BRITISH STANDARD

BS 3412 : 1992

Methods of specifying

General purpose polyethylene materials for moulding and extrusion

STANDARDS

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Plastics and Rubber Standards Policy Committee (PRM/-) to Technical Committee PRM/32, upon which the following bodies were represented:

British Cable Makers' Confederation
British Plastics Federation
British Telecommunications plc
Ministry of Defence
Packaging and Industrial Films Association
Standards Association of Australia
Telecommunications Cables Group of BCMC

This British Standard, having been prepared under the direction of the Plastics and Rubber Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 28 February 1992

First published September 1961
Second edition December 1966
Third edition March 1976
Fourth edition February 1992

The following BSI references relate to the work on this standard:
Committee reference PRM/32
Draft for comment 88/36146

ISBN 0 580 20546 0

Amendments issued since publication

Amd. No.	Date	Text affected

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Foreword

This British Standard has been prepared under the direction of the Plastics and Rubber Standards Policy Committee and was based on a draft produced by the British Plastics Federation. It was first published in 1961, revised in 1966, and revised again in 1976 when the scope was extended to include some ethylene copolymers for moulding and extrusion purposes and a classification system was introduced which was related to the International Organization for Standardization (ISO) publication ISO 1872 : 1972. This revision supersedes BS 3412 : 1976 which is withdrawn.

ISO 1872 has since been revised and issued in two Parts, ISO 1872 : Part 1 : 1986 and ISO 1872 : Part 2 : 1989.

In this British Standard, which remains related to both ISO 1872 : Parts 1 and 2, the types of polyethylene materials not particularly for British Government Service contracts, are classified by means of two designatory properties, i.e. conventional density and melt flow rate. At the next revision the need to give methods for specifying types of materials particularly for British Government Service contracts will be assessed.

No attempt is made to specify all the properties of a polyethylene or ethylene copolymer that may be of importance in a particular application, and in many cases it will be necessary for the user to state his own special requirements in addition to those specified in this standard.

Methods of test, including methods for the preparation of test specimens, are also given. It is intended that all the methods of test will be published as BS 2782 methods identical with the corresponding ISO standards. However, at the present time, although method numbers have already been allocated, some BS 2782 methods have not yet been published and, until they are, the corresponding ISO standards should be used.

The properties of a polyethylene material may be changed by the incorporation of additives such as pigments and antistatic agents and therefore it is essential that the values quoted for selected properties are related to the material in the form in which it is supplied.

The thermal history and the internal stresses of the test specimens strongly influence the thermal and mechanical properties and resistance to environmental stress cracking but exert less effect on the electrical properties which mainly depend on the chemical composition of the moulding compound.

NOTE. Properties determined according to the methods used in this British Standard will be not necessarily identical to those obtained using specimens of different dimensions and/or prepared by different procedures. The values obtained for the properties of a product depend on the compound, the shape, the test method and the morphology. The latter depends on the extrusion or moulding conditions, for example gating, pressure, temperature or injection rate. It is essential that any subsequent treatment should also be considered, for example, conditioning or annealing.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Section 1. General

1.1 Scope

This British Standard gives a method for specifying the composition and property requirements of ethylene homopolymers and ethylene copolymers having a maximum content of other 1-olefin monomers of less than 50 % (*m/m*). In addition, those with a content of non-olefinic monomers with functional groups up to a maximum of 3 % (*m/m*) are specified in section 2 whilst those particularly for British Government Service contracts having in addition a content of non-olefinic monomers with functional groups up to a maximum of 30 % (*m/m*) are specified in section 3. This British Standard applies to materials ready for normal use in the form of powder, granules and to materials unmodified by colourants, additives, fillers, etc. It does not apply to masterbatches or to ethylene-propylene copolymer (EPM rubber).

NOTE. The titles of the publications referred to in this standard are listed on page 15.

1.2 Definition

declared value

Typical physical value indicated for a material by a manufacturer or supplier.

1.3 Preparation of test specimens

The preparation of test specimens shall be in accordance with procedures described in appendix A, i.e. either by compression moulding or injection moulding.

NOTE. Compression moulding is the preferred method.

1.4 Conditioning of test specimens

Unless otherwise specified test specimens shall be conditioned at 23 °C ± 2 °C and 50 % r.h. for at least 16 h prior to testing.

