INTERNATIONAL STANDARD

ISO 5530-2

Third edition
2012-07-01

Wheat flour — Physical characteristics of doughs —

Part 2: Determination of rheological properties using an extensograph

Farines de blé tendre — Caractéristiques physiques des pâtes —

Partie 2: Détermination des caractéristiques rhéologiques au moyen de l'extensographe

Reference number
ISO 5530-2:2012(E)

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

Published in Switzerland

Contents

Page

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 5530-2 was prepared by Technical Committee ISO/TC 34, *Food products*, Subcommittee SC 4, *Cereals and pulses*.

This third edition cancels and replaces the second edition (ISO 5530-2:1997), which has been technically revised.

ISO 5530 consists of the following parts, under the general title *Wheat flour — Physical characteristics of doughs*:

— *Part 1: Determination of water absorption and rheological properties using a farinograph*

— *Part 2: Determination of rheological properties using an extensograph*

— *Part 3: Determination of water absorption and rheological properties using a valorigraph*

Wheat flour — Physical characteristics of doughs —

Part 2:
Determination of rheological properties using an extensograph

1 Scope

This part of ISO 5530 specifies a method, using an extensograph, for the determination of the rheological properties of wheat flour dough in an extension test. The recorded load–extension curve is used to assess general quality of flour and its response to improving agents.

The method is applicable to experimental and commercial flours from wheat (*Triticum aestivum* L.).

NOTE This part of ISO 5530 is based on ICC 114.[3]

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 712, *Cereals and cereal products — Determination of moisture content — Reference method*

ISO 5530-1:—,1) *Wheat flour — Physical characteristics of doughs — Part 1: Determination of water absorption and rheological properties using a farinograph*

3 Terms and definitions

For the purposes of this part of ISO 5530, the following terms and definitions apply.

3.1
energy
capacity to do work

NOTE 1 For the purposes of this part of ISO 5530, the energy is determined as the area under a recorded curve. The energy describes the work applied when stretching a dough sample.

NOTE 2 The area is measured by a planimeter and reported in square centimetres.

3.2
extensibility
E
distance travelled by the recorder paper from the moment that the hook touches the test piece until rupture of (one of the strings of) the test piece

NOTE See 9.4 and Figure 1.

3.3
extensograph water absorption
volume of water required to produce a dough with a consistency of 500 farinograph units (FU) after 5 min mixing, under specified operating conditions

NOTE Extensograph water absorption is expressed in millilitres per 100 g of flour at 14,0 % mass fraction moisture content.

1) To be published. (Revision of ISO 5530-1:1997)

3.4
maximum resistance
R_m
mean of the maximum heights of the extensograph curves from the two test pieces, provided that the difference between them does not exceed 15 % of their mean value

NOTE See 9.3.1 and Figure 1.

3.5
ratio (*R*/*E*)
quotient of the maximum resistance, R_m, and the extensibility or the resistance after 50 mm transposition of the recorder paper, R_{50}, and the extensibility

NOTE The ratio is an additional factor in the review of the dough behaviour.

3.6
resistance at constant deformation
mean of the heights of the extensograph curves after 50 mm transposition of the recorder paper from the two test pieces, provided that the difference between them does not exceed 15 % of their mean value

NOTE See 9.3.2 and Figure 1.

3.7
stretching characteristics
<dough> resistance of dough to extension and the extent to which it can be stretched until breaking, under specified operating conditions

NOTE 1 The resistance is expressed in arbitrary units (extensograph units, EU).

NOTE 2 The extent of stretching is expressed in millimetres or centimetres.

4 Principle

Dough is prepared from flour, water and salt in a farinograph under specified conditions. A test piece is then moulded on the balling unit and moulder of the extensograph into a standard shape. After a fixed period of time, the test piece is stretched and the force required recorded. Immediately after these operations, the same test piece is subjected to two further cycles of moulding, rest period and stretching.

The size and shape of the curves obtained are a guide to the physical properties of the dough. These physical properties influence the end-use quality of the flour.

5 Reagents

Use only reagents of recognized analytical grade, unless otherwise specified, and distilled or demineralized water or water of equivalent purity.

5.1 Sodium chloride.

6 Apparatus

Usual laboratory apparatus and, in particular, the following.

