



**International
Standard**

ISO 5530-1

**Wheat flour — Physical
characteristics of doughs —**

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

*Farines de blé tendre — Caractéristiques physiques des pâtes —
Partie 1: Détermination de l'absorption d'eau et des
caractéristiques rhéologiques au moyen du farinographe*

**Fourth edition
2025-01**

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 34, *Food products*, Subcommittee SC 4, *Cereals and pulses*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 338, *Cereal and cereal products*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This fourth edition cancels and replaces the third edition (ISO 5530-1:2013), which has been technically revised.

The main changes are as follows:

- a wheat flour interlaboratory test was performed in 2015 to evaluate the repeatability and reproducibility of the test method specified in this document, and the results have been added as [Annex C](#);
- more detailed procedure for electronic devices has been added.

A list of all parts in the ISO 5530 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Wheat flour — Physical characteristics of doughs —

Part 1:

Determination of water absorption and rheological properties using a farinograph

1 Scope

This document specifies a method using a farinograph for the determination of the water absorption of flours and the mixing behaviour of doughs made from them by a constant flour mass procedure or by a constant dough mass procedure.

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

NOTE This document is related to ICC 115/1^[5] and AACC Method 54-21.02^[6].

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 712-1, *Cereals and cereal products — Determination of moisture content — Part 1: Reference method*

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

consistency

resistance of a dough to being mixed in specific conditions

Note 1 to entry: For the purposes of this document, consistency refers to the resistance of dough being mixed in a farinograph under the conditions specified in the methodology.

Note 2 to entry: It is expressed in *farinograph unit (FU)* (3.2).

Note 3 to entry: Specific conditions include mixing conditions, temperature, hydration, etc.

3.2

farinograph unit

FU

arbitrary unit used for *consistency* (3.1) on the farinogram

Note 1 to entry: For the mathematical expression of FU, see 6.1.

Note 2 to entry: It is also possible to define an FU as a torque expressed in Nm, measured in the axis of the mixer.

3.3

maximum consistency

consistency (3.1) measured at the end of the *dough development time* (3.5)

Note 1 to entry: For the mathematical expression of maximum consistency, see 9.3.

Note 2 to entry: It is expressed in *farinograph unit (FU)* (3.2).

Note 3 to entry: See 3.7.

3.4

water absorption of flour

W_a

volume of water required to produce a dough with a *maximum consistency* (3.3) of 500 *farinograph unit (FU)* (3.2) under the specified operating conditions

Note 1 to entry: Water absorption is expressed in millilitres per 100 g of flour at 14 % (mass fraction) moisture content to an accuracy of 0,1 ml.

Note 2 to entry: Water absorption can also be expressed in % (ml per 100 g).

3.5

dough development time

DDT

DEPRECATED: peak time

time from the beginning of the addition of water to the point on the curve immediately before the first sign of the decrease of *maximum consistency* (3.3)

Note 1 to entry: In cases where two peaks are observed, use the second maximum to measure the DDT.

Note 2 to entry: See [Figure 1](#) and [9.3](#).

Note 3 to entry: It is expressed in minutes to the nearest 0,1 min.

3.6

stability

difference in time between the point where the top part of the curve intercepts, for the first time, the line of 500 *farinograph unit (FU)* (3.2) and the last point where leaves this line

Note 1 to entry: This value measures the tolerance of the flour to mixing.

Note 2 to entry: When the *maximum consistency* (3.3) of a peak curve deviates from the (500 ± 20) FU line, the line of this consistency should be used to read the interceptions (see also [B.5.2](#)).

Note 3 to entry: The stability is expressed in minutes, to an accuracy of 0,5 min.

3.7

degree of softening

difference between the height of the centre of the curve at the point where it begins to decline (*dough development time* (3.5)) and the height of the centre of the curve 12 min after that point

Note 1 to entry: It is expressed in *farinograph unit (FU)* (3.2).

Note 2 to entry: In cases where two peaks appear, the second peak is considered to determine the degree of softening.

Note 3 to entry: The degree of softening should be expressed to the nearest 5 farinograph unit (FU).

Note 4 to entry: This definition is equivalent to ICC 155/1^[5].

3.8

farinograph quality number

FQN

length along the time axis between the point of the addition of water and the point where the height of the centre of the curve has decreased by 30 *farinograph unit (FU)* (3.2) compared to the height of the centre of the curve at the *dough development time* (3.5)

Note 1 to entry: It is expressed in millimetres to an accuracy of 1 mm.

4 Principle

Measuring and recording, by means of a farinograph, the consistency of a dough as it is formed from flour and water, as it is developed and as it changes with time.

NOTE The maximum consistency of the dough is adjusted to a fixed value by adapting the quantity of water added. The correct water addition, which is called the "water absorption", is used to obtain a complete mixing curve, the various features of which are a guide to the rheological properties (strength) of the dough.

5 Reagent

Use only distilled or demineralized water or water conforming to grade 3 in accordance with ISO 3696.

6 Apparatus

The usual laboratory apparatus and, in particular, the following shall be used.

6.1 Farinograph¹⁾ (see [Annex A](#)), with the following operating characteristics:

- slow blade rotational frequency: $(63 \pm 2) \text{ min}^{-1}$; the ratio of the rotational frequencies of the mixing blades shall be $1,50 \pm 0,01$;
- torque per FU:
 - for a 300 g mixer: $(9,8 \pm 0,2) \text{ mN}\cdot\text{m}/\text{FU}$ [$(100 \pm 2) \text{ gf}\cdot\text{cm}/\text{FU}$];
 - for a 50 g mixer: $(1,96 \pm 0,04) \text{ mN}\cdot\text{m}/\text{FU}$ [$(20 \pm 0,4) \text{ gf}\cdot\text{cm}/\text{FU}$];
 - for chart recording devices: chart speed: $(1,00 \pm 0,03) \text{ cm}/\text{min}$;
 - for electronic devices: chart speed is not applicable but time is measured.

6.2 Water dosing system, comprising:

- a) for a 300 g mixer: a burette graduated from 135 ml to 225 ml in 0,2 ml divisions;
- b) for a 50 g mixer: a burette graduated from 22,5 ml to 37,5 ml in 0,1 ml divisions;
- c) an electronically driven water dosage system.

6.3 Thermostat, with circulating water for a constant temperature of $(30 \pm 0,2) \text{ }^\circ\text{C}$.

6.4 Balance, capable of weighing to the nearest $\pm 0,1 \text{ g}$.

6.5 Spatula, thin, made of a non-metallic material.

1) This document has been drawn up on the basis of the Brabender Farinograph, 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. Equivalent products may be used if they can be shown to lead to the same results.

7 Sampling

Sampling is not part of the method specified in this document. A recommended sampling method is given in ISO 24333^[4].

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

8 Procedure

8.1 Determination of the moisture content of the flour

Determine the water content of the flour using the method specified in ISO 712-1 or by near infrared spectroscopy. The performance of the NIR should be demonstrated in accordance with ISO 12099 and reach at least one standard error of prediction (SEP) $\leq 0,15$ % determined over the entire scope of this document.

NOTE In comparison with ISO 712-1, the error of prediction for ISO 12099 is higher.

8.2 Preparation of the farinograph

NOTE Details of the electronic farinograph characteristics and procedure are given in [Clause A.4](#).

8.2.1 Turn on the thermostat ([6.3](#)) of the farinograph and circulate the water until the required temperature is reached prior to using the instrument. Before and during use, check the temperatures of:

- the thermostat;
- the mixing bowl of the farinograph in the hole provided for this purpose.

The temperature of the mixing bowl shall be $(30 \pm 0,2)$ °C.

The laboratory temperature should be between 20 °C and 30 °C.

8.2.2 For mechanical devices, uncouple the mixer 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 [6.1](#)). Switch off the motor and then couple the mixer. For electronic devices, the zero adjustment is programmed to be done automatically at the start of each measurement.

8.2.3 For mechanical devices, 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 rotating 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. For electronic controlled devices, the lubrication of the blades is done with silicon fat.

8.2.4 For mechanical devices, adjust the arm of the pen so as to obtain identical readings from the pointer and the recording pen.

8.2.5 For mechanical devices, 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 $(1,0 \pm 0,2)$ s. This should result in a bandwidth of approximately 60 FU to 90 FU.

8.2.6 Fill the burette ([6.2](#)) with water at 30 °C. The time to flow from 0 ml to 225 ml (for a 300 g mixer) or from 0 ml to 37,5 ml (for a 50 g mixer) shall be not more than 20 s. For electronic farinographs, the time for the water flow by means of the dosing system is the same.

8.3 Test portion

8.3.1 General

If necessary, bring the flour to a temperature of between 25 °C and 30 °C.