1.5 Reporting of test data

In addition to the values of the test data the following information shall be reported:

(a) form of material tested (powder, granules, pellets, specimen from a moulded part);

(b) moulding temperature;

(c) average cooling rate;

(d) details of any additional test conditions;

(e) the numbers and dates of the appropriate British Standard test methods.

Section 2. Ethylene homopolymer and copolymer materials having a maximum content of 1-olefin monomers of less than 50 % (*m/m*) and non-olefinic monomers with functional groups up to a maximum of 3 % (*m/m*)

2.1 Designation

2.1.1 The system given in **2.1.2** shall be used. The ethylene homopolymer and copolymer materials are classified according to their method of processing, their designatory properties, i.e. conventional density and melt flow rate, and supplementary information. The designation system is only intended to indicate a broad classification and in most circumstances specific values of the designatory properties and other characteristics will be required (see **2.2.2**).

2.1.2 The designation shall consist of the following coded information, given in the following order and separated by a comma:

(a) the number and date of this British Standard, i.e. BS 3412 : 1992;

(b) identification of the plastics material, i.e. PE (polyethylene);

(c) the code as given in table 1 corresponding to the intended application and method of processing;

(d) the code as given in table 2 corresponding to additives and other supplementary information;

(e) designatory properties as coded in tables 3 and 4 separated by a hyphen.

NOTE. Figure 1 gives an example of a complete designation.

Table 1. Codes for the intended application and method of processing

Code	Intended application and method of processing
A	adhesives
B	blow moulding
B1	extrusion blow moulding
B2	injection blow moulding
C	calendering
E	extrusion
E1	extrusion of pipes
E2	extrusion of profiles
E3	extrusion of sheets
E4	extrusion of tubings
E5	coextrusion
F	extrusion of films
G	general use
H	coating
H1	powder coating
H2	dip coating
K	cable and wire coating
L	monofilament extrusion
M	injection moulding
Q	compression moulding
R	rotational moulding
S	sintering
T	tape manufacture
V	thermoforming
X	no indication
Y	textile yarns, spinning

Table 2. Codes for additives and other supplementary information

Code	Additives and other supplementary information
A	processing stabilized
B	antiblocking
C	coloured/pigmented
D	powder
E	expandable
F	modified burning characteristics
G	materials with no additives other than up to 0.02 % (*m/m*) antioxidant
H	heat-ageing stabilized
K	loss angle not greater than 300 μrad
L	light and/or weather stabilized, containing antioxidants/UV stabilizers but NOT carbon black
N	natural (unpigmented)
P	modified (impact)
Q	suitable for insulation/sheathing with added antioxidant where loss angle is unimportant
R	moulding release agent
S	lubricated
T	improved transparency
W	weather resistant containing antioxidants and carbon black
X	crosslinkable
Y	increased electrical conductivity
Z	antistatic

Table 3. Designatory properties : codes for conventional density

Code	Conventional density range
	kg/m^3
14	≤ 916
18	>916 ≤ 921
23	>921 ≤ 925
27	>925 ≤ 930
33	>930 ≤ 936
40	>936 ≤ 942
45	>942 ≤ 948
50	>948 ≤ 954
57	>954 ≤ 960
62	>960

NOTE. If an individual conventional density value falls on or near the maximum or minimum value of a conventional density range, it is essential that the manufacturer states which code should be used to designate the material. If subsequent individual conventional density values lie on or either side of the range limits for the code because of manufacturing tolerances, the designation is not affected.

Table 4. Designatory properties : codes for melt flow rate (MFR)

Code	MFR range
	g/10 min
000	≤ 0.10
001	>0.10 ≤ 0.20
003	>0.20 ≤ 0.40
006	>0.40 ≤ 0.80
012	>0.80 ≤ 1.5
022	>1.5 ≤ 3.0
045	>3.0 ≤ 6.0
080	>6.0 ≤ 12
200	>12 ≤ 25
400	>25 ≤ 50
700	>50

NOTE. If an individual MFR value falls on or near the maximum or minimum value of an MFR range, it is essential that the manufacturer states which code should be used to designate the material. If subsequent individual MFR values lie on or either side of the MFR range limits for the code because of manufacturing tolerances, the designation is not affected.

