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# International Standard



# 7323

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## Rubber, raw and unvulcanized compounded — Determination of plasticity number and recovery number — Parallel plate method

*Caoutchouc brut et mélanges non vulcanisés — Détermination de l'indice de plasticité et de l'indice de recouvrance — Méthode des plateaux parallèles*

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Descriptors: rubber, raw materials, tests, determination, plasticity index, test equipment.

## 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 7323 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*.

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# Rubber, raw and unvulcanized compounded — Determination of plasticity number and recovery number — Parallel plate method

## 1 Scope and field of application

This International Standard specifies a method using the parallel plate plastometer for the determination of the plasticity number and recovery number of uncompounded, compounded and reclaimed stocks of unvulcanized rubbers and rubber-like materials.

NOTE — The plasticity number and the recovery number are related to the viscoelastic properties of the material. The plasticity number is related to the flow properties and the recovery number is related to the elastic component. These are useful in predicting the processability characteristics, such as the ease of forming and die swell.

## 2 References

ISO 471, *Rubber — Standard temperatures, humidities and times for the conditioning and testing of test pieces.*

ISO 1796, *Rubber, raw — Sample preparation.*

ISO 3383, *Rubber — General directions for achieving elevated or sub-normal temperatures for tests.*

## 3 Definitions

**3.1 plasticity number:** The height, in millimetres, multiplied by 100, of a cylindrical test piece of volume 2 cm<sup>3</sup> and initial height approximately 10 mm after it has been subjected to a compressive force of 49 N for a specified time at a specified temperature.

**3.2 recovery number:** The difference in height, in millimetres, multiplied by 100, between that of a cylindrical test piece of volume 2 cm<sup>3</sup> and initial height approximately 10 mm after it has been subjected to a compressive force of 49 N for a specified time at a specified temperature and that after it has been allowed to recover for a specified time at a specified temperature after removing the force.

## 4 Principle

A test piece of specified volume is preheated to a specified test temperature for 15 ± 0,5 min and a compressive force of 49 ± 0,05 N is applied for a specified time. The height of the test piece (the plasticity number) is measured.

The test piece is allowed to recover at the test temperature for a specified time. The height of the recovered test piece is measured and the difference between the two heights is taken as the recovery number.

## 5 Apparatus

**5.1 Parallel plate plastometer,** the essential features of which are illustrated in figure 1.

The plastometer shall comprise the following parts.

**5.1.1 Two plates,** not less than 10 mm thick and of diameter 40 mm mounted on a suitable frame so that one plate moves with respect to the other and so that the two plates are parallel within 1° at all times.

The apparatus shall be so designed that a test piece between the parallel plates is subjected to a force of 49 ± 0,05 N, including the effect of the spring in the dial indicator gauge, during the test.

**5.1.2 Dial indicator gauge,** calibrated in divisions of 0,01 mm, mounted on the apparatus in such a manner that the distance between the plates can be determined at all times.

**5.2 Oven,** circulating air type, capable of being controlled to within 1 °C, and capable of containing the plastometer (see ISO 3383).

**5.3 Dial micrometer gauge,** having a presser foot of diameter 25 ± 2 mm actuated by a dead weight load of 800 ± 30 mN (this is required for the determination of recovery number).

## 6 Test pieces

### 6.1 Preparation

The test pieces shall be free from air pockets, and shall be cylindrical in shape and of volume 2,00 ± 0,02 cm<sup>3</sup> (a cylinder of diameter 16 mm and height 10 mm is appropriate). They may be prepared from either a solid or plied sheet of unvulcanized rubber approximately 15 mm thick, care being taken to exclude air pockets in the sheet. They may be cut from the sheet either by means of two mating dies as shown in figure 2, which produces cylinders of the correct volume, or by means of a

rotating die having an internal diameter of approximately 16 mm. If the density is known, weighing procedures may be used to adjust to the correct volume. Three test pieces shall be prepared, lightly dusted with dusting powder, and placed in a suitable holder so that they are not appreciably deformed before testing.

The method of preparation of the piece of unvulcanized rubber (see ISO 1796) from which the test pieces are cut can affect the results. For comparative results, the chosen method should be rigidly adhered to. The time between preparation of the test piece and cutting at the test piece shall be constant and not less than 1 h, and shall be stated in the test report.

## 6.2 Number

Three test pieces shall be tested.

## 7 Test conditions

**7.1** The preferred test temperatures are  $70 \pm 1$  °C and  $100 \pm 1$  °C. If other temperatures between room temperature and 100 °C are used, they should be selected from those given in ISO 471.

**7.2** Readings may be taken at any desired time following application of the load and removal of the force. The preferred intervals are 3 min following application of the force for plasticity number and 1 min following removal of the force for recovery number.

**7.3** The total force on the specimen including the effect at the spring in the dial gauge, during the test, shall be  $49 \pm 0,05$  N (see 5.1.1).

## 8 Procedure

Insert the plastometer in the oven and maintain the oven and plates at the test temperature throughout the test (see 7.1).

### 8.1 Determination of plasticity number

Place the test piece between two pieces of release material such as Holland cloth (preferably with a count of  $27 \times 21$  threads/cm or finer) to prevent the test piece sticking to the plates.

Set the dial indicator gauge (5.1.2) to read zero with two thicknesses of the release material between the plates.

Preheat the test piece at the test temperature for  $15 \pm 0,5$  min. Place the preheated test piece between the two parallel plates, lower the weight and after the desired time (see 7.2), read the dial indicator gauge to the nearest 0,01 mm and record the height  $h_1$  of the test piece in millimetres.