8.3.2 Constant flour mass procedure

Weigh (6.4), to the nearest 0,1 g, the equivalent of 300 g (for a 300 g mixer) or 50 g (for a 50 g mixer) of flour having a moisture content of 14 % mass fraction. Let this mass, in grams, be m . See Table 1 for m as a function of moisture content.

Place the test portion in the mixer. Cover the mixer and keep it covered until the end of mixing, except for the shortest possible time when water has to be added and the dough scraped down. The temperature of the measurement is defined in 8.2.1.

Table 1 — Mass of flour, in grams, equivalent to 300 g and 50 g at a moisture content of 14 % mass fraction

| Moisture content % mass fraction | Mass, m , of flour (in g) equivalent to | |
|-------------------------------------|---|------|
| | 300 g | 50 g |
| 9,0 | 283,5 | 47,3 |
| 9,1 | 283,8 | 47,3 |
| 9,2 | 284,1 | 47,4 |
| 9,3 | 284,5 | 47,4 |
| 9,4 | 284,8 | 47,5 |
| 9,5 | 285,1 | 47,5 |
| 9,6 | 285,4 | 47,6 |
| 9,7 | 285,7 | 47,6 |
| 9,8 | 286,0 | 47,7 |
| 9,9 | 286,3 | 47,7 |
| 10,0 | 286,7 | 47,8 |
| 10,1 | 287,0 | 47,8 |
| 10,2 | 287,3 | 47,9 |
| 10,3 | 287,6 | 47,9 |
| 10,4 | 287,9 | 48,0 |
| 10,5 | 288,3 | 48,0 |
| 10,6 | 288,6 | 48,1 |
| 10,7 | 288,9 | 48,2 |
| 10,8 | 289,2 | 48,2 |
| 10,9 | 289,6 | 48,3 |
| 11,0 | 289,9 | 48,3 |
| 11,1 | 290,2 | 48,4 |
| 11,2 | 290,5 | 48,4 |
| 11,3 | 290,9 | 48,5 |
| 11,4 | 291,2 | 48,5 |
| 11,5 | 291,5 | 48,6 |
| 11,6 | 291,9 | 48,6 |
| 11,7 | 292,2 | 48,7 |
| 11,8 | 292,5 | 48,8 |

Table 1 (continued)

| Moisture content % mass fraction | Mass, <i>m</i> , of flour (in g) equivalent to | |
|-------------------------------------|--|------|
| | 300 g | 50 g |
| 11,9 | 292,8 | 48,8 |
| 12,0 | 293,2 | 48,9 |
| 12,1 | 293,5 | 48,9 |
| 12,2 | 293,8 | 49,0 |
| 12,3 | 294,2 | 49,0 |
| 12,4 | 294,5 | 49,1 |
| 12,5 | 294,9 | 49,1 |
| 12,6 | 295,2 | 49,2 |
| 12,7 | 295,5 | 49,3 |
| 12,8 | 295,9 | 49,3 |
| 12,9 | 296,2 | 49,4 |
| 13,0 | 296,6 | 49,4 |
| 13,1 | 296,9 | 49,5 |
| 13,2 | 297,2 | 49,5 |
| 13,3 | 297,6 | 49,6 |
| 13,4 | 297,9 | 49,7 |
| 13,5 | 298,3 | 49,7 |
| 13,6 | 298,6 | 49,8 |
| 13,7 | 299,0 | 49,8 |
| 13,8 | 299,3 | 49,9 |
| 13,9 | 299,7 | 49,9 |
| 14,0 | 300,0 | 50,0 |
| 14,1 | 300,3 | 50,1 |
| 14,2 | 300,7 | 50,1 |
| 14,3 | 301,1 | 50,2 |
| 14,4 | 301,4 | 50,2 |
| 14,5 | 301,8 | 50,3 |
| 14,6 | 302,1 | 50,4 |
| 14,7 | 302,5 | 50,4 |
| 14,8 | 302,8 | 50,5 |
| 14,9 | 303,2 | 50,5 |
| 15,0 | 303,5 | 50,6 |
| 15,1 | 303,9 | 50,6 |
| 15,2 | 304,2 | 50,7 |
| 15,3 | 304,6 | 50,8 |
| 15,4 | 305,0 | 50,8 |
| 15,5 | 305,3 | 50,9 |
| 15,6 | 305,7 | 50,9 |
| 15,7 | 306,0 | 51,0 |
| 15,8 | 306,4 | 51,1 |
| 15,9 | 306,8 | 51,1 |
| 16,0 | 307,1 | 51,2 |
| 16,1 | 307,5 | 51,3 |

Table 1 (continued)

| Moisture content % mass fraction | Mass, <i>m</i> , of flour (in g) equivalent to | |
|-------------------------------------|--|------|
| | 300 g | 50 g |
| 16,2 | 307,9 | 51,3 |
| 16,3 | 308,2 | 51,4 |
| 16,4 | 308,6 | 51,4 |
| 16,5 | 309,0 | 51,5 |
| 16,6 | 309,4 | 51,6 |
| 16,7 | 309,7 | 51,6 |
| 16,8 | 310,1 | 51,7 |
| 16,9 | 310,5 | 51,7 |
| 17,0 | 310,8 | 51,8 |
| 17,1 | 311,2 | 51,9 |
| 17,2 | 311,6 | 51,9 |
| 17,3 | 312,0 | 52,0 |
| 17,4 | 312,3 | 52,1 |
| 17,5 | 312,7 | 52,1 |
| 17,6 | 313,1 | 52,2 |
| 17,7 | 313,5 | 52,2 |
| 17,8 | 313,9 | 52,3 |
| 17,9 | 314,3 | 52,4 |
| 18,0 | 314,6 | 52,4 |

NOTE The values in this table are calculated using the following formulae:
a) for the mass, in grams, equivalent to 300 g at 14 % mass fraction moisture content:

$$m = \frac{25\,800}{100 - H}$$

b) for the mass, in grams, equivalent to 50 g at 14 % mass fraction moisture content:

$$m = \frac{4\,300}{100 - H}$$

where *H* is the moisture content of the sample, as a percentage by mass.
Calculation example: Mass of flour to be added, e.g. having 13 % moisture:
 $m(13\%) = 300\text{ g} \times (100\% - 14\%) / (100\% - 13\%) = 296,55\text{ g}$

8.3.3 Constant dough mass procedure

Calculate the necessary mass of flour, *m*, in grams according to [Formula \(1\)](#):

$$m = \frac{C_m}{100 \pm W_a} \tag{1}$$

where

C_m is a constant number, which is 48 000 using a large bowl (for a 300 g mixer) and 8 000 using a small bowl (for a 50 g mixer);

W_a is the water absorption of flour, expressed in millilitres per 100 g of flour at 14 % (mass fraction) moisture content (determined by [9.2](#)).

Calculate the necessary volume of water, V , in millilitres according to [Formula \(2\)](#):

$$V = C_V - m \quad (2)$$

where C_V is a constant number, which is 480 using a large bowl and 80 using a small bowl.

Weigh ([6.4](#)), to the nearest 0,1 g the calculated mass, m , of flour and place the test portion in the bowl.

Fill the burette ([6.2](#)) with water at 30 °C. Start the mixer and recording mechanism and, 1 min later, add the calculated volume of water to the flour. In this case, the maximum consistency of the dough will be (500 ± 20) FU.

NOTE W_a is indicated in dependency of m , calculated by [Formula \(1\)](#) using the large or small bowl (in the water absorption range from 54 % to 77 %)^[5].

8.4 Common rules of determination

8.4.1 For the steps of the operation not specified in this document, follow the manufacturer's instructions.

8.4.2 Mix at the specified rotational frequency for 1 min or slightly longer to allow the flour to reach the temperature of the mixer. Start adding water from the burette into the right-hand front corner of the mixer within 25 s, when a whole-minute line on the recorder paper passes by the pen.

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

Add a volume of water close to that expected to produce a maximum consistency (see [9.2](#)) of 500 FU. When the dough forms, scrape down the sides of the bowl with the spatula ([6.5](#)) 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 maximum consistency of approximately 500 FU. Stop mixing and clean the mixer.

When using electronic devices, the measurement also starts after a mixing time of 1 min, but the starting point on the diagram is independent from certain lines on the chart paper.

Depending on the flour quality and evaluations being made, e.g. when using very strong flours with a long stability, it is possible that the measurement time has to be extended in order to record all the evaluation points at least 12 min after the maximum consistency.

See also [8.4.3](#).

8.4.3 Carry out additional mixings as necessary until two mixings are available:

- in which the water addition has been completed within 25 s;
- the maximum consistencies of which are between 480 FU and 520 FU;
- the recording of which has been continued for sufficient time to calculate all reported terms of the selected method, e.g. when using very strong flours with a long stability; it is possible that the measurement time has to be extended in order to record all the evaluation points;
- based on the evaluation points of two valid curves, the average values have to be calculated.

Stop mixing and clean the mixer.

