rate

Melt Mass-Flow Rate (MFR) are typically used in Quality Control and Production Control laboratory. The basic procedure foresees a manual timing, cutting and weighing of the extruded material, giving directly a value of MFR. The MFR testing shall be in accordance with ISO 1133. The requirements of the testing can be referred in Table 2 below.

Table 2: Melt Mass-Flow Rate testing requirements

Characteristics	Requirements	Test parameters	
Melt Mass-Flow Rate **MFR for PE 100**	Change of MFR by processing ± 20%	Load	5.0 kg
		Test temperature	190°C
		Time	10 minutes
		Number of test pieces	Shall conform to ISO 1133

1. A small amount around 4 to 5 grams of polyethylene is loaded in the specially designed apparatus. A die with an opening of typically around 2 mm diameter is inserted into the apparatus.
2. The material is packed properly inside the barrel to avoid formation of air. A piston is introduced which acts as the medium that causes extrusion of the molten polyethylene.
3. The sample is heated for 5 minutes at 190°C. After the sample is heated a specified weight (5.0 kg) is introduced onto the piston.
4. The weight exerts a force on the molten polyethylene and it immediately starts flowing through the die.
5. A sample of the melt is taken after the desired period of time and is weighed accurately.
6. Melt flow rate values are calculated in g/10min.

Calculation of Melt Flow Rate = (600/t(sec) x mass of extrudate in grams)
t = time of extrudate in seconds

Figure 1: Melt Mass-Flow Rate Equipments

8.1.2 Oxidation Induction Time

Oxidation induction time testing shall be conducted by accordance to EN 728 as shown in Table 3. The samples of polyethylene are heated up under a nitrogen atmosphere, typically to 200°C. Oxygen is then introduced to the sample cell, and the length of time before the onset of degradation is measured. A distortion should not occur for at least 40 minutes since the start of the test. OIT is a sensitive measure of the level of anti-oxidative additives within the material. During the testing, no failure during the test period of any test pieces.

Table 3: Oxidation Induction Time testing requirements

Characteristics	Requirements	Test parameters	
Oxidation Induction Time	≥ 40 min	Test temperature	200°C
		Number of test pieces	3

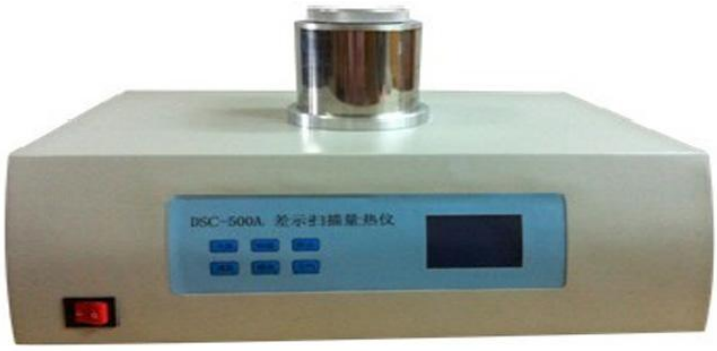


Figure 2: Oxidation Induction Time Tester

8.2 Mechanical characteristics

Table 4 shows the test parameter and requirements of mechanical characteristics of the pipe tested. The test shall conform to EN 921.

Table 4: Mechanical testing requirements

Characteristics	Requirements	Test parameters		Test method
		Parameters	Value	
Hydrostatic strength at 20°C	No failure during the test period of any test pieces	End caps	Type a)[a]	EN 921
		Conditioning period	Shall conform to EN 921	
		Number of test pieces[b]	3	
		Type of test	Water-in-water	
		Test temperature	20°C	
		Test period	100h	
		Circumferential (hoop) stress for: PE100	12.4MPa	
Hydrostatic strength at 80°C	No failure during the test period of any test pieces	End caps	Type a)[a]	EN 921
		Conditioning period	Shall conform to EN 921	
		Number of test pieces[b]	3	
		Type of test	Water-in-water	
		Test temperature	80°C	
		Test period	165h	
		Circumferential (hoop) stress for: PE100	5.4MPa	
Hydrostatic strength at 80°C	No failure during the test period of any test pieces	End caps	Type a)[a]	EN 921
		Conditioning period	Shall conform to EN 921	
		Number of test pieces[b]	3	
		Type of test	Water-in-water	
		Test temperature	80°C	
		Test period	1000h	
		Circumferential (hoop) stress for: PE100	5.0MPa	

[a] Type b) end caps may be used for batch release tests for diameters ≥ 500mm.
[b] The number of test pieces given indicates the quantity required to establish a value for the characteristic described in the table. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan (for guidance see MS 1058 Part 7 [3]).
[c] Premature ductile failures are not taken into account. For retest procedure see 7.3.