6.1 Extensograph,[2] with a thermostat consisting of a constant temperature water bath (see Annex A), with the following operating characteristics:

2) This document has been drawn up on the basis of the Brabender Extensograph, which is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product. Other equipment may be used if it can be shown to give comparable results.

— rotational frequency of balling unit: (83 ± 3) min^{-1} (r/min);

— rotational frequency of moulder: (15 ± 1) min^{-1} (r/min);

— hook speed: (1,45 ± 0,05) cm/s;

— chart speed: (0,65 ± 0,01) cm/s;

— force exerted per extensograph unit: (12,3 ± 0,3) mN/EU [(1,25 ± 0,03) gf/EU].

Some instruments have a different calibration for force/unit deflection. The procedure specified can be used with such instruments, but it is necessary for the different calibration to be taken into account when comparing the results with instruments calibrated as above.

NOTE An electronic extensograph can be used, see A.5.

6.2 Farinograph,[3)] connected to a similar thermostat as the extensograph, with the operating characteristics specified in ISO 5530-1, and a **burette** as specified in ISO 5530-1.

6.3 Balance, capable of being read to the nearest ±0,1 g.

6.4 Spatula, made of soft plastic.

6.5 Conical flask, of 250 ml capacity.

7 Sampling

Sampling is not part of the method specified in this International Standard. A recommended sampling method is given in ISO 24333.[2]

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

8 Procedure

8.1 Determination of the moisture content of the flour

Determine the moisture content of the flour using the method specified in ISO 712.

8.2 Preparation of apparatus

8.2.1 Turn on the thermostat of the farinograph (6.2) and circulate the water until the required temperatures are reached, prior to using the instrument. Before and during use, check the temperatures of

— the thermostats;

— the mixing bowl of the farinograph, in the hole provided for this purpose; and

— the extensograph cabinet.

All temperatures shall be (30 ± 0,2) °C.

8.2.2 Adjust the arm of the pen of the extensograph so as to obtain zero reading when a cradle with both its clamps plus a 150 g mass (“weight”) is placed in position.

3) The Farinograph is the trade name of a product supplied by Brabender. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

8.2.3 Pour some water into the trough of each cradle support, and place the supports, cradles, and clamps in the cabinet at least 15 min before use.

8.2.4 Uncouple the mixer of the farinograph from the driving shaft and adjust the position of the counterweight(s) so as to obtain zero deflection of the pointer with the motor running at the specified rotational frequency (see ISO 5530-1:—, 6.1). Switch off the motor and then couple the mixer.

Lubricate the mixer with a drop of water between the back-plate and each of the blades. Check that the deflection of the pointer is within the range (0 ± 5) FU with the mixing blades operating at the specified rotational frequency in the empty, clean bowl. If the deflection exceeds 5 FU, clean the mixer more thoroughly or eliminate other causes of friction.

Adjust the arm of the pen so as to obtain identical readings from the pointer and the recording pen.

Adjust the damper so that, with the motor running, the time required for the pointer to go from 1 000 FU to 100 FU is (1,0 ± 0,2) s.

8.2.5 Fill the burette of the farinograph, including the tip, with water at a temperature of (30 ± 0,5) °C.

8.3 Test portion

If necessary, bring the flour to a temperature of (25 ± 5) °C.

Weigh, to the nearest 0,1 g, the equivalent of 300 g of flour having a moisture content of 14 % mass fraction. Let this mass, in grams, be m; see ISO 5530-1:—, Table 1, for m as a function of moisture content.

Place the flour into the farinograph mixer. Cover the mixer and keep it covered until the end of mixing (8.4.2), except for the shortest possible time when water has to be added and the dough scraped down (see ISO 5530-1:—, A.1.2).

8.4 Preparation of the dough

8.4.1 Place (6,0 ± 0,1) g of the sodium chloride (5.1) in the conical flask (6.5). Run in approximately 135 ml of water from the burette and dissolve the salt. For flours having a low water absorption, use a smaller volume of water.

8.4.2 Mix in the farinograph mixer at the specified rotational frequency (see ISO 5530-1:—, 6.1) for 1 min or slightly longer. Pour the salt solution (8.4.1) through a funnel into the centre hole of the bottom part of the lid, when a whole-minute line on the recorder paper passes by the pen.

