INTERNATIONAL STANDARD

ISO 5530-1

Second edition
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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 réhologiques aux moyens du farinographe

Reference number
ISO 5530-1:1997(E)

Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 5530-1 was prepared by Technical Committee ISO/TC 34, *Agricultural food products*, Subcommittee SC 4, *Cereals and pulses*.

This part of ISO 5530 is based on Standard No. 115 of the International Association for Cereal Science and Technology (ICC).

This second edition cancels and replaces the first edition (ISO 5530-1:1988), 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*

— *Part 4: Determination of rheological properties using an alveograph*

Annexes A to C of this part of ISO 5530 are for information only.

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Wheat flour — Physical characteristics of doughs —

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

1 Scope

This part of ISO 5530 specifies a method, using a farinograph, for the determination of the water absorption of flours and the mixing behaviour of doughs made from them.

The method is applicable to flour from wheat (*Triticum aestivum* L.).

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this part of ISO 5530. At the time of the publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this part of ISO 5530 are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

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

3 Definitions

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

3.1 consistency
Resistance of a dough to being mixed in a farinograph at a specified constant speed.

NOTE — It is expressed in arbitrary units (farinograph units, FU).

3.2 water absorption (of flour)
Volume of water required to produce a dough with a maximum consistency of 500 FU, under the operating conditions specified in this part of ISO 5530.

NOTE — Water absorption is expressed in millilitres per 100 g of flour at 14 % (*m* / *m*) moisture content.

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

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 flour.

5 Reagent

5.1 Distilled water, or water of equivalent purity.

6 Apparatus

Usual laboratory apparatus and, in particular, the following.

6.1 Farinograph[2)], with a thermostat consisting of a constant temperature water bath (see annex A).

It shall have the following operating characteristics:

- slow blade rotational frequency: (63 ± 2) min^{-1} (rev/min); the ratio of the rotational frequencies of the mixing blades shall be 1,50 ± 0,01;

- torque per farinograph unit:

a) for a 300 g mixer
(9,8 ± 0,2) mN·m/FU [(100 ± 2) gf·cm/FU];

b) for a 50 g mixer
(1,96 ± 0,04) mN·m/FU [(20 ± 0,4) gf·cm/FU];

- chart speed: (1,00 ± 0,03) cm/min.

6.2 Burette

a) For a 300 g mixer, graduated from 135 ml to 225 ml in 0,2 ml divisions.

b) For a 50 g mixer, graduated from 22,5 ml to 37,5 ml in 0,1 ml divisions.

The time to flow from 0 ml to 225 ml or from 0 ml to 37,5 ml respectively shall be not more than 20 s.

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

[2)] This part of ISO 5530 has been drawn up on the basis of the Brabender Farinograph. This information is given for the convenience of users of this part of ISO 5530 and does not constitute an endorsement by ISO of this apparatus. Other equipment may be used if it can be shown to give comparable results.

6.4 Spatula, made of soft plastic.

7 Sampling

Sampling is not part of the method specified in this part of ISO 5530. A recommended sampling method is given in ISO 13690.

It is important that the laboratory receive a sample which is truly representative and 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 (6.1) 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 and of the mixing bowl, the latter in the hole provided for this purpose. The temperature of the mixing bowl shall be (30 ± 0,2) °C.

8.2.2 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.

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.

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.This should result in a bandwidth of approximately 60 FU to 90 FU.

8.2.3 Fill the burette (6.2), 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 (for a 300 g mixer) or 50 g (for a 50 g mixer) of flour having a moisture content of 14 % (m/m). Let this mass, in grams, be m; see table 1 for m as a function of moisture content.

Place the flour in the mixer. Cover the mixer, and keep it covered until the end of mixing (8.4.1) except, for the shortest possible time, when water has to be added and the dough scraped down (see A.2.2).

8.4 Determination

8.4.1 Mix at the specified rotational frequency (see 6.1) for 1 min or slightly longer. 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.

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

Add a volume of water close to that expected to produce a maximum consistency (9.1) of 500 FU. 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 maximum consistency (9.1) of approximately 500 FU. Stop mixing and clean the mixer.