An example of a complete designation is as follows:
A grade of polyethylene (PE) intended for extrusion of pipes (E1) light and/or weather stabilized (L) and not pigmented (N), conventional density of 927 kg/m^3 with a melt flow rate of 0.3 g/10 min (003).

Reference **2.1.2**	(a)	(b)	(c)	(d)	(e)
Designation	BS 3412 : 1992	PE	E1	LN	27-003

The full designation is:
BS 3412 : 1992, PE, E1, LN, 27-003

Figure 1. Example of a complete designation

2.2 Properties

2.2.1 Designatory properties

2.2.1.1 *General*

The designatory properties required to be measured for polyethylene materials are conventional density and melt flow rate.

2.2.1.2 *Conventional density*

The value of conventional density when measured by the method given in appendix B shall not differ from the declared value by more than ± 2 kg/m^3 for the range 910 kg/m^3 to 940 kg/m^3. For the density range 941 kg/m^3 to 967 kg/m^3 the value of conventional density shall not differ from the declared value by more than ± 3 kg/m^3.

When carbon black is used to confer weather resistance, the value of conventional density shall be corrected by subtracting a figure related to the level of carbon black present from the conventional density, i.e. the corrected conventional density is the conventional density of the carbon black containing material minus 4.5 times the numerical value of the percentage of carbon black in the material. For this purpose the level of carbon black shall be determined in accordance with BS 2782 : Method 452B.

For coloured material the conventional density used for the purposes of this British Standard shall be the conventional density obtained on the basic uncoloured material.

2.2.1.3 *Melt flow rate*

The melt flow rate (MFR) shall be determined according to test condition 4 of table 2 of BS 2782 : Method 720A : 1979 (at a temperature of 190 °C with a nominal force of 21.2 N). When the MFR measured at test condition 4 is less than 0.1 g/10 min, a nominal force of 49.0 N, i.e. test condition 5 of table 2 of BS 2782 : Method 720A : 1979 shall be used. When the MFR measured at test condition 5 is less than 0.1 g/10 min, a nominal force of 212 N shall be used, i.e. test condition 7 of table 2 of BS 2782 : Method 720A : 1979.

The declared value of the melt flow rate shall be within the tolerances shown in table 5.

Table 5. Melt flow rate tolerances

Melt flow rate declared value	Tolerances
g/10 min	%
≤ 0.8	± 30
> 0.8 ≤ 6	± 25
> 6 ≤ 25	± 20
> 25	± 15

2.2.2 Additional properties

Other properties to be selected will be determined by the characteristics required for processing and the characteristics required of the processed article.

NOTE. The purchaser should establish his own correlation between the properties of the processed article and the material properties required for their achievement.

Typical additional properties to be measured and the test methods to be used are listed in table 6.

2.3 Carbon black content

The carbon black content of weather resistant material shall be not less than 2.0 % (*m/m*) and not more than 3.0 % (*m/m*) when determined by BS 2782 : Method 452B.

2.4 Dispersion of carbon black and pigment

2.4.1 Carbon black

The microscopic dispersion of carbon black shall be determined in accordance with BS 2782 : Method 823A. The numerical rating shall be 5 or less and the uniformity of appearance in respect of smears and streaks shall be at least equal to photomicrograph A of figure 1 of BS 2782 : Method 823A : 1978.

2.4.2 Pigment

The dispersion of the pigment shall be determined in accordance with BS 2782 : Method 1106A and the dispersion shall be at least as uniform in appearance as that shown in photomicrograph 2 of figure 1 of BS 2782 : Method 1106A : 1983.

The density used shall be the conventional density obtained on the basic uncoloured material.

[1] BS 2782 : Part 7 : Method 720A is technically equivalent to ISO 1133.

Table 6. Additional properties[1)]