8.3 Geometrical characteristics

Several testing are conducted to ensure that the final pipe product complies to the applicable specification.

8.3.1 Outside Diameter (OD) and Internal Diameter (ID) and their tolerances

The outside diameter and internal diameter shall be in accordance with Table 1.

8.3.2 Wall thickness and their tolerances

The wall thickness shall be in accordance with Table 1.

8.3.3 Mean outside diameter and out-of-roundness (ovality)

The maximum out-of-roundness (ovality) is measured as the semi-major axis (longest diameter) minus the semi-minor axis (shortest diameter) of the pipe.

The mean outside diameters, d_{em}, and the out-of-roundness (ovality) shall be in accordance with Table 5. All dimension are in millimeters (mm).

Table 5: Mean outside diameters and out-of-roundness

Nominal size DN/OD	Nominal outside diameter, d_n	Mean outside diameter		Maximum out-of-roundaness (ovality) [b]
		d_{em}, minimum	d_{em}, maximum [a]	
16	16	16.0	16.3	1.2
20	20	20.0	20.3	1.2
25	25	25.0	25.3	1.2
32	32	32.0	32.3	1.3
40	40	40.0	40.4	1.4
50	50	50.0	50.4	1.4
63	63	63.0	63.4	1.5
73	73	75.0	75.5	1.6
90	90	90.0	90.6	1.8
110	110	110.0	110.7	2.2
125	125	125.0	125.8	2.5
140	140	140.0	140.9	2.8
160	160	160.0	161.0	3.2
180	180	180.0	181.0	3.6
200	200	200.0	201.2	4.0
225	225	225.0	226.4	4.5
250	250	250.0	251.5	5.0
280	280	280.0	281.7	9.8
315	315	315.0	316.9	11.1
355	355	355.0	357.2	12.5
400	400	400.0	402.4	14.0
450	450	450.0	452.7	15.6
500	500	500.0	503.0	17.5
560	560	560.0	563.4	19.6
630	630	630.0	633.8	22.1
710	710	710.0	716.4	-
800	800	800.0	807.2	-
900	900	900.0	908.1	-
1000	1000	1000.0	1009.0	-
1200	1200	1200.0	1210.8[c]	-
1400	1400	1400.0	1412.6[c]	-
1600	1600	1600.0	1614.4[c]	-

9.0 MARKINGS OF PIPES

The markings shall be marked at every 1m of the pipe. All pipes must be showing the markings with at least the following information:

a) 'HDPE' letters
b) Month and year of manufacture
c) Brand
d) Nominal diameter
e) Minimum wall thickness
f) The material grade (PE100)
g) Nominal Pressure (PN)
h) Standard reference
i) Serial number
j) Initial 'SAJ' in capital letter

10.0 PIPE FITTINGS

10.1 HDPE Fittings

HDPE fittings shall have a pressure rating equal to the pipe. For communication pipe (sizes 50mm and below), the use of pressure rating PN20 fittings shall be use. While, for main pipe (sizes 63mm and above) pressure rating of PN16 shall be use.

Figure 3 shows the HDPE fittings used for electro-fusion and butt-fusion jointing method. Table 6 below tabulated the pressure rating used for pipes and fittings.

