Farinograph Method for Flour

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Objective

The farinograph measures and records resistance of a dough to mixing. It is used to evaluate absorption of flours and to determine stability and other characteristics of doughs during mixing. Two basically different methods are in common use: Constant Flour Weight Procedure and Constant Dough Weight Procedure. *Since the two procedures may not yield identical results, the method employed must be specified when absorption and other farinogram values are reported.*

Apparatus

Farinograph, with mixing bowls for 300 g flour and 50 g flour.

Procedure

Adjustments of farinograph

1. Adjust farinograph thermostat to maintain temperature of 30 ± 0.2° at entrance to mixing bowl. Check temperature of circulating water with high-grade thermometer. Make sure that thermostat water is circulating freely through hose and bowl jackets. Confirm that flow pattern is the same as shown in equipment manual.

2. With help of spirit level mounted on base plate, adjust position of latter to horizontal by means of four footscrews. Then fix footscrews by means of their locknuts (see equipment manual).

3. Make certain that chart paper runs exactly horizontal. Two small plates on spring-loaded hinges at front of recording device operate as guides for paper and may be swung open to make this adjustment.

Use of large and small mixing bowls

In changing from one bowl to another, the following adjustments are involved:

1. Sensitivity. Four sensitivities are provided. There are two choices of position of linkage between balance levers (rear and front) and two choices of additional weights (400 and 1,000). Normal settings are: for 300 g, linkage toward rear of farinograph, switch on 1000; for 50 g, linkage toward front of farinograph, switch on 400.

2. Zero position of scalehead pointer. Adjust scalehead pointer to zero position of dial by changing position of threaded balance weights when instrument is running at fast speed with mixer empty. Smaller of two weights should be removed entirely when small bowl is used on older (1978) models. Make final writing-arm adjustment with knurled screw on left side of scalehead shaft so that scalehead pointer and writing pen give identical readings.

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3. Adjustment of band width. Damping device should be adjusted only after oil in damping chamber has been at operating temperature at least 1 hr and after damping piston has been moved up and down several times. To make adjustment: raise dynamometer lever arm until scalehead pointer indicates 1000. Release lever arm and measure with stop-watch time required for pointer to go from 1000 to 100 on scalehead (should be 1 ± 0.2 sec). Damping adjustment controls band width of farinogram. (Band width at peak of curve of 70–80 Brabender units [BU] is recommended.) To obtain wider damper opening and quicker movement of scalehead pointer and thus wider curve, turn adjustment screw counterclockwise. Opposite adjustment produces narrower band. It may be advantageous to mark damper adjustment screw at correct setting.

4. Cleaning. At completion of each test and while machine is running, add dry flour to bowl to make stiff dough with consistency of 800–900 BU within 1 min of mixing with test dough. Then stop machine, unscrew bowl wing nuts, take off front section of mixing bowl, and discard dough. Remove any adhering particles quickly before they dry, using small plastic spatula for scraping blades and side walls of bowl. (Spatula should be of softer material than mixing bowl in order not to damage latter.) Finally, clean bowl with dampened cloth and wipe all parts dry, including space behind paddles. (*Caution*: Never use chemical agents such as borax, or any dough stiffeners other than flour, since traces of chemicals can affect subsequent curves and may even react with metal surfaces of bowl.)

For bronze bowls, put cleaning dough through mixing bowl every morning, or after machine has stood for several hours, to rub off thin film of oxidation on surface. If preliminary titration of flour sample is conducted (as explained below), this may be regarded as cleaning dough. Stainless-steel bowl does not require cleaning dough. Also, after standing, small particles of dough may harden between shafts and blades at back of mixing bowl and cause resistance to turning. Correct this by placing few drops of water on inside back wall of bowl directly over shafts, with blades turning, to soften dough particles. Then use strong jet of water or blast of air or CO_2 to remove dough. Return of scalehead pointer to zero position indicates that these dough particles have been softened and removed.

Clean titrating buret periodically with solution made of 10 parts concentrated H_2SO_4 to 1 part saturated potassium dichromate solution. Fill buret with this solution and let stand overnight. *This solution is extremely corrosive and should be handled with caution.* After draining buret, rinse repeatedly with tap water and finally with distilled water. After recording each titration, and when not in use, keep buret, including tip, filled with water at all times.

