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METHODS OF TEST FOR VULCANIZED RUBBERS

PART III ABRASION RESISTANCE—DU PONT CONSTANT LOAD METHOD

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MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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PART III ABRASION RESISTANCE—DU PONT CONSTANT LOAD METHOD

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 27 November 1965, after the draft finalized by the Rubber Products Sectional Committee had been approved by the Chemical *Division Council.*

0.2 The need for Indian Standards on the test methods for the determination of physical properties of rubber and rubber products has been felt since quite a long time. This standard is expected to furnish the rubber industry with standardized procedures and terminology in the testing field.

0.3 *This standard is based on* ISO/R 33-1957 '*Du Pont constant load* method of measuring abrasion resistance of vulcanized natural and synthetic rubbers' issued by the International Organization for Standardization. Standards of other countries have also been freely drawn upon.

0.4 In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

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1. SCOPE

1.1 This method is intended to measure the abrasion resistance of vulcanized rubber compounds where this property is significant.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

*Rules for rounding off numerical values (*revised*).

2.1 Abrasion Loss — The volume of a vulcanized rubber compound abraded from a specified test piece when subjected to abrasive wear under specified conditions.

2.2 Abrasion Resistance — The reciprocal of abrasion loss.

2.3 Abrasion Resistance Index — The ratio of the abrasion resistance of the rubber under test to that of a standard comparison rubber compound expressed as a percentage.

3. PRINCIPLE OF THE METHOD

3.1 Abrasion resistance, as determined by different types of machines, gives both absolutely and relatively different results for different rubbers. Close relation between test results and performance is also not implied by such measurements. However, for obtaining comparable results, it is necessary to adopt an internationally agreed method, namely, Du Pont method, and standardize the same.

3.2 In this method, test pieces of rubber samples are tested at the same time and compared with test pieces of an appropriate standard comparison rubber. The samples are abraded against a specified abrasive by holding them in contact with the abrasive at a constant load by any suitable means free from friction and able to follow axial movement of the sample holder as wear takes place. The ratio, of the volume loss in millilitres of the standard-comparison-rubber for specified revolutions of the abrasive to the volume loss in millilitres of the actual test pieces for the same specified revolutions multiplied by 100, gives the abrasive resistance index, as a relative value. Higher values denote better performance.

4. APPARATUS

4.1 The Du Pont Croydon Abrasion Tester (*see* Fig. 1) has the following components.

4.1.1 A disc which carries an abrasive surface is mounted on a shaft and rotated at a uniform speed within the range from 30 rpm to 40 rpm. The provision of a revolution counter is desirable.

4.1.2 The test pieces from the same compound are mounted, with their 2 cm^2 faces on the abrasive, on a bar, diametrically disposed across the disc so that the centre of each sample is 6·35 cm from the centre of rotation.

4.1.3 The samples are held in contact with the abrasive by a force of 3·62 kg weight by any suitable means free from friction and able to follow axial movement of the sample-holder as wear takes place. (If the abrasive disc is horizontal, dead weight may be used; if the abrasive

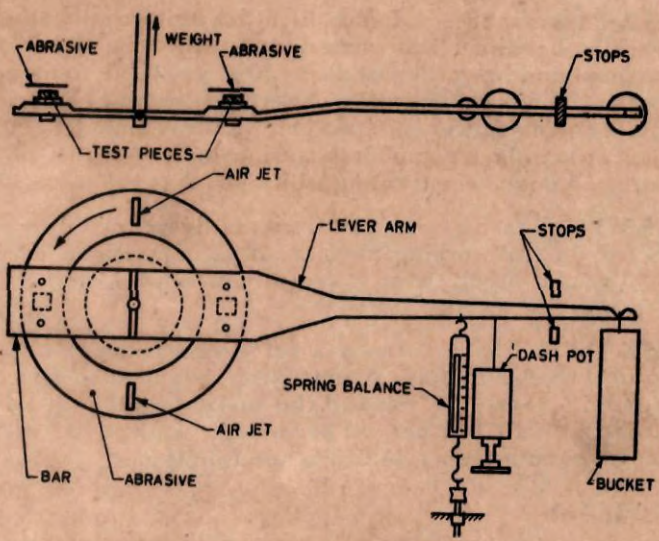

FIG. 1 DU PONT CROYDON ABRASION TESTER

disc is vertical, a wire led through a central hole in the shaft with a weight of 3·62 kg attached at the rear may be used, as in the current design of the Du Pont machine.)

4.1.4 A lever arm attached to the sample-holder is provided with means (weights and/or a spring balance) to restrain rotation and enable measurement of frictional torque to be made, if desired.

4.1.5 The abrasive is in the form of an annular disc of 16·5 cm outside diameter with a central hold of 7 cm in diameter for fixing the disc to the rotating member.

4.1.5.1 Silicon carbide abrasive grains, commercially known as 180 paper (*see* IS : 715-1966*) mounted on stiff paper have been found to be suitable and the paper backing shall have the following characteristics:

a) The weight or substance of paper shall be at least 224 g/m² with a tolerance of ± 5 percent; and

b) The paper and the adhesive used to bond the abrasive grains shall be waterproof so that a minimum of softening occurs under moist conditions.