9 Evaluation of the farinogram and calculation of the derived rheological characteristics

9.1 General

From each sample, two determinations shall be carried out. Read directly or calculate the values of each rheological characteristic to be determined from both farinograms. Express the results as the mean value of the relevant data. Two curves to be averaged shall be within the range of 480 FU to 520 FU at their DDT.

NOTE To facilitate the calculations, a computer can be used. In that case, it would be necessary to modify the farinograph by adding an electrical output for transferring the data to the computer.

9.2 Water absorption of flour

In order to obtain the water absorption of flour, first derive, from each of the mixings with maximum consistencies of between 480 FU and 520 FU, the corrected volume, V_c , in millilitres, of water corresponding to a maximum consistency of 500 FU, by means of [Formulae \(3\)](#) and [\(4\)](#):

a) for a 300 g mixer:

$$V_c = V + 0,096(C - 500) \quad (3)$$

b) for a 50 g mixer:

$$V_c = V + 0,016(C - 500) \quad (4)$$

where

V is the volume, in millilitres, of water added;

C is the maximum consistency, in FU (see [Figure 1](#)), given by:

$$C = \frac{C_1 + C_2}{2}$$

where

C_1 is the maximum height of the upper contour of the curve, in FU;

C_2 is the maximum height of the lower contour of the curve, in FU.

In the relatively infrequent case where two peaks are observed, use the height of the higher maximum.

Use for the calculation, the mean value of duplicate determinations of V_c , provided the difference between them does not exceed 2,5 ml (for a 300 g mixer) or 0,5 ml (for a 50 g mixer) of water.

The water absorption of flour, W_a , expressed in millilitres per 100 g of flour at 14 % (mass fraction) moisture content, is as given in [Formulae \(5\)](#) and [\(6\)](#):

— for a 300 g mixer:

$$W_a = (\bar{V}_c + m - 300) \times 0,333 \quad (5)$$

— for a 50 g mixer:

$$W_a = (\bar{V}_c + m - 50) \times 2 \quad (6)$$

where

\bar{V}_c is the mean value of the duplicate determinations of the corrected volume, in millilitres, of water corresponding to a maximum consistency of 500 FU;

m is the mass, in grams, of the test portion derived from [Table 1](#).

Report the result to the nearest 0,1 ml per 100 g.

NOTE In cases of curves with two peaks where the first peak is higher than the second one, the second one is used for the DDT and hence also for the water absorption (also see B.4.2)

9.3 Characteristics relating to the consistency of dough

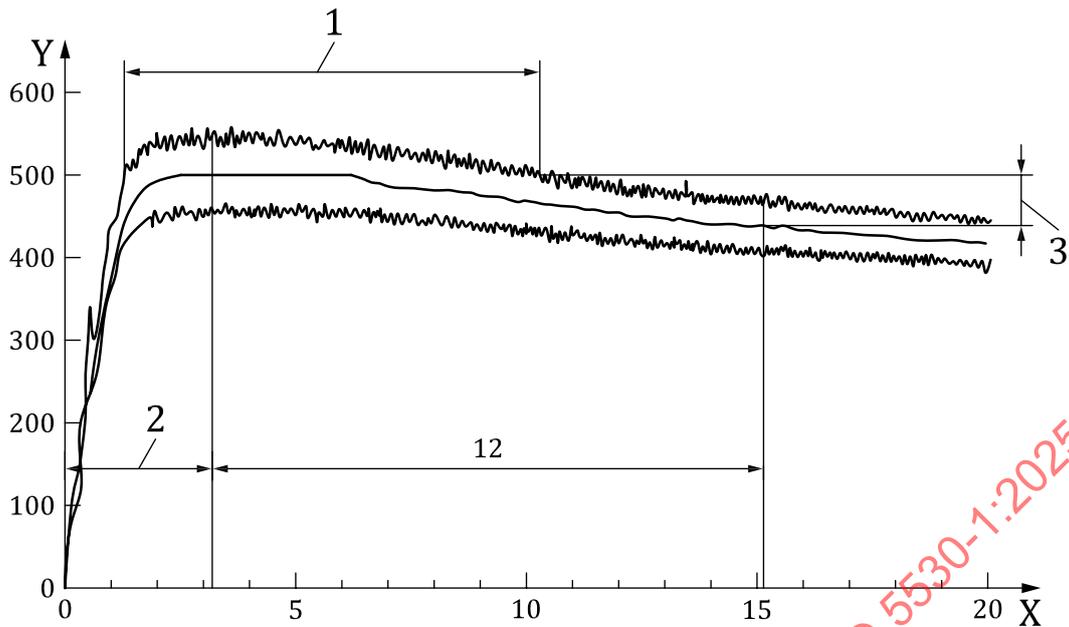
Consistency is a continuously changing characteristic of dough, which is demonstrated on the farinogram. Evaluation of the curve can be carried out in various ways. From the farinogram, the following characteristics can be derived:

- water absorption of flour;
- DDT;
- stability;
- degree of softening;
- FQN.

With enclosed software, a computer can evaluate and document the most frequently required characteristics listed above.

NOTE The FQN can be reported together with, or instead of, the stability and the degree of softening. Using the FQN instead of the stability and the degree of softening shortens the total mixing time, especially in the case of doughs from weaker flours. There is good correlation between the quality number and the stability and the degree of softening.

A representative farinogram demonstrating the commonly measured characteristics of dough consistency is shown in [Figure 1](#). Examples of farinogram types are given in [Annex B](#).



Key

X min
Y UF

1 stability
2 DDT
3 degree of softening

Figure 1 — Representative farinogram

10 Precision

10.1 Interlaboratory tests

10.1.1 The precision of farinograph measurements (wheat flour with DDT up to 4 min) were extracted from interlaboratory tests conducted between 1989 and 1990 by the Department of Cereals, Feed and Bakery Technology (IGMB) of TNO Nutrition and Food Research (Netherlands)^[8].

10.1.2 Interlaboratory tests were performed in 2015 by Cereal & Food Expertise on behalf of Brabender using electronic devices with wheat flours with different DDTs (see [Annex C](#)).

10.2 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 no more than 5 % of cases be greater than the values given in [Table 2](#). These data are based on measurements with a 300 g mixing bowl.

Table 2 — Repeatability data obtained by using a farinograph

| Characteristic | Repeatability |
|--|---------------------|
| Water absorption (ml/100 g) | |
| < 64,5 % water absorption | 0,83 |
| ≥ 64,5 % water absorption | 0,76 |
| DDT (min) | 0,342 3 X - 0,334 6 |
| Stability (min) | 0,061 2 X + 1,060 7 |
| Degree of softening (FU) | 19 |
| FQN (mm) | 16,83 |
| NOTE X is the arithmetic mean of the two determinations. | |

10.3 Reproducibility

Reproducibility is the absolute difference between two individual test results, obtained with the same method on identical material tested in different laboratories by different operators using different equipment. These data are based on measurements with a 300 g mixing bowl.

In practice, it is not appropriate to compare the results of two laboratories if the related test imposes repeatability conditions. As shown in [Table 3](#), the DDT, stability and FQN are related to the arithmetic mean of the reproducibility. Therefore, the appropriate comparison tool for these characteristic values is the critical difference as described in [10.4](#).

Table 3 — Reproducibility data obtained by using a farinograph

| Characteristic | Reproducibility |
|--|---------------------|
| Water absorption (ml/100 g) | |
| < 64,5 % water absorption | 1,26 |
| ≥ 64,5 % water absorption | 1,54 |
| DDT (min) | 0,447 3 X - 0,573 2 |
| Stability (min) | 0,146 2 X + 1,392 2 |
| Degree of softening (FU) | 27 |
| FQN (mm) | 0,065 4 X + 3,423 5 |
| NOTE X is the arithmetic mean of the two determinations. | |

10.4 Comparison of two groups of measurements in two laboratories

The critical difference (C_D) between two averaged values each obtained in two different laboratories from two test results under repeatability conditions is equal to [Formula \(7\)](#):

$$C_D = 2,8 \sqrt{s_R^2 - s_r^2 \left(1 - \frac{1}{2n_1} - \frac{1}{2n_2}\right)} = 2,8 \sqrt{s_R^2 - 0,5s_r^2} \quad (7)$$

where

s_r is the standard deviation of repeatability;

s_R is the standard deviation of reproducibility;

n_1 and n_2 are the number of test results corresponding to each averaged value.

See the calculated values for the different levels of each parameter.

Data are shown in [Annex D](#).

11 Test report

The test report shall contain at least the following information:

- a) all information necessary for the complete identification of the sample;
- b) the sampling method used, if known;
- c) the test method used, indicating the procedure (constant flour mass procedure or constant dough mass procedure), with reference to this document, i.e. ISO 5530-1;
- d) the apparatus used;
- e) the size of the mixer used;
- f) the type of flour;
- g) all operating details not specified in this document, or regarded as optional, together with details of any incidents that could have influenced the test result(s);
- h) the test result(s) obtained;
- i) if the repeatability has been checked, the final calculated result obtained;
- j) the date of the test.

