International Standard 8295

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Plastics — Film and sheeting — Determination of the coefficients of friction

Plastiques — Film et feuille — Détermination des coefficients de frottement

First edition — 1986-11-15

UDC 678-416 : 620.1 : 531.44 **Ref. No. ISO 8295-1986 (E)**

Descriptors : plastics, films, sheets, tests, friction tests, test equipment.

Price based on 4 pages

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 8295 was prepared by Technical Committee ISO/TC 61, *Plastics*.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

Printed in Switzerland

Plastics — Film and sheeting — Determination of the coefficients of friction

1 Scope and field of application

1.1 This International Standard specifies a method for determining the coefficients of starting and sliding friction of plastic film and sheeting when sliding over itself or other substances. The method is intended to be used for non-sticky plastic film and sheeting of up to approximately 0,2 mm thickness.

1.2 This test method serves primarily for quality control. It does not give a comprehensive assessment of the machinability on packaging or processing machines since other effects, e.g. electrostatic charges, air cushion, local rise of temperature, and abrasion are, as a rule, involved.

1.3 The static frictional force, as a rule, increases with the time the surfaces are in contact. Therefore, to get comparable results, this time span is specified.

1.4 Slip properties are sometimes generated by additives in the plastic material. The additives have varying degrees of compatibility with the film matrix. They may bloom or exude to the surface and change the slip properties. Since these effects are time-dependent, the measurements on such films have to be related to the age of the film.

2 References

ISO 291, *Plastics — Standard atmospheres for conditioning and testing.*

ISO 2602, *Statistical interpretation of test results — Estimation of the mean — Confidence interval.*

3 Definitions

3.1 friction: The resistance that two surfaces lying in contact with each other build up against sliding. A distinction is made between:

3.1.1 static friction, which has to be overcome as a "threshold value" at the onset of a sliding motion.

3.1.2 dynamic friction, which persists during a sliding motion at a given speed.

3.2 frictional force: The force necessary to overcome the friction:

3.2.1 static frictional force, F_S

3.2.2 dynamic frictional force, F_D

3.3 normal force, F_p: The force acting perpendicular to the two surfaces in contact.

3.4 coefficient of friction: The ratio of the frictional force to the normal force:

3.4.1 static coefficient of friction:

$$\mu_S = \frac{F_S}{F_p}$$

3.4.2 dynamic coefficient of friction:

$$\mu_D = \frac{F_D}{F_p}$$

NOTES

1 The coefficient of friction of films usually ranges between 0,2 and 1.

2 Ideally, the coefficient of friction is a characteristic independent of the testing equipment and the test conditions. Since films generally do not behave ideally, all testing parameters are specified in this International Standard.

4 Principle

The surfaces to be tested are placed together in plane contact and under uniform contact pressure. The force needed to displace the surfaces relative to each other is recorded.

5 Apparatus

5.1 The testing device may be constructed in different ways. In general, it consists of a horizontal testing table, a sled, and a driving mechanism to produce a relative motion between the sled and the testing table, regardless of which is the moving part.

Figure 1 shows an example of apparatus in which the table is moved horizontally. The descending motion of a tensile tester may also be utilized; in this case the testing table is fixed to the crosshead of the machine and the force is deflected in the vertical direction by a pulley (see figure 2).

The force is recorded by a chart recorder or an equivalent electrical data-processing unit.

5.2 The testing device shall comply with the following conditions:

5.2.1 The surface of the testing table shall be flat and smooth, and made of a non-ferromagnetic metal.

5.2.2 The normal force shall be generated by a sled with a square-shaped contact base of 40 cm^2 (edge length 63 mm). For the purpose of a uniform pressure distribution, the base of the sled shall be covered with an elastic material, for example felt. The structure of this covering material shall be fine enough to avoid embossing thin films. The total mass of the sled shall be 200 ± 2 g (exerting a normal force of 1,96 ± 0,02 N).

5.2.3 The motion that induces the friction process shall be free of vibrations and shall have a speed of 100 ± 10 mm/min.

5.2.4 The force-measuring system, including the recording instrument, shall not exceed an error of ±2 %. Its transition time $T_{99\ \%}$ shall not exceed 0,5 s. The pulling direction shall be in a straight alignment with the frictional plane.

NOTE — If the force measuring system of a tensile tester is used, the transition time $T_{99\ \%}$ should be particularly checked, as the indicating systems of these machines are often rather inert.

5.2.5 For the measurement of the static friction, the coefficient of elasticity of the force-measuring system shall be adjusted to 2 ± 1 N/cm. This may be accomplished by a suitable spring. For the measurement of the dynamic friction in the case of slipstick behaviour, this spring shall be replaced by a rigid connection.