*Specification for coated abrasives, glue bond (*under print*).

4.1.5.2 Papers shall be capable of at least 6 hours useful life and shall generally be discarded when the rate of weight loss from the standard compound has fallen by about 10 percent, but not more, of the rate of loss at the first measurement after the running-in period. The rate of loss of cutting power is dependent on the compound being tested, high grade carbon black compound causing much less loss of cut than lower grade compounds containing whiting or hard mineral fillers.

4.1.5.3 The abrasive surface is continuously cleaned by means of air jets, directed on the working surface at two positions between the samples. The air supply is at a pressure of not less than 1·75 kg/cm² and free from oil or water.

4.1.5.4 On each side there is a set of jets radially disposed and consisting of three 1-mm holes, 5 mm apart, arranged to leave a space of about 6 mm between the jets and the surface of the abrasive. The addition of stiff bristle brushes, set at an angle to the track, is advantageous in some circumstances, but their use is optional.

5. TEST PIECES

5.1 Sizes of the Test Pieces — The pieces shall be 2 cm² ± 0·05 cm² and approximately 1 cm thick with suitable lugs for fixing in the sample holder.

5.1.1 If desired, a small sample 2 cm × 2 cm × 0·5 cm may be prepared from a finished product or cut out with dies from moulded sheet and attached by cold vulcanizing solution to the base portion of a worn down used test piece, for test purposes.

5.2 Number of Test Pieces — Two test pieces are tested at the same time and compared with two test pieces of the appropriate standard comparison rubber compound.

6. PROCEDURE

6.1 Preparation of Standard Comparison Rubber Compound — Select for comparison, according to the type of vulcanized rubber compound to be tested, one of the following four standard rubbers:

Compounding Ingredients	*Tyre Standard Compound*		*Footwear Standard Compound*	
	Compound A	Compound B	Compound C	Compound D
	Parts by Weight	Parts by Weight	Parts by Weight	Parts by Weight
Natural rubber, smoked sheet, RMA 1	100	100·0	100·0	100·0

Compounding Ingredients	*Tyre Standard Compouud*		*Footwear Standard Compound*	
	Compound A	Compound B	Compound C	Compound D
	Parts by Weight	Parts by Weight	Parts by Weight	Parts by Weight
Zinc oxide	5	5·0	4·0	4·0
Stearic acid	3	2·0	3·0	3·0
EPC black	50	—	60·0	—
HAF black	—	45·0	—	60·0
Di-(2 ethyl hexyl) phthalate	—	—	3·0	—
Paraffin oil	—	—	—	3·0
Whiting	—	—	60·0	60·0
Benzothiazyl disulphide	1	—	—	—
Mercaptobenzthiazole	—	—	1·0	—
Sulphur	3	2·5	3·0	2·5
Phenyl-beta-naphthylamine	1	1·0	1·0	1·0
Cyclohexylbenzthiazyl sulphenamide	—	0·6	—	0·8
Curing time and temperature	40 min at 144°C	35 min at 143°C	40 min at 153°C	35 min at 143°C

NOTE — A high standard of mixing technique should be employed in the preparation of these compounds to ensure proper dispersion of the ingredients.

6.2 Preparation of Test Piece — Test pieces shall be trimmed off moulding flash.

6.3 Conditioning of Test Pieces — The properties of vulcanized rubber change continuously with time, these changes being particularly rapid during the first 24 hours after vulcanization. Therefore, do not carry out any test within this period; for accurate comparison between different rubbers, it may be necessary to ensure that these are tested at almost the same interval after vulcanization.

6.3.1 Protect the test pieces from light as completely as possible during the interval between vulcanization and testing.

6.3.2 Keep test pieces at a temperature of 27° ± 2°C for a period of not less than 12 hours immediately prior to measuring and testing.

6.4 Temperature of Test — Carry out the test at 27° ± 2°C.

6.5 Mount the test pieces in the holder without undue distortion of the abraded surface, but with no possibility of movement of the test pieces on the bar of the sample holder.

6.6 Allow a running-in period to give even seating of the samples on the abrasive without weighing. In the case of a new abrasive disc, use preferably the first 20 minutes for running-in samples, before starting actual weighings. Change of cutting power appears to be less rapid after this initial period.

6.7 Arrange samples replaced for successive runs to rub in the same direction on the abrasive.

6.8 Employ systematic reversal of order in a set of tests to overcome bias due to gradual change of abrasive cutting power.

6.9 Record the duration of any one test in terms of revolution of the abrasive.

6.10 Expression of Results — Express results as a figure of merit or abrasion resistance index of which higher values denote better performance, derived as follows:

$$\text{Abrasion resistance index} = \frac{S}{T} \times 100$$

where

S = volume loss, in ml/1 000 revolutions of the abrasive, from standard comparison rubber compound; and

T = volume loss, in ml/1 000 revolutions of the abrasive from the test pieces of the sample rubber.

6.10.1 Obtain the volume losses derived from weight losses by dividing the latter by the density of the particular sample, determined by the usual weight in air and water method.

6.10.2 State the standard comparison rubber compound employed, namely, A, B, C or D, as well as the type of abrasive used and the temperature of test.