INTERNATIONAL STANDARD

ISO 7971-2

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Cereals — Determination of bulk density, called "mass per hectolitre" —

Part 2: Routine method

Céréales — Détermination de la masse volumique, dite «masse à l'hectolitre» —

Partie 2: Méthode pratique

INTERNATIONAL

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Foreword

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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 7971-2 was prepared by Technical Committee ISO/TC 34, *Agricultural food products*, Subcommittee SC 4, *Cereals and pulses*, in collaboration with the International Association for Cereal Science and Technology (ICC).

ISO 7971 consists of the following parts, under the general title *Cereals — Determination of bulk density, called "mass per hectolitre"*:

— *Part 2: Routine method*

Part 1 will be a revision of ISO 7971:1986.

Annex A of this part of ISO 7971 is for information only.

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Cereals — Determination of bulk density, called "mass per hectolitre" —

Part 2:
Routine method

1 Scope

This part of ISO 7971 specifies a routine method for the determination of bulk density, called "mass per hectolitre", of cereals (wheat, barley, oats and rye), utilizing a 1 litre measuring container.

NOTES

1 The reference method for determination of bulk density, called "mass per hectolitre", is given in ISO 7971 (see reference [1]).

2 Several other routine methods are used in different countries.

2 Definition

For the purposes of this part of ISO 7971, the following definition applies.

2.1 mass per hectolitre: Ratio of the mass of a cereal to the volume it occupies after being poured into a container under well-defined conditions.

It is expressed in kilograms per hectolitre at a stated moisture content.

NOTE 3 The bulk density as described in this part of ISO 7971 should not be confused with the "packing density" or the intrinsic density of the cereals.

3 Principle

Pouring a sample in a controlled manner from a hopper into a 1 litre container then weighing it.

4 Requirements for apparatus

Variations between instruments, and operator errors in measurements, can arise from the manner in which the grain is poured into the measuring container and the manner in which the grain packs into the measuring container.

To minimize such variations and errors, the various dimensions of the apparatus and the manner of pouring shall therefore be closely controlled. The apparatus used and the method of operation shall therefore comply with the specifications given in this clause and in clause 5 (see figure 1).

NOTE 4 For information, EC recommendations for measuring instruments used to determine EEC standard mass per storage volume of grain are contained in annex II of reference [2].

4.1 Pre-filling measure

The pre-filling measure shall be made of metal and be in the shape of a straight-sided cylinder, closed at the bottom end with a flat base plate. On its internal wall there shall be an annular level mark, placed no less than 1 cm and no more than 3 cm from the open end of the cylinder.

NOTE 5 The purpose of the pre-filling measure is to control the manner in which the filling hopper (4.2) is filled with grain and thus to reduce or eliminate operator errors which might otherwise arise.