NOTE — The inertia of the mass of the sled induces an additional force at the start of the sled movement; thus the coefficient of friction differs from its true value by Δ:

$$\Delta = \frac{v}{g}\sqrt{\frac{D}{m}}$$

where

v is the speed of the sled relative to the table = 100 mm/60 s;

m is the mass of the sled = 200 g;

g is the acceleration of free fall = 9 810 mm/s^2;

D is the coefficient of elasticity (2 N/cm) = 2 × 10^5 g/s^2.

Under these conditions the overshoot of the coefficient of friction is 0,005. In the worst case, this means that at a low coefficient of friction of 0,2, the overshoot equals an error of 2,5 %.

6 Test specimens

For each measurement, two test pieces with a size of about 8 cm × 20 cm are needed. At least three such pairs of test pieces uniformly distributed over the width or the circumference in case of tubular film shall be tested. Unless otherwise specified, the long axis, and thus the testing direction, shall be parallel to the machine direction of the film.

When different frictional properties are expected for the two surfaces, front (1) and back (2), the two surfaces shall be identified and tested 1/1, 2/2 and/or 1/2 as agreed between the interested parties.

Extreme care shall be taken in handling the samples and specimens. The test surfaces shall be kept free of dust, fingerprints or any foreign matter that might change the surface characteristics.

NOTES

1 Testing of three pairs of test pieces represents a minimum for estimating the statistical tolerance interval. Depending on the intended precision and the homogeneity of the material under test, the number of specimens tested may have to be increased. See ISO 2602.

2 To avoid contamination of the surfaces, several test pieces may be cut simultaneously and separated immediately before testing.

7 Conditioning

Unless otherwise specified, the film specimens shall be conditioned for at least 16 h in standard atmosphere 23/50 (ISO 291) prior to testing. The testing shall be carried out in the same atmosphere.

8 Procedure

The following directions refer to an apparatus designed in accordance with figure 1. If another equivalent apparatus is used, the appropriate procedure should be followed.

8.1 Measurement of film against film

8.1.1 Fix the right end of the first test piece with double-faced adhesive tape on the testing table, the length axis of the test piece coinciding with that of the table. Reinforce the left end of the second test piece by attaching a small plate to it with double-faced adhesive tape. The mass of this plate shall not exceed 5 g. Connect this plate via a spring (see 5.2.5) with the load cell. Lay the second test piece upon the first one and place the sled on top gently and without shock, in the middle of the second test piece (see note 2 in 8.1.2). After 15 s, start the motion of the testing table and the recording instrument. The first peak of force is the static friction.

8.1.2 After the first peak of force, oscillations of the force may sometimes occur. In this case the oscillating part of the graph cannot be evaluated for the dynamic coefficient of fric-

tion. The dynamic coefficient shall be determined by a separate measurement in which the slipstick behaviour is suppressed by replacing the spring with a rigid connection.

This test run cannot be used for evaluating static friction because of the inertia error (see note to 5.2.5).

NOTES

1 The load cell may also be attached directly to the sled. In this case the second test piece is fastened at the front edge of the sled with double-faced adhesive tape. However, this procedure is not advisable for stiffer films since the bending moment may cause an unequal pressure distribution.

2 For films presenting high blocking or other than frictional forces, the contact area, i.e. the size of the upper test piece, should be reduced as nearly as possible to the area of the sled.

8.2 Measurement of film *versus* metal or other material

If the frictional behaviour of a film *versus* a surface of metal or other material is to be determined, the lower test piece (figure 1) shall be replaced by a specimen of the material in question. Otherwise, the same procedure shall be used.

The coefficients of friction determined in this way are dependent on the type of material as well as on its surface finish.

NOTE — If subsequent measurements are made on the same test piece of a material, it should be noted that abrasion may have occurred which will change the surface properties. Also, the transfer of slip or antislip agent should be considered.

9 Expression of results

9.1 Static friction

The maximum of the linear rising force represents the static frictional force F_S. Measurements with a high coefficient of elasticity (i.e. without a spring) which, in particular cases, have been carried out for the determination of the dynamic friction, cannot be evaluated for static friction (see 8.1.2).

The static coefficient of friction μ_S is given by the equation

$$\mu_S = \frac{F_S}{F_p}$$

where

F_S is the static frictional force, in newtons;

F_p is the normal force exerted by the mass of the sled, in newtons = 1,96 N.

9.2 Dynamic friction

The frictional force acting during the sliding motion often differs from the ideal of a constant level due to secondary effects involved with increasing length of path.

The dynamic friction force F_D is the average force on the first 6 cm of movement after the start of relative movement of the sliding surface, not considering the static force peak F_S. It is converted to the dynamic coefficient of friction μ_D, using the equation

$$\mu_D = \frac{F_D}{F_p}$$

where

F_D is the dynamic frictional force, in newtons;

F_p is the normal force exerted by the mass of the sled, in newtons = 1,96 N.

