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IULTCS/IUP 10-1

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Leather — Determination of water resistance of flexible leather —

Part 1: Repeated linear compression (penetrometer)

Cuir — Détermination de l'imperméabilité à l'eau des cuirs souples — Partie 1: Compression linéaire répétée (pénétromètre)

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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 5403-1 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 289, *Leather*, in collaboration with the Physical Test Commission of the International Union of Leather Technologists and Chemists Societies (IUP Commission, IULTCS), in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

IULTCS, originally formed in 1897, is a world-wide organization of professional leather societies to further the advancement of leather science and technology. IULTCS has three Commissions, which are responsible for establishing international methods for the sampling and testing of leather. ISO recognizes IULTCS as an international standardizing body for the preparation of test methods for leather.

This first edition of ISO 5403-1 cancels and replaces ISO 5403:2002, which has been technically revised. Subclause 5.3 has been revised and the formula in 7.2 has been corrected. The main reason for revision was to align part 1 with part 2 and editorial changes have therefore also been made.

ISO 5403 consists of the following parts, under the general title *Leather — Determination of water resistance of flexible leather*:

— *Part 1: Repeated linear compression (penetrometer)*

— *Part 2: Repeated angular compression (Maeser)*

Leather — Determination of water resistance of flexible leather —

Part 1:
Repeated linear compression (penetrometer)

1 Scope

This part of ISO 5403 specifies a method for determining the dynamic water resistance of leather by means of repeated linear compression. It is applicable to all flexible leathers but is particularly suitable for leathers intended for footwear applications.

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 2418, *Leather — Chemical, physical and mechanical and fastness tests — Sampling location*

ISO 2419, *Leather — Physical and mechanical tests — Sample preparation and conditioning*

ISO 3696:1987, *Water for analytical laboratory use — Specification and test methods*

3 Principle

A test piece is formed into the shape of a trough and flexed while partially immersed in water. The time taken for water to penetrate through the test piece is measured. The method also allows for the percentage mass of the water absorbed and the mass of the water transmitted through the test piece to be determined.

NOTE This test method uses compression-type flexing, whereas the test method of ISO 5403-2 for water resistance imparts folding-type flexing on the leather specimens. Given the two completely different flexing actions, it is not possible to compare the results obtained from the two test methods.

4 Apparatus, reagents and materials

Usual laboratory apparatus is required and, in particular, the following.

4.1 Test machine, including the parts described in 4.1.1 to 4.1.3. (See also Annex A.)

4.1.1 One or more pairs of cylinders, 30,0 mm ± 0,5 mm in diameter, made of inert rigid material, mounted with their axes horizontal and co-axial. One cylinder shall be fixed and the other moveable along the direction of its axis such that the maximum separation of the cylinders is 40,0 mm ± 0,5 mm.

4.1.2 **Electric motor**, which drives the moveable cylinder backwards and forwards along its axis with a crank motion of 50 cycles/min ± 5 cycles/min and an amplitude of 1,0 mm ± 0,1 mm, 1,50 mm ± 0,15 mm, 2,0 mm ± 0,2 mm or 3,0 mm ± 0,3 mm about its mean position.

NOTE The four amplitudes of the crank motion are such that the test piece is compressed by 5 %, 7,5 %, 10 % or 15 % respectively when the cylinders approach one another.

4.1.3 **Tank**, made from non-corroding material, holding distilled or deionized water, in which the test piece can be partially immersed.

The test machine may also include an electrical circuit that indicates when water has penetrated through the test piece.

4.2 **Ring-shaped clamps**, with internal diameter adjustable between 30 mm and 40 mm.

4.3 **Press knife**, the inner wall of which is a rectangle of 60 mm ± 1 mm × 75 mm ± 1 mm, conforming to the requirements of ISO 2419.

4.4 **Distilled or deionized water**, of grade 3 in accordance with ISO 3696:1987.

4.5 **Balance**, weighing to 0,001 g.

4.6 **Clock**, reading to 1 s.

4.7 **Abrasive paper**, grade P180, as defined in the P-series grit-size standard published by the Federation of European Producers of Abrasive Products, cut into rectangles of 65 mm ± 5 mm × 45 mm ± 5 mm, fixed to a flat, rigid base of the same size and weighted to give a total mass of 1,0 kg ± 0,1 kg. A fresh piece of abrasive paper shall be used for each test.

