



BSI Standards Publication

Cereals and cereal products — Common wheat (*Triticum aestivum* L.) — Determination of alveograph properties of dough at constant hydration from commercial or test flours and test milling methodology

National foreword

This British Standard is the UK implementation of EN ISO 27971:2015. It supersedes BS EN ISO 27971:2008 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee AW/4, Cereals and pulses.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Cereals and cereal products - Common wheat (*Triticum aestivum* L.) - Determination of alveograph properties of dough at constant hydration from commercial or test flours and test milling methodology (ISO 27971:2015)

Céréales et produits céréaliers - Blé tendre (*Triticum aestivum* L.) - Détermination des propriétés alvéographiques d'une pâte à hydratation constante de farine industrielle ou d'essai et méthodologie pour la mouture d'essai (ISO 27971:2015)

Getreide und Getreideerzeugnisse - Weizen (*Triticum aestivum* L.) - Bestimmung der Eigenschaften von Teig bei konstanter Flüssigkeitszufuhr zu handelsüblichen Mehlen oder Versuchsmehlen bei gleichen Versuchsmahlverfahren mittels Alveograph (ISO 27971:2015)

This European Standard was approved by CEN on 16 April 2015.

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (EN ISO 27971:2015) has been prepared by Technical Committee ISO/TC 34 "Food products" in collaboration with Technical Committee CEN/TC 338 "Cereal and cereal products" the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2015, and conflicting national standards shall be withdrawn at the latest by December 2015.

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Endorsement notice

The text of ISO 27971:2015 has been approved by CEN as EN ISO 27971:2015 without any modification.

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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 documents 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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is ISO/TC 34, *Food products*, Subcommittee SC 4, *Cereals and pulse*.

This second edition cancels and replaces the first edition (ISO 27971:2008), which has been technically revised.

Introduction

The end-use value of wheat is determined by a number of properties that are useful in the manufacture of baked products such as bread, rusks, and biscuits.

Such properties include the important viscoelastic (rheological) properties of dough formed as a result of flour hydration and kneading. An alveograph is used to study the main parameters by subjecting a dough test piece to biaxial extension (producing a dough bubble) by inflating it with air, which is similar to the deformation to which it is subjected during panary fermentation.

Recording the pressure generated inside the bubble throughout the deformation of the dough test piece until it ruptures provides information on the following:

- a) the resistance of the dough to deformation, or its strength. It is expressed by the maximum pressure parameter, P ;
- b) the extensibility or the possibility of inflating the dough to form a bubble; It is expressed by the parameters of extensibility, L , or swelling, G ;
- c) the elasticity of the dough during biaxial extension. It is expressed by the elasticity index, I_e ;
- d) the work required to deform the dough bubble until it ruptures, which is proportional to the area of the alveogram (sum of the pressures throughout the deformation process). It is expressed by the parameter, W .

The P/L ratio is a measurement of the balance between strength and extensibility.

Alveographs are commonly used throughout the wheat and flour industry, for the following purposes:

- selecting and assessing different varieties of wheat and marketing batches of wheat;
- blending different batches of wheat or flour to produce a batch with given values for the alveographic criteria (W , P , and L) complying with the proportional laws of blending.

Alveographs are used both on the upstream side of the industry for marketing, selecting and assessing the different wheat varieties and on the downstream side throughout the baking industries (see Bibliography).

Cereals and cereal products — Common wheat (*Triticum aestivum* L.) — Determination of alveograph properties of dough at constant hydration from commercial or test flours and test milling methodology

1 Scope

This International Standard specifies a method of determining, using an alveograph, the rheological properties of different types of dough obtained from common wheat flour (*Triticum aestivum* L.) produced by industrial milling or laboratory milling.

It describes the alveograph test and how to use a laboratory mill to produce flour in two stages:

- stage 1: preparation of the wheat grain for milling to make it easier to separate the bran from the endosperm (see [Clause 7](#));
- stage 2: the milling process, including breaking between three fluted rollers, reduction of particle size between two smooth rollers and the use of a centrifugal sieving machine to grade the products (see [Clause 8](#)).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 660, *Animal and vegetable fats and oils — Determination of acid value and acidity*

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

ISO 12099, *Animal feeding stuffs, cereals and milled cereal products — Guidelines for the application of near infrared spectrometry*

3 Principle

The behaviour of dough obtained from a mixture of different types of flour and salt water is evaluated during deformation. A dough disk is subjected to a constant air flow; at first it withstands the pressure. Subsequently, it inflates into a bubble, according to its extensibility, and ruptures. The change in the dough is measured and recorded in the form of a curve called an alveogram.

4 Reagents

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

4.1 Sodium chloride solution, obtained by dissolving $(25 \pm 0,2)$ g of sodium chloride (NaCl) in water and then making the volume up to 1 000 ml. This solution shall not be stored for more than 15 d and its temperature shall be (20 ± 2) °C when used.

4.2 Refined vegetable oil, low in polyunsaturates, such as peanut oil. It is possible to use olive oil if its acid value is less than 0,4 (determined according to ISO 660). Store in a dark place in a closed container and replace regularly (at least every three months).

Alternatively, **liquid paraffin** (also known as “soft petroleum paraffin”), with an acid value of less than or equal to 0,05 and the lowest possible viscosity [maximum 60 mPa·s (60 cP) at 20 °C].

4.3 Cold degreasing agent, optimum safety.

5 Apparatus

Usual laboratory apparatus and, in particular, the following.

