IS 14333 (1996): High density polyethylene pipe for sewerage - [CED 50: Civil Engineering]

REAFFIRMED 2005

IS 14333 : 1996

भारतीय मानक

मलक जल व्यवस्था के लिए उच्च घनत्व वाले पालिएथिलीन पाइप — विशिष्टि

Indian Standard

HIGH DENSITY POLYETHYLENE PIPES FOR SEWERAGE — SPECIFICATION

ICS 23.040 : 13.060.30

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

March 1996 Price Group 11

AMENDMENT NO. 2 SEPTEMBER 2003
TO
IS 14333 : 1996 HIGH DENSITY POLYETHYLENE PIPES FOR SEWERAGE — SPECIFICATION

(*Page* 1, *clause* **5.1.2**, *lines* 1 *and* 2) — Substitute '940.0 kg/m^3 and 958.0 kg/m^3' *for* '940.5 kg/m^3 and 946.4 kg/m^3'.

(*Page* 1, *clause* **5.1.3**, *line* 2) — Substitute '0.20 and 1.10' for '0.41 and 1.10'.

(CED 50)

Reprography Unit, BIS, New Delhi, India

AMENDMENT NO. 3 DECEMBER 2004
TO
IS 14333 : 1996 HIGH DENSITY POLYETHYLENE PIPES FOR SEWERAGE — SPECIFICATION

(*Page* 1, *clause* **5.1**, *first para*) — Substitute the following for the existing:

'High density polyethylene (HDPE) used for the manufacture of pipes shall conform to designation PEEWA-45-T-003 or PEEWA-45-T-006 or PEEWA-50-T-003 or PEEWA-50-T-006 or PEEWA-57-T-003 or PEEWA-57-T-006 of IS 7328. HDPE conforming to designation PEEWA-45-T-012 or PEEWA-50-T-012 or PEEWA-57-T-012 of IS 7328 may also be used with the exception that melt flow rating (MFR) shall be between 0.20 g/10 min to 1.10 g/10 min (both inclusive). '

[*Page* 1, *clause* **5.1.2**, *line* 2 (*see also Amendment No.* 2)] — Substitute '958.4' *for* '958.0'.

[*Page* 1, *clause* **5.1.3**, *line* 2 (*see also Amendment No.* 2)] — Substitute '0.20 g/10 min and 1.10 g/10 min' *for* '0.20 and 1.10'.

(*Page* 3, *clause* **8.4**) — Substitute the following for the existing:

'When tested from a composite sample of minimum three pipes, as per IS 2530, at 190°C with nominal load of 5 kgf, MFR shall be between 0.20 g/10 min to 1.10 g/10 minutes. The MFR shall also be within 30 percent of the MFR of the material used in manufacturing pipes (*see* **5.1.3**).'

[*Page* 5, *Annex* A, *clause* **A-1** (*see also Amendment No.* 1)] — Substitute the following for the existing:

'With the advancement in technology natural (unpigmented) resin designation PEEAA-45-T-003 or PEEAA-45-T-006 or PEEAA-50-T-003 or PEEAA-50-T-006 or PEEAA-57-T-003 or PEEAA-57-T-006 of IS 7328 and PEEAA-45-T-012 or PEEAA-50-T-012 or PEEAA-57-T-012 of IS 7328 with the exception that melt flow rating (MFR) shall be between 0.20 g/10 min to 1.10 g/10 min (both inclusive) duly stabilized with antioxidants (*see* **5.2**) may be compounded with suitable black master batch or processed directly after physical mixing with suitable black master batch in the pipe extruder for production of pipe which shall conform to the performance requirements of the pipes as specified in this standard (*see* **8**). The material of pipe to be produced shall conform to requirements of **5.1**.'

(CED 50)

Reprography Unit, BIS, New Delhi, India

AMENDMENT NO. 4 JANUARY 2009
TO
IS 14333 : 1996 HIGH DENSITY POLYETHYLENE PIPES FOR SEWERAGE — SPECIFICATION

(*Page* 2, *Table* 1, *col* 1 *to* 4) — Insert the following new values at the end:

Table 1 Outside Diameter, Tolerance and Ovality of Pipes
(*Clause* 6.1)

Nominal Diameter DN	Outside Diameter mm	Tolerance mm (only positive tolerances)	Ovality mm
(1)	(2)	(3)	(4)
710	710.0	6.4	24.9
800	800.0	7.2	28.0
900	900.0	8.1	31.5
1 000	1 000.0	9.0	35.0

(CED 50)

Reprography Unit, BIS, New Delhi, India

Indian Standard

HIGH DENSITY POLYETHYLENE PIPES FOR SEWERAGE — SPECIFICATION

1 SCOPE

This standard lays down the requirements for high density polyethylene pipes from 63 mm to 630 mm nominal diameter of pressure rating from 0·25 MPa to 1·0 MPa for sewerage applications.

2 REFERENCES

The Indian Standards listed below are necessary adjuncts to this standard:

IS No.	*Title*
2530 : 1963	Method of test for polyethylene moulding materials and polyethylene compounds
4905 : 1968	Methods for random sampling
7328 : 1992	High density polyethylene materials for moulding and extrusion (*first revision*)

3 DESIGNATION

3.1 Pipes shall be designated according to the pressure rating (*see* **3.2**) and nominal diameter (*see* **3.3**). For example, PN 10 DN 200 indicates a pipe having a pressure rating 1·0 MPa and outside nominal diameter 200 mm.

3.2 Pressure Rating

Pipes shall be classified by pressure rating (PN) as follows:

Pressure Rating of Pipe	*Maximum Permissible Working Pressure*, MPa
PN 2·5	0·25
PN 4	0·40
PN 6	0·60
PN 10	1·00

3.3 Nominal Diameter (DN)

The nominal diameter of pipes covered in this standard are:

63, 75, 90, 110, 125, 140, 160, 180, 200, 225, 250, 280, 315, 355, 400, 450, 500, 560 and 630 mm.

4 COLOUR

The colour of the pipe shall be black.

5 MATERIALS

5.1 High Density Polyethylene

High density polyethylene (HDPE) used for the manufacture of pipes shall conform to designation PEEWA-45-T-006 of IS 7328 : 1992. HDPE conforming to designation PEEWA-45-T-012 of IS 7328 : 1992 may also be used with the exception that melt flow rate (MFR) shall not exceed 1·10 g/10 min (*see* **A-1**).

5.1.1 The MRS (Minimum Required Strength) of the material used should not be lower than 6·3 MPa at 20°C at 50 years. A conformity certificate from the manufacturer of the resin shall be obtained to this effect.

5.1.2 The specified base density between 940.5 kg/m³ and 946.4 kg/m³ (both inclusive) shall be determined at 27°C according to procedure prescribed in Annex A of IS 7328 : 1992. The value of the density shall also not differ from the nominal value by more than 3 kg/m³ as per **5.2.1.1** of IS 7328 : 1992.

5.1.3 The MFR of the material shall be between 0·41 and 1·10 (both inclusive) when tested at 190°C with nominal load of 5 kgf as determined by method prescribed in 7 of IS 2530 : 1963. The MFR of the material shall also be within ±20 percent of the value declared by the manufacturer.

5.1.4 The resin shall be compounded with carbon black. The carbon black content in the material shall be within 2·5 ± 0·5 percent and the dispersion of carbon black shall be satisfactory when tested according to the procedure described in IS 2530 : 1963.

5.2 Anti-Oxidant

The percentage of anti-oxidant used shall not be more than 0·3 percent by mass of finished resin.

5.3 Reworked Material

The addition of not more than 10 percent of the manufacturer's own rework material resulting from the manufacture of pipes of this standard is permissible. No other reworked or recycled material shall be used.

