INTERNATIONAL STANDARD

ISO 289-1

Second edition
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Rubber, unvulcanized — Determinations using a shearing-disc viscometer —

Part 1: Determination of Mooney viscosity

Caoutchouc non vulcanisé — Déterminations utilisant un consistomètre à disque de cisaillement —

Partie 1: Détermination de l'indice consistométrique Mooney

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 289-1 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 2, *Testing and analysis*.

This second edition cancels and replaces the first edition (ISO 289-1:1994), which has been revised to update the normative references.

ISO 289 consists of the following parts, under the general title *Rubber, unvulcanized — Determinations using a shearing-disc viscometer*:

— *Part 1: Determination of Mooney viscosity*

— *Part 2: Determination of pre-vulcanization characteristics*

— *Part 3: Determination of the Delta Mooney value for non-pigmented, oil-extended emulsion-polymerized SBR*

— *Part 4: Determination of the Mooney stress-relaxation rate*

Rubber, unvulcanized — Determinations using a shearing-disc viscometer —

Part 1:
Determination of Mooney viscosity

WARNING — Persons using this International Standard should be familiar with normal laboratory practice. This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any national regulatory conditions.

1 Scope

This part of ISO 289 specifies a method, using a shearing-disc viscometer, for measuring the Mooney viscosity of uncompounded or compounded rubbers.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1795, *Rubber, raw natural and raw synthetic — Sampling and further preparative procedures*

ISO 2393, *Rubber test mixes — Preparation, mixing and vulcanization — Equipment and procedures*

ISO 6508-1, *Metallic materials — Rockwell hardness test — Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)*

ISO/TR 9272, *Rubber and rubber products — Determination of precision for test method standards*

ISO 23529, *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

3 Principle

The torque which has to be applied under specified conditions in order to rotate a metal disc in a cylindrical chamber formed from mating dies filled with rubber is measured. The resistance offered by the rubber to this rotation is expressed in arbitrary units as the Mooney viscosity of the test piece.

4 Apparatus

The essential parts of the apparatus (see Figure 1) are:

a) two dies to form a cyclindrical cavity;

b) a rotor;

c) a means for maintaining the dies at a constant temperature;

d) a means for maintaining a specified closure pressure;

e) a means for rotating the rotor at constant angular velocity;

f) a means for indicating the torque required to rotate the rotor.

The rotor and die cavity have the dimensions shown in Table 1.

Table 1 — Dimensions of essential parts of the apparatus

Part	Dimension mm
Rotor diameter	38,10 ± 0,03
Rotor thickness	5,54 ± 0,03
Die cavity diameter	50,9 ± 0,1
Die cavity depth	10,59 ± 0,03

NOTE Normally, a rotor with these dimensions is called a large rotor.

It is permissible to use a smaller rotor where high viscosity makes this necessary. This small rotor shall have the same dimensions as the large rotor except that the diameter shall be 30,48 mm ± 0,03 mm. Results obtained with the small rotor are not identical with those obtained using the large rotor.

4.1 Dies

The two dies forming the cavity shall be formed from non-deforming unplated hardened steel of minimum Rockwell hardness 60 HRC (see ISO 6508-1). The dimensions of the cavity are given in Figure 1 and shall be measured from the highest surfaces. For good heat transfer, each die should preferably be made from only one piece of steel. The flat surfaces shall have radial V-grooves to prevent slippage. The grooves shall be spaced radially at 20° intervals and shall extend from an outer circle of diameter 47 mm to an inner circle of diameter 7 mm for the upper die and to within 1,5 mm of the hole in the lower die; each groove shall form a 90° angle in the die surface with the bisector of the angle perpendicular to the surface and shall be 1,0 mm ± 0,1 mm wide at the surface (see Figure 2).