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Annex A (informative)

Description of the farinograph

WARNING — The safety provisions installed by the manufacturer shall be used properly. These safety provisions stop the drive if the mixer is not covered or if the front part is separated from the back wall. With earlier instruments without these safety provisions, consider the following precautions:

- keep fingers and objects out of the running mixer;
- keep ties, sleeves, etc. away from the rotating driving shaft of the farinograph.

Be careful not to damage the paddles by reaching with the spatula into the running blades at the beginning of the test or during the cleaning operation with the mixer coupled to the farinograph and the motor running at low rotational speed.

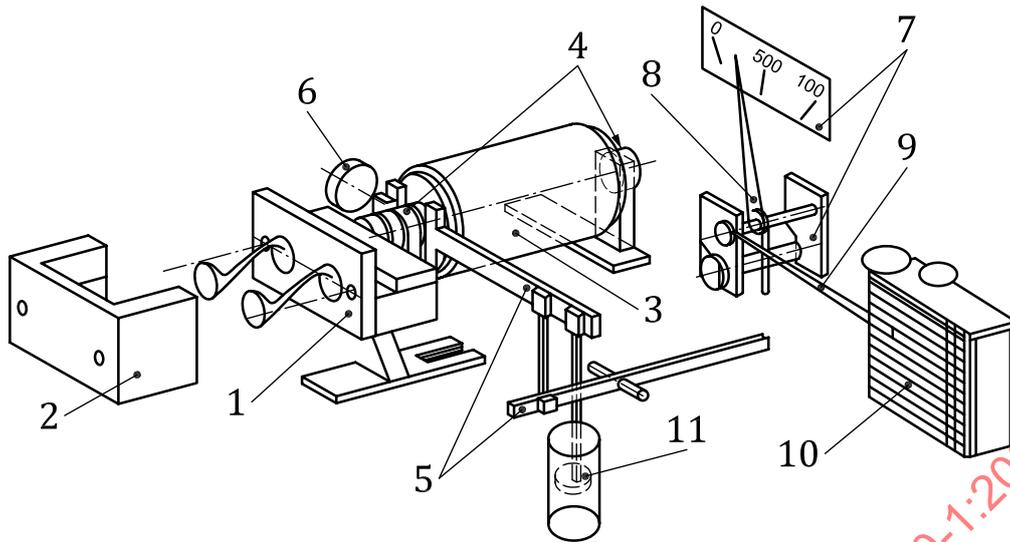
For steps of the operation not specified in this document, follow the manufacturer's instructions.

A.1 The main unit of the apparatus

A.1.1 The main unit of the apparatus consists of a water-jacketed mixer, which is a means for recording the dough consistency in the form of farinograms. It is mounted on a heavy cast-iron base plate having four levelling screws and consists of:

- a) a detachable, water-jacketed mixer (see [A.1.2](#));
- b) an electric motor, driving the mixer (see [A.1.3](#));
- c) a gear and lever system, acting as a dynamometer to measure the torque on the driving shaft between the gear and the mixer (see [A.1.3](#));
- d) in mechanical devices: a dash-pot to dampen the movements of the dynamometer (see [A.1.3](#));
- e) in mechanical devices: a scale, the pointer of which is actuated by movements of the dynamometer (see [A.1.3](#)); in electronic devices, the signal is registered digitally;
- f) in mechanical devices: a recorder, the pen of which is actuated by the movements of the dynamometer (see [A.1.4](#));
- g) burettes ([6.2](#)), to measure the volume of water added to the flour;
- h) an electronically driven water dosage system ([6.2](#)).

The parts of the farinograph are illustrated in [Figure A.1](#).



Key

- | | | | |
|---|---------------------------------------|----|-----------------|
| 1 | back wall of mixer with mixing blades | 7 | scale head |
| 2 | remainder of mixer | 8 | pointer |
| 3 | housing of motor and gears | 9 | pen arm |
| 4 | ball-race bearings | 10 | recorder |
| 5 | levers | 11 | dash-pot damper |
| 6 | counterweight | | |

Figure A.1 — Diagram of mechanical farinograph

A.1.2 The mixer is two-bladed and is designed to mix doughs from either 300 g or 50 g of flour. It is in two parts:

- a) a hollow back-plate, through which water from the thermostat circulates and, at the back, a gearbox driving the two mixer blades that project forward through this back-plate;
- b) the remainder of the mixer, i.e. two sides, front and bottom in one piece, through which water from the thermostat circulates.

The two parts are held together by means of two bolts and wing nuts, and can be dismantled for cleaning.

The slower mixing blade is driven directly by the shaft from the gear. In recent (at the time of publication) farinographs, it rotates at a frequency of 63 min^{-1} . The faster mixing blade is geared, by cog-wheels, to rotate at a frequency that is 1,5 times that of the slower blade.

Previous farinographs were made with rotational frequencies of the driving shaft, which differ from the standardized value of 63 min^{-1} . The effect of the rotational frequency on the determination can be neglected if it is within the range of 61 min^{-1} to 65 min^{-1} . If it is outside this range, approximately correct water absorption can be obtained by substituting a consistency, C , for the standard consistency of 500 FU. The value of C can be calculated from the actual rotational frequency, n , in reciprocal minutes, of the driving shaft or slower mixing blade, by means of [Formula \(A.1\)](#):

$$C = 500 + 200 \ln \left(\frac{n}{63} \right) \quad (\text{A.1})$$

If a consistency, C , has to be substituted for the standard consistency, the DDT varies according to [Formula \(A.2\)](#):

$$t_0 = t - 320 \left(\frac{1}{n} - \frac{n}{63} \right) \quad (\text{A.2})$$

where

- t_0 is the DDT, in minutes, that would be measured with a farinograph that is in accordance with [6.1](#);
- t is the DDT, in minutes, which is read on the curve actually recorded. Insufficient data are available to make a similar correction for the degree of softening. The mixer can be closed by a lid which, in farinographs at the time of publication, consists of two parts, as follows:
 - a) A bottom part, to be opened only to place the flour into the mixer. When it is opened, the security system switches off the instrument. This part has slots to allow the dough to be scraped down from the sides of the bowl with a spatula. The water shall be added through the front end of the slot at the right-hand side of the mixer.
 - b) A top part, to be placed on the bottom part to close its slots. It shall be opened only for adding water or scraping the dough down.

In older farinographs, the mixer is closed by a flat plastic plate, which is laid on top of the mixer. It is removed to add water and scrape the dough down.

A.1.3 The motor and its reduction and dynamometer gears are placed together in a housing. From the front and rear ends of this housing, shafts that protrude are supported by ball-race bearings. The housing can pivot on these shafts.

The shaft from the front end drives the mixing blades. The resistance of the dough to being mixed causes a torque on this shaft, which, if not balanced, would cause rotation of the motor housing.

The motor housing carries an arm, one end of which is connected by the lever system to the scale and recorder pen. This causes a counter-torque on the motor housing, which is linearly related to the deflection of the scale pointer and recorder pen. As a result, the deflections of the scale pointer and recorder pen are, if the two torques balance one another, proportional to the torque on the driving shaft, i.e. to the resistance of the dough to being mixed. The operator can choose the correct torque for each unit deflection ([6.1](#)) by selecting:

- the appropriate effective counterweight in the scale head; this is done by a handle that can lift a counterweight and so make it ineffective;
- the appropriate effective length of the front part of the lower lever arm; this is done by varying the position of the link between the lower lever arm and the motor housing lever arm.

In instruments, at the time of publication, both possibilities for adjustment are used. In older instruments, there is only the second possibility.

Movements of the motor housing, lever system, scale and recorder pen are damped by a piston immersed in oil. The piston is connected to the right-hand end of the arm of the motor housing. The extent of damping can be adjusted. More damping results in a narrower curve.

A.1.4 The paper for the recorder is supplied in the form of a roll. It is moved by an electric clock-type motor at a rate of 1,00 cm/min. Along its length, it bears a printed scale in minutes. Across its width, it bears a circular scale (radius 200 mm) with arbitrary units, running from 0 FU to 1 000 FU.

A.2 Circulating thermostat

The circulating thermostat normally consists of a tank with water and contains the following parts.