6 DIMENSIONS OF PIPES

6.1 Outside Diameter

The outside diameters of pipes, tolerance on the same and ovality of pipe shall be as given in Table 1 (*see* A-2).

Table 1 Outside Diameter, Tolerance and Ovality of Pipes

(*Clause* 6.1)

Nominal Diameter, DN	Outside Diameter, mm	Tolerance mm (only positive tolerances)	Ovality mm
(1)	(2)	(3)	(4)
63	63·0	0·6	1·5
75	75·0	0·7	1·6
90	90·0	0·9	1·8
110	110.0	1·0	2·2
125	125·0	1·2	2·5
140	140·0	1·3	2·8
160	160·0	1·5	3·2
180	180·0	1·7	3·6
200	200·0	1·8	4·0
225	225·0	2·1	4·5
250	250·0	2·3	5·0
280	280·0	2·6	9·8
315	315·0	2·9	11·1
355	355·0	3·2	12·5
400	400·0	3·6	14·0
450	450·0	4·1	15·6
500	500·0	4·5	17·5
560	560·0	5·0	19·6
630	630·0	5·7	22·1

6.2 Wall Thickness

The minimum and maximum wall thickness of pipes shall be as given in Table 2 (*see* A-3).

6.3 Method of Measurement

6.3.1 The outside diameter of the pipe shall be taken as the average of two measurements taken at right angles for pipes up to 110 mm diameter. Alternatively and for higher sizes, the diameter shall be measured preferably by using a flexible Pi tape or a circometer, having an accuracy of not less than 0·1 mm. The wall thickness shall be measured by a dial vernier or ball ended micrometer. The resulting dimension shall be expressed to the nearest 0·1 mm.

NOTES

1 The outside diameter shall be measured at a distance of at least 300 mm from the end of the pipe.

2 In the case of dispute, the dimension of pipes shall be measured after conditioning at room temperature for 4 hours.

6.3.2 Ovality shall be measured at the manufacturers end as the difference between maximum outside diameter and minimum outside diameter measured at the same cross-section of the pipe, at 300 mm away from the cut end. For coiled pipes re-rounding of pipes shall be carried out prior to the measurement of ovality.

6.4 Length of Straight Pipe

The length of straight pipe shall be 5 m to 20 m, as agreed between the manufacturer and the purchaser. Short lengths of 3 m (minimum) up to a maximum of 10 percent of the total supply may be permitted.

6.5 Coiling

The pipes supplied in coils shall be coiled on drums of minimum diameter of 25 times the nominal diameter of the pipe ensuring that kinking of pipe is prevented.

7 VISUAL APPEARANCE

The internal and external surfaces of the pipes shall be smooth, clean and free from grooving and other defects. The ends shall be cleanly cut and shall be square with axis of the pipes. Slight shallow longitudinal grooves or irregularities in the wall thickness shall be permissible provided that the wall thickness remains within the permissible limits.

8 PERFORMANCE REQUIREMENTS

8.1 Hydraulic Characteristics

When subjected to internal pressure creep rupture test in accordance with procedure given in Annex B, the pipes under test shall show no signs of localized swelling, leakage or weeping, and shall not burst during the prescribed test duration. The temperatures, duration of test and induced stresses for the test shall conform to those specified in Table 3.

8.2 Reversion Test

When tested according to the procedure given at Annex C, the value of the longitudinal reversion shall not be greater than 3 percent.

8.3 Density

When tested from a composite sample of minimum three pipes as per Annex A of IS 7328 : 1992, it shall meet the requirement as given in 5.1.2.

Table 2 Wall Thickness of Pipes

(*Clause* 6.2)

All dimensions in millimetres.

Nominal Diameter	Wall Thickness of Pipes for Pressure Ratings of							
	PN 2·5		PN 4		PN 6		PN 10	
DN	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
63	2·6	3·0	4·0	4·6	5·8	6·5	9·0	10·1
75	3·0	3·5	4·7	5·4	6·9	7·7	10·8	12·0
90	3·6	4·2	5·7	6·4	8·2	9·2	12·9	14·4
110	4·4	5·1	6·9	7·8	10·0	11·2	15·8	17·5
125	5·0	5·7	7·9	8·8	11·4	12·7	17·9	19·9
140	5·6	6·4	8·8	9·9	12·8	14·2	20·0	22·2
160	6·4	7.3	10·0	11·2	14·6	16·2	22·9	25·4
180	7·2	8·2	11·3	12·6	16·4	18·2	25·8	28·5
200	8·0	9·0	12·5	14·0	18·2	20·2	28·6	31·7
225	9·0	10·1	14·1	15·7	20·5	22·7	32·2	35·6
250	10·0	11·2	15·7	17·4	22·8	25·2	35·8	39·5
280	11·2	12·6	17·5	19·5	25·5	28·2	40·0	44·2
315	12·6	14·1	19·7	21·9	28·7	31·7	45·0	49·7
355	14·2	15·9	22.2	24·7	32·3	35·7	50·8	56·0
400	16·0	18·6	25·0	29·0	36·4	42·2	—	—
450	18·0	20·9	28·2	32·6	41·0	47·3	—	—
500	20·0	23·2	31·3	36·2	45·5	52·5	—	—
560	22·4	26·0	35·0	40·5	51·0	58·8	—	—
630	25·2	29·2	39·4	45·5	—	—	—	—

Table 3 Requirement of Pipes for Internal Pressure Creep Rupture Test

(*Clauses* 8.1, 9.1.2 *and* B-4.3)

Sl No.	Test	Test Temp °C	Test Duration Minimum Holding (Time) hours	Induced Stress σ_1 in MPa
(1)		(2)	(3)	(4)
i)	Type test	80	165	3·5
ii)	Acceptance test	80	48	4·1

8.4 Melt Flow Rate (MFR)

When tested from a composite sample of minimum three pipes as per IS 2530 : 1963, at 190°C with nominal load of 5 kgf, MFR shall be between 0·4 to 1·1 g/10 min and also shall not differ by more than 30 percent of the MFR of the material used in manufacturing pipes (*see* **5.1.3**).

8.5 Carbon Black Content and Dispersion

When tested from a composite sample of minimum three pipes, in accordance with IS 2530 : 1963, the carbon black content shall be within 2·5 ± 0·5 percent and the dispersion of carbon black shall be satisfactory.

9 SAMPLING, FREQUENCY OF TESTS AND CRITERIA FOR CONFORMITY

9.1 Type Tests

9.1.1 Type tests are intended to prove the suitability and performance of a new composition, a new technique or a new size of a pipe. Such tests, therefore, need be applied only when a change is made in polymer composition or method of manufacture, or when a new size of pipe is to be introduced. Even if no change is envisaged, type test shall be done at least once in two years on each pressure rating of pipe of the highest size manufactured during the period.

9.1.2 Three samples of the same size and same pressure rating selected at random shall be tested for compliance with the requirements of the type test, given in Table 3.

9.1.3 If all the samples pass the requirements of the type test, the type of the pipe under consideration shall be considered eligible for type approval.

9.1.4 In case any of the samples fails in the type test, the testing authority, at its discretion, may call for fresh samples not exceeding the original number and subject them to the type test again. If in repeat test, no single failure occurs, the type of pipe under consideration shall be considered eligible for type approval. If any of the samples fails in the repeat tests, the type of pipe shall not be approved. The manufacturer or the supplier may be asked to improve the design and resubmit the product for type approval.

9.1.5 At the end of the validity period (normally two years) or earlier as may be necessary, the testing authority may call for fresh samples for type test for the purpose of type approval.

