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प्लास्टिसाइज़र एस्टर — विशिष्टि

(आई. एस. 14421 का पहला पुनरीक्षण)

Draft Indian Standard

PLASTICIZER ESTERS — SPECIFICATION

(*First Revision of* IS 14421)

(ICS 71.080; 83.040.30)

Plastics Sectional Committee,	Last date for Comments
PCD 12	01 November 2025

FOREWORD

(*formal clause to be added later*)

A plasticizer is defined as a material incorporated into plastics to increase their workability, flexibility, or extensibility. The addition of a plasticizer may lower the melt viscosity, the second-order transition temperature, or the elastic modulus of the plastic. For a plasticizer to be effective with any polymeric material, the two must be intimately mixed. The use of plasticizers always involves a compromise of desirable properties, making the choice of a specific plasticizer for a given application challenging. The efficiency of a plasticizer refers to its ability to produce the desired effect. The greater the amount required to achieve this effect, the lower its efficiency. Generally, more viscous plasticizers are less efficient than less viscous ones, although there are some exceptions. A high proportion of compatibility-inducing groups in the molecule usually lowers efficiency. The principal exception is with linear polyester plasticizers: their high molecular weight results in high viscosity, but their predominantly aliphatic linear structures allow them to react almost segment by segment, making them far more efficient as plasticizers than would otherwise be predicted.

The principal use of plasticizers is with thermoplastic resins, which may be modified only slightly to facilitate processing or transformed into radically different materials. Polyvinyl chloride (PVC) is particularly suited for modification by plasticizers and accounts for the largest share of organic plasticizer consumption. Organic plasticizers are generally moderately high molecular weight liquids or, less commonly, low-melting solids. They are most often esters of carboxylic or phosphoric acids, such as phthalates, adipates, sebacates, and azelates. Other types include hydrocarbons, halogenated hydrocarbons, ethers, polyglycols, and sulfonamides.

Phthalate esters, particularly Dialkyl phthalates, are considered general-purpose plasticizers and are widely used due to their balanced performance characteristics, such as resin compatibility, flexibilizing efficiency, low volatility, and resistance to extraction. Dialkyl phthalate plasticizers have dominated plasticizer technology since the 1930s. For many years, di-2-ethylhexyl phthalate (commonly known as DOP) was the accepted industry benchmark for general-purpose plasticizers for PVC, against which other plasticizers were compared. Its overall performance was so effective that it alone accounted for nearly one-fourth of total plasticizer production.

The Indian Standard on phthalate plasticizer ester was first published in 1965, namely, 'Specification for Di-n-butyl phthalate' (IS 3371: 1965) followed by standards on 'Di-octyl phthalate' (IS 3672: 1966) and 'Dimethyl phthalate plasticizer' (IS 6627: 1972). All of these standards were revised in 1980 to incorporate additional test requirements and to align testing methods with corresponding international standards. Subsequently, IS 9572: 1980 'Benzyl butyl phthalate plasticizer' was formulated considering its importance amongst the phthalate plasticizer.

Considering the various changes and advancements in the field of plasticizers, along with the requirements of both manufacturers and users, and to enable a possible merger of the existing four Indian Standards on phthalate plasticizers, the concerned Technical Committee critically reviewed the standards and decided to formulate a consolidated Indian Standard in 1997 in line with international practices. With the publication of this standard, the existing standards—IS 3371:1980, IS 3672:1980, IS 6627:1980, and IS 9572:1980—were rendered obsolete. Considerable assistance was derived from the following publications during the preparation of this standard:

BS 573,574, 1995, 1996,2535, 2536, 3647: 1973 Specification for plasticizer esters. British Standards Institution.

BS 4968-70: 1973 Specifications for Di-isobutyl phthalate, Di-Isooctyl phthalate, Di-Isooctyl sebacates. British Standards Institution.

The major changes in this (first) revision are as follows:

i) Inclusion of two additional types of materials, namely Dioctyl Terephthalate (DOTP) and Diisononyl Phthalate (DINP);
ii) Deletion of volatile loss characteristics; and
iii) Incorporation of the amendment.

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: 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1 SCOPE

This standard specifies the requirements, methods of sampling and tests for various types of plasticizer esters (phthalates and terephthalates only) for use as plasticizers for plastics and for other purposes requiring similar quality of materials.

2 REFERENCES

The following standards contain provisions which, through reference in this text, constitute provisions of the 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*
IS 2828: 2019	Plastics - Vocabulary (*Second Revision*)
IS 9591: 2023	Plasticizer Esters Methods of Sampling and Tests

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 2828 shall apply.

4 TYPES

There shall be eight types of the materials as indicated below:

Type 1 Di-n-butyl phthalate, [$C_6H_4(COOC_4H_9)_2$], CAS Registry No. (84-74-2), consisting essentially of the di-ester of phthalic acid and butane-1-ol (n-butanol) commonly known as DBP.

Type 2 Di-(2-ethylhexyl) phthalate, [$C_6H_4(COOCH_2CH(C_2H_5)\ C_4H_9)_2$], CAS Registry No. (117-81-7), consisting essentially of the diester of phthalic acid and 2-ethylhexanol, commonly known as DOP.

Type 3 Di-isooctyl phthalate [$C_6H_4(COOCH_2CH(C_2H_5)\ C_4H_9)_2$], CAS Registry No. (27554-26-3), consisting essentially of the diester of phthalic acid and iso octanol, commonly known as DIOP.

Type 4 Dimethyl phthalate [$C_6H_4(COOCHG_3)_2$], CAS Registry No. (131-11-3), consisting essentially of the diester of phthalic acid and methanol, commonly known as DMP.