5.1 Mechanical cleaner, fitted with sieves for wheat cleaning, in accordance with the manufacturer’s instructions.

5.2 Conical or riffle sample divider.

5.3 Analytical balance, accurate to 0,01 g.

5.4 Glass burette, of 50 ml in capacity, graduated in 1 ml divisions.

5.5 Rotary blender¹⁾, for grain conditioning and flour homogenization, including the following components:

5.5.1 Constant speed stirrer.

5.5.2 Two worm screws integral with the flask, possibly via the stopper (one for wheat preparation, the other for flour homogenization).

5.5.3 Several wide-necked plastic flasks, 2 l capacity.

5.6 Test mill (laboratory mill), manually or automatically operated (see [Annex A](#)).

5.7 Complete alveograph system (see [Table 1](#) for specifications and characteristics of the accessories) including the following devices:

5.7.1 Kneading machine [for models MA 82, MA 87, and MA 95, see [Figure 1 a](#)]; for model NG, see label a in [Figure 2](#) and [Figure 3](#)], with accurate temperature control, for dough sample preparation.

5.7.2 Hydraulic manometer or Alveolink²⁾ [for models MA 82, MA 87, and MA 95, see [Figure 1 b](#)]; for model NG, see label b in [Figure 2](#) and [Figure 3](#)] for recording the pressure curve.

5.7.3 Alveograph³⁾ [for models MA 82, MA 87, and MA 95, see [Figure 1 c](#)]; for model NG, see label c in [Figures 2](#) and [Figure 3](#)] with accurate temperature control, for biaxial deformation of the dough

1) The Chopin MR 2 l rotary blender is an example of a suitable product available commercially. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of this product.

2) Alveolink is an example of a suitable product available commercially. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of this product.

3) The methods specified in this International Standard are based on the use of the MA 82, MA 87, MA 95 and NG models of Chopin alveograph which are examples of suitable products commercially available. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of this product.

test pieces. It has two rest chambers, each containing five plates on which the dough test pieces can be arranged prior to deformation.

5.8 Burette with stopcock, supplied with the apparatus, 160 ml capacity, graduated in divisions of 0,1 % of moisture content.

NOTE Throughout this International Standard, “content” is expressed as a “mass fraction” (see ISO 80000-9, 12[6]), i.e. the ratio of the mass of substance in a mixture to the total mass of the mixture.

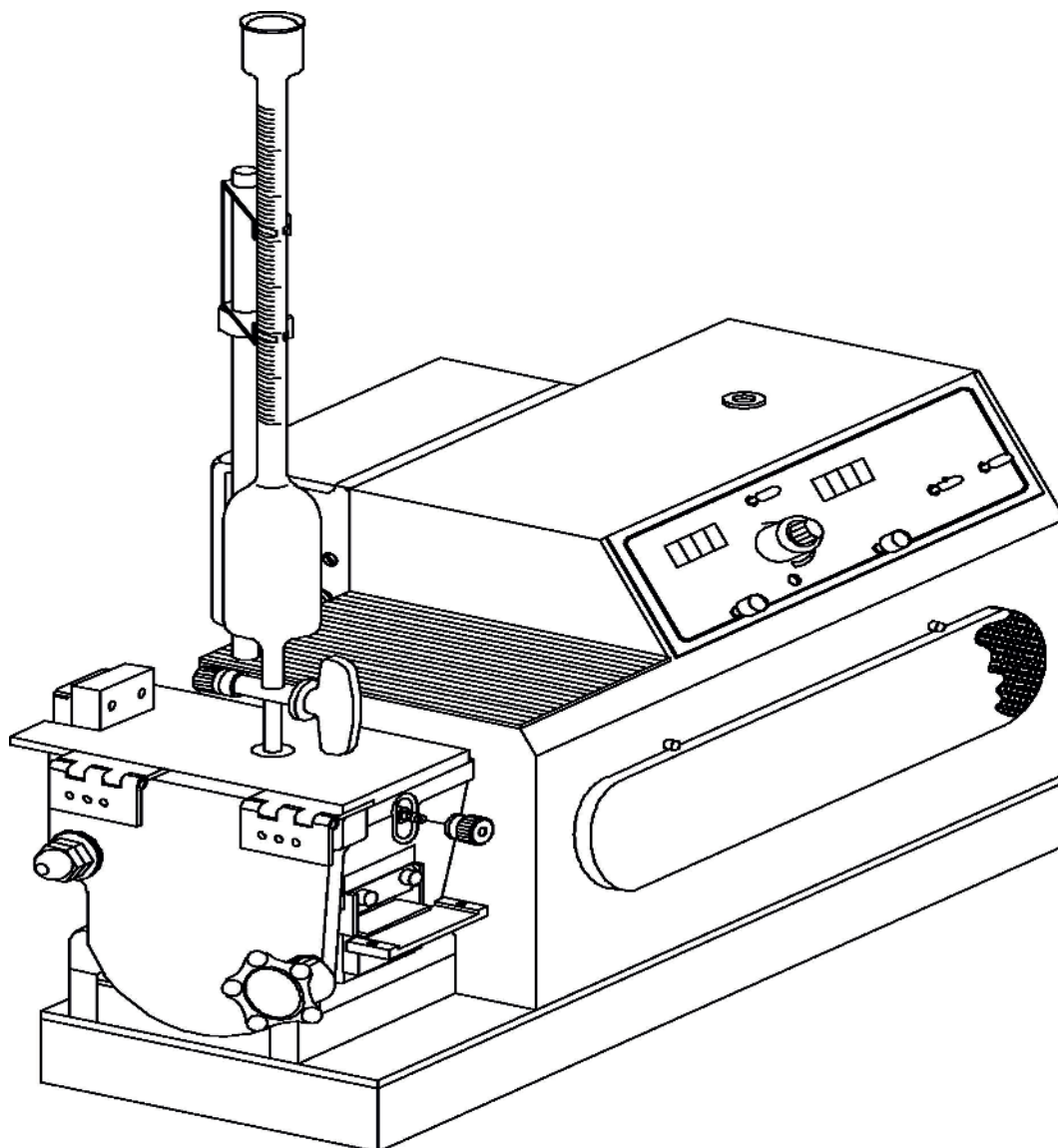
5.9 Timer, for use with model MA 82 only.