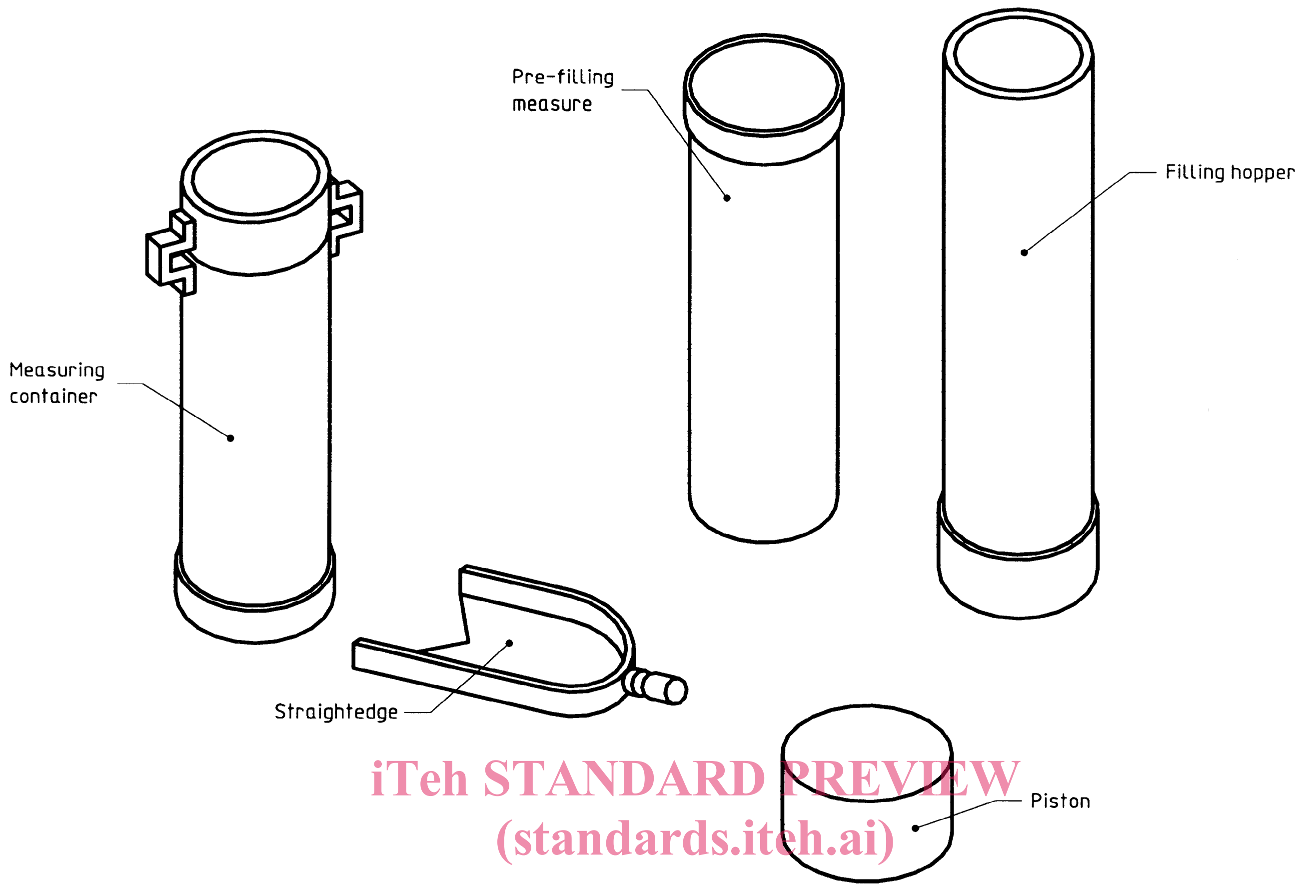

Figure 1 — Apparatus for determining the bulk density of cereals, utilizing a 1 litre measuring container

4.2 Filling hopper

The hopper shall be made of metal and be in the shape of a straight-sided cylinder, open at both ends. At the bottom of the cylinder an extended projection around the circumference of the cylinder enables the filling hopper to be pushed onto the measuring ring at the top of the measuring container (4.3). The hopper receives from the pre-filling measure (4.1) a volume of grain greater than 1 litre.

4.3 Measuring container with measuring ring

The 1 litre volume of the measuring container is formed by the internal surface of the container wall, the upper surface of the inserted piston (4.4) and the lower surface of the fully inserted straightedge (4.5). The maximum permissible relative error on the capacity of the container is $\pm$ 3/1 000. The wall of the measuring container shall be made of a seamless drawn-brass tube or a stainless steel tube in the shape of a straight-sided cylinder, open at the top and closed at the base, and shall have an external reinforcement on the edge. The measuring edge shall be ground flat.

A measuring ring, the internal diameter of which is the same as that of the measuring container, shall be attached to the measuring container over the measuring edge. The gap between the measuring edge and the measuring ring shall be large enough for the straightedge (4.5) to be able to be pushed through easily but without any noticeable clearance.

The base of the measuring container shall be flat and perforated so as to allow the escape of air during use of the apparatus. The external reinforcement encircling the base of the measuring container and its three feet shall be in one piece. It shall be soldered to the measuring container wall and be secure against shifting.

4.4 Piston

The piston shall be made of brass plate in the shape of a straight-sided cylinder with flat ends. Internally,

it shall be stiffened such that the stamping (see clause 10) may be carried out without the surface being dented. If the piston should be dented, or otherwise damaged, it shall be replaced because the dent would alter the volume of the grain being tested.