Property	Unit	BS 2782 Method	Corresponding international method	Specimen dimensions	Particulars
				mm	
Mechanical properties					
Tensile stress at yield[2)]	MPa	320A	ISO R 527	115 × 25/6 × 2	Testing speed 100 ± 10 mm/min
Tensile stress at break[2)]	MPa	320A	ISO R 527	115 × 25/6 × 2	Testing speed 100 ± 10 mm/min
Tensile elongation at yield[2)]	%	320A	ISO R 527	115 × 25/6 × 2	Testing speed 100 ± 10 mm/min
Tensile elongation at break[2)]	%	320A	ISO R 527	115 × 25/6 × 2	Testing speed 100 ± 10 mm/min
Tensile elastic modulus	MPa	320A	ISO R 527	115 × 25/6 × 2	Testing speed 1 mm/min
Flexural modulus at 1 % strain	MPa	335A	ISO 178	80 × 10 × 4	Testing speed 2 mm/min
Shear modulus and mechanical loss factor	MPa		ISO 537	60 × 10 × 1	
Tensile creep modulus[3)]	MPa		ISO 899	115 × 25/6 × 2	
Flexural creep modulus[3)]	MPa		ISO 6602	80 × 10 × 4	
Izod impact resistance[4)] vs temperature	kJ/m^2	350/1A	ISO 180/1A	80 × 10 × 4 Specimen type 1	Notch type A
Charpy impact resistance[5)] vs temperature	kJ/m^2	359/1A	ISO 179/1A	80 × 10 × 4 Specimen type 1	Notch type A
Ball indentation hardness	MPa	365D	ISO 2039-1	10 × 10 × 4	—
Rockwell hardness	—	365C	ISO 2039-2	10 × 10 × 4	Load 35.8 daN, time 30 s
Shore A or D hardness	—	365B	ISO 868	—	—
Thermal properties					
Temperature of deflection[6)]	°C	121B	ISO 75 method B	110 × 10 × 4	
Vicat softening temperature	°C	120A	ISO 306 method A	25 × 25 × 4	Heating rate 50 K/h
Brittleness temperature	°C	150	ISO 974	20 × 2.5 × 1.6	—
Electrical properties					
Surface resistance	Ω	231A	IEC 93	120 × 120 × 1	500 V measuring voltage
Volume resistivity	Ω·cm	230A	IEC 93	120 × 120 × 1	
Electric strength	kV/mm	220	IEC 243	120 × 120 × 0.5	AC voltage is rapidly applied under oil, using 25 mm/75 mm diameter electrodes and a 500 V/s rise rate
Relative permittivity, ε_r	—	240B	IEC 250	120 × 120 × 1	AC voltage 1 MHz
Dissipation factor	tan δ	240B	IEC 250	120 × 120 × 1	AC voltage 1 MHz
Comparative tracking index	—	—	IEC 112	50 × 50 × 3	AC voltage 50 Hz, solution A

Table 6. Additional properties[1)] (*concluded*)

Property	Unit	BS 2782 Method	Corresponding international method	Specimen dimensions	Particulars
				mm	
Other properties					
Density of moulded pieces	g/cm^3	620	ISO 1183		
Water absorption	mg	430A	ISO 62 method 1	Disc diameter 50 and thickness 0.1	
Water vapour transmission rate	g/m^2 per 24 h	820A[7)]	ISO 2528 condition A	Disc diameter 80 and thickness 0.1	Testing atmosphere: 25 ± 2 °C, 90 ± 5 % r.h.
Gas transmission rate	mL/m^2 per 24 h	821A	ISO 2556	Sheet of thickness 0.1	
Effects of liquid chemicals including water	% change	830A	ISO 175		Immersion time 7 days
Viscosity number	cm^3/g	730A	ISO 1628/3	Granules or powder	
Environmental stress cracking[8)]	h	—	ISO 4600	80 × 10 × 4	
Resistance to stress cracking[8)]	h	—	ISO 6252	80 × 10 × 4	
Ageing properties					
Natural weathering[9)]		550A	ISO 4607		
Artificial light weathering[9)]:		552A	ISO 4582		
Methods of exposure to laboratory light sources[10)]		540B	ISO 4892		

[1)]Preferred specimens and conditions are given, but some alternatives are indicated in the footnotes. It is intended to make the preferred conditions mandatory at the next revision.

[2)]Speed F is preferred. It is essential that alternative speeds, for example 50 mm/min, are reported.

[3)]A graph of modulus against time at specified temperatures and stresses is recommended.

[4)]Izod specimen 1 A is preferred. Specimen 4 A is an alternative, but it is essential that its use is reported.

[5)]Charpy specimen 1 A is preferred with distance between supports of 40 mm. Specimens 1 C and 2 C are alternatives, but it is essential that their use is reported.

[6)]110 mm × 10 mm × 4 mm size specimen is preferred. 110 mm × 12.7 mm × 4 mm is an alternative, but it is essential that its use is reported.

