IS 10889 (2004): High density polyethylene films [PCD 12: Plastics]

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भारतीय मानक

उच्च घनत्व की पालीईथाइलीन फिल्में

(पहला पुनरीक्षण)

Indian Standard

HIGH DENSITY POLYETHYLENE FILMS

(First Revision)

ICS 83.140.10

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

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Price Group 3

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Plastics Sectional Committee had been approved by the Petroleum, Coal and Related Products Division Council.

This standard was first published in 1984. Considering the latest technological development in this field, the Committee decided to revise this standard. In this revision the following modifications have been effected:

a) Material clause has been modified and more HDPE grade designations have been introduced,

b) Melt flow index requirement has been modified as melt flow rate, and

c) Test method for various requirements like density, melt flow rate, tensile strength and elongation at break, impact resistance (falling dart) have been updated by referring to latest methods.

Films made for high molecular mass high density polyethylene (HM HDPE) and medium molecular mass high density polyethylene (MM HDPE) are being increasingly used for packaging, agriculture and construction purposes.

HDPE films have many advantages such as high shear and tensile strength, good barrier properties, high rigidity and high service temperature. They are mainly used for packaging, agriculture, operations construction work and related applications. Of late, HM HDPE a films are also being used for canal lining purposes.

For tropical countries like India, the standard temperature and the relative humidity shall be taken as 27 ± 2°C and 65 ± 5 percent respectively.

The composition of the Committee responsible for formulation of this standard is given in Annex C.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified values in this standard.

Indian Standard

HIGH DENSITY POLYETHYLENE FILMS

(First Revision)

1 SCOPE

1.1 This standard prescribes requirements, methods of sampling and test for natural and black colour (carbon black pigment) high density polyethylene (HDPE) films.

1.2 Coloured films other than black shall be as agreed to between the purchaser and the supplier.

2 REFERENCES

The following standards, contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
2530 : 1963	Methods of test for polyethylene moulding material and polyethylene compounds
4905 : 1988	Methods for random sampling
7019 : 1998	Glossary of terms in plastics and flexible packaging, excluding paper (*second revision*)
7328 : 1992	High density polyethylene materials for moulding and extrusion — Specification (*first revision*)
7497 : 1985	Specification for high abrasion furnace (HAF) carbon black (*first revision*)
8134 : 1996	Intermediate super abrasion furnace (ISAF) N220 carbon black — Specification (*second revision*)
10141 : 2001	Positive list of constituents of polyethylene in contact with foodstuffs, pharmaceuticals and drinking water (*first revision*)
10148 : 1982	Positive list of constituents of polyvinyl chloride and its co-polymer for safe use in contact with foodstuffs, pharmaceuticals and drinking water
10357 : 1990	General purpose furnace [(GPF)(N660)] carbon black — Specification (*first revision*)
10358 : 1991	Carbon black super abrasion furnace [(SAF)(N110)] — Specification (*first revision*)
13360 (Part 3/ Sec 1) : 1995	Plastics — Methods of testing: Part 3 Physical and dimensional properties, Section 1 Determination of density and relative density of non-cellular plastics
13360 (Part 4/ Sec 1) : 1995	Plastics — Methods of testing: Part 4 Rheological properties, Section 1 Determination of melt mass-flow rate (MFR) and melt volume flow rate (MVR) of thermoplastics
13360 (Part 5/ Sec 1) : 1996	Plastics — Methods of testing: Part 5 Mechanical properties, Section 1 Determination of tensile properties general principles
13360 (Part 5/ Sec 3) : 1999	Plastics — Methods of testing: Part 5 Mechanical properties, Section 3 Determination of tensile properties — Test conditions for films and sheets
13360 (Part 5/ Sec 6) : 1999	Plastics — Methods of testing: Part 5 Mechanical properties, Section 6 Determination of impact resistance by the free falling dart method — Staircase method

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 7019 shall apply.

4 GRADES

4.1 The material shall be of the following two grades:

a) *Grade* 1 — High molecular weight, high density polyethylene (HM HDPE), and

b) *Grade* 2 — Medium molecular weight, high density polyethylene (MM HDPE).