When the straightedge (4.5) is withdrawn, the piston falls smoothly down the measuring container (4.3), thus driving air through the exit holes in the base of the measuring container. This therefore controls the rate of fall and ensures the smooth flow of grain from the filling hopper (4.2) into the measuring container (4.3).

4.5 **Straightedge** (leveling blade)

The straightedge shall be a flat, thin but rigid, hardened-steel blade, equipped with a handle. The surfaces shall be flat and parallel. It shall be large enough to cover the cross-section of the measuring container completely at its limit of travel. The blade shall be cut to the form of an open V at the front, and bevelled such that the line of cutting is in the middle of the thickness of the blade.

The blade slides horizontally into the slot in the measuring container (4.3) and is pushed manually through the grain, guided by the slot, in a smooth and continuous movement. This separates precisely 1 litre of grain (below the blade) from excess grain above the blade.

4.6 Base plate

The base plate shall be made of metal and arranged such that the measuring container (4.3) can be firmly connected to it by simply rotating. It shall not be perforated. It shall be fixed to a mounting plate of hardwood or to the hardwood lid of the transport case for the apparatus. The mounting plate or the transport case shall be provided with vertical-adjustment screws and a spirit level such that, when placed on a flat horizontal surface, the apparatus stands firm and vertical, otherwise errors will be introduced.

4.7 Weighing device

The grain contained in the measuring container is weighed using a balance which has been weighted to compensate for the mass of the empty container plus piston; therefore one single weighing gives the mass of the grain. The maximum permissible relative error of the weighing device for the quantity weighed is ± 1/1 000. The device shall be regularly calibrated by a competent authority.

5 Dimensions of apparatus

The dimensions of the different parts of the apparatus shall be as specified in 5.1 to 5.6.

5.1 Pre-filling measure

Capacity to level mark	(1 350 ± 10) ml
Internal diameter	(86 ± 0,2) mm

5.2 Filling hopper

Internal diameter	(79 ± 0,1) mm
Wall thickness	(1 ± 0,2) mm
Height above piston	(280 ± 2) mm

5.3 Piston

Diameter	(87,5 ± 0,1) mm
Height	(40 ± 0,2) mm
Mass	(450 ± 2) g

5.4 Measuring container

Internal diameter	(88,2 ± 0,1) mm
Internal height above piston	(163,7 ± 0,1) mm
Wall thickness	(1,2 ± 0,5) mm
External reinforcement of upper edge:	
thickness	(2,5 ± 0,5) mm
height	(6,0 ± 1,0) mm
Base thickness	(4,5 ± 0,1) mm
Diameter of base perforations	(3,0 ± 0,1) mm
Height of feet	(9,0 ± 0,1) mm
Diameter of feet	(6,0 ± 0,1) mm
Gap between base and base plate	(6,0 ± 0,1) mm
Number of perforations in base	1 + 4 + 8 + 12 + 16 + 20 + 24 = 85
Measuring ring:	
internal diameter	(88,2 ± 0,1) mm
height	(40,5 ± 0,1) mm

5.5 Base plate

Diameter of locating circle	(80,0 ± 0,1) mm

5.6 Straightedge

Thickness	(1 ± 0,05) mm
Cut-out angle	(90° ± 2°)
Width of bevel of cutting edge	(3 ± 0,5) mm

6 Calibration and accuracy

NOTE 6 Standard apparatus can be found in many countries at national metrological institutions.

6.1 Calibration

Calibration of the apparatus (I) shall be carried out by comparison with a national or international standard apparatus (E).

The calibration shall be carried out on a cereal free from impurities under the same conditions of temperature and humidity as the atmosphere of the room where the measurement is to be made.

For this purpose, spread the cereal in a thin layer and leave it for 10 h (one night) in the room where the measurement is to be made, ensuring that the relative humidity of the air does not exceed 60 %.

Carry out six measurements with each apparatus, using the same sample of grain in the following order (before each new measurement, the grain contained in the measuring container should be intimately mixed with the excess grain poured off from above the straightedge during the previous measurement):

Measurement No.	1	2	3	4	5	6
Order of measurement	E-I	I-E	E-I	I-E	E-I	I-E

6.2 Accuracy error

The accuracy error of the apparatus is the difference between the arithmetic mean of the six measurements using apparatus I and the arithmetic mean of the six measurements using apparatus E.

The maximum permissible accuracy error is ± 1 g.