[7)]In preparation.

[8)]These tests are not applicable to all grades of polyethylene.

[9)]The property required to be assessed should be specified by the purchaser.

[10)]Change in numerical value induced in 'blue dyed wool standards'.

Table 7. Antioxidants for use with polyethylene compositions

Chemical	Commercially available product of the type (trade name)	BPF/BIBRA listed max. permitted level for the final compound
		% (*m*/*m*)
Group 1		
2,6-di-*tert*-butyl-*p*-cresol	Ionol CP, Topanol OC	0.20
O,O′′′-dioctadecyl pentaerythritol bis(phosphite)	Weston 618	0.30
tris(2,4-di-*tert*-butylphenyl)phosphite	Irgafos 168	0.20
tetrakis(2,4-di-*tert*-butylphenyl) biphenyl-4,4′-ylenebis(phosphonate)	Irgafos P-EPQ	0.20
dioctadecyl-3,3′-thiodipropionate	DSTDP	1.00
didodecyl-3,3′-thiodipropionate	DLTDP	1.00
Group 2		
bis[3,3-bis-(4′-hydroxy-3′*tert*-butyl-phenyl)-butyric acid] glycol ester	Hostanox 03	0.50
2,2′,2′′,6,6′,6′′-hexa-*tert*-butyl-α,α',α''-(2,4,6-trimethyl benzene-1,3,5-triyl)tri-*p*-cresol	Irganox 1330	1.00
octadecyl-3-(3,5-di-*tert*-butyl-4-hydroxphenyl)propionate	Irganox 1076	0.50
pentaerythritol tetrakis [3-(3,5-di-*tert*-butyl-4-hydroxyphenyl)propionate]	Irganox 1010	0.50
6,6′-bis(1-methylcyclohexyl)-2,2′-methylenedi-*p*-cresol	Permanax WSP	0.20
6,6′-di-*tert*-butyl-4,4′-thiodi-*m*-cresol	Santonox or TBM6T or Santonox R or TBM6P	0.25
6,6′,6′′-tri-*tert*-butyl-4,4′,4′′-(1-methylpropan-1-yl-3-ylidene) tri-*m*-cresol	Topanol CA	0.25

NOTE 1. It is recommended that antioxidants in group 1 are not used on their own but in conjunction with antioxidants from group 2.

NOTE 2. The nomenclature follows the International Union of Pure and Applied Chemistry (IUPAC) rules and may differ from nomenclature used by some manufacturers.

'Weston' is the registered trade mark of Borg Warner Chemical Limited.
'Ionol' is the registered trade mark of the Shell Group of companies.
'Irganox' and 'Irgafos' are the registered trade marks of Ciba-Geigy Limited.
'Permanax' is the registered trade mark of Vulnax International Limited.
'Topanol' is the registered trade mark of ICI Limited.
'TBM6' is the registered trade mark of Societé Française d'Organo Synthèse.
'Hostanox' is the registered trade mark of Hoechst Limited.

2.5 Antioxidants

2.5.1 General limitations

When required, stabilization shall be achieved by the addition of antioxidants. The antioxidants for materials in contact with foodstuffs or water intended for human consumption (see **2.5.2** and **2.5.3**) shall be one or more selected from groups 1 and 2 of table 7.

In addition, for contact with foodstuffs and water intended for human consumption antioxidants shall be used in such amounts that when the compound is tested as described in BS 2782 : Method 434D the total antioxidant content (group 1 plus that of group 2) shall be between 0.025 % (*m/m*) and 0.8 % (*m/m*).

2.5.2 Contact with foodstuffs

If the polyethylene is used in contact with foodstuffs, the antioxidants used therein shall be approved by the British Plastics Federation (BPF) and listed in the British Industrial Biological Research Association (BIBRA) Code of Practice as approved for use in contact with foodstuffs[1)].

2.5.3 Contact with water intended for human consumption

Where polyethylene based products are used in contact with water intended for human consumption in applications covered by a British Standard, its requirements with respect to polyethylene based materials shall be met. If no standard exists, the material used in the application shall comply with BS 6920 : Part 1 : 1990, when tested by the methods contained therein.

2.5.4 New or additional antioxidants

NOTE. Applications for approval of new antioxidants should be submitted to the Secretary of the BSI committee responsible for the preparation of this standard.