5.10 Planimetric scales, supplied with the apparatus where an Alveolink is not included.

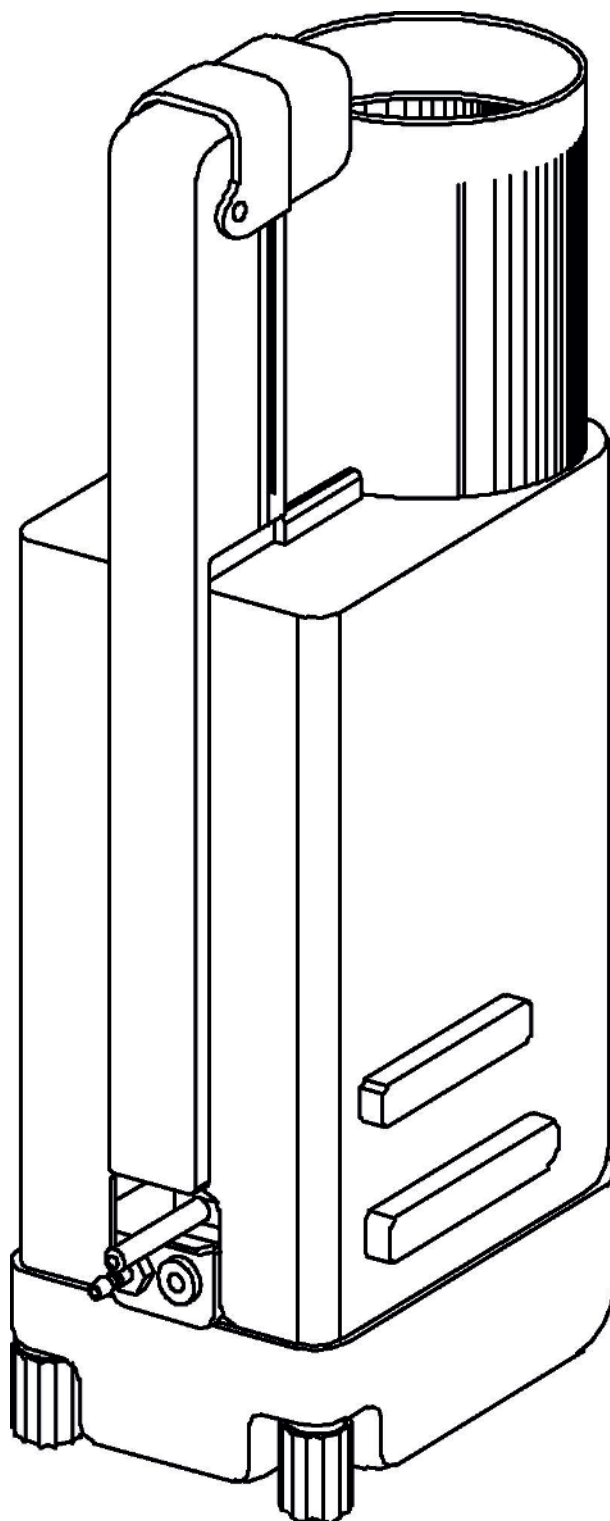
5.11 System for recording the test environment conditions (temperature and relative air humidity) as specified in [8.1](#) and [9.1](#).