4.2 Rotor

The rotor shall be fabricated from non-deforming unplated hardened steel of minimum Rockwell hardness 60 HRC. The rotor surfaces shall have rectangular-section grooves 0,80 mm ± 0,02 mm wide, of uniform depth 0,30 mm ± 0,05 mm and spaced 1,60 mm ± 0,04 mm apart (distance between central axes). The flat surfaces of the rotor shall have two sets of such grooves at right angles to each other (see Figure 3). The edge of the rotor shall have vertical grooves of the same dimensions. The large rotor shall have 75 vertical grooves and the small rotor shall have 60. The rotor is fastened at right angles to a shaft having a diameter of 10 mm ± 1 mm and a length such that, in the closed die cavity, the clearance above the rotor does not differ from that below by more than 0,25 mm. The rotor shaft shall bear on the spindle which turns the rotor shaft, not on the wall of the die cavity. The clearance at the point where the rotor shaft enters the cavity shall be

small enough to prevent rubber leaving the cavity. A grommet, O-ring or other sealing device may be used as a seal at this point.

The eccentricity or runout of the rotor while turning in the viscometer shall not exceed 0,1 mm.

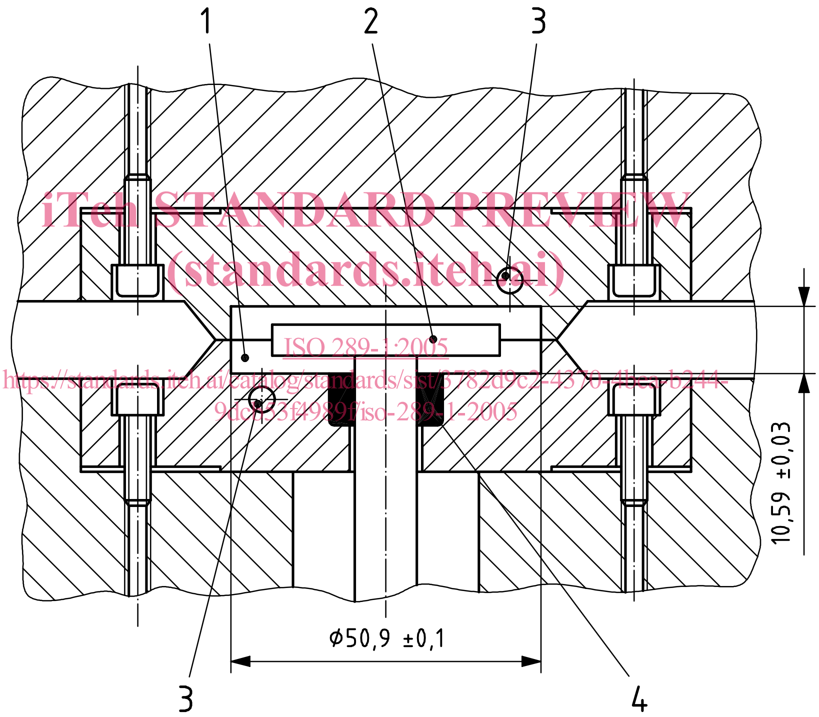
The angular velocity of the rotor shall be 0,209 rad/s ± 0,002 rad/s (2,00 r/min ± 0,02 r/min).

4.3 Heating device

The dies are mounted on, or form part of, platens equipped with a heating device capable of maintaining the temperature of the platens and that of the dies to within ± 0,5 °C of the test temperature. After insertion of the test piece, the devices shall be capable of returning the temperature of the dies to within ± 0,5 °C of the test temperature within 4 min.

NOTE Older machines may not comply with these requirements and may give less reproducible results.

