The tested value of MFR shall be within

Table 2 Characteristics of the PE Compound in Granules Form

(*Clauses* 5.1 *and* 5.7)

Sl No.	Characteristics	Unit	Requirements	Test Parameters	Test Method
(1)	(2)	(3)	(4)	(5)	(6)
i)	Conventional density (of base polymer)	kg/m³	≥ 930	23 °C	IS 7328
ii)	Melt flow rate (MFR)	g/10 min	0.20 ≤ MFR ≤ 1.40 ~~Maximum deviation of~~ ± 20 percent of the nominated value declared by the compound manufacturer	190 °C/5.0 kg	IS 2530
iii)	Thermal stability (oxidation induction time)	min	≥ 20	200 °C	Annex B of IS 4984
iv)	Volatile content	mg/kg	≤ 350	Number of test pieces = 01	Annex C of IS 4984
v)	Water content[1)]	mg/kg	≤ 300 (equivalent to < 0.03 percent by mass)	Number of test pieces = 01	Annex D of IS 4984
vi)	Pigment dispersion	Grade	≤ 3		Annex A

[1)] This requirement is only applicable if the measured volatile content is not in conformity to the specified requirement. In case of dispute, the requirement for water content shall apply. The requirement applies to the compound producer at the stage of compound manufacturing and to the compound user at the stage of processing. (If the water content exceeds the limit specified, drying is required prior to use.)

Table 3 Characteristics of the PE Compound in Pipe Form

(*Clauses* 5.1 *and* 5.7)

Sl No.	Characteristics	Unit	Requirements	Test Parameters	Test Method
(1)	(2)	(3)	(4)	(5)	(6)
i)	Resistance to gas condensate	–	No failure during the test period of the test piece	*Test Temperature* = 80 °C *Test Period* = 20 h, *Min*	**5.5**
ii)	Resistance to weathering	–	**5.6**	**5.6**	**5.6**
iii)	Tensile properties				
	a) Tensile yield strength, *Min*	MPa	15	23 °C	**8.8**
	b) Elongation at break, *Min*	percent	350	23 °C	**8.8**
iv)	Resistance to slow crack growth rate (hydraulic characteristics of notched test pieces for pipes of size more than 63 mm)		No failure during the test period of the test piece	*Test Temperature* = 80 °C *Internal Test Pressure:* PE 80 = 0.8 MPa PE 100 = 0.92 MPa *Test Period* = 500 h, *Min* Test pieces to be prepared as per Annex J of IS 4984 from SDR 11/110 mm nominal dia pipes	Annex E of IS 4984

NOTE — PE compound supplier shall also provide test results for conformity to resistance to rapid crack propagation as per ISO 4437-1 : 2014 'Plastic piping systems for the supply of gaseous fuels – Polyethylene (PE) – Part 1: General' for each individual lot or batch of compound received by the pipe manufacturer. The pipe manufacturer shall obtain from the PE compound supplier, the test results for the above test carried out on the highest wall thickness of the pipes being manufactured by him.

Table 9 Test Requirements for Internal Pressure Creep Rupture Test for Plain Pipes

(*Clause* 8.1)

SI No.	Test Temperature °C	Test Duration h	Induced Stress MPa		Frequency
			PE 80	PE 100	
(1)	(2)	(3)	(4)	(5)	(6)
Type tests					
i)	20	100	9.0	12.0	Once in two years
ii)	80	1 000	4.0	5.0	Once in four years
Acceptance tests					
iii)	80	165	4.5	5.4	As per Table 14

8.2 Reversion Test

8.2.1 *Longitudinal Reversion*

When tested according to the procedure given in Annex F of IS 4984, the value of longitudinal reversion shall not be greater than 3 percent.

8.2.2 *Circumferential Reversion of Pipes with $d_n \geq 250$ mm*

The circumferential reversion of pipes with d_n equal to or greater than 250 mm shall be determined between 24 h and 48 h after manufacture and after conditioning in water at 80 °C. The minimum conditioning period for various wall thicknesses of pipes shall be as given in Table 10. The pipe test pieces shall be $3d_n$ in length. With the test piece at (27 ± 2) °C, circumferential measurements shall be taken to establish d_o at a distance of $0.1d_n$ and $1.0\ d_n$, respectively, from the end of the test piece and reported as $d_{o,\ 0.1\ d_n}$ and $d_{o,\ 1.0\ d_n}$. The difference between $d_{o,\ 0.1\ d_n}$ and $d_{o,\ 1.0\ d_n}$ shall not be greater than the tolerance range on mean outside diameter as specified in Table 4.