5.12 Volumetric flask, 1 000 ml capacity, complying with the requirements of ISO 1042, class A.

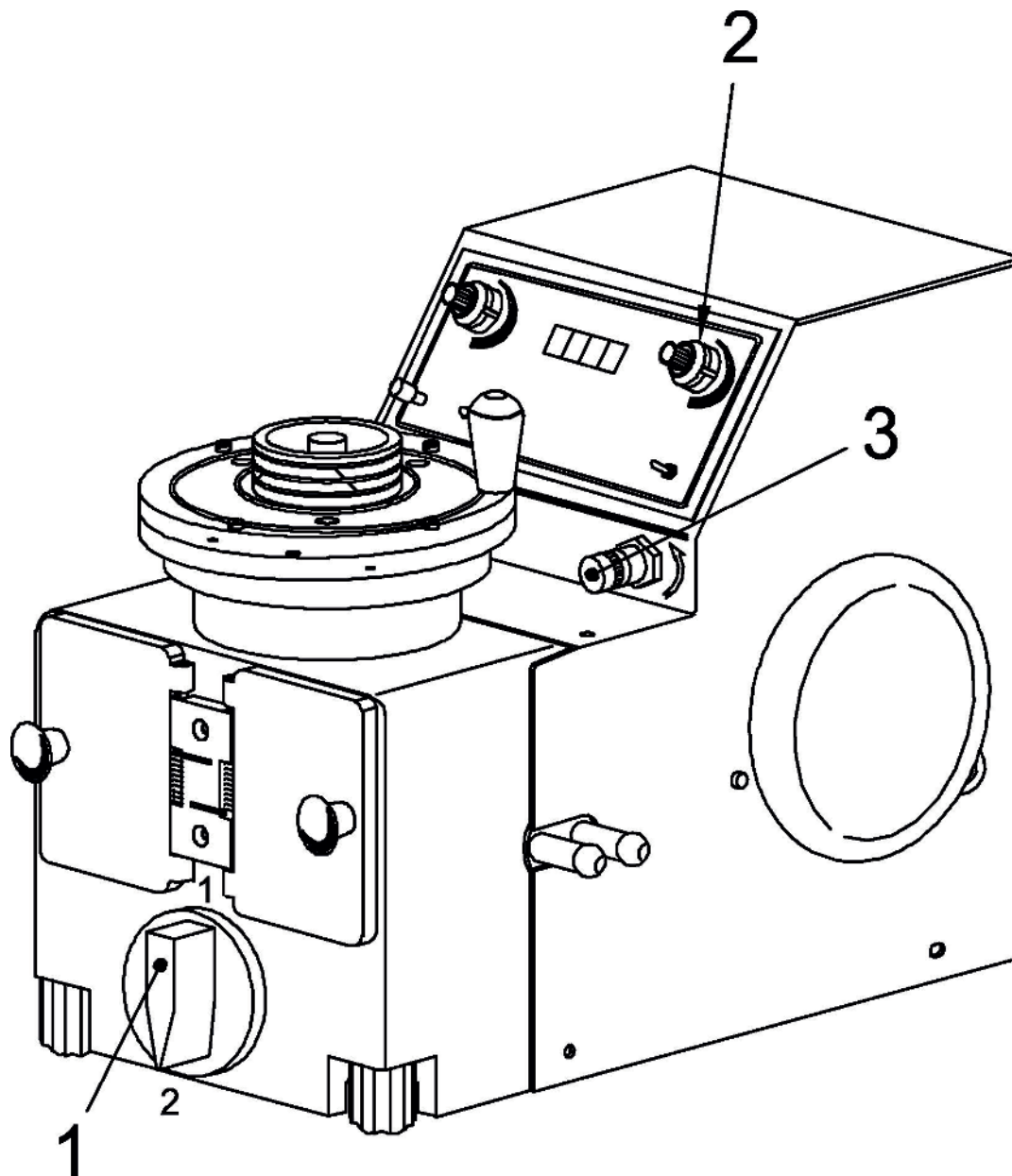
5.13 Pipette, 25 ml capacity, graduated in divisions of 0,1 ml, complying with the requirements of ISO 835, class A.



a) Kneading machine



b) Manometer

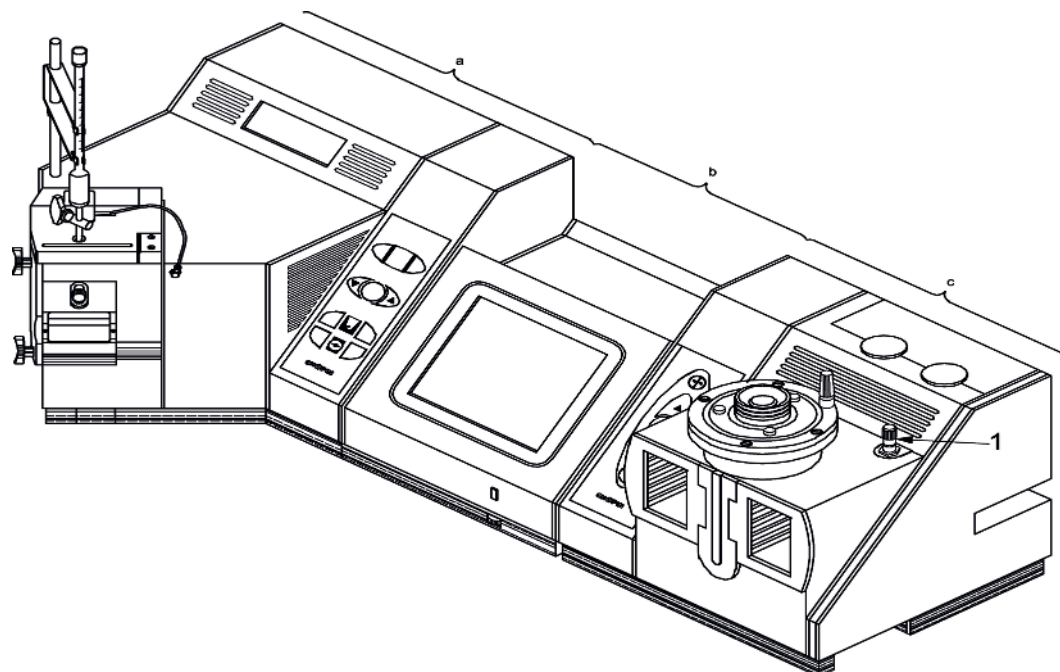


c) Alveograph

Key

- 1 handle A in position 2
- 2 pump potentiometer
- 3 micrometric valve for air flow adjustment