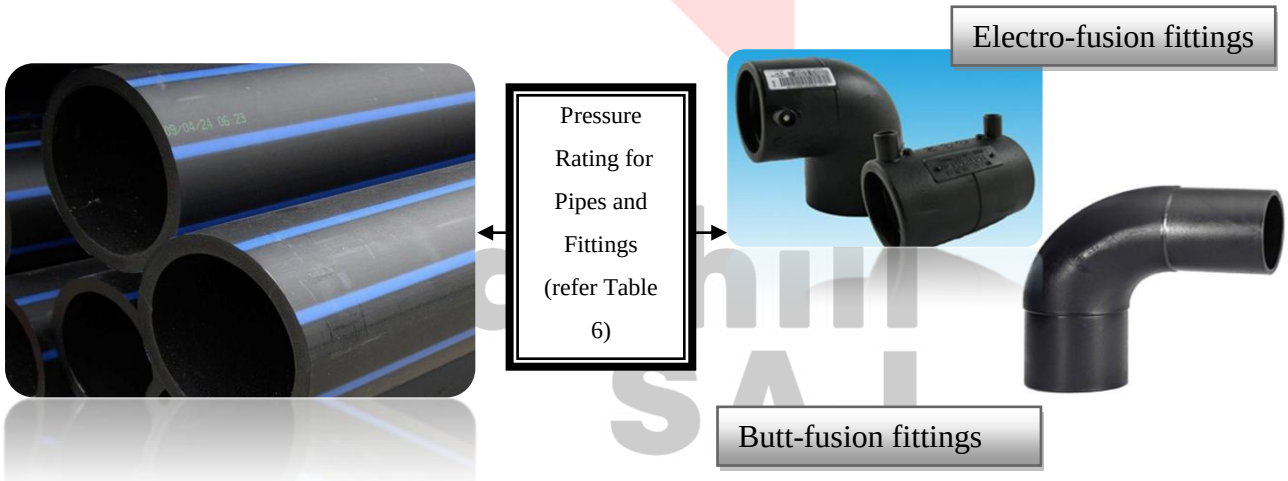


Figure 3: HDPE Fittings

Table 6: Pressure rating for pipes and fittings

Pressure Rating / Nominal Pressure	PN16 (for 63mm and above)		PN20 (for 50mm and below)	
	Pipes	Fittings	Pipes	Fittings
PN16	✓	✓	-	-
PN20	-	-	✓	✓

10.2 Electro-fusion Fittings

Electro-fusion fittings consists of straight coupler, reducing coupler, elbow/bend, transition adaptor, saddle and etc. Figure 4 below shows the various types of electro-fusion fittings that available for electro-fusion jointing method.

Figure 4: Electro-fusion fittings

10.3 Butt-fusion Fittings

Figure 5 shows the butt-fusion fittings available in market for butt-fusion jointing method.

Figure 5: Butt fusion fittings

11.0 HDPE PIPE JOINTING

11.1 Electro-fusion Jointing

The effectiveness of electro-fusion jointing depends on attention to preparation of the jointing surfaces and the geometry of the assembly, in particular the removal of the oxidized surface of the pipe over the socket depth or saddle mounting area, ensuring the jointing surfaces are clean and free from contamination, and the assembly and clamping instructions are correctly followed.

A good practice of fusion preparation is as follows:

1. Rectangular cut of pipe ends
2. Roughly cleaning of jointing area
3. Marking of peeling area
4. Scrapping the fusion zone
5. Cleaning of prepared area
6. Marking of insertion depth
7. Mounting of components such as coupler and saddle
8. Fusion process
9. Cooling time
10. Records

11.1.1 Electro-fusion design requirements

The design of the heating coil zone has a direct impact on the quality of the connection. Table 7 shows the penetration depth and fusion zone length by according to each nominal diameter as tabulated in MS 1053: Part 3: 2006 and BS EN 12201-3.

Table 7: Electro fusion socket dimension

Nominal Diameter of the Fitting, d_n (mm)	Penetration depth (mm)	Fusion zone length (mm)
20	41	≥ 10
25	41	≥ 10
32	44	≥ 10
40	49	≥ 10
50	55	≥ 10
63	63	≥ 11
75	70	≥ 12
90	79	≥ 13
110	82	≥ 15
125	87	≥ 16
140	92	≥ 18
160	98	≥ 20
180	105	≥ 21
200	112	≥ 23
225	120	≥ 26
250	129	≥ 33
280	139	≥ 35
315	150	≥ 39
355	164	≥ 42
400	179	≥ 47
450	195	≥ 51
500	212	≥ 56
560	235	≥ 61
630	255	≥ 67

The longer the fusion zone, i.e. the area actually available for the homogenous material connection, the greater the processing safety in rough construction site conditions and by extension the long-term tightness of the pipe connection.

11.2 Butt fusion Jointing

Butt fusion is a process of welding HDPE pipes and fittings using an electrically heated plate. It is suitable for jointing a straight pipe. However, only pipes and fittings of the same material type, size and rating shall be butt welded.

The process of butt fusion jointing consists of:

a) Preparation of equipment
b) Setting up
c) Trimming
d) Bead up
e) Heat soak
f) Plate removal
g) Fusion jointing
h) Cooling
i) Debeading
j) Records
k) Maintenance, service and calibration

12.0 STORAGE

All materials should be carefully inspected at the time of delivery and any defective material set-aside before accepting the delivery into stores. The defective materials should be returned to the suppliers immediately.

Pipes and fittings should be used in the order of delivery to ensure the correct rotation of stock.

12.1 Storage at for Pipes

All pipe stacks should be made on sufficiently firm, flat ground to support the weight of the pipes and any necessary lifting equipment. Stacking heights should be generally be kept to a minimum and adequate space allocated for lifting machinery to maneuver without causing accidental damage.

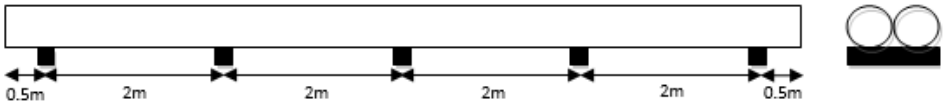
At all times pipes should be stored away from exhaust outlets and all other high temperature sources. Care should be taken to avoid contact with lubricating or hydraulic oils, gasoline, solvents and other aggressive chemicals.