### 8.2 Determination of recovery number

At the end of the compression period, after reading the dial indicator gauge, remove the force on the upper plate and permit the test piece to recover for the desired time at the test temperature.

At the end of this period, measure the height  $h_2$  of the test piece at the test temperature using the dial micrometer gauge (5.3). Record this value as the "recovery height" in millimetres.

## 9 Expression of results

### 9.1 Plasticity number

The plasticity number is given by the formula

$$100 h_1$$

where  $h_1$  is the height, in millimetres, of the test piece under load (see 8.1).

Record the median value for the three test pieces.

### 9.2 Recovery number

The recovery number is given by the formula

$$100 (h_2 - h_1)$$

where

$h_1$  is as defined in 9.1;

$h_2$  is the recovery height, in millimetres (see 8.2).

Record the median value for the three test pieces.

## 10 Test report

The test report shall include the following information:

- a) sample details:
  - 1) a full description of the sample and its origin,
  - 2) preparation of test pieces, for example milling procedure (see ISO 1796), whether plied, and the time between preparation and test,
  - 3) compound details, where appropriate;
- b) test method:
 

a full reference to the test method used, i.e. the number of this International Standard;
- c) test details:
  - 1) temperature of the oven during the test,
  - 2) duration of application of the force to the test piece,
  - 3) duration of recovery;
- d) test results:
  - 1) plasticity number,
  - 2) recovery number;
- e) date of test.

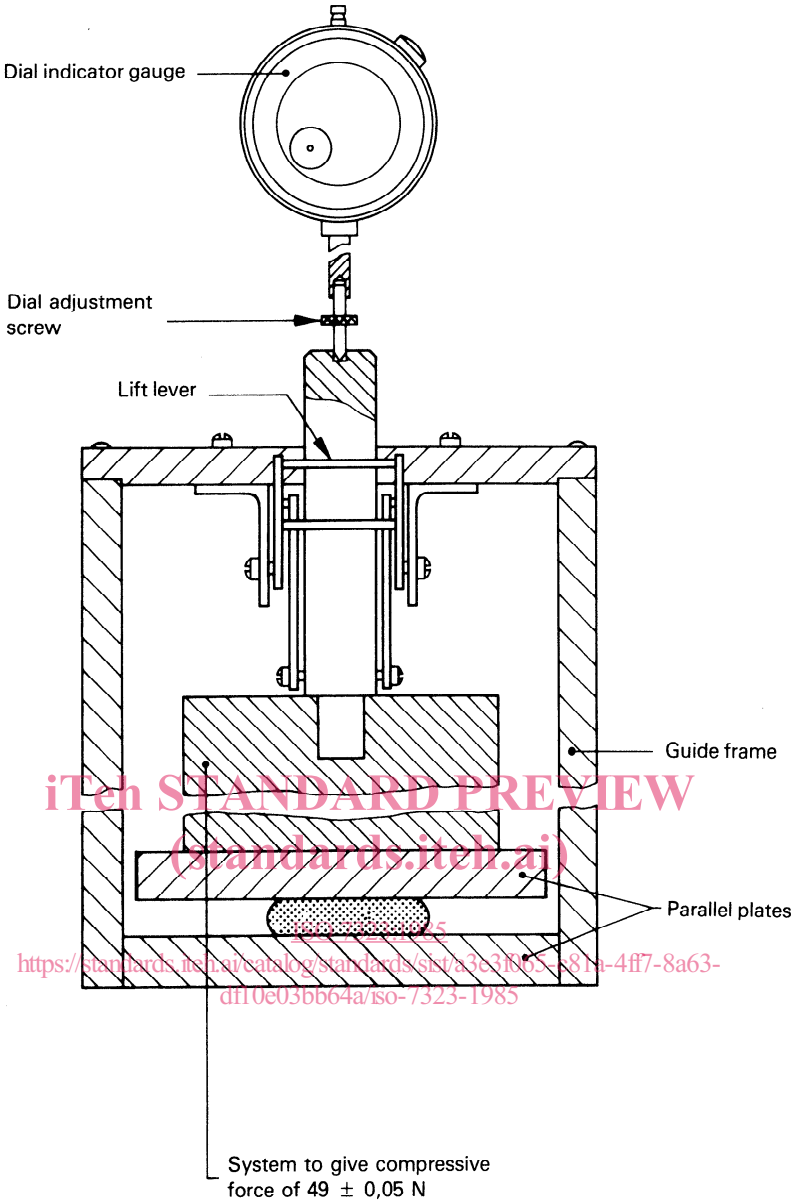


Figure 1 – Typical parallel plate plastometer

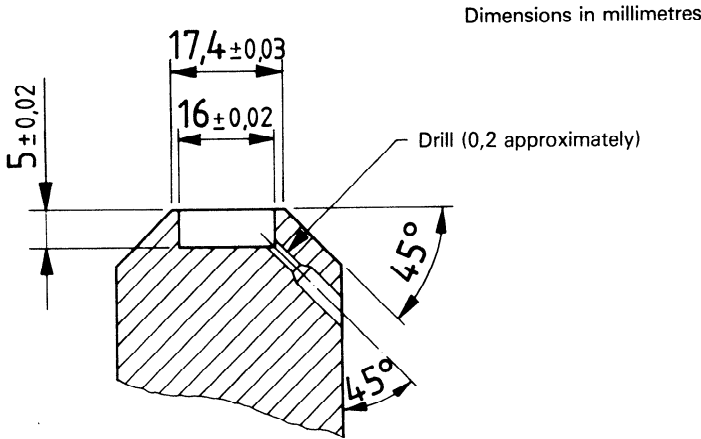


Figure 2 – Hardened steel die for forming the test piece (two are required)

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