9.2 Acceptance Tests

9.2.1 Acceptance tests are carried out on samples selected from a lot for the purpose of acceptance of the lot.

9.2.2 *Lot*

All pipes of the same size, and same pressure rating and also manufactured essentially under similar conditions of manufacture, shall constitute a lot. For ascertaining conformity of the lot to the requirements of this specification, samples shall be selected in accordance with the provisions as mentioned here in under and tested for compliance.

9.2.3 *Dimensional and Visual Requirements*

9.2.3.1 The number of test samples shall be in accordance with Table 4.

9.2.3.2 These pipes shall be selected at random from the lot and in order to ensure the randomness of selection, a random number table shall be used. For guidance and use of random number tables, IS 4905 : 1968 may be referred. In the absence of a random number table the following procedure may be adopted.

Starting from any pipe in the lot count them as 1,2,3,4......etc, up to *r* and so on where *r* is the integral part of N/n, N being the number of pipes in the lot and n is the number of pipes in the samples. Every *r*th pipe so counted shall be withdrawn so as to contitute the required sample size.

9.2.3.3 The number of pipes given for the first sample in col 3 of Table 4 shall be examined for dimensional and visual requirements given in **6.1**, **6.2** and **7**. A pipe failing to satisfy any of these requirements shall be considered as defective. The lot shall be deemed to have satisfied these requirements. if the number of defectives found in the first sample are less than or equal to the corresponding acceptance number given in col 5 of Table 4. The lot shall be deemed not to have met these requirements if the number of defectives found in the first sample is greater than or equal to the corresponding rejection numbers given in col 6 of Table 4. If, however, the number of defectives found in the first sample lies between the corresponding acceptance and rejection numbers given in col 4 and 5 of Table 4, the second sample of the size given in col 3 of Table 4 shall be taken and examined for these requirements. The lot shall be considered to have satisfied these requirements, if the number of defectives found in the cumulative sample is less than or equal to the corresponding acceptance number given in col 5 of Table 4; otherwise not.

Table 4 Scale of Sampling for Visual and Dimensional Requirements
(*Clauses* 9.2.3.1 *and* 9.2.3.3)

No. of Pipes in the Lot	Sample No.	Sample Size	Cumulative Sample Size	Acceptance No.	Rejection No.
(1)	(2)	(3)	(4)	(5)	(6)
Up to 150	First	13	13	0	2
	Second	13	26	1	2
151 to 280	First	20	20	0	3
	Second	20	40	3	4
281 to 500	First	32	32	1	4
	Second	32	64	4	5
501 to 1 200	First	50	50	2	5
	Second	50	100	6	7
1 201 to 3 200	First	80	80	3	7
	Second	80	160	8	9
3 201 to 10 000	First	125	125	5	9
	Second	125	250	12	13
10 001 to 35 000	First	200	200	7	11
	Second	200	400	18	19

9.2.4 *Hydraulic Characteristics, Reversion, Density, MFR and Carbon Black Content/Dispersion Tests*

9.2.4.1 The lot having satisfied dimensional and visual requirements shall be tested for hydraulic characteristics, reversion, density, MFR and carbon black content/dispersion requirements.

9.2.4.2 A separate sample size for each of the test, shall be taken as stipulated in Table 5 and selected at random from the sample already examined for dimensional and visual inspection. All the pipes in each of the sample size shall be tested for compliance of the requirements for hydraulic characteristics (**8.1**), reversion (**8.2**) density (**8.3**), MFR (**8.4**), and carbon black content/dispersion (**8.5**). The lot shall be considered to have met the requirements of these tests, if none of samples tested fails.

Table 5 Scale of Sampling for Tests for Hydraulic Characteristics, Reversion, Density, MFR and Carbon Black Content/Dispersion

(*Clause* 9.2.4.2)

No. of Pipes	Sample Size
(1)	(2)
Up to 150	3
151 to 1 200	5
1 201 to 35 000	8

10 MARKING

10.1 Each straight length of pipe shall be clearly marked in indelible ink/paint on either end and for coil at both ends or hot embossed on white base every meter throughout the length of pipe/coil with the following information:

a) Manufacturer's name/Trade mark,

b) Designation of pipe (*see* **3.1**), and

c) Lot number/Batch number.

10.2 BIS Certification Marking

Each pipe may also be marked with the Standard Mark.

10.2.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. The details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

ANNEX A

(*Clauses* 5.1, 6.1 *and* 6.2)

EXPLANATORY NOTES

A-1 MASTER BATCH

With the advancement in technology, natural (unpigmented) resin duly stabilised with anti-oxidants (*see* **5.2**) may be compounded/processed with the black master batch fulfiling the requirements as laid down in the standard. This will be strictly permitted only in such cases where the facilities of compounding/processing are available with the pipe manufacturer and the material thus produced shall conform to the material designation(s) given in **5.1**.

A-2 TOLERANCE ON OUTSIDE DIAMETER AND MAXIMUM OVALITY

A-2.1 The values specified for tolerance on outside diameter have been calculated as 0·009 DN, rounded off to the next higher 0·1 mm, subject to minimum of 0·3 mm. No negative tolerances are allowed.

A-2.2 The ovality specified corresponds to Grade N of ISO/DIS 11922-1. Thermoplastic pipes for transport of fluids, dimensions and tolerances', The basis for the values specified is:

a) For nominal outside diameters ≤ 75, the tolerance equals (0 008 DN + 1·0) mm, rounded to the next higher 0·1 mm, with a minimum value of 1·2 mm.

b) For nominal outside diameters > 75 and ≤ 250, the tolerance equals 0·02 DN rounded to the next higher 0·1 mm.

c) For nominal outside diameters > 250, the tolerance equals 0·035 DN rounded to the next higher 0·1 mm.

A-3 WALL THICKNESS

A-3.1 The wall thickness of pipes are based on the maximum allowable hydrostatic design stress (σ) of 3·0 MPa.

A-3.2 Minimum wall thickness s, in mm of the pipe have been calculated as follows and rounded off for the next higher 0·1 mm.

$$s = \frac{p \times d}{2\sigma + p}$$

where

p = maximum permissible working pressure in MPa;

d = nominal outside diameter in mm; and

σ = maximum allowable hydrostatic design stress, that is 3·0 MPa.

A-3.3 Maximum wall thickness has been calculated as follows:

a) For pipes with an outside diameter less than or equal to 355 mm, maximum wall thickness) = 1·1 × minimum wall thickness + 0·2 mm), rounded off to next higher 0·1 mm.

b) For pipes with outside diameter equal to or greater than 400 mm, maximum wall thickness (= 1·15 × minimum wall thickness + 0·2 mm), rounded off to the next higher 0·1 mm.

NOTE — Considering operational problems, maximum wall thickness of pipes are considered around 60 mm.

ANNEX B

(*Clause* 8.1)

INTERNAL PRESSURE CREEP RUPTURE TEST

B-1 GENERAL

The test shall be carried out not earlier than 24 hours after the pipes have been manufactured.

B-2 TEST SPECIMENS

A sample of pipe having free length between the end fittings equal to ten times the outside diameter but not less than 250 mm and not greater than 750 mm, shall be taken for testing from each pipe to be tested.

B-3 APPARATUS

Equipment permitting the application of a controlled internal hydraulic pressure to the specimen which are immersed in a thermostatically controlled water-bath.

B-4 PROCEDURE

B-4.1 The pipes shall be fitted with the locking plugs at both ends in such a way that the axial forces coming from the internal pressure are transmitted to the pipe. The pipe shall remain free to move in longitudinal direction.

B-4.2 Through a closable opening in one of the locking plugs, the pipe shall be filled with water at ambient temperature. It shall be then put in a water bath at the test temperature of 80°C (permissible deviation ±1°C) and kept in the bath for minimum one hour to adjust the temperature.