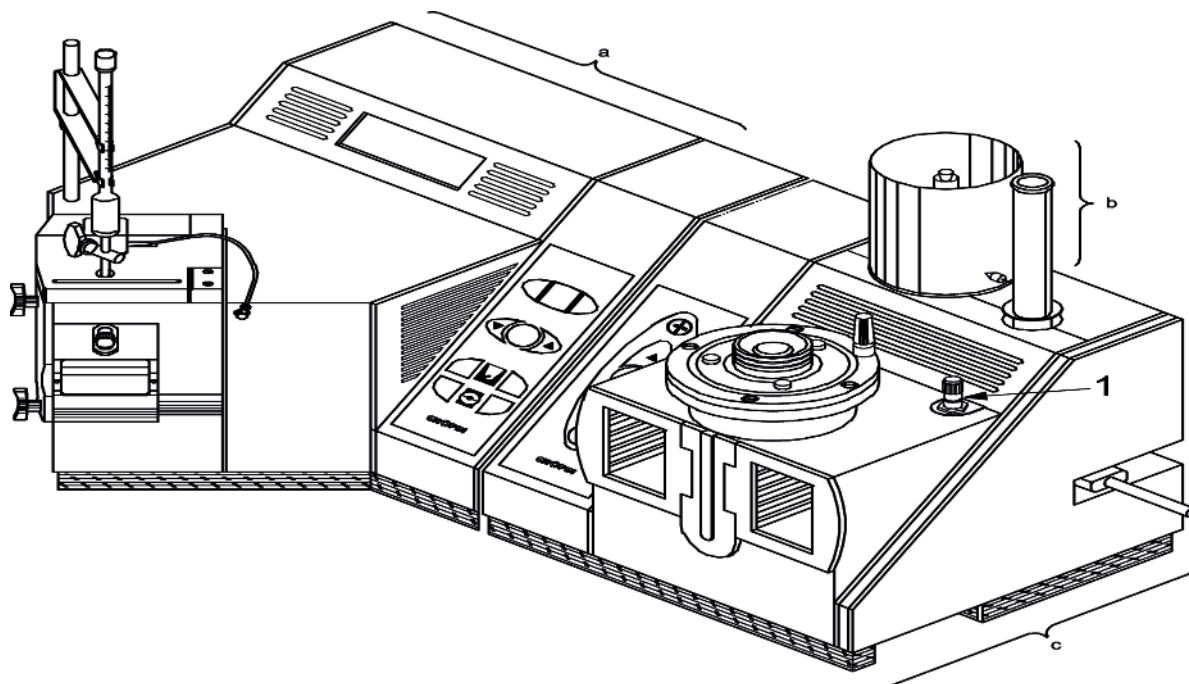
Figure 1 — Model MA 82, MA 87, and MA 95 alveograph assemblies



Key

- 1 micrometric valve for air flow adjustment
- a NG kneading machine.
- b NG integrator-recorder.
- c NG alveograph (with NG integrator-recorder).

Figure 2 — NG alveograph assembly with Alveolink integrator-recorder



Key

- 1 micrometric valve for air flow adjustment
- a NG kneading machine.
- b NG recording machine.
- c NG alveograph (with hydraulic recording manometer).

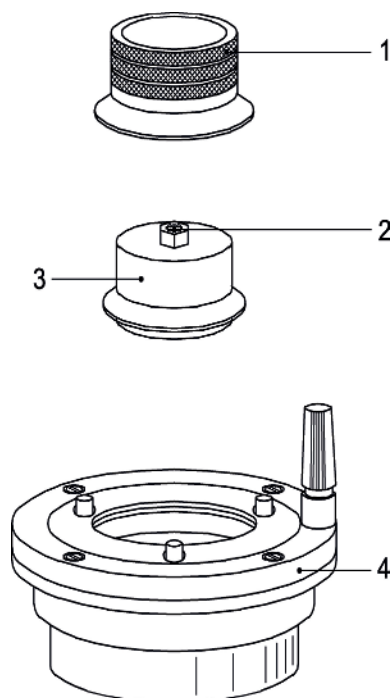
Figure 3 — NG alveograph assembly with hydraulic recording manometer

Table 1 — Specifications and characteristics of the accessories required for the test

Quantity	Value and tolerance
Rotational frequency of the kneading machine blade	(60 ± 2) Hz
Height of sheeting guides	$(12,0 \pm 0,1)$ mm
Large diameter of the sheeting roller	$(40,0 \pm 0,1)$ mm
Small diameter of the sheeting roller	$(33,3 \pm 0,1)$ mm
Inside diameter of the dough cutter	$(46,0 \pm 0,5)$ mm
Diameter of the aperture created when the moving plate opens (which determines the effective diameter of the test piece)	$(55,0 \pm 0,1)$ mm
Theoretical distance between the fixed and moving plates after clamping (equal to the thickness of the test piece before inflation)	$(2,67 \pm 0,01)$ mm
Volume of air automatically injected to detach the test piece prior to inflating the bubble ^a	(18 ± 2) ml
Linear speed of the periphery of the recording drum	$(5,5 \pm 0,1)$ mm/s
Air flow ^b ensuring inflation	(96 ± 2) l/h
^a Some older devices are fitted with a pear-shaped rubber bulb for manual injection of the 18 ml required to detach the test piece.	
^b To adjust the flow rate of the air generator used to inflate the bubble, fit the nozzle (Figure 4) to create a specified pressure drop (and obtain a pressure corresponding to a height of 92 mmH ₂ O(12,3 kPa) on the manometer chart). The air flow rate is set with the standardized pressure drop to obtain a pressure corresponding to a height of 60 mmH ₂ O(8,0 kPa) on the manometer chart, i.e.(96 ± 2) l/h (see Figure 4 and Figure 5).	