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A. Constant Flour Weight (Variable Dough Weight) Procedure
Large bowl

1. Turn on thermostat and circulating pump at least 1 hr prior to using instrument.
2. Determine moisture content of flour as directed in any oven method for flour (Methods **44-15.02** and following). (Keep flour samples in moisture-proof containers. Accurate moisture values are very important.)
3. Place in bowl 300 ± 0.1 g flour (14% moisture basis). See Note 1 and Table **82-23**.
4. Fill large buret with water at room temperature, making sure that tip is full and automatic zero adjustment of buret is functioning properly.
5. Put few drops of ink in pen and place in contact with 9-min position on chart. Turn on machine to high-speed setting and run for 1 min until zero-min line is reached. At this instant begin adding water to right front corner of bowl from large buret. Add water to volume nearly that of expected absorption of flour. When dough begins to form, with the mixer running, scrape down sides of bowl with plastic scraper, starting on right side, front, and working counterclockwise. Cover with glass plate. If it appears that mixing curve will level off at value larger than 500 BU, cautiously add more water. This will be used to estimate next attempt. After water is added, again cover bowl with glass plate to prevent evaporation.
6. First titration attempt rarely produces curve that has maximum resistance centered on 500-BU line; therefore, in subsequent titration, adjust absorption either up or down until this is achieved to within 20 BU. The higher the absorption, the lower the maximum resistance. Titration producing wider variation affects scoring of curve. As a guide to correcting preliminary titration values, it can be reckoned that the difference between each horizontal line (20 BU) corresponds approximately to 0.6–0.8% absorption (1.8–2.4 ml water), depending on flour. When correct absorption is achieved, curve at maximum dough development is centered on 500-BU line.
7. For final titration, add all water within 25 sec after opening buret stopcock. Permit machine to run until adequate curve is available for evaluation as desired (see *Interpretation*), i.e., absorption, slightly beyond peak; stability, until top of curve recrosses 500-BU line after peak; valorimeter, 12 min beyond peak. At this point, lift pen from paper by means of small locking knob on pen arm, add dry flour to bowl, and proceed with cleaning of bowl.
8. Report absorption values to nearest 0.1%. Calculate absorption on 14% moisture basis determined with large bowl, by means of following equation: Absorption percent = $(x + y - 300)/3$, where x = ml water to produce curve with maximum consistency centered on 500-BU line, and y = g flour used, equivalent to 300 g, 14% moisture basis.

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Small bowl

Use same principle as for large bowl, except 50 ± 0.1 g flour (14% moisture basis). See Note 2 and Table **82-23**. Titration is conducted with *small* buret. In this case, each interval between horizontal lines of chart (20 BU) corresponds to about 0.4 ml water.

Calculate absorption on 14% moisture basis, determined with small bowl, using equation: Absorption percent = $2(x + y - 50)$, where x = ml water to produce curve with maximum consistency centered on 500-BU line, and y = g flour used, equivalent to 50 g, 14% moisture basis.

B. Constant Dough Weight Procedure

Large bowl

1. Turn on thermostat and circulating pump at least 1 hr prior to using instrument.
2. Use dough weight of 480 g (Table **54-28A**) and add water with large buret (225 ml). Weigh flour to ±0.1 g.
3. Make estimate of as-is absorption to produce curve centered on 500-BU line. From Table **54-28A**, determine weights of flour and water that correspond to estimated as-is absorption. Add flour, weighed to ±0.1 g, to bowl. Set pen point at 9-min mark on chart.
4. Start mixer and run at 63 ± 2 rpm with dry flour 1 min until zero-min line is reached. At this instant, begin adding water from large buret at right front corner of mixing bowl. All water must be added within 25 sec. Scrape down sides of bowl with plastic spatula. Cover with glass plate to prevent evaporation.
5. Since first attempt rarely produces curve centered on 500-BU line at maximum consistency, reestimate absorption according to the approximate relationship 20 BU = 0.6% absorption, determine corresponding flour and water weights from Table **54-28A**, and conduct second run. When curve is obtained with maximum consistency centered at 500 ± 20 BU, continue mixing until adequate curve is available for evaluation as desired (see *Interpretation*).
6. At this point, lift pen from paper by means of small locking knob on pen arm, add dry flour to bowl, and proceed with cleaning of bowl.
7. Obtain absorptions on 14% moisture basis to nearest 0.1%: a) by calculations as illustrated in Note 2, b) from Table **54-29**, or, preferably, c) from Table **82-21**.

Small bowl

Principle is same as for large bowl.

1. Use dough weight of 80 g (Table **54-28A**) and add water with *small* buret. Weigh flour to ±0.1 g.

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2. Obtain absorptions on 14% moisture basis to nearest 0.1% a) by calculations as illustrated in Note 2, b) from Table **54-29**, or, preferably, c) from Table **82-21**.