5 COMPOSITION

5.1 The compound used for manufacturing film shall consist only of polyethylene resins complying with **5.1.1**.

NOTE — When the film is meant for food contact applications, the compound used shall also comply with IS 10141 and IS 10148.

5.1.1 The material used for the film shall be any of the following designation conforming to IS 7328.

5.1.1.1 *Grade* 1

PE FAN C 45 T 003
PE FAN C 50 T 003
PE FAN C 45 T 006
PE FAN C 50 T 006

5.1.1.2 *Grade* 2

PE FAN C 50 T 012
PE FAN C 57 T 012
PE FAN C 50 T 022
PE FAN C 57 T 022

5.2 Black Compound

The base polymers for the black films shall conform to grades as specified in **5.1.1** and shall contain 2.5 ± 0.5 percent carbon black by mass (*see also* **6.1.6**).

5.2.1 *Carbon Black*

The relevant specifications for carbon black used in polyethylene films are IS 7497, IS 8134, IS 10357 and IS 10358.

6 REQUIREMENTS

6.1 General

6.1.1 *Appearance*

The film shall be uniform in colour texture and finish. The material shall be substantially free from pinholes and reasonably free from undispersed raw materials, streaks and particles or foreign matter. There shall be no other visible defects, such as melt fracture, holes, tears or blisters. The edges shall be free from nicks and cuts visible to unaided eye.

6.1.2 *Film Form*

The film shall be furnished in the form of flat sheet or rolls or in the form of flat tubing or in any other form as agreed to between the supplier and the purchaser.

6.1.3 *Odour*

The film shall be free from any objectionable odour.

6.1.4 *Density*

The density of the film, when determined in accordance with IS 13360 (Part 3/Sec 1) shall be as prescribed for the appropriate grade specified in **5.1.1** and **5.2**.

6.1.4.1 For grades mentioned in **4.1**, density of base material shall be obtained by subtracting from the density of the black material figure relating to the proportion of carbon black present as indicated below:

Density of base material = Density of black material − 0.004 5 × Percent by mass of carbon black content

6.1.5 *Melt Flow Rate*

The melt flow rate of the film when determined in accordance with IS 13360 (Part 4/Sec 1) shall be as prescribed for the appropriate grade specified in **5.1.1** and **5.2**.

6.1.6 *Black Film*

When tested in accordance with :

a) Clause **10** of IS 2530, the percentage of carbon black in the material shall be 2.5 ± 0.5 percent by mass; and
b) Clause **16** of IS 2530, the dispersion of the carbon black shall be satisfactory.

6.2 Dimensional Requirements

6.2.1 *Nominal Thickness*

Nominal thickness is the theoretically desired thickness of a film for a particular application.

6.2.1.1 *Tolerance on thickness*

When tested by the method prescribed in Annex A, the tolerance on nominal thickness at any given point and the average thickness of polyethylene films for various thicknesses shall be as given in Table 1.

Table 1 Tolerances on Thickness

Sl No.	Nominal Thickness	Tolerance, Percent Grade 1 and 2
(1)	(2)	(3)
i)	Up to and including 40 µm	± 25
ii)	Above 40 µm	± 20

6.2.2 *Nominal Width*

Nominal width is the theoretically desired width of a film for a particular application as agreed to between the supplier and the purchaser.

6.2.2.1 *Tolerance on width*

The tolerance on width shall be as given in Table 2.

Table 2 Tolerances on Width
(*Clause* 6.2.2.1)

Sl No.	Nominal Width mm	Tolerance, Percent Grade 1 and 2
(1)	(2)	(3)
i)	Up to 50	± 5
ii)	Above 50 and up to 125	± 8
iii)	Above 125 and up to 250	± 20
iv)	Above 250 and up to 300	± 40
v)	Above 300	± 65

6.3 Yield Tolerance

The actual yield shall be determined in accordance with the method given in Annex B and shall be within tolerance limits of the nominal yields as given in Table 3.