NOTE — Circumferential reversion or "tow-in" of the pipe end is created by the residual stress of the pipes during extrusion. This results in a small reduction of diameter at the cut end of the pipes.

Table 10 Conditioning Periods

(*Clause* 8.2.2)

Sl No.	Thickness, e_{min} mm	Minimum Conditioning Period *h*
(1)	(2)	(3)
i)	$3 \leq e_{min} < 8$	3
ii)	$8 \leq e_{min} < 16$	6

NOTE — It is recognized that extended conditioning periods beyond those specified in Table 10 could influence the test results.

8.3 Density

When tested from a composite sample of minimum of 3 pipes as per IS 7328, the base density of the pipe shall be ≥ 930 kg/m^3 at 23 °C.

8.4 Melt Flow Rate (MFR)

When tested from a composite sample of minimum three pipes as per IS 2530 at 190 °C with normal load of 5 kgf, MFR of the pipe material shall not deviate from the MFR of the resin by more than 20 percent of the value specified by the compound manufacture.

8.5 Pigment Dispersion

When tested from a composite sample of minimum three pipes, in accordance with Annex A, the grading shall be ≤ 3.

8.6 Thermal Stability (Oxidation Induction Time)

The minimum oxidation induction time (OIT) of the pipe when tested in accordance with the method given in Annex B of IS 4984 shall be not less than 20 min.

8.7 Volatile Matter Content

When tested in accordance with Annex C of IS 4984, the value of volatile matter content shall be not more than 350 mg/kg.

8.8 Tensile Properties (Tensile Yield Strength and Elongation at Break)

When tested in accordance with Annex H of IS 4984 and with test parameters as per Table 6 of IS 4984, however, the conditioning temperature and temperature of testing being 23 ± 1 °C, the yield stress and elongation at break shall be as follows:

a) Yield stress = 15 MPa, *Min*; and

b) Elongation at break = 350 percent, *Min*.

8.9 Resistance to Weathering

After exposure to sunlight in accordance with Annex B, pipes shall comply with the requirements given in **5.6**.

8.10 Slow Crack Growth Rate Test

8.10.1 When subjected to test parameters as given below and tested in accordance with the procedure given in Annex E of IS 4984, the notched test specimens prepared from 110 mm SDR 11 pipe in accordance with Annex J of IS 4984 shall show no signs of localized swelling, leakage or weeping and shall not burst during the prescribed test period.

Sl No.	*Test Temperature* °C	*Test Duration* h	*Internal Test Pressure, Min (or Induced Hoop Stress, Min)* MPa	
			PE 80	PE 100
(1)	(2)	(3)	(4)	(5)
i)	80 ± 1	165	0.8 (4.0)	0.92 (4.6)
ii)	80 ± 1	500	0.8 (4.0)	0.92 (4.6)

8.10.1.1 If 110 mm SDR 11 pipes are not being manufactured, the test shall be carried out on the nearest higher size SDR 11 pipe being manufactured with test parameters as given in **8.10.1**.

ANNEX A

(*Table* 2 *and Clause* 8.5)

ASSESSMENT OF PIGMENT DISPERSION IN POLYOLEFIN PIPES AND FITTINGS BY MICROTOME METHOD

A-1 GENERAL

This Annex describes the method for the assessment of pigment dispersion in polyolefin pipes and fittings.

A-2 PRINCIPL E

A microtomed section of material is examined by transmitted light at a magnification of X 100 and compared against standard photomicrographs.

A-3 APPARATUS

A-3.1 A Microtome

A-3.2 A Microscope, of at least X 100 linear magnification and circular field of view of 0.7 ± 0.07 mm diameter set for transmitted light.

A-3.3 Microscope Slides and Cover Slips

A-4 TEST PIECE

Microtome section 10 µm to 20 µm thick shall be cut from a cross-section of the pipe or fitting. They shall have an area of approximately 7.0 mm^2.