B-4.3 The pressure in the pipe shall then be increased to the test pressure (p) gradually and without shock preferably within 10 to 30 seconds in the bath whose temperature has been adjusted in accordance with **B-4.2**. The pressure with a permissible deviation of ± 2·5 percent shall be maintained for the period laid down in Table 3.

The test pressure (p) shall be calculated as follows from the minimum dimensions given in the Table 2 and the corresponding induced stress values given in Table 3.

$$p = \frac{2\sigma_1 s}{(d - s)}$$

where

p = test pressure in MPa;

s = minimum wall thickness in mm;

σ_1 = induced stress in MPa; and

d = outside diameter of pipe, in mm.

B-5 ASSESSMENT OF RESULTS

The samples shall not show signs of localized swelling or leakage and shall not burst during the prescribed test duration. The test showing failure within a distance equivalent to the length of end cap from the end shall be disregarded and the test repeated.

ANNEX C

(*Clause* 8.2)

LONGITUDINAL REVERSION TEST

C-1 APPARATUS

C-1.1 Air Oven

Thermostatically controlled at 110 ± 2°C and is capable of re-establishing this temperature within 15 minutes after the introduction of test specimen in the oven.

C-1.2 Thermometer, graduated to 0.5°C

C-1.3 Test Specimens

Either 3 complete sections of pipe, approximately 200 mm long, shall be taken as test pieces, or where the pipe diameter is greater than 200 mm, pieces of pipe of about 200 mm axial length and with an approximate circumferential arc length of 200 mm shall be prepared by cutting. In such cases, the entire circumference of approximately 200 mm long section of pipe shall be divided into pieces measuring approximately 200 mm square. The direction of the pipe axis shall be marked on the pieces. All pieces are required to be tested. A mark shall be scribed on the external surface approximately 50 mm from each end of the test pieces in the axial direction of pipe (in the case of complete section of pipe, the mark shall be scribed around the whole circumference). The distance between the two marks, l_0 (reference length), shall be approximately 100 mm and shall be measured to the nearest 0·25 mm at ambient temperature.

C-2 PROCEDURE

C-2.1 Place the test pieces concave side up on a glass plate previously dusted with talcum, to ensure that changes in length take place unimpeded. The test pieces shall not touch each other.

C-2.2 Set the oven temperature at 110 ± 2°C. The glass plate with the test pieces shall then be placed in the oven heated to test temperature and capable of maintaining continuous forced air circulation. The test pieces shall be kept in the oven at the temperatures and for the periods specified below:

Wall Thickness, S mm	*Test Temperature* °C	*Period of Stressing*, *t* min
Up to 8	110 ± 2	60 ± 1
Over 8 up to 16	110 ± 2	120 ± 2
Over 16	110 ± 2	240 ± 5

C-2.3 Remove the test pieces from the oven and allow to cool in air, without being moved at the ambient temperature. Measure the minimum distance between the two marks.

C-3 EXPRESSION OF RESULTS

C-3.1 For each test piece, calculate the longitudinal reversion, *T*, as a percentage, as follows:

$$T = \frac{l_0 - l_1}{l_0} \times 100$$

where l_0 and l_1 are the distances in mm before and after the test.

C-3.2 The average value (arithmetic mean) of all the test pieces shall be obtained and reported.

ANNEX D

(*Foreword*)

CHEMICAL RESISTANCE CLASSIFICATION TABLE FOR HDPE PIPES AND FITTINGS

D-1 GENERAL

D-1.1 This Technical Report is a reference document and provides guidelines on classification of the chemical resistance of High density Polyethylene(HDPE) pipe material to specified fluids over a range of temperatures (20°C and 60°C). It is intended to provide information on suitability of HDPE piping for the conveyance of fluids.

D-1.2 The preliminary chemical-resistance classification given in the annexed table is only suitable for use with pipes which are not subjected to internal and external mechanical stresses (for example, those caused by internal pressure, flexural stresses). In order to assess the behaviour of pipes and fittings for conveyance of fluids under pressure or in the presence of other stresses, if the preliminary classification is S or L, it will be necessary to carry out further tests as specified in ISO 8584-1 and or ISO/TR 8584-2.

D-1.3 To assess the tendency of a material towards environmental stress cracking, separate tests have to be carried out. Other properties of the pipe material (for example, permeability) or of the fluid conveyed (for example toxicity, inflammability, etc,) should also be considered separately.

D-1.4 The table summarizes the data given in a number of chemical resistance tables at present in use in various countries, derived from both practical experience and test results. This evaluation is based on values obtained by immersion of high density polyethylene test specimens in the fluid concerned at 20°C or 60°C and atmospheric pressure, followed in certain cases by the determination of tensile characteristics.

D-1.5 In the preparalion of this appendix, assistance has been derived trom the following:

a) ISO/TR 10358-1993 — Plastics pipes and fittings — Combined chemical resistance classification table.

b) Chemical resistance of 'Sclair' polyethylene resins from Du Pont, Canada.

c) Marlex (Phillips) — Low, medium and high density polyethylenes : properties — Processing.

D-2 EXPLANATION OF SYMBOLS AND ABBREVIATIONS

D-2.1 Classification (Last Column in the Table)

The following symbols are used to indicate the behaviour of HDPE pipes in contact with chemical agents:

S : Satisfactory resistance. No indication that the serviceability would be impaired.

The pipes can be used for applications in which they are not subjected to pressure or other stresses; for applications in which they are exposed to pressure, the final assessment shall be on the basis of subsequent test under pressure.

L : Limited resistance, depending on condition of use.

HDPE pipes can be used for applications in which they are not subjected to pressure or other stress, but a case in which a certain amount of corrosion can be accepted. For applications in which they are exposed to pressure, the final assessment shall be on the basis of a subsequent test under pressure.

NS : Resistance Not Satisfactory. Not recommended for service applications under any condition.

The pipes are seriously attacked. They shall not be used for either pressure or non-pressure applications. There is no point in conducting tests under pressure as the pipes would be certain to fail these tests.

D-2.2 Description of Fluids

D-2.2.1 *Nature of Chemicals (Column 2 in the Table)*

The fluids are listed by their most common names, including trivial and trade names, in alphabetical order, with some of the chemicals, synonyms are also listed, in the alphabetical order.

In some cases, further information on nature of chemical is given, namely:

KSCA : Known Stress-Crack Agent

SSCA : Suspected Stress-Crack Agent

P : Plasticiser

O : Oxidiser

Subl. : Sublimes

dec. : Decomposes

D-2.2.2 *Characteristics of Chemicals (Columns 3 and 4 in the Table)*

Melting point (m.p.) and boiling point (b.p.) in degree Celsius (°C) are given wherever appropriate. The values refer to fluids of technical-grade purity at standard atmospheric pressure, unless otherwise stated.

D-2.2.3 *Concentration of Chemicals (Column 5 in the Table)*

The concentration and/or purity of the fluid is indicated, using the following symbols:

Dil. sol. = Dilute aqueous solution at a concentration equal to or less than 10 percent.

Sol. = Aqueous solution at a concentration higher than 10 percent but not saturated.

Sat. sol. = Saturated aqueous solution, prepared at 20°C.

Conc. = Concentrated fluid

All conc. = Behaviour of fluid over entire range of concentration

tg = At least technical — grade purity

tgs = Technical — grade solid

tg-l — Technical grade, liquid

tg-g — Technical grade, gas

Work. sol. — Working solution of the concentration usually used in the industry concerned.

Susp. — Suspension of solid in a saturated solution at 20°C,

The concentrations are expressed as a percentage by mass at 20°C, unless other wise stated.