7 Sampling

It is important that the laboratory receive a sample which is truly representative and has not been damaged or changed during transport or storage.

Sampling is not part of the method specified in this International Standard. A recommended sampling method is given in ISO 950.[3]

8 Procedure

8.1 Preliminary operations

The grain sample shall be air-dry, free from foreign bodies and have achieved ambient temperature. The atmospheric relative humidity of the room shall be between 40 % and 75 %.

NOTE 7 It is recommended to determine the moisture content of the grain in accordance with ISO 712[4].

Install the apparatus vertically and free from vibrations on a firm, non-sprung base. Before each filling, ensure that the measuring container, slit and piston are free from dust and grain residues or other foreign bodies. Fix the measuring container to the base plate and push the straightedge into the slit of the measuring container in such a way that the inscription "Top" can be seen from above.

Place the piston on the straightedge in such a way that the surface bearing the production number is uppermost. Put on the filling hopper in such a way that its production number can be seen from the front.

8.2 Determination

Fill the pre-filling measure with the sample of grain up to the level mark. Then empty it to within 3 cm or 4 cm from the upper edge of the filling hopper in such a way that the grain sample flows evenly into the middle of the filling hopper in 11 s to 13 s. After filling, quickly pull out the straightedge, but without shaking the apparatus.

When the piston and the grain have fallen into the measuring container, place the straightedge back in the slit and push it through the grain in a single stroke. If a particle becomes jammed between the slit edge and the straightedge in the process, the pouring shall be repeated. Throw out excess grain lying on the straightedge. Then remove the filling hopper and straightedge.

Throughout the procedure it is important that the apparatus should not be tapped, knocked or shaken, otherwise a falsely high result will be obtained. However, once the 1 litre volume has been isolated, this restriction need not be observed.

Weigh the contents of the measuring container to the nearest 1 g using the weighing device (4.7). Alternatively, the grain may be poured into a separate previously tared receptacle and weighed to the nearest 1 g.

9 Expression of results

To determine the bulk density, expressed in kilograms per hectolitre, take the mass in grams of the cereal contained in the 1 litre measuring container (m) and apply the following equation.

Bulk density, in kilograms per hectolitre, equals

for wheat	$0{,}100\ 2\ m + 0{,}53$
for barley	$0{,}103\ 6\ m - 2{,}22$
for rye	$0{,}101\ 7\ m - 0{,}08$
for oats	$0{,}101\ 3\ m - 0{,}61$

Express the result to the nearest 0,1 kg/hl at a stated moisture content.

NOTE 8 The equations provide linear mathematical conversions from grams per litre to kilograms per hectolitre. The factors are derived from reference [5].

10 Marking of apparatus

The following shall appear on the apparatus:

a) reference to this part of ISO 7971;

b) nominal capacity on the measuring container and the pre-filling container;

c) manufacturer's name or the manufacturer's trademark on the measuring container, and the year of manufacture;

d) production number of the apparatus on the measuring container, the base plate, the straightedge, the filling hopper, the pre-filling container and on the top of the piston;

e) the word "Top" on the top of the straightedge.

The apparatus shall be accompanied by operating instructions.

The various parts of the apparatus shall be maintained, and used, as a set.

11 Test report

The test report shall specify

— the method in accordance with which sampling was carried out, if known,

— the moisture content of the grain, if determined,

— the method used,

— the test result(s) obtained, and

— if the repeatability has been checked, the final quoted result obtained.

It shall also mention all operating details not specified in this part of ISO 7971, or regarded as optional, together with details of any incidents which may have influenced the test result(s).

The test report shall include all information necessary for the complete identification of the sample.

Annex A
(informative)

Bibliography

[1] ISO 7971:1986, *Cereals — Determination of bulk density, called "mass per hectolitre" (Reference method).*

[2] European Directive 71/347/EEC.

[3] ISO 950:1979, *Cereals — Sampling (as grain).*

[4] ISO 712:—[1], *Cereals and cereal products — Determination of moisture content — Routine reference method.*

[5] *Tables of the determination of mass per hectolitre of wheat, barley, rye and oats.* Brunswick: Physikalisch-Technische Bundesanstalt, 1967.

1) To be published. (Revision of ISO 712:1985)

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