Type 5 Diethyl phthalate, [$C_6H_4(COOC_2H_5)_2$], CAS Registry No. (84-66-2), consisting essentially of the diester of phthalic acid and ethanol, commonly known as DEP.

Type 6 Di-(2-methyl propyl) phthalate, {$C_6H_4[COOCH_2CH(CH)_3.CH_3]_2$}, CAS Registry No. (84-69-5) consisting essentially of the diester of phthalic acid and 2-methylpropan-1-ol (isobutanol), commonly known as DIBP.

Type 7 Di-isodecyl phthalate, [$C_6H_4(COOC_{10}H_{21})_2$) CAS Registry No. (2761-42-0), consisting essentially of the diester of phthalic acid and iso decanol, commonly known as DIDP.

Type 8 Benzyl butyl phthalate [$C_6H_4(COOC_4H_9.COOCH_2C_6H_5)$) CAS Registry No. (85-68-7), consisting essentially of the diester of phthalic acid and butyl benzyl alcohol, commonly known as BBP.

Type 9 Dioctyl terephthalate, [$C_6H_4(COOC_8H_{17})_2$], CAS Registry No. (6422-86-2), consisting essentially of the diester of terephthalic acid and 2-ethylhexanol, commonly known as DOTP.

Type 10 Diisononyl phthalate [$C_6H_4(COOC_9H_{19})_2$], CAS Registry No.: 28553-12-0 and 68515-48-0, consisting essentially of the diester of phthalic acid and isononyl alcohols (a mixture of C_9 branched isomers), commonly known as DINP.

5 REQUIREMENTS

5.1 Description

The materials shall be clear liquids and free from sediments and matter in suspension, as determined by visual inspection.

5.2 The material shall also comply with the requirements given in Table 1, when tested according to the methods prescribed in column 13 of Table 1.

Table 1 Requirements for Plasticizer Esters

Sl No.	Characteristics	Requirements of Types										Methods of Tests Ref to Cl No. of IS 9591
		1(DBP)	2(DOP)	3(DIOP)	4(DMP)	5(DEP)	6(DIBP)	7(DIDP)	8(BBP)	9(DOTP)	10(DINP)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
i)	Colours, in Hazen units, Max	100	100	100	100	100	100	75	150	75	75	6
ii)	Relative density at 27/27°C	1.041 to 1.045	0.980 to 0.986	0.980 to 0.986	1.186 to 1.191	1.113 to 1.118	1.034 to 1.041	0.963 to 0.968	1.114 to 1.120	0.980 to 0.986	0.970 to 0.978	7
iii)	Refractive index at 27°C	1.489 to 1.492	1.484 to 1.488	1.484 to 1.488	1.511 to 1.514	1.499 to 1.502	1.483 to 1.487	1.482 to 1.486	1.538 to 1.542	1.480 to 1.489	1.484 to 1.490	8
iv)	Water content, percent by mass, Max	0.10	0.10	0.10	0.15	0.15	0.10	0.10	0.10	0.10	0.10	9
v)	Ash, percent by mass, Max	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	10
vi)	Acidity (as phthalic acid), percent by mass, Max	0.01	0.02	0.02	0.01	0.01	0.01	0.02	0.025	0.01	0.01	11
vii)	Ester value (as mg KOH/g	399 to 405	284 to 290	284 to 290	571 to 580	499 to 507	399 to 405	248 to 254	355 to 363	284 to 290	264 to 270	12

viii)	Colour after heat treatment, in Hazen units, Max	150	75	150	150	150	100	200	250	100	100	13
ix)	Sucrose test[1]) (Total colour value), Lovibond scale, Max	—	—	—	15	15	—	—	—	—	—	15
x)	Matter oxidizable by[2]) potassium dichromate, percent by mass, Max	—	0.07	0.10	—	—	—	—	—	—	—	16

NOTES:

1. [1)] This test is designed to detect trace impurities that would affect the suitability of the material for plasticizing cellulose acetate.
2. [2)] Results are calculated as free alcohol content of the esters like 2-ethylhexanol and octanol in case of DOP and DIOP, respectively.

6 PACKING AND MARKING

6.1 Packing

The material shall be packed in well-closed containers as agreed to between the purchaser and the supplier.

6.2 Marking

The containers shall be securely closed and legibly and indelibly marked with the following information:

a) Indication of the source of manufacture and recognized trade-mark, if any;
b) Name and type of the material;
c) Tare, gross and net mass;
d) Date of manufacture; and
e) Batch No. or Code No.

6.3 BIS Certification Marking

The containers may also be marked with the Standard Mark.

6.3.1 The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the Bureau of Indian Standards Act, 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the Standard Mark.

7 SAMPLING AND CRITERIA FOR CONFORMITY

7.1 The method of drawing representative samples of the material shall be as prescribed in 4 of 1S 9591 using appropriate instruments.

7.2 Number of Tests

7.2.1 Test for the determination of ester value shall be conducted on each of the individual samples constituting the set of test samples.

7.2.2 Tests for remaining characteristics shall be conducted on the composite sample.

7.3 Criteria for Conformity

7.3.1 *For Individual Samples*

The mean and the range for the test results for determination of ester value shall be calculated as follows:

Mean (X) = The sum of the test results divided by the number of the results.
Range (R) = The difference between the maximum and minimum values of the test results.

7.3.1.1 If the value of the expression (X - 0.6 R) or (X + 0.6 R) as calculated from the test results, lies between the values stipulated, the lot shall be declared to have satisfied the requirement of ester value.

7.3.2 *For Composite Sample*

The test results on the composite sample shall meet the corresponding requirements.

7.3.3 A lot shall be declared as conforming to the specification, if it satisfies the requirements for each of the characteristics as prescribed under 5.

7.3.4 If the requirements for any of the characteristics are not met, the lot shall be declared to have not satisfied the requirements of this specification.