8.4.2 Make further mixings as necessary, until two mixings are available:

- in which the water addition has been completed within 25 s;
- the maximum consistencies (9.1) of which are between 480 FU and 520 FU; and
- the recording of which has been continued for at least 12 min after the end of the development time (9.2), if the degree of softening is to be reported.

Stop mixing and clean the mixer.

Table 1 — Mass of flour, in grams, equivalent to 300 g and 50 g at a moisture content of 14 % (*m* / *m*)

Moisture content	Mass *m* of flour equivalent to		Moisture content	Mass *m* of flour equivalent to	
% (*m*/*m*)	300 g	50 g	% (*m*/*m*)	300 g	50 g
9,0	283,5	47,3	13,6	298,6	49,8
9,1	283,8	47,3	13,7	299,0	49,8
9,2	284,1	47,4	13,8	299,3	49,9
9,3	284,5	47,4	13,9	299,7	49,9
9,4	284,8	47,5	14,0	300,0	50,0
9,5	285,1	47,5	14,1	300,3	50,1
9,6	285,4	47,6	14,2	300,7	50,1
9,7	285,7	47,6	14,3	301,1	50,2
9,8	286,0	47,7	14,4	301,4	50,2
9,9	286,3	47,7	14,5	301,8	50,3
10,0	286,7	47,8	14,6	302,1	50,4
10,1	287,0	47,8	14,7	302,5	50,4
10,2	287,3	47,9	14,8	302,8	50,5
10,3	287,6	47,9	14,9	303,2	50,5
10,4	287,9	48,0	15,0	303,5	50,6
10,5	288,3	48,0	15,1	303,9	50,6
10,6	288,6	48,1	15,2	304,2	50,7
10,7	288,9	48,2	15,3	304,6	50,8
10,8	289,2	48,2	15,4	305,0	50,8
10,9	289,6	48,3	15,5	305,3	50,9
11,0	289,9	48,3	15,6	305,7	50,9
11,1	290,2	48,4	15,7	306,0	51,0

Moisture content % (m/m)	Mass m of flour equivalent to 300 g	50 g	Moisture content % (m/m)	Mass m of flour equivalent to 300 g	50 g
11,2	290,5	48,4	15,8	306,4	51,1
11,3	290,9	48,5	15,9	306,8	51,1
11,4	291,2	48,5	16,0	307,1	51,2
11,5	291,5	48,6	16,1	307,5	51,3
11,6	291,9	48,6	16,2	307,9	51,3
11,7	292,2	48,7	16,3	308,2	51,4
11,8	292,5	48,8	16,4	308,6	51,4
11,9	292,8	48,8	16,5	309,0	51,5
12,0	293,2	48,9	16,6	309,4	51,6
12,1	293,5	48,9	16,7	309,7	51,6
12,2	293,8	49,0	16,8	310,1	51,7
12,3	294,2	49,0	16,9	310,5	51,7
12,4	294,5	49,1	17,0	310,8	51,8
12,5	294,9	49,1	17,1	311,2	51,9
12,6	295,2	49,2	17,2	311,6	51,9
12,7	295,5	49,3	17,3	312,0	52,0
12,8	295,9	49,3	17,4	312,3	52,1
12,9	296,2	49,4	17,5	312,7	52,1
13,0	296,6	49,4	17,6	313,1	52,2
13,1	296,9	49,5	17,7	313,5	52,2
13,2	297,2	49,5	17,8	313,9	52,3
13,3	297,6	49,6	17,9	314,3	52,4
13,4	297,9	49,7	18,0	314,6	52,4
13,5	298,3	49,7			

NOTE — The values in this table were calculated using the following formulae:

a) for the mass, in grams, equivalent to 300 g at 14 % (m/m) moisture content:

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

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

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

where H is the moisture content of the sample, as a percentage by mass.

9 Expression of results

NOTE — To facilitate the calculations, a computer may be used. The farinograph 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 9.1 to 9.4, and documents the diagram and the results.