In order to reduce the waiting time, the recorder paper may be moved forward during mixing of the flour. Do not move it backwards.

NOTE 1 With older models of farinograph, whose bowl is covered by a single plate (see ISO 5530-1:—, A.1.2), the salt solution is poured into the right-hand front corner of the bowl.

Add from the burette, into the right-hand front corner of the mixer, a volume of water approximately equal to that expected to obtain a consistency of 500 FU after mixing for 5 min. When the dough forms, scrape down the sides of the bowl with the spatula (6.4), adding any adhering particles to the dough without stopping the mixer. If the consistency is too high, add a little more water to obtain a consistency of 500 FU after mixing for 5 min. Stop mixing and clean the mixer.

NOTE 2 If the first dough meets the requirements of 8.4.3, test pieces from it can be moulded (8.4.4) and stretched (8.5.1).

8.4.3 Make further mixings as necessary, until a dough is obtained:

— to which the salt solution and water have been added within 25 s;

— the consistency of which, measured at the centre of the curve after mixing for 5 min, is between 480 FU and 520 FU; and

— the mixing time, which is indicated by the development time determined by farinograph.

Stop mixing after this time.

8.4.4 Take a support with two cradles from the cabinet of the extensograph (6.1); remove their clamps.

Remove the dough from the mixer. Weigh a (150 ± 0,5) g test piece. Place it in the balling unit and perform 20 revolutions of the plate. Remove the dough from the balling unit and pass it once through the moulder, ensuring that the test piece enters the back centrally, base first. Roll the test piece off the moulder into the centre of a cradle and clamp it. Set the timer for 45 min. Weigh a second test piece, and ball, mould and clamp it in the same way. Place the support with two cradles and test pieces in the cabinet.

Very sticky doughs may be dusted lightly with rice flour or starch before being put into the moulder.

In the case of doughs showing substantial elastic recovery, the clamps should be held down for a few seconds to ensure that they fix the dough properly.

Clean the farinograph mixer.

8.5 Determination

8.5.1 Exactly 45 min after clamping the first test piece, place the first cradle in the balance arm of the extensograph (6.1); the bridge between the two halves of the cradle shall be on the left-hand side so as not to be touched by the stretching hook when travelling. Adjust the pen to zero force. Immediately start the stretching hook.

Observe the test piece (see 9.4, paragraph 2). After rupture of the piece, remove the cradle.

NOTE In recent models of extensograph, the hook automatically returns to its upper position. With older models it is necessary, by means of a switch, to stop the hook after breaking of the test piece, and to initiate the return to its upper position.

8.5.2 Collect the dough from the cradle and the hook. Repeat the balling and moulding operations as specified in 8.4.4 on this test piece. Reset the timer for 45 min.

8.5.3 Turn the recorder paper back to the same starting position as for the first test piece. Repeat the stretching operation (8.5.1) on the second test piece. Collect the dough from the cradle and the hook. Repeat the balling and moulding operations (8.4.4) on the second test piece.

8.5.4 Repeat the stretching, balling, and moulding operations specified in 8.5.1 to 8.5.3, returning the moulded test pieces to the cabinet. These operations take place after slightly more than 90 min from the end of mixing.

8.5.5 Repeat the operation specified in 8.5.1, stretching both test pieces in turn. This operation takes place after slightly more than 135 min from the end of mixing.

8.5.6 In order to carry out quick and time-saving measurements, another procedure may be suitable. The difference from the standard procedure is in the rest periods. Stretching after 45 min, 90 min and 135 min after mixing are replaced by stretching after 30 min, 60 min and 90 min after mixing. The shape and the size of the curves obtained differ from those of the standard extensograms. When the quick procedure is used, it is necessary to state this in the test report.

9 Expression of results

9.1 General

To facilitate the calculations, a computer may be used. The extensograph has to be modified by adding an electrical output for transferring the data to the computer. With the appropriate software, the computer evaluates the diagram according to 9.2 to 9.5 and documents the diagram and the results.

9.2 Water absorption

Calculate the extensograph water absorption, expressed in millilitres per 100 g of flour at 14 % mass fraction moisture content, as specified in ISO 5530-1:—, 9.1, for the 300 g mixer.