New or additional antioxidants submitted for approval shall be accompanied by the following information:

(a) chemical formula, trade name and manufacturer;

(b) proposed concentration range;

(c) whether suitable for use in a polymer in contact with foodstuffs and water intended for human consumption;

(d) a technical comparison with antioxidant(s) in table 7 illustrating the ability of the antioxidant to confer adequate stability for fabrication and use of the polyethylene.

1) *'Plastics for food contact applications. A Code of Practice for safety in use'*, 1981, and published by the British Plastics Federation, 5 Belgrave Square, London SW1X 8PH.

Section 3. Polyethylene materials for British Government Service contracts

3.1 Classification

3.1.1 General

Materials shall be classified in accordance with their polymer type (**3.1.2**) and modifications (**3.1.3**).

3.1.2 Polymer type

The word 'Type' followed by a single letter shall be used to denote polymer type as follows:

(a) Type A : ethylene homopolymers containing not more than 0.5 % (*m/m*) of hydrocarbon comonomer;

(b) Type D : ethylene copolymers containing not more than 30 % (*m/m*) of olefinic comonomer;

(c) Type G : ethylene copolymers containing not more than 30 % (*m/m*) of non-olefinic comonomer.

3.1.3 Modifications

The word 'Class' followed by a single letter shall be used to denote modifications to the polymer as follows:

(a) Class H : materials with no additives other than up to 0.02 % (*m/m*) antioxidant;

(b) Class J : materials with no additives other than those normally added to protect the polymer during processing;

(c) Class N : materials with additives and/or pigments excluding those materials specified in Class Q, Class R, Class S and Class W;

(d) Class Q : materials suitable for insulation and sheathing with added antioxidant with or without colour, where electrical losses due to the loss angle of the material are not important to the application;

(e) Class R : materials suitable for insulation and sheathing with added antioxidant and without colour, where the loss angle complies with **3.2.1**;

(f) Class S : materials with no additive other than up to 0.01 % (*m/m*) of antioxidant where the loss angle complies with **3.2.1**;

(g) Class W : weather resistant materials containing antioxidants and adequately dispersed finely divided carbon black. The carbon black shall have an iodine absorption number of not less than 110, when tested by the method described in BS 5293.

3.2 Properties

3.2.1 Loss angle

The loss angle δ at any one frequency within the range 1 MHz to 20 MHz shall be determined on sheet prepared and conditioned as specified in **1.3** and **1.4**, by BS 2782 : Method 207A : 1970 except that the results shall be expressed in microradians. The loss angle of Type A, Class R and Class S materials shall not be greater than 300 μrad.

3.2.2 Additional properties

Additional test data shall be provided as indicated by the purchaser using the methods given in table 6 and the methods of specimen preparation specified in **1.3**.

3.3 Antioxidants

Unless otherwise agreed by the purchaser, the nature and quantity of antioxidant Classes H, Q and W shall be selected from any of those listed in group 2 of table 7 with or without the admixture of material(s) from group 1, but for Class R and Class S they shall only be selected from those listed in group 2 of table 7. Where there is a mixture of the listed antioxidants, the total amount of the antioxidant shall be determined. Unless otherwise indicated by the purchaser, BS 2782 : Method 434D shall be used. If the antioxidants present are unknown, they shall be identified by using BS 2782 : Method 434A.

3.4 Marking

The material shall be supplied with a notification of the polymer type and class and additional data required by the purchaser.

Appendices

Appendix A. Preparation of test specimens

A.1 Principle

Precise methods of compression and injection mouldings are specified.

A.2 Compression moulding

A.2.1 *General*

Specimens shall be prepared either by stamping or machining from a compression moulded sheet as described in BS 2782 : Method 930A[1]. In addition the guidelines given in **A.2.2** to **A.2.6** apply.

NOTE. Details of compression moulding of sheet are given in BS 2782 : Method 901A[2].

A.2.2 *Mould*

A flash mould is preferred for thin sheet but positive moulding is sometimes required for sheet greater than 5 mm in thickness.

A.2.3 *Predrying*

Predry the material for 3 h at 90 °C if the presence of moisture is suspected, e.g. evidenced by voids in the moulding.

NOTE. Compounds containing carbon black can be hygroscopic.