9.1 Calculation of water absorption

From each of the mixings with maximum consistencies between 480 FU and 520 FU, derive the corrected volume V_c , in millilitres, of water corresponding to a maximum consistency of 500 FU, by means of the following equations:

a) for a 300 g mixer:

$$V_c = V + 0{,}096(C - 500)$$

b) for a 50 g mixer:

$$V_c = V + 0{,}016(C - 500)$$

where

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

C is the maximum consistency, in farinograph units (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 farinograph units;

c_2 is the maximum height of the lower contour of the curve, in farinograph units.

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

Use for the calculation the mean value of duplicate determinations of V_c, provided that 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 farinograph water absorption, expressed in millilitres per 100 g of flour at 14 % (m/m) moisture content, is equal to

a) for a 300 g mixer:

$$\left(\bar{V}_c + m - 300\right) \times \frac{1}{3}$$

b) for a 50 g mixer:

$$\left(\bar{V}_c + m - 50\right) \times 2$$

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.

9.2 Calculation of dough development time

The dough development time is the time from the beginning of addition of water to the point on the curve immediately before the first signs of the decrease of consistency (see figure 1).

NOTE — In the relatively infrequent case where two maxima are observed, use the second maximum to measure the development time.

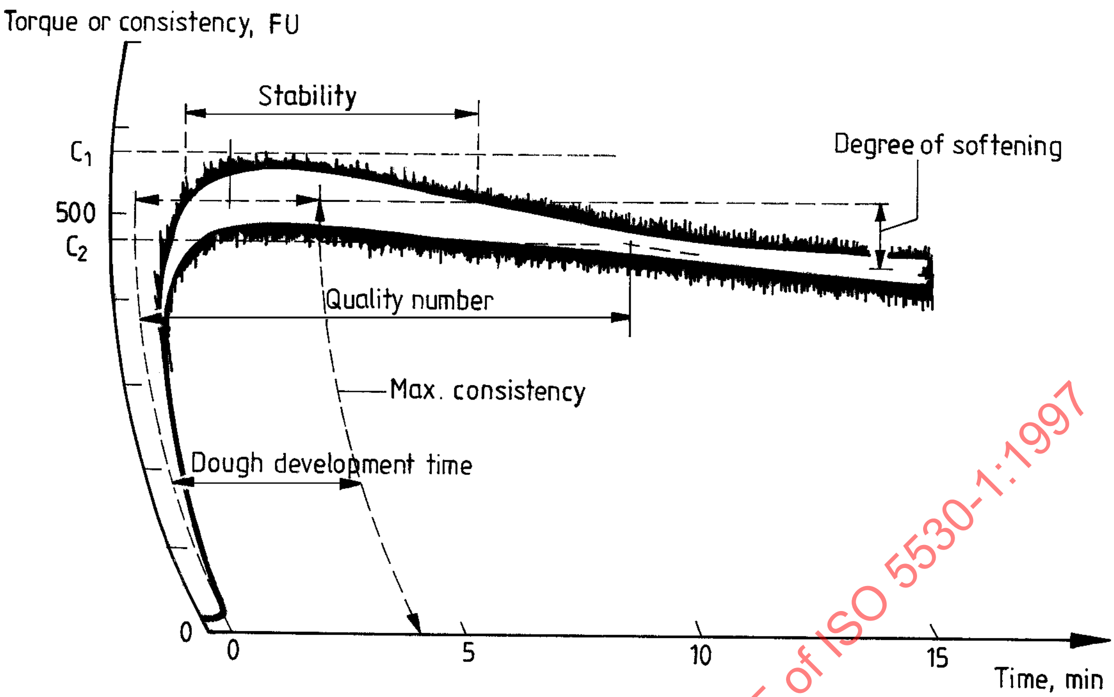


Figure 1 — Representative farinograph showing the commonly measured indices

Take as the result the mean dough development time from the two curves to the nearest 0,5 min, provided that the difference between them does not exceed 1 min for development times of up to 4 min, or 25 % of their mean value for longer development times.