D-2.2.4 Service Temperature (*Column 6 in the Table*)

Test temperatures at which chemical resistance determined (20°C and 60°C).

D-2.2.5 *Classification* (*Last column in the Table*)

The chemical resistance of HDPE pipe materials is given in accordance with the classification system as described under D-2.1 above.

Chemical Resistance of High Density Polyethylene Pipes and Fittings

Sl No.	Chemical	m.p. °C	b.p. °C	Conc. %	Temperature °C	Classification
1.	Acetaldehyde (KSCA)	—123	21	40	20 60	L NS
				tg-l	20 60	S L
2.	Acetic Acid (KSCA)	17	118	Upto 10	20 60	S S
				10 to 40	20	S
				50	20	S
				40 to 60	20 60	S L
				80	20 60	S L
3.	Acetic Acid, glacial (KSCA)	17	118	> 96	20 60	S L
4.	Acetic Anhydride (SSCA)	—73	140	tg-l	20 60	NS NS
5.	Acetone	—95	56	tg-l	20 60	L L
6.	Acrylic emulsion			Work sol.	20 60	S S
7.	Adipic acid	151	338	Sat. sol.	20 60	S S
8.	Air			tg-g	20 60	S S
9.	Allyl alcohol	—129	97	tg-l	20 60	S S
10.	Aluminium chloride	194 (5.2 atm.)	181 (Subl.)	All conc.	20 60	S S
11.	Aluminium fluoride	1040	1276 (Subl.)	Susp.	20 60	S S

Sl No.	Chemical	m.p. °C	b.p. °C	Conc. %	Tempe-rature °C	Classifi-cation
12.	Aluminium hydroxide	− H_2O 300		Susp.	20 60	S S
13.	Aluminium nitrate	73	150 dec.	Sat. sol.	20 60	S S
14.	Aluminium oxychloride	226		Susp.	20 60	S S
15.	Aluminium potassium sulphate (Alum-all types)	− H_2O 92		Sat. sol.	20 60	S S
16.	Aluminium sulphate	770 dec.		All conc.	20 60	S S
17.	Ammonia aqueous	− 78	− 34	Sat. Sol.	20 60	S S
18.	Ammonia, dry gas	− 78	− 34	tg-g	20 60	S S
19.	Ammonia liquid	− 78	− 34	tg-g	20 60	S S
20.	Ammonium carbonate (dec at 58°C)			Sat. sol.	20 60	S S
21.	Ammonium chloride	339 dec.		Sat. sol.	20 60	S S
22.	Ammonium fluoride	Subl.		Up to 20	20 60	S S
				Sat. sol.	20 60	S S
23.	Ammonium hydrogen carbonate	35 dec.		Sat. sol.	20 60	S S
24.	Ammonium hydroxide	− 78		10	20 60	S S
				28	20 60	S S
25.	Ammonium metaphosphate			Sat. sol.	20 60	S S
26.	Ammonium nitrate	170	210 dec.	Sat. sol.	20 60	S S
27.	Ammonium persulphate	120 dec.		Sat. sol.	20 60	S S
28.	Ammonium sulphate	230 dec.		Sat. sol.	20 60	S S
29.	Ammonium sulphide	− 18	dec.	Sat. sol.	20 60	S S

Sl No.	Chemical	m. p. °C	b. p. °C	Conc. %	Temperature °C	Classification
30.	Ammonium thiocyanate	150	170 dec.	Sat. Sol.	20 60	S S
31.	Amyl acetate (SSCA/P)	— 100	142	tg-l	20 60	NS NS
32.	Amyl alcohol (KSCA/P)	— 79	137	tg-l	20 60	S L
33.	Amyl chloride (P)	— 99	98	tg-l	20 60	NS NS
34.	Aniline (KSCA/P)	— 6	184	tg-l	20 60	NS NS
35.	Antimony (III) chloride	73	223	Sat. Sol.	20 60	S S
36.	Apple juice			Work sol.	20	S
37.	Aqua regia (O)			HCl/HNO_3 (3:1)	20 60	NS NS
38.	Aromatic hydrocarbons (SSCA/P)				20 60	NS NS
39.	Arsenic acid	36		All conc.	20 60	S S
40.	Ascorbic acid	190 dec.		10	20 60	S S
41.	Barium bromide	854	dec.	Sat. sol.	20 60	S S
42.	Barium carbonate	1 360 dec.		Susp.	20 60	S S
43.	Barium chloride	962	2029	Sat. sol.	20 60	S S
44.	Barium hydroxide	78		Sat. sol.	20 60	S S
45.	Barium sulphate	1 580		Susp.	20 60	S S
46.	Barium sulphide	2 227		Sat. sol.	20 60	S S
47.	Beer			Work sol.	20 60	S S
48.	Benzaldehyde	— 26	178	tg-l	20 60	S L
49.	Benzene (SSCA/P)	6	80	tg-l	20 60	NS NS
50.	Benzene sulfonic acid	50		Sol.	20 60	S S

Sl No.	Chemical	m.p. °C	b.p. °C	Conc. %	Temperature °C	Classification
51.	Benzoic acid	122	250	All conc.	20 60	S S
52.	Bismuth carbonate	dec.		Sat. sol.	20 60	S S
53.	Bleach lye			10	20 60	S S
54.	Borax	— H_2O 75	320	Sat. sol.	20 60	S S
55.	Boric acid	236		All conc.	20 60	S S
56.	Boron trifluoride	— 129	— 101	Sat. sol.	20 60	S S
57.	Brine			All conc.	20 60	S S
58.	Bromine, gas	— 7	58	tg-g	20 60	NS NS
59.	Bromine, liquid (O)	— 7	58	tg-l	20 60	NS NS
60.	Butandiol (KSCA)	21	230	All conc.	20 60	S S
61.	Butane, gas	— 135	— 0·5	tg-g	20 60	S S
62.	Butter (SSCA)	20 to 25			20 60	S S
63.	n-Butyl acetate (SSCA/P)	— 74	126	tg-l	20 60	L NS
64.	n-Butyl alcohol (KSCA)	— 80	117	tg-l	20 60	S S
65.	Butyric acid (P)	— 5	164	tg-l	20 60	NS NS
66.	Calcium bisulphide	18 dec.		Sol.	20 60	S S
67.	Calcium carbonate	900 dec.		Susp.	20 60	S S
68.	Calcium chlorate	340		Sat. sol.	20 60	S S
69.	Calcium chloride	772	1 940	Sat. sol,	20 60	S S
70.	Calcium hydroxide	— H_2O 522		Sat. sol.	20 60	S S

Sl No.	Chemical	m.p. °C	b.p. °C	Conc. %	Temperature °C	Classification
71.	Calcium hypochlorite (dec. at 10 percent chlorine)			Sol.	20 60	S S
72.	Calcium nitrate	561		Sat. sol.	20 60	S S
73.	Calcium oxide	2 927	3 500	Susp.	20 60	S S
74.	Calcium sulphate	1 400		Susp.	20 60	S S
75.	Calcium sulphide	2 400		Dil. sol.	20 60	L L
76.	Camphor oil (SSCA/P)	177	204	Work sol.	20	L
77.	Carbon dioxide, dry gas	— 56	— 78	tg-g	20 60	S S
78.	Carbon dioxide, wet gas	— 56	— 78	tg-g	20 60	S S
79.	Carbon disulphide	— 112	46	tg-l	20 60	NS NS
80.	Carbon monoxide, gas	— 205	— 192	tg-g	20 60	S S
81.	Carbon tetrachloride	— 23	27	tg-l	20 60	L NS
82.	Carbonic acid			Work sol.	20 60	S S
83.	Castor oil (KSCA)	— 12		Conc.	20 60	S S
84.	Chlorine, dry gas (O)	— 101	— 35	tg-g	20 60	L NS
85.	Chlorine, liquid (O)	— 101	— 35	tg-g	20 60	NS NS
86.	Chlorine water	— 101	— 35	Sat. sol. (2 percent)	20 60	S S
87.	Chloroacetic acid	61	188	Sol.	20 60	S S
88.	Chlorobenzene (SSCA/P)	— 45	132	tg-l	20 60	NS NS
89.	Chloroform (SSCA/P)	— 64	62	tg-l	20 60	NS NS
90.	Chloromethane, gas	— 97	— 24	tg-g	20	L