- a) An electric heating element.
- b) A thermoregulator to control the heating element, capable of maintaining the temperature of the mixing bowl at $(30 \pm 0,2)$ °C.
- c) A thermometer.
- d) A motor-driven pump and stirrer. The pump is connected to the water jackets of the mixing bowl by means of flexible tubing. It shall have sufficient capacity to maintain the temperature of the walls of the mixing bowl at $(30 \pm 0,2)$ °C. For a 300 g mixer, the flow of water through the jackets shall be at least 2,5 l/min (preferably 5 l/min or more), and for a 50 g mixer, at least 1 l/min. Except in some earlier mechanical models of the farinograph, the dash-pot damper can also be connected to the pump. However, temperature control of the dash-pot damper is not really necessary if the viscosity of the oil in it is only slightly sensitive to temperature.
- e) One or two coils of metal tubing. At the time of publication, thermostats supplied by the manufacturer of the farinograph have two coils. One of them is used to cool the thermostat bath by a flow of tap water. The distilled water can be pumped through the other one into the burette to adjust its temperature (see 8.2.6). If there is only one coil, it shall be used to cool the thermostat bath, except under exceptional conditions. If cooling of the bath by tap water is not necessary, the distilled water can be pumped through the only coil to adjust its temperature.

A.3 Calibration of the farinograph

The reproducibility of the determination with farinographs is influenced by the calibration status of the farinograph and the mixers used in conjunction with the farinograph.

The dynamometer, lever system and scale (for the electronic devices the display) of the farinograph can be adjusted to give correct results. Also, the burette can be calibrated. However, there is no method for absolute adjustment of the mixer. Each mixer (or instrument) shall be compared with another mixer (or instrument) using a range of flours.

It is possible to have the mixer adjusted by the manufacturer to their standard. With old or badly worn instruments, this will be impossible. It is likely that the results from a given mixer will change with increasing usage of the mixer. If good agreement between instruments is to be maintained, frequent checks are required.

A.4 Electronic farinograph

A.4.1 Application

Farinograph (or any compatible) software is a computer-controlled system for measuring the mixing characteristics of wheat or dough for determining the flour quality and the processing characteristics of the dough.

The electronic farinograph (farinograph-E) can be operated with infinitely variable speed controlled by the computer. This allows for use of the instrument not only for the standard farinograph test with the prescribed speed of 63 min^{-1} , but also with other speeds.

The test results are recorded by a computer and can be represented graphically and/or numerically on the monitor during the running test. The measured data are evaluated automatically in conformity to International Standards and can be printed in the form of tables and diagrams (farinogram).

A.4.2 Features and operating principle

A farinograph -E consists of:

- a drive unit (dynamometer);
- farinograph (or any compatible) software and cable.

The following parts may be or may need to be ordered separately (see [Figure A.2](#)):

- a measuring mixer;
- a thermostat;
- a water dosing system (electronic or burette);
- a computer with printer and monitor;
- additional evaluation software (e.g. to carry out farinograph data correlation).

An example for electronic devices is shown in [Figure A.2](#).



Figure A.2 — Example of an electronic farinograph

A.4.3 Drive unit with torque measurement

Measuring principle: the basic farinograph unit is a drive unit with torque measurement (dynamometer), which provides a variable speed of, for example, 2 min^{-1} to 200 min^{-1} (software-controlled). The dynamometer unit with its modern, high-precision electronic torque measuring system is mounted on sturdy and distortion-free base plate. The torque of the linear dynamometer is measured directly without any intermediate member.

The measuring principle is based on making visible the resistance put up by the sample material (dough) against the rotating blades or rotors in the measuring head. The torque proportional to this resistance is recorded as a measure of viscosity and consistency. The measuring signal is digitized in the farinograph and transmitted to the computer via a USB port.

The results are represented graphically on the monitor during the running test. The results can be stored and printed on a separate printer.

Annex B (informative)

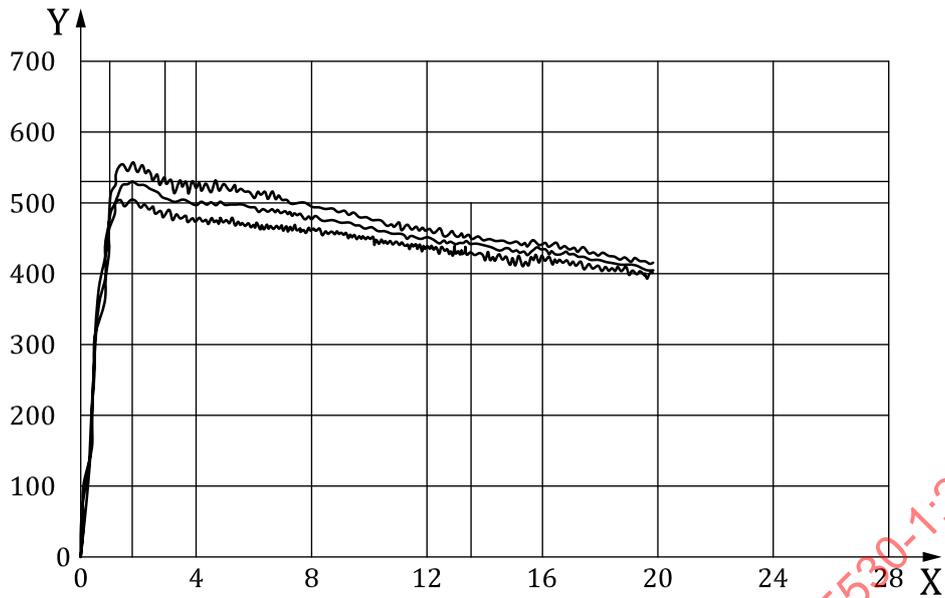
Examples of farinogram types

B.1 General

The following reports and corresponding diagrams given in [Clauses B.2](#) to [B.6](#) show examples of different flour qualities, recorded by a farinograph.

B.2 Low DDT and low stability flour

| | |
|--|---|
| Evaluation of: | Date: |
| Method: | Operator: |
| Mixer: | 300 g |
| Moisture of flour: | 13,4 % |
| Consistency: | 515 FU with water absorption: 65,5 % ^a |
| Water absorption: | 65,9 % ^a (corrected for 500,0 FU) |
| Water absorption: | 65,2 % ^a (corrected to 14,0 %) |
| Dough development time (DDT): | 1,7 min |
| Stability: | 1,9 min |
| Degree of softening: | 87 FU |
| Farinograph quality number (FQN): | 41 mm |
| Remarks: | |
| ^a ml water per 100 g of flour | |



Key

X min
Y FU

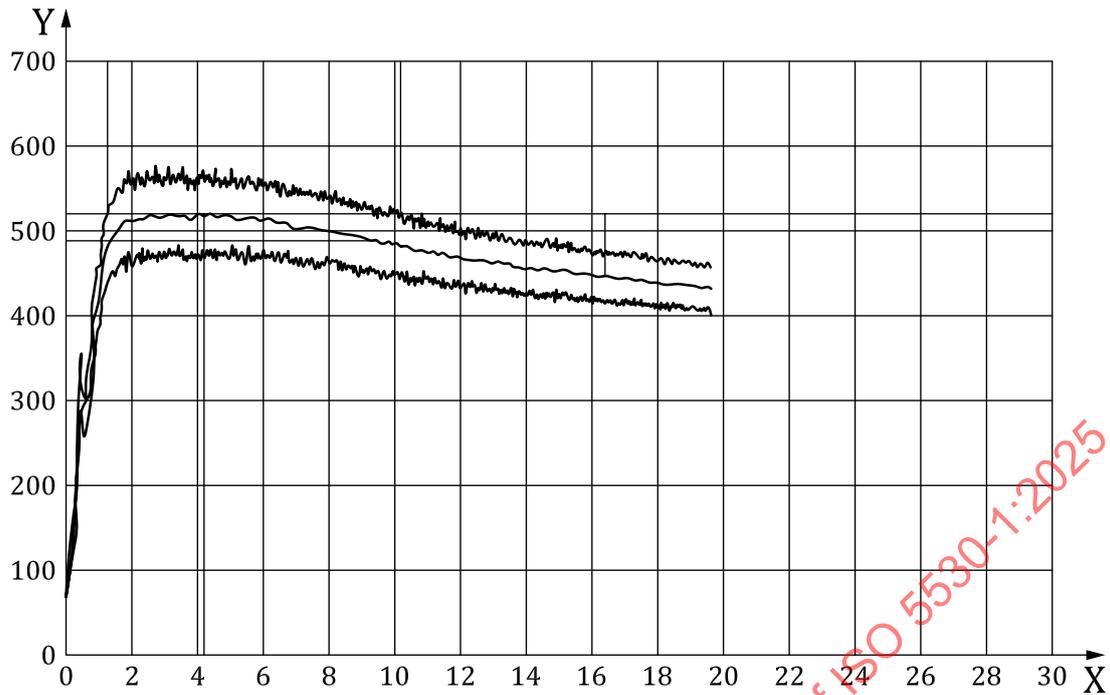
Figure B.1 — Low DDT and low stability flour

