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Rubber — Determination of frictional properties

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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 3.

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.

International Standard ISO 15113 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 2, *Physical and degradation tests*.

Annexes A to D of this International Standard are for information only.

Introduction

Various geometrical arrangements can be used when measuring friction, but each is likely to give a different value for μ, the coefficient of friction. Each may be appropriate in particular circumstances, but it is desirable that some standard method utilizing specified test conditions be employed when comparisons between materials are undertaken.

Rubber samples are most readily available in sheet form, and for many practical applications measurement between two planar surfaces most nearly approaches service behaviour. Consequently, this is the most widely used geometry. For this geometry, the apparatus used needs careful design in order to ensure reproducible contact between the surfaces, and this is discussed in annex A.

Where rubber moulding facilities are available, some workers prefer to use a hemispherical rubber slider and a planar test track. This gives a more definable contact area and minimizes the errors involved if the friction plane does not contain both the line of action of the load cell and that of the towing force. However, when this geometry is used, the frictional force is not proportional to the normal load (see annex B), and the contact area is estimated from a knowledge of the modulus of the rubber. Hence care should be taken when quoting values for coefficients of friction. The big disadvantage of the method is that special test pieces need to be moulded from unvulcanized rubber, and rubber products cannot be accommodated. Finally, since some degree of wear is inseparable from friction, extended testing will produce a "flat" on the hemispherical test piece. Frequent inspection of the test surface is recommended, therefore, to ensure that the initial contact geometry is maintained.

The alternative "ball on flat" geometry where a hard ball slides on a flat rubber surface is not an exact equivalent. The ploughing action of the ball through the rubber results in an energy loss by hysteresis which gives a higher measured coefficient of friction. However, in some circumstances this may be an appropriate test procedure.

Although there may be some uncertainty in the contact area using plane-on-plane geometry, this International Standard is based on this geometry because of its wide practical applicability. However, it is emphasized that it is necessary to have a well designed apparatus with the line of action of the load cell included in the plane of contact of the test pieces (see annex A). The method can be adapted to cover other contact geometries to suit particular products, including the ball-on-flat geometry set out in annex B.

This International Standard is based on linear motion, and guidance on the experimental arrangement is given in annex A. Because friction generates heat, it is usual to restrict testing to velocities typically below 1 000 mm/min in order to avoid a large temperature rise at the interface. If service conditions involve high speeds, then an entirely different method based on rotary motion is more appropriate as discussed in annex A. The method of test set out here enables kinetic friction to be measured at a number of fixed velocities. It can be arranged that the lowest velocity is such that movement is barely discernible, and this gives an approximation to frictional behaviour close to zero velocity (static friction). This may be different from the starting friction, which may involve some element of adhesion (stiction) as discussed in annex C. This method is suitable for measuring the initial friction only if the machine has a constant-rate-of-load facility and a sufficiently compliant load cell. A discussion on static friction and the correct approach to its measurement is given in annex C.

Rubber friction is complex, and the coefficient of friction is dependent on the contact geometry, normal load, velocity and temperature, as well as the composition of the rubber. A discussion of the influence of these parameters and some other factors which affect measurement is presented in annex D.

Rubber — Determination of frictional properties

1 Scope

This International Standard outlines the principles governing the measurement of coefficient of friction and describes a method suitable for measuring the coefficient of friction of a rubber against standard comparators, against itself, or against any other specified surface.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

NOTE Those documents to which reference is made in the text but which are only informative in nature, are listed in the bibliography.

ISO 471:1995, *Rubber — Temperatures, humidities and times for conditioning and testing.*

ISO 3383:1985, *Rubber — General directions for achieving elevated or subnormal temperatures for test purposes.*

ISO 5893:1993, *Rubber and plastics test equipment — Tensile, flexural and compression types (constant rate of traverse) — Description*.

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply:

3.1
coefficient of friction
the ratio of the frictional force opposing motion between two surfaces to the normal force between the surfaces under specified test conditions

NOTE Coefficient of friction is dimensionless and its value is not restricted to numbers less than unity.

3.2
area of contact
the whole of the apparent area made between the two test surfaces (test track and test piece)

NOTE The real area of contact (see 3.3) may well be less than this.

3.3
real area of contact
the sum total of the minute contact areas at which the two test surfaces touch