Dimensions in millimetres

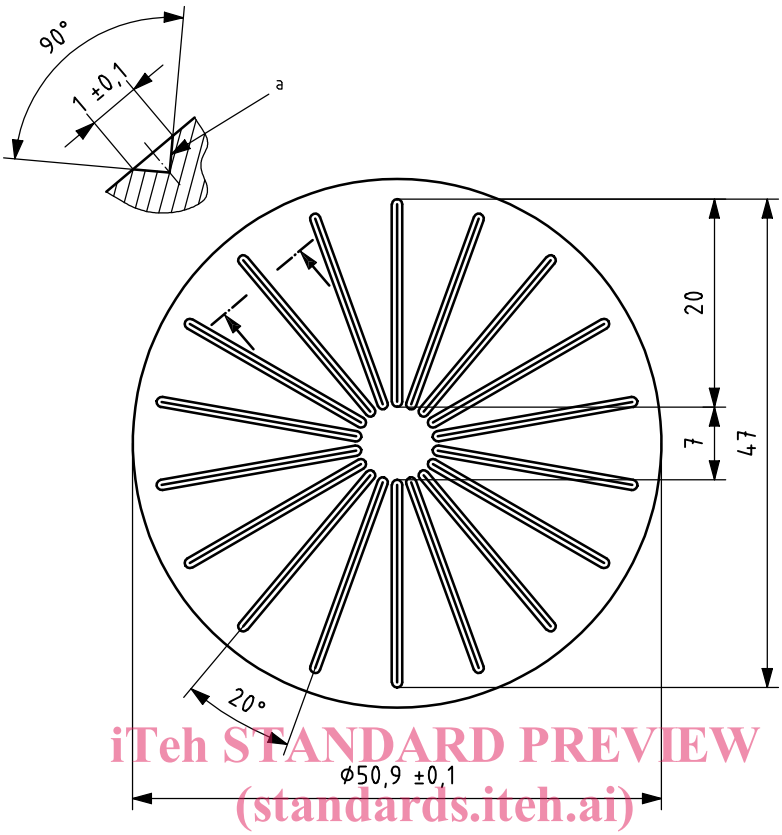


Key

1 die cavity
2 rotor
3 temperature sensor
4 sealing device

Figure 1 — Typical shearing-disc viscometer

Dimensions in millimetres

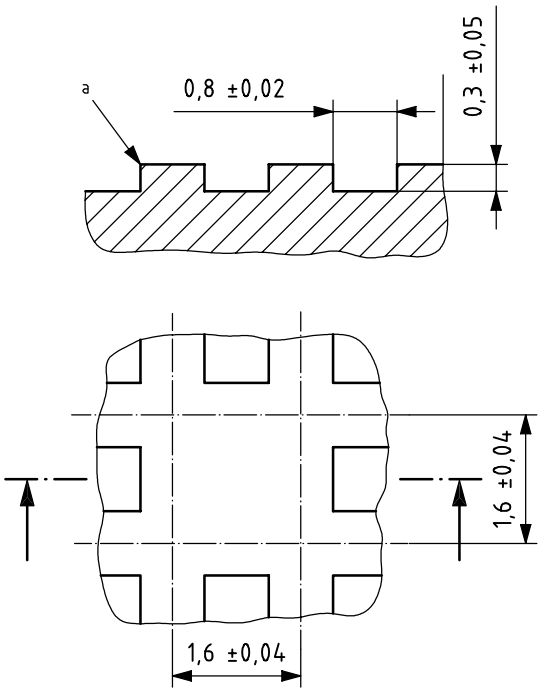


Key

a Section through groove.

Figure 2 — Die with radial V-grooves

Dimensions in millimetres



Key

a R at edge of groove $\leqslant$ 0,1 mm.

Figure 3 — Rotor with rectangular-section grooves

4.4 Temperature-measurement system

4.4.1 The test temperature is defined as the steady-state temperature of the closed dies with the rotor in place and the cavity empty. This temperature is measured by two thermocouple measurement probes, which can be inserted into the cavity for this purpose as shown in Figure 4. These measurement probes are also used to check the temperature of the test piece as described in 7.2.

4.4.2 In order to control the supply of heat to the dies, a temperature sensor shall be present in each die to measure the die temperature. The sensor shall be located for the best possible heat contact with the dies, i.e. heat gaps and other heat resistance shall be excluded. The axes of the sensors shall be at a distance of 3 mm to 5 mm from the working surface of the dies and 15 mm to 20 mm from the rotational axis of the rotor (see Figure 1).

4.4.3 Both the thermocouple measurement probes and the temperature sensors shall be capable of indicating temperature to an accuracy of ± 0,25 °C.

4.5 Die-closure system

The dies may be closed and held closed by hydraulic, pneumatic or mechanical means. A force of 11,5 kN ± 0,5 kN shall be maintained on the dies during the test.

A greater force may be required to close the dies when rubbers of high viscosity are tested; at least 10 s before starting the viscometer, the force shall be reduced in such cases to 11,5 kN ± 0,5 kN and maintained at this level throughout the test.

For all types of closing device, a piece of soft tissue paper not thicker than 0,04 mm placed between the mating surfaces shall show a continuous pattern of uniform intensity when the dies are closed. A non-uniform pattern indicates incorrect adjustment of the die closure, worn or faulty mating surfaces or distortion of the dies; any of these conditions may result in leakage and erroneous results.