B.3 Standard flour

| | |
|-----------------------------------|---|
| Evaluation of: | Date: |
| Method: | Operator: |
| Mixer: | 300 g |
| Moisture of flour: | 13,0 % |
| Consistency: | 519 FU with water absorption: 57,5 % ^a |
| Water absorption: | 58,0 % ^a (corrected for 500,0 FU) |
| Water absorption: | 56,8 % ^a (corrected to 14,0 %) |
| Dough development time (DDT): | 4,3 min |
| Stability: | 9,0 min |
| Degree of softening: | 70 FU |
| Farinograph quality number (FQN): | 94 mm |

Remarks:

^a ml water per 100 g of flour



Key
 X min
 Y FU

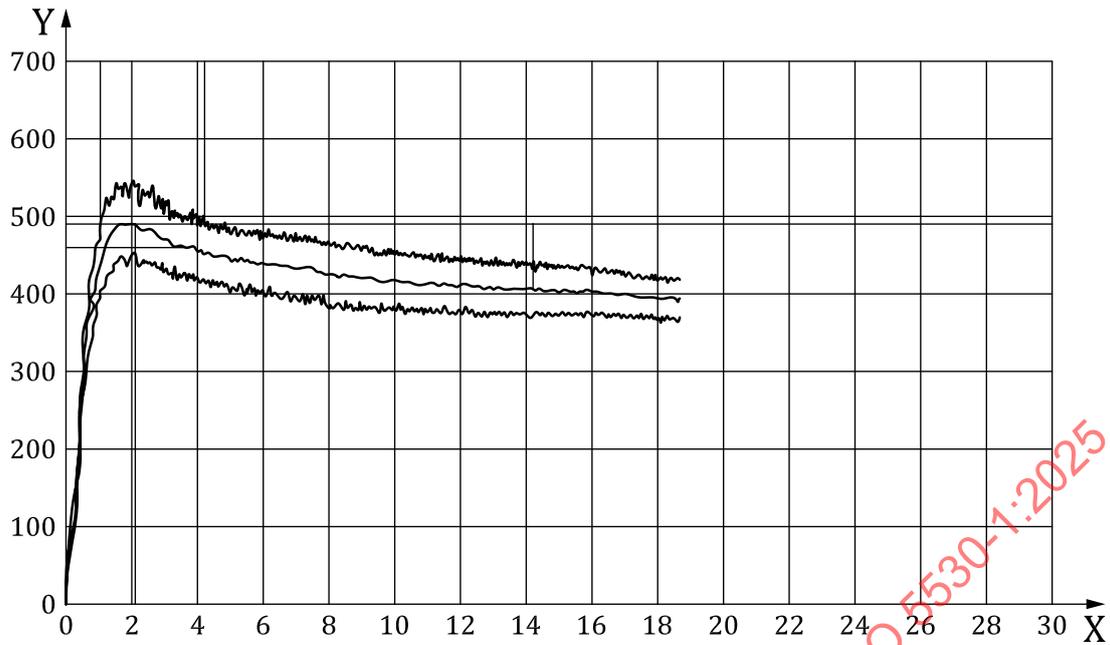
Figure B.2 — Standard flour

B.4 Low stability flour

| | |
|-----------------------------------|---|
| Evaluation of: | Date: |
| Method: | Operator: |
| Mixer: | 300 g |
| Moisture of flour: | 14,0 % |
| Consistency: | 493 FU with water absorption: 56,3 % ^a |
| Water absorption: | 56,1 % ^a (corrected for 500,0 FU) |
| Water absorption: | 56,1 % ^a (corrected to 14,0 %) |
| Dough development time (DDT): | 2,1 min |
| Stability: | 3,1 min |
| Degree of softening: | 82 FU |
| Farinograph quality number (FQN): | 37 mm |

Remarks:

^a ml water per 100 g of flour



Key

X min
Y FU

Figure B.3 — Low stability flour

B.5 Two peaks flour

B.5.1 Example

Evaluation of:

Date:

Method:

Operator:

Mixer:

300 g

Moisture of flour:

10,8 %

Consistency:

491 FU with water absorption: 57,5 %^a

Water absorption:

61,3 %^a (corrected for 500,0 FU)

Water absorption:

57,7 %^a (corrected to 14,0 %)

Dough development time (DDT):

13,4 min

Stability:

18,9 min

Degree of softening:

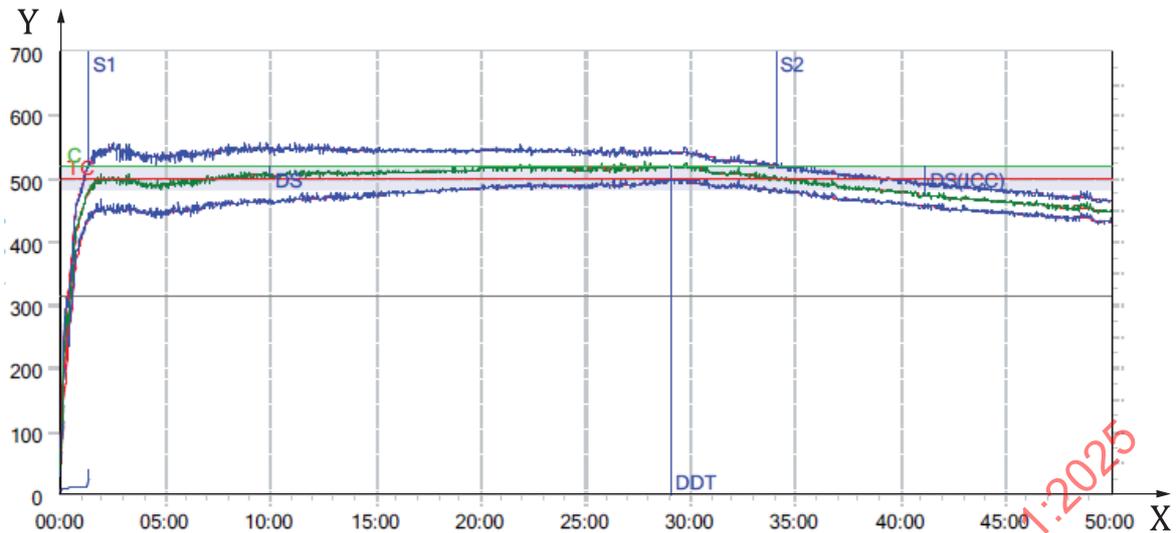
57 FU

Farinograph quality number (FQN):

214 mm

Remarks:

^a ml water per 100 g of flour



Key

- X time [mm:ss]
- Y torque [FE]
- C consistency
- S1 stability arrival time
- S2 stability departure time
- DS degree of softening 10 min after start
- DS (ICC) degree of softening 12 min after maximum peak
- DDT dough development time

Figure B.4 — Two peaks flour

B.5.2 Comments

Some flours cause curves with two peak peaks. The second maximum can appear as a visible peak or as a plateau. In both of these cases, water absorption and DDT are always determined by using the second peak. If the two peaks are at the same height, also consider the second maximum.

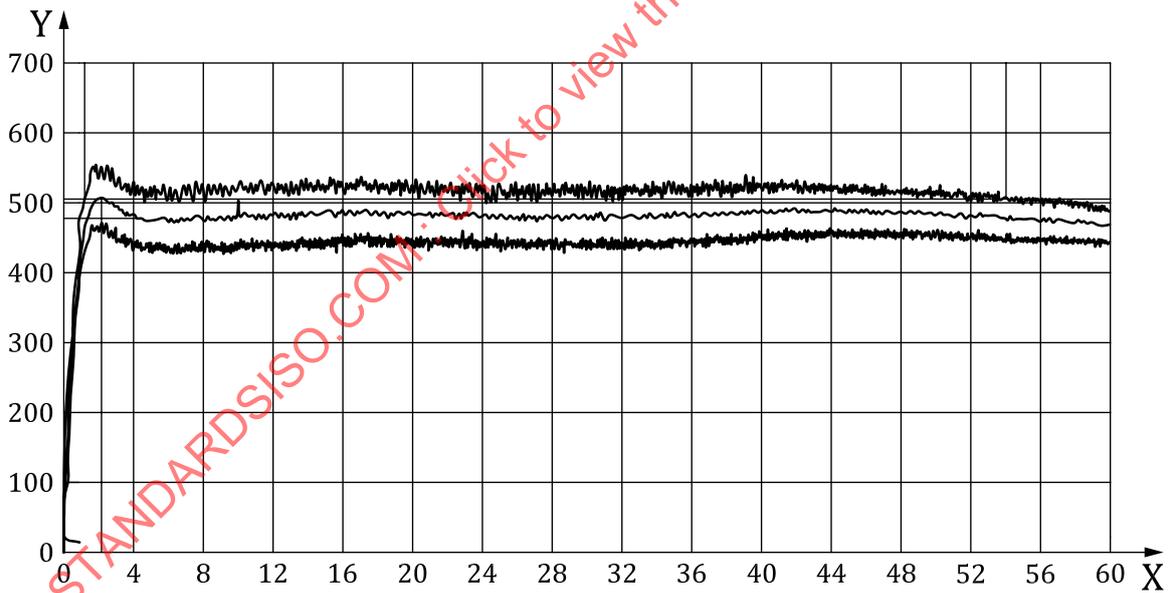
The selected peak has to target the 500 FU line.