Table 3 Tolerances on Nominal Yield

Sl No.	Nominal Yield	Tolerance, Percent Grade 1 and 2
(1)	(2)	(3)
i)	One roll	± 10
ii)	Lots of 250 kg	± 10
iii)	Lots over 250 kg and up to 1 250 kg	± 5
iv)	Lots of 1 250 kg	± 3

6.4 Mechanical Properties

6.4.1 *Tensile Strength at Break*

The minimum tensile strength at break when tested as prescribed in IS 13360 (Part 5/Sec 1) and IS 13360 (Part 5/Sec 3) for all thicknesses of polyethylene film shall be as given in Table 4.

Table 4 Tensile Strength at Break

Sl No.	Direction	Grade 1 and 2
(1)	(2)	(3)
i)	Machine direction, kgf/cm^2	300
ii)	Transverse direction, kgf/cm^2	250

6.4.2 *Elongation at Break*

The minimum elongation at break when tested as prescribed in IS 13360 (Part 5/Sec 1) and IS 13360 (Part 5/Sec 3) for all thickness of polyethylene film shall be as given in Table 5.

Table 5 Elongation at Break

Sl No.	Direction	Elongation at Break, Percent Grade 1 and 2
(1)	(2)	(3)
i)	Machine direction	300
ii)	Transverse direction	300

6.4.3 *Impact Resistance (Falling Dart)*

When tested as prescribed in IS 13360 (Part 5/Sec 6) the impact failure load obtained from the drop of 66 cm shall not be less than that given in Table 6 for the appropriate average thickness of film.

Table 6 Impact Resistance (Falling Dart)

Sl No.	Average Thickness of Film	Impact Failure Load, g f	
	(μm)	Grade 1 Film	Grade 2 Film
(1)	(2)	(3)	(4)
i)	12.5	35	—
ii)	25.0	70	25
iii)	50.0	140	100

NOTE — Values for impact failure loads for intermediate thickness may be obtained by interpolation.

7 PACKING AND MARKING

7.1 Packing

The roll of polyethylene film shall be packed as agreed to between the purchaser and the supplier.

7.2 Marking

Each roll shall be marked legibly with the following information:

a) Manufacturer's name and his recognized trade-mark, if any;
b) Grade of the film;
c) Width of the roll;
d) Length of the roll;
e) Mass of the roll;
f) Thickness of the film; and
g) Batch number and date of manufacture.

7.2.1 *BIS Certification Marking*

The rolls may also be marked with the Standard Mark.

7.2.1.1 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 the license for the use of the Standard Mark may be granted to the manufacturers or the producers may be obtained from the Bureau of Indian Standards.

8 SAMPLING

8.1 Lot

In any consignment, all rolls of polyethylene film of the same grade shall be grouped together to constitute a lot.

8.1.1 Tests for determining the conformity of the lot to the requirements of the standard shall be done on each lot separately. The number of rolls to be selected

for this purpose shall be in accordance with col 2 and 3 of Table 7.

8.1.2 The rolls shall be selected at random. In order to ensure the randomness of selection, reference may be made to IS 4905.

8.2 Number of Tests and Criteria for Conformity

8.2.1 From each of the rolls selected according to **8.1.2** approximately 10 m^2 of the film of full width shall be cut, care being taken to exclude not less than 2 m lengths of film (or three full turns of the rolls) from either end. The test specimens for the various tests shall be cut from different parts of each of the 10 m^2 pieces.

8.2.2 Each of the pieces obtained in **8.2.1** from a lot shall be examined for appearance (*see* **6.1.1**), odour (*see* **6.1.3**), density (*see* **6.1.4**), melt flow rate (*see* **6.1.5**), dimensional requirements (*see* **6.2**) and yield tolerance (*see* **6.3**). Any piece which does not meet the requirement of any of the above characteristics shall be considered as defective.

8.2.3 If the number of defectives found (*see* **8.2.2**) is less than or equal to the corresponding permissible number of defectives given in col 4 of Table 7, the lot shall be tested for the remaining requirements of the specification.