4.8 **Absorbent cloth**, cut into rectangles of 120 mm ± 5 mm × 40 mm ± 5 mm, machine washed prior to first use following the cycle recommended by the cloth manufacturer.

A suitable cloth is terry towelling (frotté) in 100 % cotton and weighing about 300 g/m^2. The absorbency of this material might not be optimal when new, and therefore the cloths shall be washed before the first use.

4.9 **Auxiliary apparatus**, to determine the stiffness of the test piece, consisting of one pair of cylinders of 30,0 mm ± 0,5 mm in diameter mounted with their axes horizontal and co-axial, a means of moving the cylinders together, a means of measuring the reduction in distance between the cylinders, to the nearest 0,1 mm, and a means of measuring the force exerted along the axes of the cylinder to the nearest 5 N.

5 Sampling and sample preparation

5.1 Sample in accordance with ISO 2418. Cut four test pieces by applying the press knife (4.3) to the grain (or to the outer surface when worn). Cut two test pieces with the longer side parallel to the backbone and two test pieces with the longer side perpendicular to the backbone.

If there is a requirement for more than two hides or skins to be tested in one batch, then only one test piece in each direction need be taken from each hide or skin, provided that the overall total is not less than two test pieces in each direction.

5.2 Prepare the four test pieces using the following method.

Lightly buff the grain (or the outer surface when worn) by placing the test-piece grain (or the outer surface when worn) upwards on a flat surface. Place the weighted abrasive paper (4.7) on the test piece and move the abrasive paper ten times backwards and forwards along the full length of the test piece without applying any more downward force than is applied by the weighted abrasive.

NOTE In some situations, it might be more appropriate to flex a sample for 20 000 cycles using the method and apparatus specified in ISO 5402-1.

Many leathers have a surface coat on the grain or on the outer surface when worn. This surface coat greatly increases the water resistance of the leather. If microcracks develop rapidly in this coat as a result of flexing during wear or the coat is damaged by abrasion, then measurements made on the leather as received can be misleading. The abrasion and flexing treatments described above are intended to simulate the abrasion which the leather would receive while being worn and the test piece should therefore be abraded or flexed before the test. The purpose of this abrasion is not to remove the surface coat but merely to scratch it lightly.

5.3 Store the test specimens in a standard controlled environment in accordance with to ISO 2419 for at least 48 h. It is not necessary to carry out the test in this atmosphere.

5.4 If the water transmitted through the test piece is to be measured, condition a rectangle of absorbent cloth (4.8) in accordance with 5.3, weigh it to the nearest 0,001 g and record the mass.

5.5 If the water absorption of the test piece is to be measured, weigh the test piece to the nearest 0,001 g and record the mass.

6 Procedure

6.1 Determination of stiffness and test amplitude

NOTE The stiffness and test amplitude are not determined if the test amplitude is otherwise specified.

6.1.1 Adjust the auxiliary apparatus (4.9) so that the cylinders are at the maximum separation.

6.1.2 Bend the test piece along the longer edges, with the grain, or outer surface when worn, facing outwards to form a trough and with the shorter edges parallel and at the same level. Attach the longer edges to the cylinders by means of the ring clamps (4.2) with the same length of test piece (about 10 mm) overlapping each cylinder and with the test piece under sufficient tension to remove folds. The inner edges of the two ring clamps should lie as nearly as possible in the planes of the adjacent ends of the cylinders so that the length of the trough is the same as the distance between the cylinders. If the test piece and cylinders are to be transferred to the main test machine (4.1), ensure that the test piece forms a seal against the cylinder.

6.1.3 Move the cylinders 2,0 mm ± 0,1 mm closer to each other evenly over a period of 5 s ± 2 s and immediately return the cylinders to their original position over a period of 5 s ± 2 s.

6.1.4 Repeat the operations in 6.1.3 and record the force acting on the cylinders to the nearest 5 N.

6.1.5 Repeat the operation in 6.1.3 but this time moving the cylinders 4,0 mm ± 0,2 mm closer to each other and record the force acting on the cylinders to the nearest 5 N.

6.1.6 Calculate the arithmetic mean of the forces recorded in 6.1.4 and 6.1.5. If the mean force is greater than or equal to 100 N, then the amplitude of test is 1,0 mm ± 0,1 mm (equivalent to a 5 % compression of the test piece).