The software uses the peak with the highest maximum value automatically. In the case of older software versions, the second peak has to be selected manually.

B.6 High stability flour

| | |
|-----------------------------------|---|
| Evaluation of: | Date: |
| Method: | Operator: |
| Mixer: | 300 g |
| Moisture of flour: | 14,9 % |
| Consistency: | 506 FU with water absorption: 56,0 % ^a |
| Water absorption: | 56,1 % ^a (corrected for 500,0 FU) |
| Water absorption: | 57,1 % ^a (corrected to 14,0 %) |
| Dough development time (DDT): | 2,2 min |
| Stability: | 53,2 min |
| Degree of softening: | 22 FU |
| Farinograph quality number (FQN): | 46 mm |
| Remarks: | Conditioned grain at 15 % of moisture. Flour with 24 h of rest. |

^a ml water per 100 g of flour



Key
 X min
 Y FU

Figure B.5 — High stability flour

Annex C (informative)

Results of interlaboratory test

C.1 General

Cereal & Food Expertise organized the interlaboratory test described in this annex (see [Tables C.1](#) to [C.5](#)) in order to evaluate the repeatability and reproducibility of the test method specified in this document. The scope of this method is to determine the water absorption and the rheological characteristics of wheat flour using an electronic farinograph apparatus.

C.2 Participants

The test samples were sent to 15 laboratories, including both industrial and research institutes, in 9 countries. From 9 laboratories, the results of all the tests were received. The other laboratories analysed only part of the samples.

| | |
|---|--|
| Number of laboratories participating: | 9 laboratories |
| Details on the laboratories/sectors: | milling companies, research institutes, application laboratories |
| Number of laboratories after removing outliers: | 8 laboratories |
| Number of countries represented: | 6 |

C.3 Samples

Each participant received five homogenized flours varying from very weak to very strong in triplicate. The samples had a random number so that participants were not aware of the sample they received.

| | |
|---|---|
| Number of samples tested: | 5 flours, each measured in triplicate, in total 15 samples |
| Basic information on samples, sample range: | commercial flours with a broad range of parameters (Canadian Western Red Spring, Chinese, high quality bread, medium to low quality bread, biscuit), e.g. water absorption from 51,7 % to 69,4 % ^a ^a ml water per 100 g of flour |

C.4 Procedure

Test protocol + mixer used: 300 g mixer

The method was conducted following the constant mass method. The flour was weighed according to the moisture content.

In order to guarantee the correct functioning of the apparatus in the ring test, the maintenance and calibration of all farinograph devices was checked and found to be acceptable before the start of the ring test. This checking of proper functioning of the farinograph was not mentioned in earlier ring tests.

ISO 5530-1:2025(en)

Parameters measured/evaluated:

- water absorption
- DDT
- stability
- degree of softening
- FQN

C.5 Evaluation and results

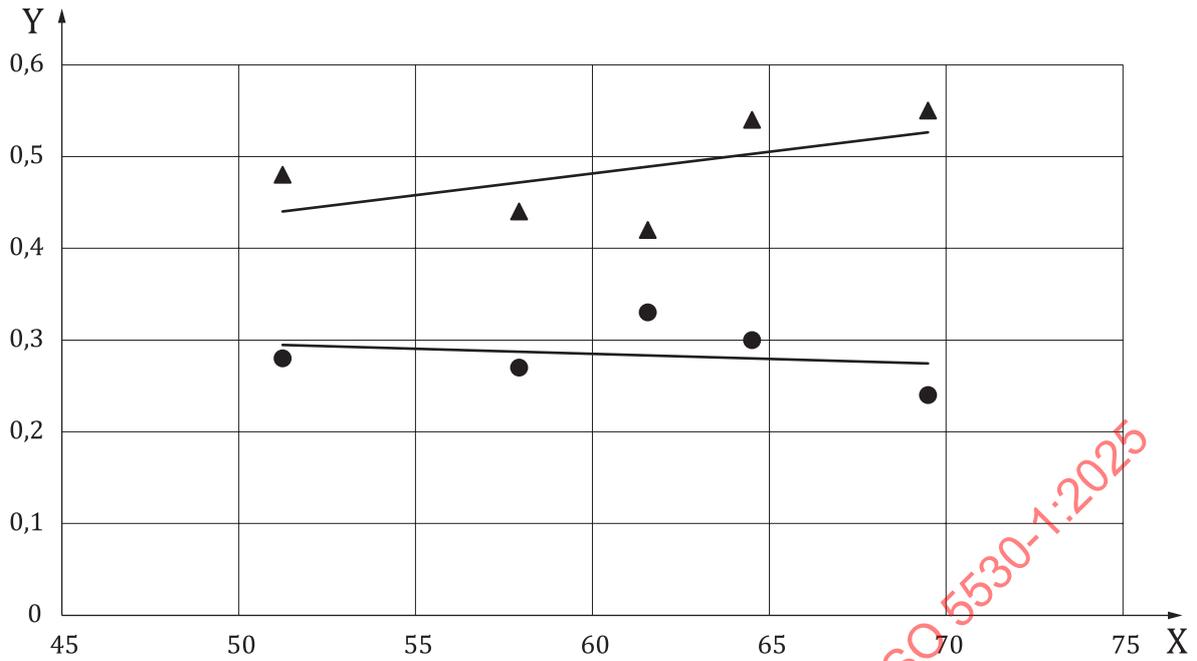
The calculation of repeatability and reproducibility values obtained for each analytical parameter is taken from the application of a statistical analysis in accordance with ISO 5725-1^[1] and ISO 5725-2^[2]. This analysis was conducted by the Wageningen University and Research Institute (Netherlands).

The data of the analysis and of the different flours are presented in [Tables C.1](#) to [C.5](#). These data are based on measurements with a 300 g mixing bowl.

Table C.1 — Results and statistical data for the parameter water absorption

| Parameter | Flour 1 | Flour 2 | Flour 3 | Flour 4 | Flour 5 |
|--|------------|------------|------------|------------|------------|
| Number of laboratories | 9 | 9 | 9 | 9 | 9 |
| Number of samples | triplicate | triplicate | triplicate | triplicate | triplicate |
| Number of outliers (laboratories) | 1 | 1 | 1 | 1 | 1 |
| Number of accepted results | 108 of 120 | | | | |
| Mean value (%) | 51,24 | 57,93 | 61,56 | 64,51 | 69,49 |
| Repeatability standard deviation, s_r (%) | 0,28 | 0,27 | 0,33 | 0,30 | 0,24 |
| Coefficient of variation of repeatability, $C_{v,r}$ (%) | 0,56 | 0,47 | 0,54 | 0,46 | 0,34 |
| Repeatability limit, r (%) | 0,80 | 0,76 | 0,93 | 0,84 | 0,67 |
| Reproducibility standard deviation, s_R (%) | 0,48 | 0,44 | 0,42 | 0,54 | 0,55 |
| Coefficient of variation of reproducibility, $C_{v,R}$ (%) | 0,94 | 0,76 | 0,69 | 0,84 | 0,80 |
| Reproducibility limit, R (%) | 1,35 | 1,24 | 1,18 | 1,52 | 1,55 |

The repeatability and reproducibility standard deviations do not vary with the measured water absorption (see [Figure C.1](#)) and are considered constant between 50,0 % and 70,0 %.