9.3 Calculation of stability

Stability is defined as the difference in time, to the nearest 0,5 min, between the point at which the top of the curve first intercepts the 500 FU line and the point at which the top of the curve leaves the 500 FU line. This value, in general, gives some indication of the tolerance of the flour to mixing.

When the maximum consistency deviates from the 500 FU line (see 9.1), the line of this consistency should be used to read the interceptions.

9.4 Calculation of degree of softening

The degree of softening is the difference in height between the centre of the curve at the end of the dough development time and the centre of the curve 12 min after this point (see figure 1).

Take as the result the mean degree of softening from the two curves to the nearest 5 FU, provided that the difference between them does not exceed 20 FU for degrees of softening up to 100 FU, or 20 % of their mean value for larger values.

9.5 Other characteristics

9.5.1 The curve characteristics given in 9.1 to 9.4 are derived strictly from the recorded curve (figure 1).

9.5.2 In some countries, the quality number is calculated; this is the length, in millimetres, along the time axis, between the point of water addition and the point where the height of the centre of the curve has decreased by 30 FU compared to the height of the centre of the curve at the development time.

NOTE — The quality number may be reported together with, or instead of, the stability and the degree of softening. Using the quality number 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 respectively.

9.5.3 In the United States of America and some other countries, further interpretations of the recorded curve are used, giving the following characteristics: arrival time, peak time, mixing tolerance index, departure time, 20-min drop, time to breakdown and valorimeter value. Some of these characteristics are defined in another way and cannot be compared with the characteristics in this part of ISO 5530. They are reported in references [2] and [3].

10 Precision

Details of an interlaboratory test on the precision of the method are summarized in annex B. The values derived from this interlaboratory test may not be applicable to concentration ranges and matrices other than those given.

11 Test report

The test report shall specify

- all information necessary for the complete identification of the sample;
- the sampling method used, if known;
- the test method used; with reference to this part of ISO 5530;
- the size of the mixer used;
- the type of flour;
- all operating details not specified in this part of ISO 5530, or regarded as optional, together with details of any incidents which may have influenced the test result(s);
- the test result(s) obtained; and
- if the repeatability has been checked, the final quoted result obtained.

Annex A
(informative)

Description of the farinograph

WARNING — The safety provisions installed by the manufacturer must 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 your fingers and other objects out of the running mixer;

- keep ties, sleeves etc. away from rotating driving shaft of the farinograph.

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

A.1 General description

The farinograph comprises two units:

a) the farinograph unit itself, consisting of a water-jacketed mixer, a means for recording dough consistency in the form of farinograms, and a burette (A.2);

b) a thermostat for the circulation water (A.3).

The components of the farinograph are illustrated diagramatically in figure A.1.

A.2 Farinograph unit

A.2.1 The farinograph unit is mounted on a heavy cast-iron base plate having four levelling screws, and consists of:

a) a detachable, water-jacketed mixer (A.2.2);

b) an electric motor, driving the mixer (A.2.3);