Table 1 (continued)

Quantity	Value and tolerance
Rotation time of the manometer drum (from stop to stop)	(55 ± 1) s
^a Some older devices are fitted with a pear-shaped rubber bulb for manual injection of the 18 ml required to detach the test piece. ^b To adjust the flow rate of the air generator used to inflate the bubble, fit the nozzle (Figure 4) to create a specified pressure drop (and obtain a pressure corresponding to a height of 92 mmH₂O(12,3 kPa) on the manometer chart). The air flow rate is set with the standardized pressure drop to obtain a pressure corresponding to a height of 60 mmH₂O(8,0 kPa) on the manometer chart, i.e. (96 ± 2) l/h (see Figure 4 and Figure 5).	



Key

- 1 knurled ring
- 2 nozzle
- 3 nozzle holder
- 4 top plate

Figure 4 — Flow control system

6 Sampling

A representative wheat or flour sample should have been sent to the laboratory. It shall not have been damaged or changed during transport or storage.

Sampling is not part of the method specified in this International Standard. Recommended sampling methods are given in ISO 24333.[1]

7 Preparation of the wheat for laboratory milling.

7.1 Cleaning the laboratory sample

Pass the laboratory sample through a mechanical cleaner ([5.1](#)) to ensure that all stones and metal fragments are removed and to avoid damaging the rollers during milling. A magnetic device may also be used to remove ferrous metal fragments.

7.2 Test portion

The test portion shall be representative of the initial wheat mass. Use the sample divider ([5.2](#)) to homogenize and divide the laboratory sample until the mass required for laboratory milling plus moisture content determination is obtained. The minimum wheat mass of the test portion for milling shall be 800 g.

7.3 Wheat moisture content determination

Determine the moisture content of the test portion as specified in ISO 712, or using a rapid device the measurement of which does not differ from the reference value by $\pm 0,4$ g water per 100 g of sample (see ISO 7700-1).

7.4 Wheat preparation

7.4.1 General

Preparing the wheat for milling makes it easier to separate the bran from the endosperm. The target moisture content is $(16,0 \pm 0,5)$ %.

7.4.2 Wheat with initial moisture content between 13 % and 15 % (one-stage moistening)

Using the balance ([5.3](#)), weigh a test portion (minimum 800 g) to the nearest 1 g of wheat and pour it into the blender.

Add the required amount of water (see [Table B.1](#)) to the grain from the burette ([5.4](#)) directly, or after weighing it to the nearest 0,5 g.

Immediately after adding the water, insert the stopper fitted with the worm screw provided for use with wheat into the flask, shake vigorously for a few seconds and place on the rotary blender ([5.5](#)).

Run the rotary blender for (30 ± 5) min (time required to distribute the water evenly across the surface of the grains).

Allow it to rest for a period that brings the total time of the moistening, shaking and resting operations to (24 ± 1) h.

7.4.3 Wheat with a moisture content less than 13 % (two-stage moistening)

As a larger volume of water is required, divide it into two halves and add in two stages during the preparation period.

Proceed as described in [7.4.2](#), using only half the total quantity of water required (see [Table B.1](#)).

Shake the flask as described in [7.4.2](#) and allow it to rest for at least 6 h.

Then add the second half of the total quantity of water between the 6th hour and the 7th hour.

After adding the second half, shake the flask again for (30 ± 5) min, then allow it to rest for a period that brings the total time of the moistening, shaking and resting operations to (24 ± 1) h.

7.4.4 Wheat with a moisture content greater than 15 % (preliminary drying followed by moistening, as described above)

The wheat shall be dried to produce a moisture content lower than 15 %.

Spread the laboratory sample in a thin layer to optimize the exchange between the grain and the air. Allow to dry in the open air in a dry place for at least 15 h.

Perform the moisture content determination process again (7.3).

Then prepare the wheat as specified in 7.4.2 or 7.4.3, depending on the new moisture content.

8 Laboratory milling

8.1 General

The test mill (5.6) shall be used with the manufacturer's settings. Additional weights shall not be used and the tension on the reduction side spring shall not be changed.

The quality of the milling process depends on several factors:

- a) environmental conditions that allow the final moisture content of the flour to be between 15,0 % and 15,8 % (wheat should be milled in an ambient temperature between 18 °C and 23 °C with a relative air humidity between 50 % and 75 %);
- b) the condition of the sieves; the sieving area shall remain uniform — if a sieve is pierced, it shall be replaced immediately;
- c) beater condition and setting: worn blades reduce the extraction rate;
- d) compliance with flow rates: the efficiency of the roll and the efficiency of the sieving process are strictly dependent on a regular feed rate. The speed at which the products pass through the sieving drum can be set by adjusting the position of the blades⁴⁾ on the beaters.

8.2 Milling procedure

8.2.1 Breaking

Switch on the device.

Set the feed rate to allow the conditioned wheat to pass through the mill in (5 ± 1) min.

Pour the conditioned wheat (7.4) into the mill feed hopper and, at the same time, start the timer to check milling time.

After the last grains of wheat have passed through, let the mill continue to operate for (180 ± 30) s to completely clear out the sieve.

When the mill stops, weigh (5.3) separately, the bran, the semolina, and the flour to the nearest 0,1 g.

Calculate the percentage of semolina obtained compared with the mass of wheat used, expressing the result to one decimal place.

8.2.2 Reduction

Switch on the device.

4) Two adjustable blades in the middle and at the end of the beater on the break side, four blades at the end on the reduction side.

Adjust the feed rate to allow the semolina produced in [8.2.1](#) to pass through the mill in (5 ± 1) min.