8.2.4 The lot having been found satisfactory according to **6.2.3** shall be tested for tensile strength at break (*see* **6.4.1**), elongation at break (*see* **6.4.2**), impact resistance (*see* **6.4.3**). For this purpose the rolls already tested according to **8.2.2** and found satisfactory shall be used, subject to the restriction that not more than 15 rolls shall be used for testing any of these characteristics. In case there are more than 15 rolls, 15 rolls shall be selected from them at random. Specimen(s) for these tests shall be cut from 10 m^2 piece already taken from each roll selected (*see* **8.2.1**).

8.2.4.1 The lot shall be deemed to have satisfied these requirements if all the test results for different characteristics given in **8.2.4** are found meeting the relevant requirements of the standard.

Table 7 Scale of Sampling and Permissible Number of Defectives
(*Clauses* 8.1.1 *and* 8.2.3)

Sl No.	Lot Size	Number of Rolls to be Selected	Permissible Number Defectives
	N	*n*	
(1)	(2)	(3)	(4)
i)	1	1	0
ii)	2–15	2	0
iii)	16–40	3	0
iv)	41–65	5	0
v)	66–110	7	0
vi)	111–180	10	0
vii)	181–300	15	1
viii)	301–500	25	1
ix)	501–800	35	2
x)	801–1 300	50	3
xi)	1 301 and above	75	4

8.2.5 The lot shall be declared as conforming to the requirements of the standard, if the requirements for various characteristics as given in **8.2.3** and **8.2.4** are satisfied.

ANNEX A

(*Clause* 6.2.1.1)

DETERMINATION OF THICKNESS

A-1 GENERAL

This method outlines the procedure for the determination of thickness.

A-1.1 Apparatus

A-1.1.1 A dead-weight dial micrometer with a flat anvil of 6 mm diameter or larger in area and 4.8 mm diameter flat surface on the head of the spindle, or a spring micrometer which has been calibrated against a dead-weight dial micrometer shall be used. In case of dispute only dead-weight dial micrometer shall be used and the reading shall be taken between 15 s and 2 min after the load is applied.

A-1.2 Specimens

Test five specimens, at least 5 cm × 5 cm in area, taken uniformly across the width of the test piece.

A-1.3 Procedure

Dry and clean the surface of the anvil and spindle head, and of the specimen. Place the specimen on the anvil and lower the spindle-head on to it slowly. The total load applied by the spindle shall be 110 g. Make one measurement on each specimen approximately at the centre of the specimen. Take mean on the measurements of all the specimens of a sample to obtain the average thickness of the sample.

ANNEX B

(*Clause* 6.3)

DETERMINATION OF YIELD TOLERANCE

B-1 GENERAL

This method outlines the procedure for the determination of yield tolerance.

B-1.1 Calculation of Actual Yield

Yield is the amount of area provided by a given mass of a film of specified thickness. The actual yield Y_a shall be calculated as follows:

$$Y_a = \frac{A}{M} \text{ cm}^2/\text{kg}$$

where

A = area, in cm^2, calculated from the length and the width of the roll, and

M = mass, in kg, of the film on the roll.

B-1.2 Calculation of Nominal Yield

The nominal yield Y_n shall be calculated as follows:

$$Y_n = \frac{1\,000}{dt} \text{ cm}^2/\text{kg}$$

where

d = density, in g/ml, as determined in **6.1.4**, and

t = nominal thickness in cm as determined in Annex A.

B-1.3 Calculation of Deviation of Actual Yield from the Nominal Yield

The deviation of actual yield from the nominal yield shall be calculated as follows:

$$D = \frac{(Y_n - Y_a) \times 100}{Y_n}$$

where

D = deviation from the nominal yield in percent, and

Y_n, Y_a = nominal yield and actual yield respectively as determined in **B-1.1** and **B-1.2**.

ANNEX C

(Foreword)

COMMITTEE COMPOSITION

Plastics Sectional Committee, PCD 12

Organization	*Representative(s)*
Borouge Pvt Ltd, Mumbai	SHRI P. R. SINGHVI (***Chairman***)
All India Plastic Industries Association, Delhi	SHRI RAVI K. AGGARWAL SHRI V. P. BHARDWAJ (*Alternate*)
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Member Secretary
SHRI A. K. BHATNAGAR
Joint Director (PCD), BIS

Bureau of Indian Standards

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

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