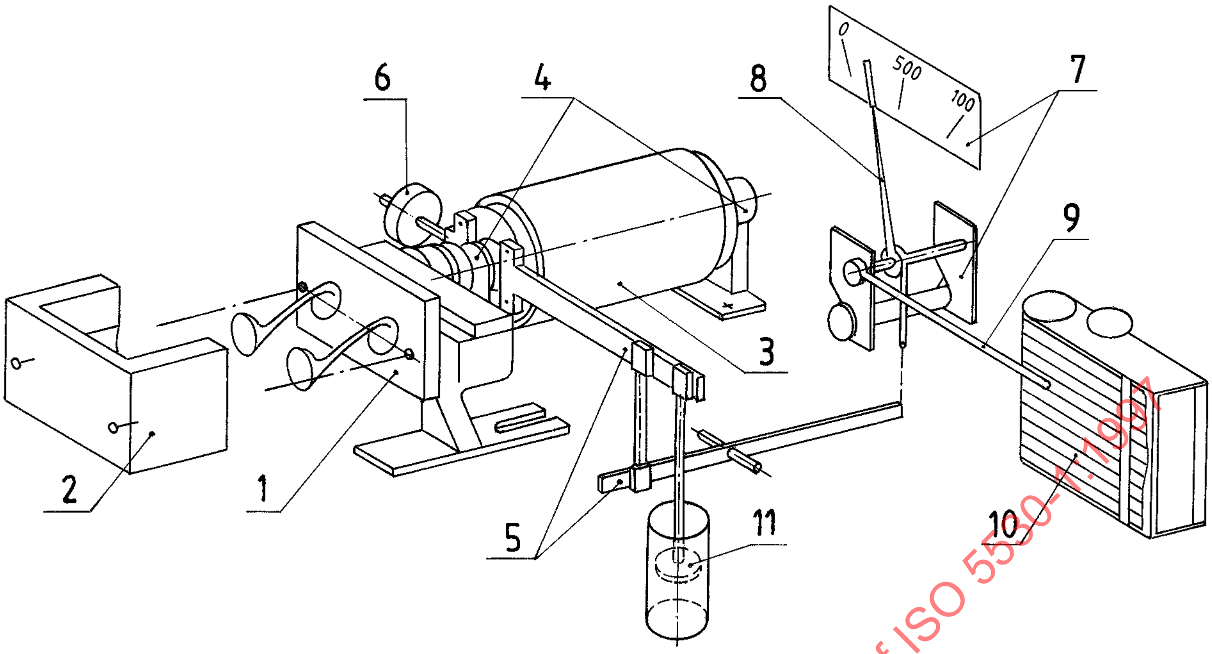
c) a gear and lever system, acting as a dynamometer to measure the torque on the driving shaft between the gear and the mixer (A.2.3);

d) a dash-pot to damp the movements of the dynamometer (A.2.3);

e) a scale, the pointer of which is actuated by movements of the dynamometer (A.2.3);

f) a recorder, the pen of which is actuated by the movements of the dynamometer (A.2.4);

g) a burette to measure the volume of water added to the flour.



Key

1 Back wall of mixer with mixing blades
2 Remainder of mixer
3 Housing of motor and gears
4 Ball-race bearings
5 Levers
6 Counterweight
7 Scale head
8 Pointer
9 Pen arm
10 Recorder
11 Dash-pot damper

Figure A.1 — Diagram of farinograph

A.2.2 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 gear-box 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; it rotates at a frequency of 63 min^{-1} in recent farinographs. The faster mixing blade is geared, by cog-wheels, to rotate at a frequency that is 1,5 times that of the slower blade.

NOTE - Previous farinographs were made with rotational frequencies of the driving shaft that differ from the presently standardized value of 63 min^{-1}. The effect of the rotational frequency on the determination can be neglected if it is within the range 59 min^{-1} to 67 min^{-1}. If it is outside this range, an 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 the equation

$$C = 500 + 200 \ln \left(\frac{n}{63} \right)$$

If a consistency C has to be substituted for the standard consistency, the development time varies according to the equation

$$t_0 = t - 320 \left(\frac{1}{n} - \frac{1}{63}\right)$$

where

t_o is the development time, in minutes, that would be measured with a farinograph that is in accordance with 6.1;

t is the development time, in minutes, that 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 recent farinographs, consists of two parts.

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 dough to be scraped down from the sides of the bowl with a spatula. The water has to 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 is to be opened only for adding water or scraping down the dough.

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

A.2.3 The motor and its reduction and dynamometer gears are placed together in a housing. From the front and rear ends of this housing, shafts protrude that 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 per 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 recent instruments, both possibilities for adjustment are used. In older instruments there is only the second possiblity.

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.2.4 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.3 Thermostat

The 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 ± 0,2) °C. Under adverse conditions, a slightly higher water temperature may be necessary; it shall be controlled with the same accuracy.

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 ± 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 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. Recent 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 (5.1) can be pumped through the other one into the burette to adjust its temperature (8.2.3). 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.4 Calibration of farinographs

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 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 his 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.