A.2.4 *Moulding temperature*

A moulding temperature of 180 ± 5 °C is preferred. If other temperatures have to be used because of the nature of the polymer, generally in the range 130 °C to 200 °C, they shall be reported.

NOTE. Low density polyethylene requires a lower temperature than high density polyethylene, also high molecular weight polyethylene requires a higher temperature than medium molecular weight polyethylene.

A.2.5 *Average cooling rate*

The average cooling rate shall be one of the following.

(a) Preferred rate : 15 ± 5 °C min.

(b) Quench cooling rate : 60 ± 30 °C min.

(c) Slow cooling rate : 5 ± 0,5 °C h.

If a rate other than (a) is used because of the requirements of the user, it shall be reported.

A.2.6 *Moulding procedure*

The contact pressure time shall be 5 min to 10 min and the full pressure time 2 min to 5 min. The demoulding temperature shall be not less than 40 °C.

A.3 Injection moulding

When required by the purchaser injection moulded test specimens shall be prepared as described in BS 2782 : Method 910A[3]. The properties of injection moulded test specimens strongly depend on the equipment and conditions used. At present, because of the very wide range of polyethylene materials available, it is not yet possible to fully standardize an injection moulding procedure.

Appendix B. Method of determining conventional density

B.1 Principle

The polymer is extruded under controlled conditions and its density determined by a density gradient column method.

B.2 Apparatus

B.2.1 *Rheometer*, as described in BS 2782 : Method 720A[4].

B.2.2 *Density gradient column*, complying with BS 2782 : Method 620D[5].

B.3 Procedure

Determine the conventional density on an extrudate from a rheometer (**B.2.1**), prepared under suitable conditions in order to obtain a strand of suitable length, free of voids, with a smooth surface. After being cut off, the strand is allowed to fall on to a cold metal plate. It is subsequently annealed by immersing it in 200 mL of boiling water in a beaker, boiled for 30 min, and allowed to cool for 1 h by keeping the beaker and contents in the laboratory atmosphere. The density of the specimen is then determined within 24 h according to BS 2782 : Method 620D.

[1]BS 2782 : Method 930A is technically equivalent to ISO 2818.
[2]BS 2782 : Method 901A is technically equivalent to ISO 293.
[3]BS 2782 : Method 910A is identical with ISO 294.
[4]BS 2782 : Method 720A is technically equivalent to ISO 1133.
[5]BS 2782 : Method 720D is technically equivalent to ISO 1183.

Publication(s) referred to

BS 2782 : 1970 Methods of testing plastics

BS 2782 Methods of testing plastics
Part 1 Thermal properties
Method 120A Determination of Vicat softening temperature of thermoplastics
Method 121B Determination of temperature of deflection under a bending stress of 0.45 MPa of plastics and ebonite
Method 150A Determination of stiffness in torsion as a function of temperature
Part 2 Electrical properties
Method 207A Loss tangent and permittivity of moulding material at 10 KHz to 100 MHz
Method 220 Determination of electric strength : rapidly applied voltage method
Method 230A Determination of volume resistivity
Method 231A Determination of surface resistivity
Method 240B Determination of loss tangent and permittivity at power and audio frequencies
Part 3 Mechanical properties
Method 320A Tensile strength, elonation and elastic modulus
Method 335A Determination of flexural properties of rigid plastics
Method 350 Determination of Izod impact strength of rigid materials
Method 359 Determination of Charpy impact strength of rigid materials (Charpy impact flexural test)
Method 365B Determination of indentation hardness by means of a durometer (Shore hardness)
Method 365C Determination of Rockwell hardness
Method 365D Determination of hardness of plastics and ebonite by the ball indentation method
Part 4 Chemical properties
Method 430A Determination of water absorption at 23°C
Method 434A The identification of antioxidants and ultraviolet absorbers in polyolefin compounds by thin layer chromatography
Method 434D Determination of antioxidants in polyolefin compounds by a spectrophotometric method
Method 452B Determination of carbon black content of polyolefin compound
Part 5 Optical and colour properties, weathering
Method 540B Methods of exposure to laboratory light sources, (xenon arc lamp, enclosed carbon arc lamp, open-flame carbon arc lamp, fluorescent tube lamps)
Method 550A Methods of exposure to natural weathering
Method 552A Determination of changes in colour and variations in properties after exposure to daylight under glass, natural weathering or artifical light
Part 6 Dimensional properties
Method 620D Determination of density of solid plastics excluding cellular plastics (density gradient column method)
Part 7 Rheological properties
Method 720A Determination of melt flow rate of thermoplastics
Method 730A Determination of reduced viscosity (viscosity number) and intrinsic viscosity of plastics in dilute solution
Part 8 Other properties
Method 820A[1)] Determination of water vapour transmission rate (dish method)
Method 821A Determination of the gas transmission rate of films and thin sheets under atmospheric pressure (manometric method)
Method 823A Methods for the assessment of carbon black dispersion in polyethylene using a microscope
Method 830A Determination of the effects of liquid chemicals, including water
Part 9 Sampling and test specimen preparation