9.3 Resistance to stretching

9.3.1 Maximum resistance

Take as the maximum resistance to stretching, R_m, the mean of the maximum heights of the extensograph curves (see Figure 1) from the two test pieces, provided that the difference between them does not exceed 15 % of their mean value.

Report each of the mean values of R_{m45}, R_{m90}, and R_{m135} to the nearest 5 EU.

9.3.2 Resistance at constant deformation

Some workers prefer to measure the height of the curve at a fixed extension of the test piece, usually corresponding to 50 mm transposition of the recorder paper. The extension is measured from the moment that the hook touches the test piece; i.e. when the force is suddenly different from zero.

Take as the result of the resistance to stretching at constant deformation, R_{50}, the mean of the heights of the extensograph curves after 50 mm transposition of the recorder paper (see Figure 1) from the two test pieces, provided that the difference between them does not exceed 15 % of their mean value.

Report each of the mean values of $R_{50,45}$, $R_{50,90}$ and $R_{50,135}$ to the nearest 5 EU.

Owing to the greater depression of the cradle, a more resistant test piece is extended to a lesser extent at 50 mm transposition of the recorder paper than a less resistant test piece. It is possible, by means of a suitable template, to read the resistances of all test pieces at the same net extension. If such a template is used, it is necessary to mention this in the test report.

9.4 Extensibility, E

The extensibility, E, is the distance travelled by the recorder paper from the moment that the hook touches the test piece until rupture of (one of the strings of) the test pieces. Rupture is indicated on the extensograph curve either by a smooth fall of the curve almost to zero force, or by a sharp break in the curve (see Figure 1).

Beyond the breaking point, the course of the recording depends on the inertia of the lever system and on the time interval between the breaking of the two strings of the test piece. For measurement of the extensibility, the curve is supposed to proceed, from the breaking point, along a circular ordinate line (dashed line in Figure 1) down to zero force. To identify the breaking point on the curve properly, it is necessary to observe the test piece when breaking.

Take as the result of the extensibility the mean distance on the extensograph curves from the two test pieces, provided that the difference between them does not exceed 9 % of their mean value.

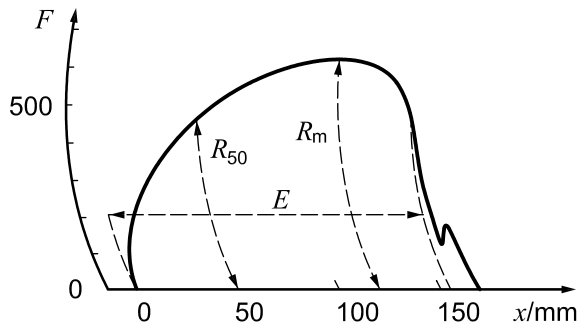
Report each of the mean values of E_{45}, E_{90} and E_{135} to the nearest millimetre.

9.5 Energy

The energy is defined as the area under the recorded curve. The energy describes the work applied when stretching a dough sample. The area is measured by a planimeter and reported in square centimetres.

9.6 Ratio (R/E)

The ratio R/E is the quotient of the resistance R_m or R_{50} and the extensibility. The ratio is an additional factor in the review of the dough behaviour.



Key

F force

x time or extension

E extensibility

R_m maximum resistance

R_{50} resistance after 50 mm transposition of the recorder paper

Figure 1 — Representative extensogram showing the commonly measured indices

10 Precision

10.1 Repeatability

The absolute difference between two independent single test results, obtained using the same method on identical test material in the same laboratory by the same operator using the same equipment within a short interval of time, will in not more than 5 % of cases be greater than values given in Table 1

Table 1 — Repeatability data obtained by using extensograph

Characteristic	Repeatability results
Maximum resistance	66,79
Extensibility 135	15,50
Energy 135	14,12
Ratio (R_m/E) 135	0,80
Ratio (R_{50}/E) 135	0,86

10.2 Reproducibility

The absolute difference between two single test results, obtained using the same method on identical test material in different laboratories with different operators using different equipment, will in not more than 5 % of cases be greater than values given in Table 2.

Table 2 — Reproducibility data obtained by using extensograph

Characteristic	Reproducibility results
Maximum resistance	311,67
Extensibility 135	89,02
Energy 135	103,48
Ratio (R_m/E) 135	3,62
Ratio (R_{50}/E) 135	2,27