Pour the semolina into the feed hopper and, at the same time, start the timer to check the time.

After the last grains of semolina have passed through, let the mill continue to operate for (180 ± 30) s to completely clear out the sieve.

Repeat the above reduction procedure if the mass of semolina obtained from the break system is greater than or equal to 48 %⁵⁾ of the mass of conditioned wheat.

When the mill stops, weigh [\(5.3\)](#) separately, the middlings and the reduction flour to the nearest 0,1 g.

Ensure that the milling ratio, *BM* (ratio of the sum of the masses of the milled products to the total conditioned wheat mass), is equal to at least 98 %.

NOTE A milling ratio less than 98 % indicates excessively worn beaters or an obstruction in the sieves, causing some of the product to remain inside the sieving drum.

8.2.3 Flour homogenization

Pour the break and reduction flour into the blender flask [\(5.5.3\)](#).

Insert the stopper fitted with the worm screw [\(5.5.2\)](#) provided for use with flour into the flask and place the flask on the blender [\(5.5\)](#).

Mix for (20 ± 2) min.

Remove the worm screw [\(5.5.2\)](#) and replace it with the flask stopper. The flour is now ready for the alveograph test.

8.2.4 Storage of the flour

The flask containing the flour shall be kept in the room where the alveograph test is performed.

8.3 Expression of milling results

Calculate the extraction rate, *ER*, as a percentage of dry mass, of flour extracted from the cleaned wheat using Formula (1):

$$ER = \frac{(100 - H_f) \times M_f}{(100 - H_b) \times M_b} \times 100 \quad (1)$$

where

H_f is the moisture content, as a percentage, of the flour obtained (determined according to ISO 712);

H_b is the moisture content, as a percentage, of the wheat test portion for milling before moistening (determined according to ISO 712);

M_f is the mass, in grams, of the total flour obtained;

M_b is the wheat mass, in grams, of the test portion for milling before moistening.

Express the result to the nearest 0,1 % mass fraction.

5) Round up the values: 47,4 becomes 47 and 47,5 becomes 48.

Calculate the percentage of bran, S , using Formula (2):

$$S = \left[M_s / (M_b + M_e) \right] \times 100 \quad (2)$$

Calculate the percentage of middlings, R , using Formula (3):

$$R = \left[M_r / (M_b + M_e) \right] \times 100 \quad (3)$$

where

M_s is the mass, in grams, of bran;

M_r is the mass, in grams, of middlings;

M_b is the initial mass, in grams, of the wheat before conditioning;

M_e is the mass, in grams, of water added (numerically equal to the volume, V_e , in millilitres, of water added).

Express the results to the nearest integer.

9 Preparation and alveograph test

9.1 Preliminary checks

Ensure that the ambient temperature is between 18 °C and 22 °C with a relative humidity between 50 % and 80 %.

Ensure that the various components of the apparatus (kneading machine, alveograph, recorder, burette, tools, etc.) are clean.

Check that the F-register is in place in the extrusion aperture to prevent any loss of flour or salt solution leakage.

Ensure that the temperature of the kneading machine (5.7.1) at the start of the test is $(24,0 \pm 0,5)$ °C; the temperature of the alveograph shall be continuously set to $(25,0 \pm 0,5)$ °C.

NOTE A rise in the kneading machine temperature during the kneading process is normal and characteristic of flour under test. The continuous control feature provided on the NG models should not be used.

Regularly check that the pneumatic circuit on the apparatus is sealed (no air leakage) by following the manufacturer's recommended procedure.

Check the air flow settings using the nozzle (see Table 1, Note b), creating the specified loss of pressure [see Figure 1c), Label 1 in Figures 2 and 3, and Figures 4 and 5] by setting:

- the air generator to a pressure corresponding to 92 mmH₂O (12,3 kPa) on the hydraulic manometer chart or on the recorder screen;
- the micrometer flow rate valve to a pressure corresponding to 60 mmH₂O (8,0 kPa) on the manometer chart or the recorder screen.

Check that the alveograph plate is horizontal.

If a recording manometer is employed, use the timer (5.9) to check the rotation time of the recording drum according to the manufacturer's recommended procedure.

