UDC 678.4

Ref. No.: ISO/R 289 - 1963 (E)

ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION
R 289

DETERMINATION OF VISCOSITY OF NATURAL AND SYNTHETIC RUBBERS BY THE SHEARING DISK VISCOMETER

1st EDITION
January 1963

For each individual country the only valid standard is the national standard of that country.

Printed in Switzerland

Also issued in French and Russian. Copies to be obtained through the national standards organizations.

BRIEF HISTORY

The ISO Recommendation R 289, *Determination of Viscosity of Natural and Synthetic Rubbers by the Shearing Disk Viscometer*, was drawn up by Technical Committee ISO/TC 45, *Rubber*, the Secretariat of which is held by the British Standards Institution (B.S.I.).

Work on this question by the Technical Committee began in 1959 and led, in 1960, to the adoption of a Draft ISO Recommendation.

In May 1960, this Draft ISO Recommendation (No. 378) was circulated to all the ISO Member Bodies for enquiry. It was approved by the following Member Bodies:

Australia	Germany	Portugal
Austria	Hungary	Republic of South Africa
Brazil	India	Spain
Canada	Israel	Sweden
Chile	Italy	Switzerland
Colombia	Japan	United Kingdom
Czechoslovakia	Netherlands	U.S.A.
Denmark	New Zealand	U.S.S.R.
France	Poland	Yugoslavia

No Member Body opposed the approval of the Draft.

The Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided, in January 1963, to accept it as an ISO RECOMMENDATION.

ISO Recommendation R 289 January 1963

DETERMINATION OF VISCOSITY OF NATURAL AND SYNTHETIC RUBBERS BY THE SHEARING DISK VISCOMETER

1. SCOPE

The method given in the present ISO Recommendation describes the procedure for determining the viscosity, expressed in Mooney viscosity units, of uncompounded or compounded unvulcanized natural or synthetic rubbers or reclaimed rubbers, by means of the shearing disk viscometer.

Caution should be exercised in interpreting viscosity values obtained by this method as a measure of molecular mass of the higher molecular mass rubbers. For example, as the molecular mass increases, the viscosity values for butyl rubbers reach an upper limit of about 80 at 100 °C, using the specified rotor at a speed of 2 revolutions/minute, and may then decrease to considerably lower values. For these higher molecular mass rubbers, better correlation between viscosity and molecular mass is obtained if the rotor speed is reduced or the test temperature increased.

2. PRINCIPLE OF TEST

The test involves the determination of the torque which should be applied under specified conditions in order to rotate a metal disk in a cylindrical chamber filled with rubber. A number proportional to this torque is taken as an index of the viscosity of the rubber.

3. PREPARATION OF TEST PIECES

Two disks of rubber, about 45 mm in diameter and of sufficient thickness to fill completely the die cavity of the viscometer, are prepared. The test piece should be cut with a die slightly smaller than the die cavity, but of a thickness to give an excess volume, i.e. about 25 cm^3. The rubber disks should be as free as possible from air and from pockets that may trap air against the rotor and die surfaces. A hole is pierced or cut through the centre of one disk to permit the insertion of the rotor stem.

NOTE. – The viscosity is affected by the manner in which the rubber is prepared and the conditions of storage prior to test. Accordingly, the prescribed procedure in methods for evaluating the particular rubber should be followed rigorously.

4. APPARATUS

The essential parts of the apparatus are:

- a rotor,
- a hollow cylindrical die,
- a means for rotating the rotor,
- a means for indicating the torque required to rotate the rotor, and
- controls for maintaining the die at a constant temperature.

The rotor and die cavity have the dimensions shown in *either* column (*a*) *or* column (*b*) of the following table, but in order to ensure the greatest accuracy of results, the metric dimensions should in future be as shown in column (*a*).

TABLE. – **Dimensions of essential parts of the apparatus**

	(a) millimetres	(a) inches	(b) millimetres
Rotor diameter	38.10 ±0.03	1.500 ±0.001	38.10 ±0.05
Rotor thickness	5.54 ±0.03	0.218 ±0.001	5.50 ±0.05
Die cavity diameter	50.93 ±0.13	2.005 ±0.005	50.80 ±0.05
Die cavity depth	10.59 ±0.03	0.417 ±0.001	10.60 ±0.05

It is permissible to use a smaller rotor where high viscosity makes this desirable. This small rotor should have the same dimensions as the large rotor except that the diameter is 30.48 ±0.03 mm (1.200 ±0.001 in).

Results obtained with the small rotor are not identical with those obtained with the large rotor. However, for the purposes of comparing rubbers or compounds, they lead to the same conclusions.

The die cavity should preferably be formed from only two pieces of unplated hardened steel for improved heat transfer, and have radial V-grooves on the flat surfaces to retard slipping. The grooves are spaced at 20° intervals, and extend from at least the 7 mm circle to the 47 mm diameter circle; each groove forms a 90° angle in the die surface, with the bisector of the angle perpendicular to the surface, and is 1.00 ±0.25 mm wide at the surface.

The die cavity may alternatively be formed from four pieces of steel with rectangular-section grooves on the cavity surfaces to retard slipping. The grooves are 0.80 ±0.02 mm wide, of uniform depth between 0.25 and 0.38 mm, and spaced on 1.60 ± 0.04 mm centres. The flat surfaces of the cavity have two sets of these grooves at right angles to each other.

The rotor surfaces are grooved as described for the die cavity formed from four pieces of steel. The hardened rotor is fastened to a shaft not exceeding 11 mm in diameter and positioned securely, so that in the closed die cavity the clearance above the rotor does not differ from the clearance below the rotor by more than 0.25 mm. The eccentricity or runout of the rotor while turning in the viscometer should not exceed 0.013 mm. The rotor shaft bears on the spindle which turns the rotor, and not on the wall of the die cavity. The clearance at the point where the rotor enters the cavity should be small enough to prevent rubber leaving the cavity. A grommet may be used as a seal at this point.

The dies forming the die cavity are mounted on/or form part of platens equipped with a heating device capable of maintaining the die cavity within ±0.5 °C of the test temperature (see section 6).

NOTE. – The test temperature is defined as the steady-state temperature of the closed cavity, with rotor in place but without rubber. Since a temperature difference may exist between the platens and the die cavity, it may be necessary to adjust the platen temperatures to obtain the correct cavity temperature. In making such adjustments, it is important that the temperatures of the two platens be within 0.5 °C of each other. The cavity temperature is determined within 0.3 °C and may be measured with calibrated thermocouples or thermistors, using wires about 0.3 mm in diameter to minimize thermal conduction to the exterior.

The die cavity may be closed by hydraulic, pneumatic or mechanical means. If fluid pressure is used, a force of 1 400 kgf may be required for the initial closure, when rubbers of very high viscosity are tested. At least 10 seconds before starting the viscometer, the force is reduced to 350 ± 20 kgf and maintained at this value during the test. If mechanical closure is used, the platens are adjusted, preferably by means of a gauge block, so that the total deformation of the parts is between 0.10 and 0.15 mm when the die cavity is closed at the test temperature.