[1)] In preparation.

	Method 901A Compression moulding test specimens of thermoplastic materials Method 910A Injection moulding test specimens of thermoplastic materials Method 930A Preparation of test specimens by machining Part 11 Thermoplastics pipes, fittings and valves Method 1106A Assessment of pigment dispersion in polyolefin pipes and fittings : microtome method
BS 5293	Methods for sampling and testing carbon black for use in the rubber industry
BS 6920	Suitability of non-metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of the water
ISO 62	Plastics — Determination of water absorption
ISO 75	Plastics and ebonite — Determination of temperature of deflection under load
ISO 175	Plastics — Determination of the effects of liquid chemicals, including water
ISO 178	Plastics — Determination of flexural properties of rigid plastics
ISO 179	Plastics — Determination of Charpy impact strength of rigid materials
ISO 180	Plastics — Determination of Izod impact strength of rigid materials
ISO 293	Plastics — Compression moulding test specimens of thermoplastic materials
ISO 294	Plastics — Injection moulding test specimens of thermoplastic materials
ISO 306	Plastics — Thermoplastic materials — Determination of Vicat softening temperature
ISO/R 527	Plastics — Determination of tensile properties
ISO 537	Plastics — Testing with the torsion pendulum
ISO 868	Plastics and ebonite — Determination of indentation hardness by means of a durometer (Shore hardness)
ISO 899	Plastics — Determination of tensile creep
ISO 974	Plastics — Determination of the brittleness temperature by impact
ISO 1133	Plastics — Determination of the melt flow rate of thermoplastics
ISO 1183	Plastics — Methods for determining the density and relative density of non-cellular plastics
ISO 1628/3	Plastics — Determination of viscosity number and limiting viscosity number Part 3 Polyethylenes and polypropylenes
ISO 1872	Plastics — Polyethylene (PE) and ethylene copolymer thermoplastics Part 1[1)] Designation Part 2[1)] Preparation of test specimens and determination of properties
ISO 2039	Plastics — Determination of hardness Part 1 Ball indentation method Part 2 Rockwell hardness
ISO 2528	Sheet materials — Determination of water vapour transmission rate — Dish method
ISO 2556	Plastics — Determination of the gas transmission rate of films and thin sheets under atmospheric pressure — Manometric method
ISO 2818	Plastics — Preparation of test specimens by machining
ISO 4582	Plastics — Determination of changes in colour and variations in properties after exposure to daylight under glass, natural weathering or artificial light
ISO 4600	Plastics — Determination of environmental stress cracking (ESC) — Ball or pin impression method
ISO 4607	Plastics — Methods of exposure to natural weathering
ISO 4892	Plastics — Methods of exposure to laboratory light sources
ISO 6252	Plastics — Determination of environmental stress cracking (ESC) — Constant tensile stress method
ISO 6602	Plastics — Determination of flexural creep by three-point loading

[1)]Referred to in the foreword only.

IEC 93	Methods of test for volume resistivity and surface resistivity of solid electrical insulating materials
IEC 112	Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions
IEC 243	Recommended methods of test for electrical strength of solid insulating materials at power frequencies
IEC 250	Recommended methods for the determination of the permittivity and dielectric dissipation factor of electrical insulating materials at power, audio and radio frequencies including metre wavelengths

'Plastics for food contact applications. A Code of Practice for safety in use', revised edition 1981, published by the British Plastics Federation, 5 Belgrave Square, London SW1X 8PH.

'Antioxidants in Food Regulations 1978' (Statutory Instrument 1978 Number 105) and its subsequent amendment (Statutory Instrument Number 1831) to ensure compliance with UK legal requirements.

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