Sl No.	Chemical	m. p. °C	b. p. °C	Conc. %	Temperature °C	Classification
91.	Chlorosulphonic acid	68	147 in vac.	tg-s	20 60	NS NS
92.	Chrome alum (chromium potassium sulphate)	89	100	Sol.	20 60	S S
93.	Chromic acid	196	dec.	20	20 60	S L
				50	20 60	S L
94.	Cider (KSCA)			Work. sol.	20 60	S S
95.	Citric acid (KSCA)	153		Sat. sol.	20 60	S S
96.	Coconut oil alcohols (KSCA)			Work. sol.	20 60	S S
97.	Coffee			Work. sol.	20 60	S S
98.	Cola concentrates (KSCA)			Work. sol.	20 60	S S
99.	Copper (II) chloride	620	dec.	Sat. sol.	20 60	S S
100.	Copper (II) cyanide	dec.		Sat. sol.	20 60	S S
101.	Copper (II) fluoride	950 dec.		2	20 60	S S
102.	Copper (II) nitrate	114·5		Sat. sol.	20 60	S S
103.	Copper (II) sulphate	300 dec.		Sat. sol.	20 60	S S
104.	Corn oil (SSCA)	10 to 20		tg-l	20 60	S S
105.	Cotton seed oil (KSCA)	10 to 22		tg-l	20 60	S S
106.	Cresylic acid			Sat. sol.	20	L
107.	Cyclohexanol	24	161	tg-l	20 60	S S
108.	Cyclohexanone	− 26	156	tg-l	20 60	NS NS
109.	Decalin	− 51 to − 36	185 to 193	tg-l	20 60	S L
110.	Detergent, Synthetic (KSCA)			Work. sol.	20 60	S S

Sl No.	Chemical	m. p. °C	b. p. °C	Conc. %	Temperature °C	Classification
111.	Developers (Photographic)			Work. sol.	20 60	S S
112.	Dextrin			Sol.	20 60	S S
113.	Dextrose (dec. at 200°C)	146		Sol.	20 60	S S
114.	Diazo salts			Sol.	20 60	S S
115.	Dibutylphthalate (SSCA)	— 35	340	tg-l	20 60	L L
116.	Dichlorobenzene (o- & p-) (SSCA/P)	— 17/53	180/174	tg-l	20 60	NS NS
117.	Diethylketone (SSCA/P)	— 39	102	tg-l	20 60	L NS
118.	Diethylene glycol (KSCA)	— 11	245	tg-l	20 60	S S
119.	Diglycolic acid (KSCA)	148	dec.	Sol.	20 60	S S
120.	Dimethylamine	— 93	8	sol.	20 60	NS NS
121.	Dioctylphthalate		255 to 265 (20 mm)	tg-l	20 60	S L
122.	Dioxane	12	100	tg-l	20 60	S S
123.	Disodium phosphate				20 60	S S
124.	Emulsions, photographic (KSCA)				20 60	S S
125.	Ethyl acetate (SSCA/P)	— 83	77	tg-l	20 60	L NS
126.	Ethyl alcohol (KSCA)	— 114	78	40	20 60	S L
				100	20 60	S L
127.	Ethyl benzene (SSCA/P)	— 95	136	tg-l	20 60	NS NS
128.	Ethyl chloride (P)	— 136	12	sol.	20 60	NS NS

Sl No.	Chemical	m.p. °C	b.p. °C	Conc. %	Temperature °C	Classification
129.	Ethylene glycol (KSCA)	— 11	198	tg-l	20 60	S S
130.	Ethyl ether (P)	— 113	35	tg-l	20 60	NS NS
131.	Ferric chloride	306	dec.	Sat. sol.	20 60	S S
132.	Ferric nitrate	47	dec.	Sat. sol.	20 60	S S
133.	Ferric sulphate	480 dec.		Sat. sol.	20 60	S S
134.	Ferrous chloride	670-674		Sat. sol.	20 60	S S
135.	Ferrous sulphate			Sat. sol.	20 60	S S
136.	Fluoboric acid	130 dec.		sol.	20 60	S S
137.	Fluorine gas, dry	— 220	— 188	tg-g	20 60	NS NS
138.	Fluorine gas, wet	— 220	— 188	tg-g	20 60	NS NS
139.	Fluosilicic acid		dec.	40	20 60	S S
				conc.	20 60	S S
140.	Formaldehyde	— 92	— 19	30 to 40	20 60	S S
141.	Formic acid	8	101	All conc.	20 60	S S
142.	Fructose	104 dec.		Sat. sol.	20 60	S S
143.	Fruit pulp (SSCA)				20 60	S S
144.	Fuel oil				20 60	L NS
145.	Furfural (P)	— 39	162	tg-l	20 60	NS NS
146.	Furfuryl alcohol (SSCA/P)	— 29	170	tg-l	20 60	S L
147.	Gallic acid			Sat. sol.	20 60	S S
148.	Gas, Manufactured			tg-g	20	S

Sl No.	Chemical	m.p. °C	b.p. °C	Conc. %	Temperature °C	Classification
149.	Gas, Natural, Dry			tg-g	20 50	S S
150.	Gas, Natural, Wet			tg-g	20	S
151.	Gasoline (Fuel) (SSCA/P)			Work. sol.	20 60	L NS
152.	Gelatine			Sol.	20 60	S S
153.	Glucose (dec > 200°C)	146		Sol.	20 60	S S
154.	Glycerine (KSCA)	20	290	tg-l	20 60	S S
155.	Glycol (KSCA)	— 12	199	tg-l	20 60	S S
156.	Glycolic acid (KSCA)	80	dec.	30	20 60	S S
157.	Grapefruit juice			Work. sol.	20	S
158.	Heptane (SSCA/P)	— 90	98	tg-l	20 60	L NS
159.	Hexachlorobenzene	230	322 subl.	sol.	20 60	S S
160.	Hexanol (KSCA)	— 47	158	tg-l	20 60	S S
161.	Honey			Work sol.	20 60	S S
162.	Horseradish			Work sol.	20 60	S S
163.	Hydrobromic acid	— 87	— 67	All conc.	20 60	S S
164.	Hydrochloric acid	— 112	— 85	All conc.	20 60	S S
165.	Hydrocyanic acid	— 15	25	10	20 60	S S
				Sat. sol.	20 60	S S
166.	Hydrofluoric acid	— 85	20	Up to 10	20 60	S S
				60	20 60	S L