Great care shall be exercised to ensure that the pipes and specials are not subject to any kind of shock or sudden load during hauling and handling.

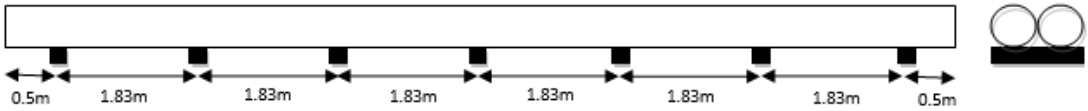
All pipes and pipe specials shall be lifted by means of reinforced canvas slings. For pipe length greater than 6 m, the pipe shall be lifted by crane using spreader beam and suitable slings. Chains or end hooks should not be used. Care should be taken to avoid damage to pipes and pipe ends during lifting. On no account shall the pipes and specials be dropped or let fall onto the ground.

The pipe shall be stacked and supported on wooden saddles and shall be firmly held in position at each wooden saddles by straps tightened by turnbuckles in such a manner that the external coating is not damaged as shown in Figure 6 (example for 6m, 9m and 12m length of pipes). Two saddles shall be placed 0.5m from each end of pipes and approximately maximum 2m spacing under the rest of the pipes. The spacing of the saddles shall be not more than 2m.

(a) Saddle spacing for 6m length pipe



(b) Saddle spacing for 9m length pipe



(c) Saddle spacing for 12m length pipe

Figure 6: Saddle as pipe support

When the pipes are properly stacked, the pipes shall be covered with canvas at the top in order to protect the pipes from hot temperature and to ensure the safety of the pipe. Besides that, end caps also shall be installed at the ends of each pipe to ensure that there is no soils, rubbish and etc. remains in the pipe. The contractor shall make sure the pipe is in clean condition before, during and after pipe laying.

For similar reasons, pipe coils should be stored flat and the number of coils per stack should be limited to:

- 7 coils for 20mm pipe
- 6 coils for 25mm pipe
- 5 coils for 32mm pipe
- 4 coils for 50mm pipe
- 3 coils for 63mm pipe
- 2 coils for 90mm pipe

Where the individual pipe lengths are stacked in pyramidal fashion, deformation may occur in the lower layers. Such stacks should therefore be not greater than 1m high as shown in Figure 7.

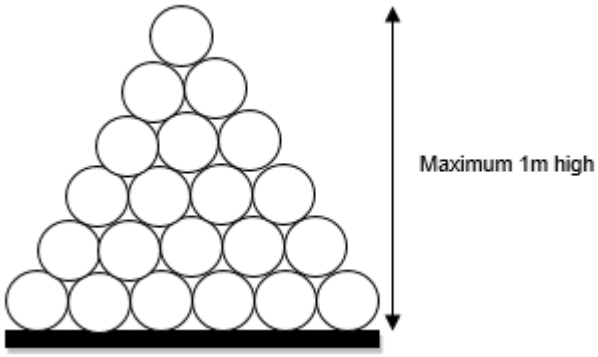


Figure 7: Individual pipe storage

12.2 Storage for Fittings

Electro-fusion fittings should be stored under cover, preferably on racking and in the manufacturer's protective wrapping or cartons which should be kept intact until the fitting is required for use except spigot fittings. Each electro-fusion fittings generally supplied in a protective wrapping and packed in cardboard boxes.

At all times fittings should be stored away from exhaust outlets and all other high temperature sources. Care should be taken to avoid contact with lubricating or hydraulic oils, gasoline, solvents and other aggressive chemicals.

12.3 Storage for Tools

All special tool and equipment associated with the jointing of pipes and fittings should be stored separately and securely until they are required for use.

13.0 PRE-DELIVERY INSPECTION AND EVALUATION

13.1 It is the responsibility of the tenderer to inform SAJ for inspection purposes during manufacturing and before delivery.

13.2 SAJ reserve the right to inspect and witness the testing of product offered.

13.3 At any time, when requested, the supplier is to provide SAJ a sample of the product offered for evaluation purposes. All costs shall be borne by the supplier.

13.4 If at any time the supplier fails to deliver the required sample, the product is deemed fail to meet the specifications.

14.0 CERTIFICATION

14.1 Manufacturer or supplier are required to provide a copy of certificate of analysis of raw material to SAJ.

14.2 Manufacturer or supplier are required to provide a copy of certificate of analysis of pipes for every batch to SAJ.

14.3 Manufacturer of supplier are required to provide a copy of certificate and testing report from SIRIM, IKRAM or other recognized certification body to SAJ.

14.4 Manufacturer or supplier are required to provide a copy of SPAN's registration certificate for each product to be supplied separately. (i.e. pipes and fittings) to SAJ.

14.5 SAJ have the right to refuse offer or reject supply if the documents required are not enclosed.