Key

X water absorption

Y fidelity standard deviation

● repeatability standard deviation (s_r)

▲ reproducibility standard deviation (s_R)

Formula of the regression line for s_r : $Y = -0,001\ 1\ X + 0,351\ 5$

Coefficient of determination R^2 for $s_r = 0,051\ 3$

Formula of the regression line for s_R : $Y = 0,004\ 7\ X + 0,197\ 7$

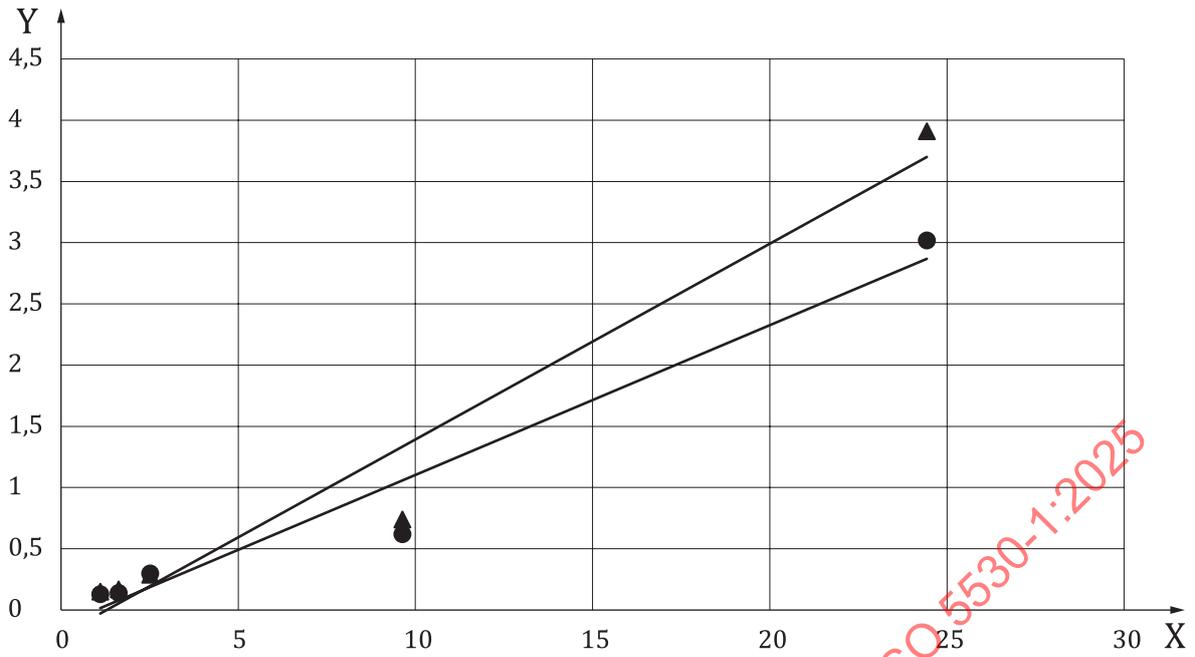
Coefficient of determination R^2 for $s_R = 0,313\ 4$

Figure C.1 — Evolution of the fidelity standard deviations as a function of the water absorption

Table C.2 — Results and statistical data for the parameter DDT

| Parameter | Flour 1 | Flour 2 | Flour 3 | Flour 4 | Flour 5 |
|--|------------|------------|------------|------------|------------|
| Number of laboratories | 9 | 9 | 9 | 9 | 9 |
| Number of samples | triplicate | triplicate | triplicate | triplicate | triplicate |
| Number of outliers (laboratories) | 1 | 1 | 1 | 1 | 1 |
| Number of accepted results | 108 of 120 | | | | |
| Mean value (%) | 1,11 | 1,63 | 2,52 | 24,43 | 9,63 |
| Repeatability standard deviation, s_r (%) | 0,13 | 0,14 | 0,30 | 3,02 | 0,62 |
| Coefficient of variation of repeatability, $C_{v,r}$ (%) | 11,8 | 8,7 | 11,8 | 12,4 | 6,4 |
| Repeatability limit, r (%) | 0,37 | 0,40 | 0,83 | 8,45 | 1,74 |
| Reproducibility standard deviation, s_R (%) | 0,15 | 0,17 | 0,29 | 3,91 | 0,74 |
| Coefficient of variation of reproducibility, $C_{v,R}$ (%) | 13,7 | 10,2 | 11,7 | 16,0 | 7,7 |
| Reproducibility limit, R (%) | 0,43 | 0,46 | 0,82 | 10,94 | 2,07 |

The repeatability and reproducibility standard deviations vary with the measured DDT (see [Figure C.2](#)) and evolve gradually between 1,0 min and 25,0 min. [Table D.1](#) provides examples of the application of fidelity limits.



Key

X DDT

Y fidelity standard deviation

● repeatability standard deviation (s_r)

▲ reproducibility standard deviation (s_R)

Formula of the regression line for s_r : $Y = 0,122\ 3 X - 0,119\ 8$

Coefficient of determination R^2 for $s_r = 0,959\ 9$

Formula of the regression line for s_R : $Y = 0,159\ 9 X - 0,205\ 5$

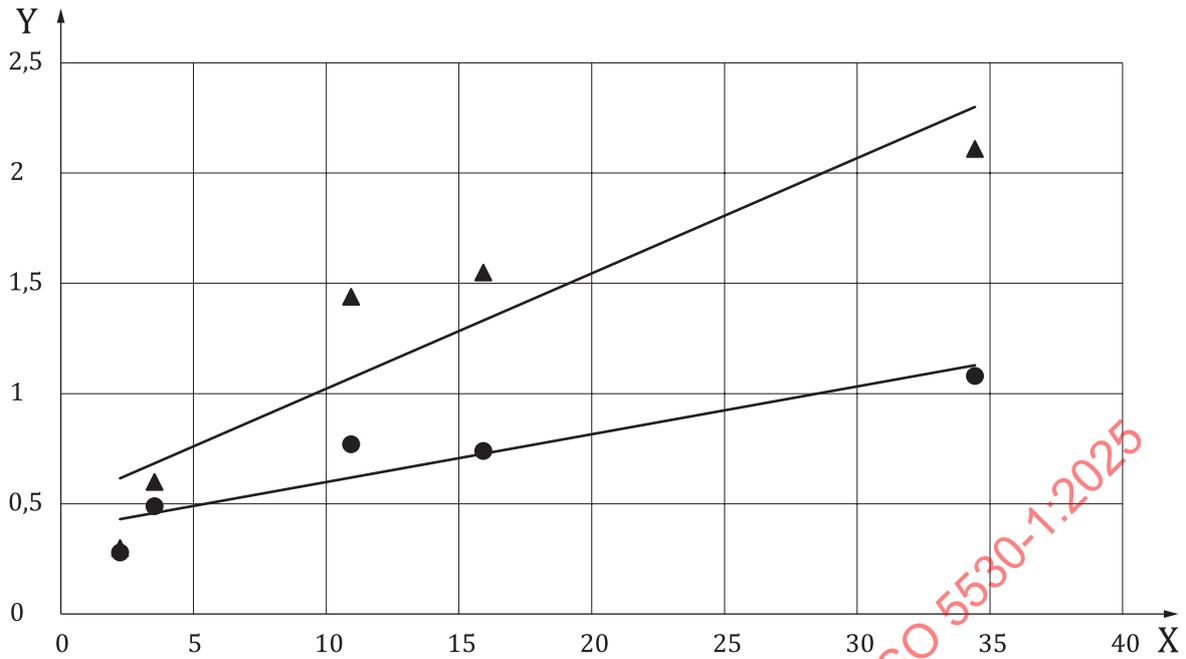
Coefficient of determination R^2 for $s_R = 0,956\ 8$

Figure C.2 — Evolution of the fidelity standard deviations as a function of the DDT

Table C.3 — Results and statistical data for the parameter stability

| Parameter | Flour 1 | Flour 2 | Flour 3 | Flour 4 | Flour 5 |
|--|------------|------------|------------|------------|------------|
| Number of laboratories | 9 | 9 | 9 | 9 | 9 |
| Number of samples | triplicate | triplicate | triplicate | triplicate | triplicate |
| Number of outliers (laboratories) | 1 | 1 | 1 | 1 | 1 |
| Number of accepted results | 100 of 112 | | | | |
| Mean value (%) | 2,23 | 3,53 | 10,93 | 34,44 | 15,91 |
| Repeatability standard deviation, s_r (%) | 0,28 | 0,49 | 0,77 | 1,08 | 0,74 |
| Coefficient of variation of repeatability, $C_{v,r}$ (%) | 12,4 | 13,9 | 7,0 | 3,1 | 4,7 |
| Repeatability limit, r (%) | 0,78 | 1,37 | 2,15 | 3,03 | 2,08 |
| Reproducibility standard deviation, s_R (%) | 0,30 | 0,60 | 1,44 | 2,11 | 1,55 |
| Coefficient of variation of reproducibility, $C_{v,R}$ (%) | 13,2 | 17,0 | 13,1 | 6,1 | 9,7 |
| Reproducibility limit, R (%) | 0,83 | 1,68 | 4,02 | 5,90 | 4,34 |

The repeatability and reproducibility standard deviations vary with the measured stability (see [Figure C.3](#)) and evolve gradually between 2,0 min and 35,0 min. [Table D.2](#) provides examples of the application of fidelity limits.



Key

X stability

Y fidelity standard deviation

● repeatability standard deviation (s_r)

▲ reproducibility standard deviation (s_R)

Formula of the regression line for s_r : $Y = 0,021\ 7 X + 0,381\ 2$

Coefficient of determination R^2 for $s_r = 0,866\ 8$

Formula of the regression line for s_R : $Y = 0,052\ 3 X + 0,499\ 0$

Coefficient of determination R^2 for $s_R = 0,849\ 8$

Figure C.3 — Evolution of the fidelity standard deviations as a function of the stability