Sl. No.	Chemical	m.p. °C	b.p. °C	Conc. percent	Temp. °C	Classification
167.	Hydrogen		-253	tg-g	20 60	S S
168.	Hydrogen peroxide	1	158	Upto 10	20 60	S S
				30	20 60	S S
				90	20 60	S NS
169.	Hydrogen sulphide, dry gas		-61	tg-g	20 60	S S
170.	Hydroquinone	170	286 (730 mm)	Sat. sol.	20 60	S S
171.	Hypochlorous acid		dec.	Conc.	20 60	S S
172.	Inks (KSCA)				20 60	S S
173.	Iodine (O) (In potassium iodide)	681	1330	Sat. sol.	20 60	NS NS
174.	Iodine, in alcohol	114	183	Work. sol.	20 60	NS NS
175.	Lactic acid	18	119 (12 mm)	All conc.	20 60	S S
176.	Lead acetate	75		Sat. sol.	20 60	S S
177.	Lead nitrate	470 dec.			20 60	S S
178.	Magnesium carbonate	350 dec.		Susp.	20 60	S S
179.	Magnesium chloride	714	1412	Sat. sol.	20 60	S S
180.	Magnesium hydroxide	$-H_2O$ 350		Sat. sol.	20 60	S S
181.	Magnesium nitrate	129		Sat. sol.	20 60	S S

Sl No.	Chemical	m.p. °C	b.p. °C	Conc. %	Temperature °C	Classification
182.	Magnesium sulphate	1 124 dec.		Sat. sol.	20 60	S S
183.	Maleic acid (dec 160°C)	131		Sat. sol.	20 60	S S
184.	Maleic acid (Subl.)	136		Sol.	20 60	S S
				Sat. sol.	20 60	S S
185.	Mayonnaise			Work. sol.	20	S
186.	Mercuric chloride	276	302	Sat. sol.	20 60	S S
187.	Mercuric cyanide	dec.		Sat. sol.	20 60	S S
188.	Mercurous nitrate	70		Sat. sol.	20 60	S S
189.	Mercury	— 39	357	tg-l	20 60	S S
190.	Methyl alcohol (KSCA)	— 97	65	tg-l	20 60	S S
191.	Methyl bromide (SSCA)	— 94	4	tg-l	20 60	L NS
192.	Methylene chloride (SSCA/P)	— 95	40	tg-l	20 60	NS NS
193.	Methyl ethyl ketone	— 86	80	tg-l	20 60	NS NS
194.	Milk			Work. sol.	20 60	S S
195.	Mineral oils			Work. sol.	20 60	S NS
196.	Molasses			Work. sol.	20 60	S S
197.	Mustard, aqueous			Work. sol.	20	S
198.	Naphtha (KSCA/P)				20 60	L NS
199.	Naphthalene (SSCA/P)	81	218		20 60	NS NS
200.	Nickel chloride	1 001	Subl.	Sat. sol.	20 60	S S
201.	Nickel nitrate	57	137	Sat. sol.	20 60	S S

Sl No.	Chemical	m.p. °C	b.p. °C	Conc. %	Temperature °C	Classification
202.	Nickel sulphate	848 dec.		Sat. sol.	20 60	S S
203.	Nicotinic acid (KSCA)	236		Susp.	20	S
204.	Nitric acid (O)			5	20 60	S S
				10	20 60	S S
				20	20 60	S S
				25	20 60	S S
				50	20 60	L NS
				> 50	20 60	NS NS
205.	Nitric acid, fuming (with nitrogen dioxide)				20 60	NS NS
206.	Nitrobenzene (SSCA/P)	6	211	tg-l	20 60	NS NS
207.	n-Octane	— 57	126	tg-l	20 60	S S
208.	Oils & Fats			tg-l	20 60	S I
209.	Oleic acid	16	280 (100 mm)	tg-l	20 60	S S
210.	Oleum			Conc.	20 60	NS NS
211.	Oxalic acid (KSCA) (Subl.)	102		Sat. sol.	20 60	S S
212.	Oxygen, gas		— 183	tg-g	20 60	S L
213.	Ozone, gas		— 112	tg-g	20 60	L NS
214.	Perchloroethylene (P)	— 19	121	tg-l	20 60	NS NS
215.	Petroleum ether (SSCR)		40-80		20 60	NS NS
216.	Phenol	41	182	Sol.	20 60	S S
217.	Phosphine	— 134	— 88	tg-g	20 60	S S

Sl No.	Chemical	m. p. °C	b. p. °C	Conc. %	Temperature °C	Classification
218.	Phosphoric acid	42		Up to 50	20 60	S S
219.	Phosphorus (III) chloride	— 92	75	tg-l	20 60	S S
220.	Photographic solutions				20 60	S S
221.	Pickling baths :					
	Sulphuric acid				20 60	S S
	Hydrochloric acid				20 60	S S
	Sulphuric-Nitric				20 60	S NS
222.	Picric acid (Subl)	122		Set. sol.	20	S
223.	Plating solutions (KSCA):					
	Brass				20 60	S S
	Cadmium				20 60	S S
	Chromium				20 60	S S
	Copper				20 60	S S
	Gold				20 60	S S
	Indium				20 60	S S
	Lead				20 60	S S
	Nickel				20 60	S S
	Rhodium				20 60	S S
	Silver				20 60	S S
	Tin				20 60	S S
	Zinc				20 60	S S
224.	Potassium bicarbonate	100-200 dec.		Sat. sol.	20 60	S S
225.	Potassium bisulphate	190 dec.		Sat. sol.	20 60	S S
226.	Potassium borate	950		Sat. sol.	20 60	S S
227.	Potassium bromate	434 dec.		Sat. sol.	20 60	S S
				Up to 10	20 60	S S

Sl No.	Chemical	m. p. °C	b. m. °C	Conc. %	Temperature °C	Classification
228.	Potassium bromide	734	1 435	Sat. sol.	20 60	S S
229.	Potassium carbonate	— H_2O 132		Sat. sol.	20 60	S S
230.	Potassium chlorate	356	400 dec.	Sat. sol.	20 60	S S
231.	Potassium chloride	770	1 500 subl.	Sat. sol.	20 60	S S
232.	Potassium chromate	968		Sat. sol.	20 60	S S
				40	20 60	S S
233.	Potassium cyanide	635		Sol.	20 60	S S
				Sat. sol.	20 60	S S
234.	Potassium dichromate	242	500 dec.	Sat. sol.	20 60	S S
235.	Potassium ferricyanide/ ferrocyanide	dec.		40	20 60	S S
				Sat. sol.	20 60	S S
236.	Potassium fluoride	858	1 505	Sat. sol.	20 60	S S
237.	Potassium hexacyanoferrate (II) (Potassium pherocynide)			Sat. sol.	20 60	S S
238.	Potassium hydrogen sulphite	190 dec.		Sol.	20 60	S S
239.	Potassium hydroxide	360	1 324	Con. sol.	20 60	S S
				10-20	20 60	S S
240.	Potassium hypochlorite			Sol.	20 60	S L
241.	Potassium nitrate	334	400 dec.	Sat. sol.	20 60	S S
242.	Potassium orthophosphote	1 340		Sat. sol.	20 60	S S
243.	Potassium perborate		100 dec.	Sat. sol.	20 60	S S

Sl No.	Chemical	m. p. °C	b. p. °C	Conc. percent	Temperature °C	Classification
244.	Potassium perchlorate	610	400 dec.	Sat. sol.	20 60	S S
245.	Potassium permanganate	<240 dec.		20	20 60	S S
246.	Potassium persulphate	> 300	dec.	Sat. sol.	20 60	S S
247.	Potassium sulphate	1 069		Sat. sol.	20 60	S S
248.	Potassium sulphide	840		Sat. sol.	20 60	S S
249.	Potassium sulphite	dec.		Sat. sol.	20 60	S S
250.	Potassium thiosulphate	— H_2O 200	dec.	Sat. sal.	20 60	S S
251.	Propargyl alcohol (KSCA)	— 48	114		20 60	S S
252.	Propionic acid	— 20	141	50	20 60	S S
				tg-l	20 60	S L
253.	Iso Propyl alcohol (KSCA)	— 90	82	tg-l	20 60	S S
254.	n-Propyl alcohol (KSCA)	—127	97	tg-l	20 60	S S
255.	Propylene dichloride (SSCA/P)	—100	96	tg-i	20 60	NS NS
256.	Propylene glycol (KSCA)		189	tg-l	20 60	NS NS
257.	Pyridine (SSCA)	— 42	115	tg-l	20 60	S L
258.	Resorcinol	111	178	Sat. sol.	20 60	S S
259.	Salicylic acid (Subl.)	156		Sat. sol.	20 60	S S
260.	Sea water				20 60	S S
261.	Selenic acid		260 dec.	sol.	20 60	S S
262.	Shortening (KSCA)				20 60	S S