Interpretation

Values other than absorption are frequently derived from farinograph curves. Among those that have been proposed are the following:

1. Dough development time. This is interval, to nearest 0.5 min, from first addition of water to that point in maximum consistency range immediately before first indication of weakening. This value has also been referred to as "peak" or "peak time." For flours having curve that is nearly flat for several minutes, peak time may be determined by taking mean between midpoint of flat portion of top of curve and highest point of arc of bottom of curve. Occasionally two peaks may be observed; the second should be taken for determination of dough development time.

2. Valorimeter value. This is an empirical single-figure quality score based on dough development time and tolerance to mixing that is derived from the farinogram by means of a special template supplied by manufacturers of farinograph equipment.

3. Tolerance index. This value is difference in BU from top of curve at peak to top of curve measured at 5 min after peak is reached. Related measurement called "drop-off" refers to difference in BU from 500-BU line to center of curve measured at 20 min from addition of water.

4. Stability. This is defined as time difference, to closest 0.5 min, between point where top of curve first intersects 500-BU line (arrival time) and point where top of curve leaves 500-BU line (departure time). If curve is not centered exactly on 500 line at maximum resistance but rather, for example, at 490 or 510 level, line must be drawn at 490 or 510 level parallel to 500 line. This new line is then used in place of 500 line to determine arrival time, departure time, and stability.

5. Time to breakdown. This is time from start of mixing until there has been decrease of 30 units from peak point. It is determined by drawing a horizontal line through center of curve at its highest point and then drawing another parallel line at 30-unit lower level. Time from start of mixing until center of descending curve crosses this lower line is "time to breakdown."

Notes

1. Farinograms of various flours are affected differently with addition of malt supplement. In general, addition of malt shortens dough development time and lowers absorption. Practical evaluation of a flour may require addition of malt in amount required for proper diastatic activity.

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2. Example: If flour sample contains 12.5% moisture, the amount of flour required for 300-g test would be: (86.0/87.5) × 300 = 294.9 g. For the 50-g test this would be: (86.0/87.5) × 50 = 49.1 g.

3. The following equation may be used to convert as-is absorption determined by Constant Dough Weight procedure to absorption at 14% moisture content.

$$A = 86\ \frac{(B + M)}{(100 - M)} - 14$$

where A = absorption, 14% moisture basis; B = absorption, as-is moisture basis; M = flour moisture, as-is basis. This equation is derived from the following considerations: One may equate two doughs of equal weight, of same consistency in farinograph, made from same flour but at different moisture contents. Total water in each dough is same.

Then

$$\frac{\text{Water added} + \text{water in flour}}{\text{Dry weight of flour}} = \frac{\text{Water added} + \text{water in flour}}{\text{Dry weight of flour}}$$

For example, to calculate absorption (A) at 14% moisture equivalent to 70% absorption (B) at 11.1% moisture (M),

$$\frac{A + 14}{100 - 14} = \frac{70 + 11.1}{100 - 11.1},\ \text{or}$$

$$A = 86\ \frac{(B + M)}{(100 - M)} - 14 = 86\ \frac{(81.1)}{(88.9)} - 14 = 64.5\%$$

Farinograms should report exactly how absorption was obtained. This includes amount of water added to flour, absorption correction to 500 BU, and correction to 14% moisture.

4. A computerized version of the instrument is available, or older instruments can be retrofitted.

5. A rapid method with a farinograph quality number can be obtained from the manufacturer.

6. For the farinograph “E” (electronic) model, some of the adjustments for the mechanical instrument may not apply. However, the methodology and results are identical to those of the mechanical farinograph.

References

1. Bailey, C. H. Physical tests of flour quality. Leland Stanford Jr. Univ. Food Res. Inst. Wheat Studies 16:243. (Sept. 1939–May 1940).
2. Brabender, C. W. 1932. Studies with the farinograph for predicting the most suitable types of American export wheats and flours for mixing with European soft wheats and flours. Cereal Chem. 9:617.
3. D’Appolonia, B. L., and Kunerth, W. H., eds. 1984. The Farinograph Handbook, 3rd ed. Am. Assoc. Cereal Chem., St. Paul, MN.

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4. Geddes, W. F., Aitken, T. R., and Fisher, M. H. 1940. The relation between the normal farinogram and the baking strength of Western Canadian wheat. Cereal Chem. 17:528.
5. Johnson, J. A., Shellenberger, J. A., and Swanson, C. O. 1946. Farinograms and mixograms as a means of evaluating flours for specific uses. Cereal Chem. 23:388.
6. Locken, L., Laska, S., and Shuey, W. 1972. The Farinograph Handbook. 2nd ed. Am. Assoc. Cereal Chem., St. Paul, MN.