If the mean force is greater than or equal to 50 N (but less than 100 N), then the amplitude of test is 1,50 mm ± 0,15 mm (equivalent to a 7,5 % compression of the test piece).

If the mean force is less than 50 N, follow the procedure in 6.1.7 and 6.1.8.

6.1.7 Repeat the operation in 6.1.3, this time moving the cylinders 6,0 mm ± 0,3 mm closer to each other, and record the force acting on the cylinder to the nearest 5 N.

6.1.8 Calculate the arithmetic mean of the forces recorded in 6.1,4, 6.1.5 and 6.1.7. If the mean force is greater than or equal to 20 N, then the amplitude of the test is 2,0 mm ± 0,2 mm (equivalent to a 10 % compression of the test piece). If the mean force is less than 20 N, then the amplitude of test is 3,0 mm ± 0,3 mm (equivalent to a 15 % compression of the test piece).

6.2 Determination of penetration time

6.2.1 Set the test machine (4.1) so that the amplitude of test is as determined in (6.1) or as required by the specification.

6.2.2 Adjust the test machine (4.1) so that the cylinders (4.1.1) are at the maximum separation.

6.2.3 Bend the test piece along the longer edges, with the grain, or outer surface when worn, facing outwards to form a trough with the shorter edges parallel and at the same level. Attach the longer edges to the cylinders by means of the ring clamps (4.2) with the same length of test piece (about 10 mm) overlapping each cylinder and with the test piece under sufficient tension to remove folds. The inner edges of the two ring clamps should lie as nearly as possible in the planes of the adjacent ends of the cylinders so that the length of the trough is the same as the distance between the cylinders. Ensure that the test piece forms a seal against the cylinders.

If the cylinders are removable, then they and the attached test piece may be transferred from the auxiliary apparatus (4.9) to the test machine (4.1).

6.2.4 Raise the level of water in the freshly filled tank until the surface lies 10 mm ± 1 mm below the top of the cylinders.

6.2.5 Start the motor and note the time.

6.2.6 Observe the test piece continuously for the first 15 min, then at intervals of 15 min until water is seen to penetrate through the test piece. If water penetrates between the test piece and the cylinder, reject the result and repeat the determination using a fresh test piece. Note the time when penetration occurs.

An electrical device may be used to assist in the determination of water penetration, but penetration should also be confirmed visually.

NOTE Penetration might be seen as a damp patch or as a droplet (or droplets) of water formed on the surface. The droplets are often easier to see using a suitable light source.

6.3 Determination of water absorption

6.3.1 Carry out the steps given in 6.2.1 to 6.2.5.

6.3.2 After the required time has elapsed, stop the test machine, remove the test piece, blot gently to remove adhering water, weigh the test piece to the nearest 0,001 g and record the mass.

6.3.3 If other determinations are required, replace the test piece and continue the test.

6.4 Determination of water penetration

6.4.1 After initial water penetration has occurred, place a rolled-up rectangle of absorbent material into the trough formed by the test piece.

6.4.2 Continue the test until the required time has elapsed. Remove the absorbent material and use it to mop up any excess water from the trough.

6.4.3 Weigh the absorbent material to the nearest 0,001 g and record the mass.

7 Expression of results

7.1 Penetration time

The penetration time shall be reported directly in minutes or hours and minutes, as convenient.

7.2 Water absorption

The percentage water absorption, w_a, shall be calculated using the formula:

$$w_a = \frac{(m_1 - m_0) \times 100}{m_0}$$

where

m_1 is the mass of the test piece after any time period, in grams;

m_0 is the initial conditioned mass of the test piece, in grams.

7.3 Water transmission

The water transmission, m_{wt}, in grams, shall be calculated using the formula:

$$m_{wt} = m_{am1} - m_{am0}$$

where

m_{am1} is the mass of the absorbent material after test, in grams;

m_{am0} is the initial conditioned mass of the absorbent material, in grams.

8 Test report

The test report shall include the following:

a) a reference to this part of ISO 5403, i.e. ISO 5403-1:2011;

b) full details for identification of the sample and any deviation from ISO 2418 with respect to sampling;

c) the conditions in ISO 2419 used to condition the test specimens, if different from reference standard conditions;

d) the penetration time for each test piece tested;

e) the water absorption, m_a, at each time interval, if measured;

f) the water transmission, m_{wt}, and the period over which it was determined, if measured;

g) any deviations from the method specified in this part of ISO 5403.