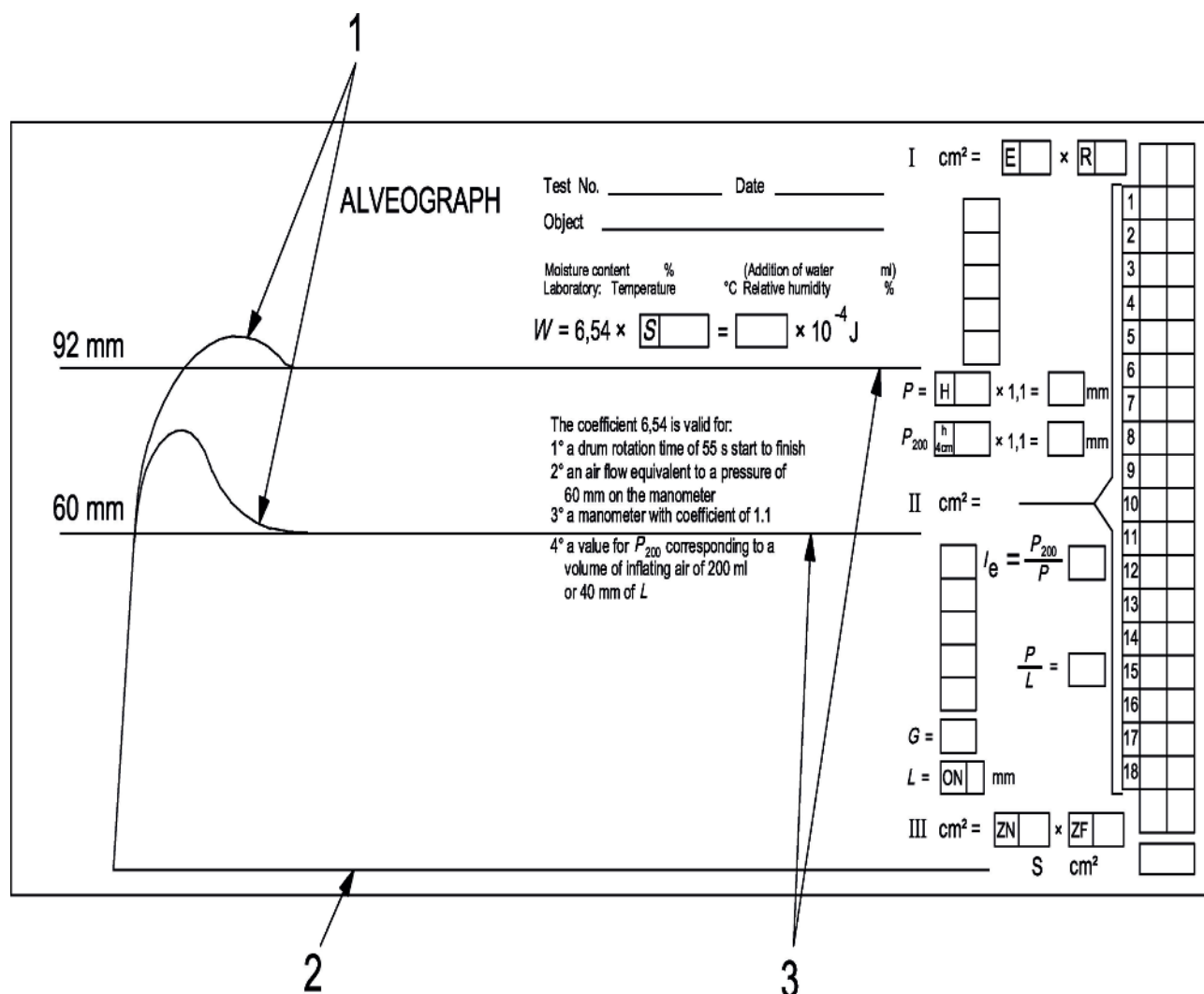


Figure 5 — Measurement pressure setting

9.2 Preliminary operations

At the beginning of the test, the temperature of the flour shall be the ambient temperature.

Determine the moisture content of the flour according to the method specified in ISO 712 or with an apparatus using near infrared spectroscopy whose performance has been demonstrated in accordance with ISO 12099 and meets at minima a SEP $\leq 0,15$ % determined on the entire scope of this standard. From Table 2, find the quantity of sodium chloride solution (4.1) to be used in 9.3 to prepare the dough.

Table 2 — Volume of sodium chloride solution (4.1) to be added during kneading

Moisture content of the flour %	Volume of solution to be added ml	Moisture content of the flour %	Volume of solution to be added ml	Moisture content of the flour %	Volume of solution to be added ml
8,0	155,9	11,0	142,6	14,0	129,4
8,1	155,4	11,1	142,2	14,1	129,0
8,2	155,0	11,2	141,8	14,2	128,5
8,3	154,6	11,3	141,3	14,3	128,1
8,4	154,1	11,4	140,9	14,4	127,6
8,5	153,7	11,5	140,4	14,5	127,2
8,6	153,2	11,6	140,0	14,6	126,8
8,7	152,8	11,7	139,6	14,7	126,3
8,8	152,4	11,8	139,1	14,8	125,9
8,9	151,9	11,9	138,7	14,9	125,4
9,0	151,5	12,0	138,2	15,0	125,0
9,1	151,0	12,1	137,8	15,1	124,6
9,2	150,6	12,2	137,4	15,2	124,1
9,3	150,1	12,3	136,9	15,3	123,7
9,4	149,7	12,4	136,5	15,4	123,2
9,5	149,3	12,5	136,0	15,5	122,8
9,6	148,8	12,6	135,6	15,6	122,4
9,7	148,4	12,7	135,1	15,7	121,9
9,8	147,9	12,8	134,7	15,8	121,5
9,9	147,5	12,9	134,3	15,9	121,0
10,0	147,1	13,0	133,8	16,0	120,6
10,1	146,6	13,1	133,4		
10,2	146,2	13,2	132,9		
10,3	145,7	13,3	132,5		
10,4	145,3	13,4	132,1		
10,5	144,9	13,5	131,6		
10,6	144,4	13,6	131,2		
10,7	144,0	13,7	130,7		
10,8	143,5	13,8	130,3		
10,9	143,1	13,9	129,9		

NOTE The volume of sodium chloride solution (4.1), V_{NaCl} , to be added during kneading is calculated from the formula:

$$V_{\text{NaCl}} = 191,175 - (4,411\,75 \times H_f)$$

where H_f is the moisture content of the flour.

These values have been calculated to obtain constant hydration, i.e. equivalent to a dough made from 50 ml of sodium chloride solution (4.1) and 100 g of flour with a moisture content of 15 %.

9.3 Kneading

Place 250 g of flour, weighed (5.3) to within 0,5 g, in the kneading machine (5.7.1). Secure the lid with the locking device.