Sl No.	Chemical	m. p. °C	b. p. °C	Conc.	Temperature °C	Classification
263.	Silicic acid	150 dec.		sol.	20 60	S S
264.	Silver acetate	dec.		Sat. sol.	20 60	S S
265.	Silver cyanide	320 dec.		Sat. sol.	20 60	S S
266.	Silver nitrate	212	444 dec.	Sat. sol.	20 60	S S
267.	Soap solution (KSCA)			All conc.	20 60	S S
268.	Sodium acetate	324		Sat. sol.	20 60	S S
269.	Sodium anitmonate	280 dec.		Sat. sol.	20 60	S S
270.	Sodium arsenite			Sat. sol.	20 60	S S
271.	Sodium benzoate			Sat. sol.	20 60	S S
272.	Sodium bicarbonate	— CO_2 270		Sat. sol.	20 60	S S
273.	Sodium bisulphate	> 315	dec.	Sat. sol.	20 60	S S
274.	Sodium bisulphite	dec.		Sat. sol.	20 60	S S
275.	Sodium borate	966		Sol.	20 60	S S
276.	Sodium bromide	747	1 390	Sat. sol.	20 60	S S
277.	Sodium carbonate	851	dec.	Sat. sol.	20 60	S S
				25	20 60	S S
				Up to 50	20 60	S S
278	Sodium chlorate	248 — 261	dec.	Sat. sol.	20 60	S S
279.	Sodium chloride	801	1 413	All conc.	20 60	S S
280.	Sodium chlorite	180 — 200		2	20	S

Sl No.	Chemical	m. p. °C	b. m. °C	Conc. %	Temperature °C	Classification
281.	Sodium chromate			Dil. sol.	20 60	S S
282.	Sodium cyanide	564	1 496	Sat. sol.	20 60	S S
283.	Sodium dichromate	357		Sat. sol.	20 60	S S
28 .	Sodium ferricyanide			Sat. sol.	20 60	S S
285.	Sodium ferrocyanide			Sat. sol.	20 60	S S
286.	Sodium fluoride	993	1 695	Sat. sol.	20 60	S S
287.	Sodium hydrogensulphite	dec.		Sat. sol.	20 60	S S
288.	Sodium hydroxide	318	1 390	All conc.	20 60	S S
289.	Sodium hypochlorite	18		10 to 15	20 60	S S
290.	Sodium nitrate	307	380 dec.	Sat. sol.	20 60	S S
291.	Sodium nitrite	271	320 dec.	Sat. sol.	20 60	S S
292.	Sodium phosphate, acid			Sat. sol.	20 60	S S
293.	Sodium phosphate, neutral			Sat. sol.	20 60	S S
294.	Sodium silicate			Sol.	20 60	S S
295.	Sodium sulphate	884		Sat. sol.	20 60	S S
				0, 1	20 60	S S
296.	Sodium sulphide	1 180		Sat. sol.	20 60	S S
297.	Sodium sulphite	dec.		Sat. sol.	20 60	S S
				40	20 60	S S
298.	Stannic chloride	— 33	114	Sat. sol.	20 60	S S

Sl No.	Chemical	m. p. °C	b. p. °C	Conc. %	Temperature °C	Classification
299.	Stannous chloride	246	652	Sat. sol.	20 60	S S
300.	Starch solution (KSCA)			Sat. sol.	20 60	S S
301.	Stearic acid (KSCA)	71	360 dec.		20 60	S S
302.	Sulphur dioxide, dry gas	— 73	—10		20 60	S S
303.	Sulphur trioxide	17	45	tg-l	20 60	NS NS
304.	Sulphuric acid (O)			Upto 10	20 60	S S
				10 to 50	20 60	S S
				50 to 75	20 60	S L
				80	20 60	S NS
				98	20 60	L NS
				Fuming	20 60	NS NS
305.	Sulphurous acid			Up to 30	20 60	S S
306.	Tallow (P)				20	S
307.	Tannic acid (KSCA)	210 — 215 dec.		Sat. sol,	20 60	S S
308.	Tertaric acid (dec)	170		Sol.	20 60	S S
				Sat. sol.	20 60	S S
309.	Tetrahydrofuran (SSCA/P)		67	tg-l	20 60	NS NS
310.	Thionyl chloride	— 105	79	tg-l	20 60	NS NS
311.	Tin (II) chloride	247	652	Sat. sol.	20 60	S S
312.	Tin (IV) chloride	— 33	113	Sol.	20 60	S S

Sl No.	Chemical	m. p. °C	b. p. °C	Conc. %	Temperature °C	Classification
313.	Titanium tetrachloride (SSCA)			tg-l	20	NS
314.	Toluene (SSCA/P)	— 95	111	tg-l	20 60	NS NS
315.	Transformer oil				20 60	S L
316.	Trichloroethylene (SSCA/P)	— 85	87	tg-l	20 60	NS NS
317.	Triethanolamine	18	190 (5 mm)	Sol.	20 60	S L
318.	Triethylene glycol (SSCA)	— 5	278	tg-l	20 60	S S
319.	Trisodium phosphate			Sat. sol.	20 60	S S
320.	Turpentine (P)			tg-l	20 60	L L
321.	Urea	133		0 to 30	20 60	S S
322.	Urine				20 60	S S
323.	Vanilla Extract (KSCA)				20 60	S S
324.	Vinegar			Work. sol.	20 60	S S
325.	Water				20 60	S S
326.	Water, brackish				20 60	S S
327.	Water, distilled				20 60	S S
328.	Water, fresh				20 60	S S
329.	Water, Mineral			Work. sol.	20 60	S S
330.	Water, Potable			Work. sol.	20	S
331.	Water, Sea				20 60	S S
332.	Wetting agents (KSCA)			Work. sol.	20 60	S S
333.	Whiskey (KSCA)			Work. sol.	20 60	S S

Sl No.	Chemical	m.p. °C	b.p. °C	Conc. %	Tempe-rature °C	Classi-fication
333.	Wines (SSCA)			Work. sol.	20 60	S S
334.	Wines and spirits			Work. sol.	20 60	S S
335.	Xylenes (P)	— 53 to	138 to 144	tg-l	20 60	NS NS
336.	Yeast			Susp.	20 60	S S
337.	Zinc bromide	394	650	Sat. sol.	20 60	S S
338.	Zinc carbonate	— CO_2 300		Susp.	20 60	S S
339.	Zinc chloride	283	732	Sat. sol.	20 60	S S
				58	20 60	S S
340.	Zinc nitrate	46		Sat. sol.	20 60	S S
341.	Zinc oxide	1 975		Susp.	20 60	S S
342.	Zinc stearate	130		sol.	20 60	S S
334.	Zinc sulphate	600 dec.		Sat. sol.	20 60	S S

ANNEX E

(*Foreword*)

COMMITTEE COMPOSITION

Plastic Pipes and Fittings Sectional Committee, CED 50

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Joint Director (Civil Engg), BIS

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