Six test pieces shall be taken from different parts of the cross-section.

NOTE — It is often easier to take microtome sections if the pipe or fitting has been cooled to below room temperature.

A-5 PROCEDURE

Place the pieces on a microscope slide so that each one is equidistant from its neighbour(s) and from adjacent edge(s) of the slide and cover with Canada balsam before placing a coverslip over the test pieces. Examine the six test pieces in turn through the microscope at a linear magnification of X 100 ± 10. Scan the whole of each test piece and compare the worst field of view of each with the standard photomicrographs numbered 1 to 6 in Fig. 1.

Assign to each of the six test pieces a numerical rating corresponding to the number of the photomicrograph equivalent to the worst field of view of each test piece.

A-6 EXPRESSION OF RESULTS

Record the rating of each test piece as per Fig. 1.

A-7 TEST REPORT

The test report shall include the following:

a) Full identification of pipe or fitting from which the test pieces were taken;

b) The individual rating of each test piece; and

c) The date of testing.

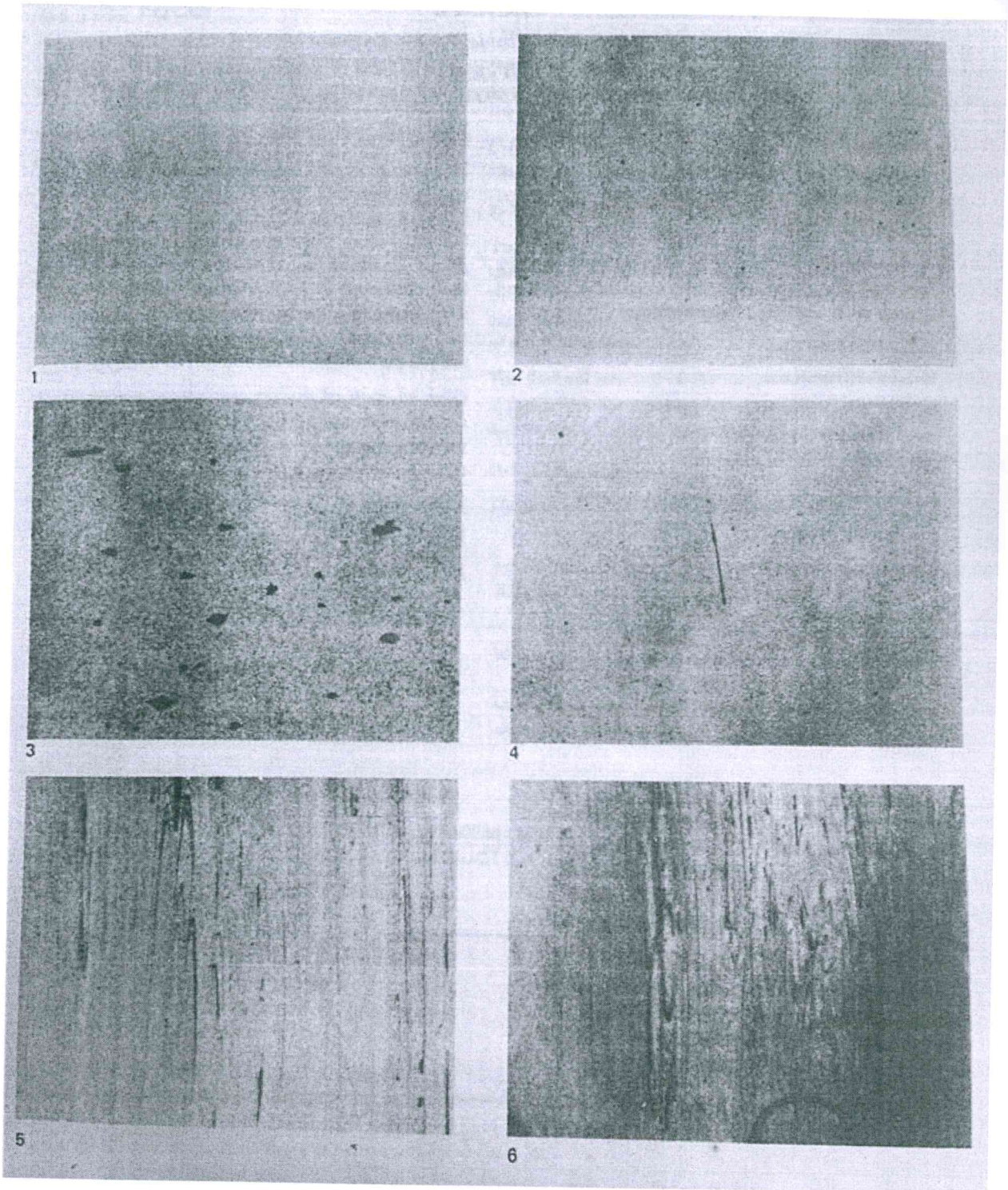

FIG. 1 PIGMENT DISPERSION PICTOMICROGRAPHS (GRADES 1 TO 6)

Pub
Replace the figure with the one provided through email on 10 Feb 2022

ANNEX B

(*Clauses* 5.6 *and* 8.9)

RESISTANCE TO WEATHERING

B-1 The equipment shall be capable of supporting specimen of pipe, such that the exposed surface of the specimen shall be at 45° to the horizontal with the upper end pointing to the north and the exposed surface to the south.

B-2 The size of the apparatus and the distance between the specimens shall be such that no shadow fall across the specimens for the period of at least 8 h during which the sun is normally the strongest.

B-3 The specimen shall be approximately 1 m long pipe and shall normally be selected from those having the thinnest wall for the size to be tested. The test pieces shall be taken from the outside surface of the pipe after removing the upper 0.2 mm layer.

B-4 The pipe sample shall be exposed for a period of two years.

B-5 After weathering exposure, the sample shall be tested as per **5.6**.

ANNEX C

(*Clause* 8.11)