10 Test report

The test report shall include the following particulars:

a) reference to this International Standard;

b) type and description of the plastic film sample, and, if known, the approximate age of the film;

c) identification of the tested surface;

d) average and individual values, and if required, standard deviation and number of tests for

1) static coefficient of friction and

2) dynamic coefficient of friction;

e) in case of measurements in contact with other materials, exact description of these surfaces;

f) any deviations from this International Standard.

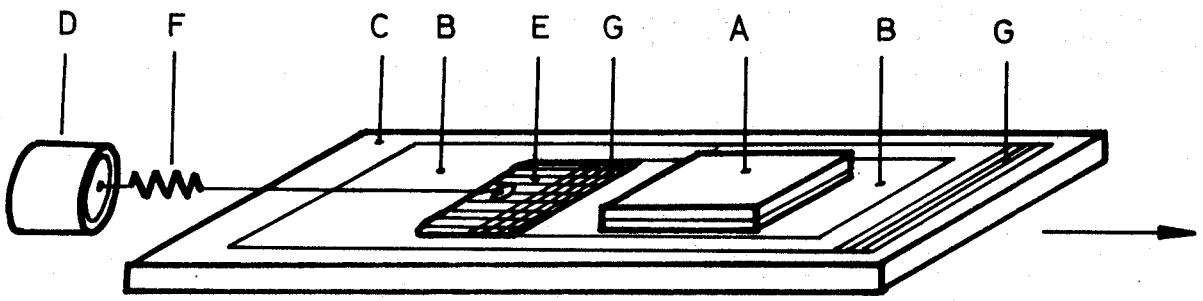

Figure 1 — Moving table apparatus for determination of coefficients of friction

A Sled
B Test pieces
C Moving table
D Load cell
E Reinforcement plate
F Spring
G Double-faced adhesive tape

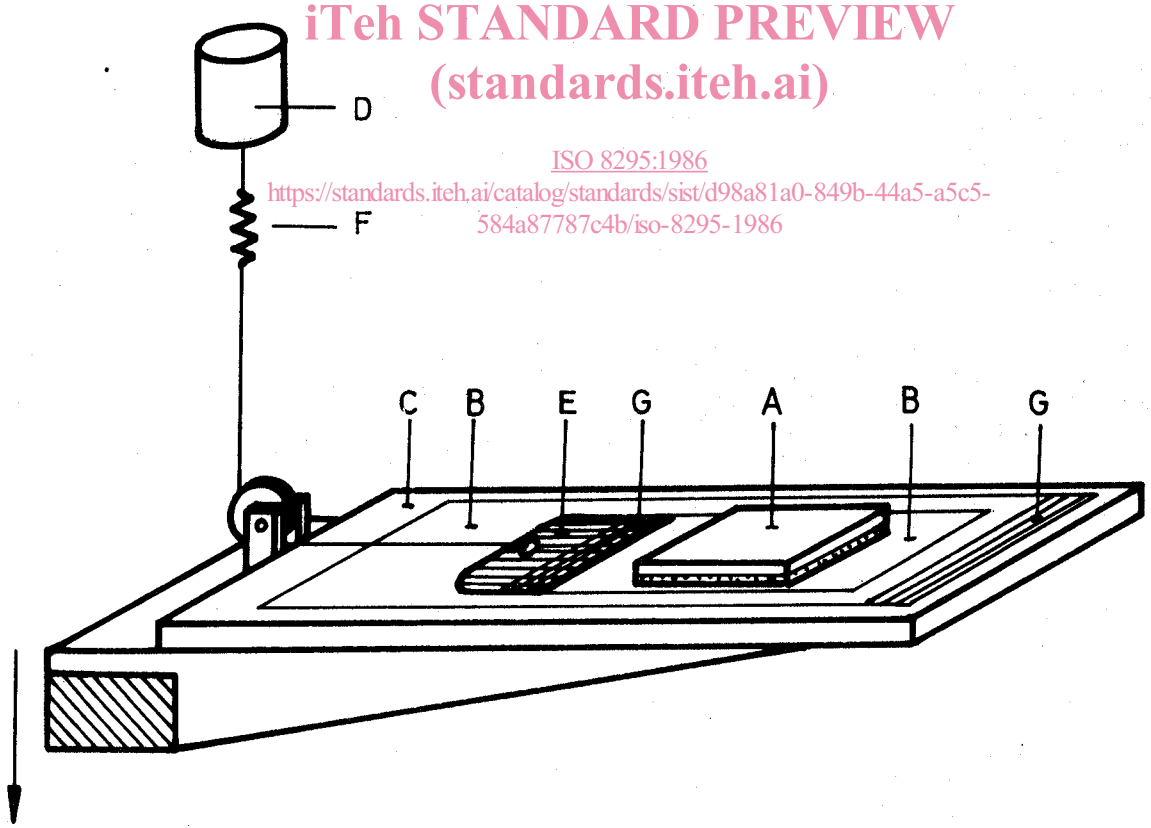

Figure 2 — Testing table mounted onto the crosshead of a tensile tester