TEST METHOD FOR THE RESISTANCE TO INTERNAL PRESSURE AFTER APPLICATION OF SQUEEZE-OFF

C-1 GENERAL

This standard specifies a method for determining the resistance to internal pressure of polyethylene (PE) pipes after being subjected to squeeze-off procedure.

C-2 PRINCIPLE

A polyethylene (PE) pipe, conditioned to 0 °C, is squeezed between two parallel circular-section bars located at right angles to the pipe centreline, at a position mid-way between the pipe ends. The squeeze is subsequently released after an appropriate time period. The pipe is then subjected to a hydrostatic strength test at 80 °C.

NOTE — The technique of squeeze-off is used to restrict the flow of fluid in PE piping systems whilst effecting maintenance and repair operations. The test described herein may be used to assess the effect of squeeze-off on the strength of pipes.

C-3 APPARATUS

C-3.1 Squeeze-off equipment, comprising compressive loading device with a combination of a fixed bar and a movable bar contained within a framework designed to withstand the forces generated by the squeeze-off action.

Each bar shall have a circular cross-section having sufficient rigidity to ensure a uniform separation between and along the bars in the course of squeeze-off. Each bar shall have the same diameter which shall be not less than the applicable minimum value given in Table 15.

The movable bar may be hydraulically or mechanically operated to achieve the applicable level of squeeze-off given in Table 15.

Table 15 Squeeze-off Levels

(*Clauses* C-3.1 *and* C-5.1)

Sl No.	Nominal Outside Diameter, d_n	Minimum Bar Diameter	Squeeze-off Level, L
	mm	mm	percent[1)]
(1)	(2)	(3)	(4)
i)	$d_n \leq 63$	25.0	80
ii)	$63 < d_n \leq 250$	38.0	80
iii)	$250 < d_n \leq 400$	50.0	90

[1)] The squeeze-off level, L, is the percentage ratio of the distance between the squeeze-off bars, in millimetres, and twice the specified minimum wall thickness of the pipe, e_{min}, in millimetres.

Means shall be provided for the measurement and maintenance of the bar displacement to within ± 0.2 mm of the required squeeze-off level, L during the squeeze-off phase.

C-3.2 Temperature conditioning apparatus, capable of establishing and maintaining the test piece temperature (before squeeze-off) at (0 ± 1.5) °C.