Alveograph Method for Soft and Hard Wheat Flour[1]

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Objective

The alveograph measures resistance of dough to extension and extent to which it can be stretched under the conditions of the method. In this method, a sheet of dough of definite thickness prepared under specified conditions is expanded by air pressure into a bubble until it is ruptured. The internal pressure in bubble is graphically recorded on moving paper or automated integrator.

Apparatus

1. Alveograph (with circulating water bath, optional) consisting of:
   a. Dough mixer (mixer blade speed 60 ± 1 rpm) with burette graduated in percentage of moisture content from 11.6 to 17.8% (accuracy 0.1%) or burette of 160-ml capacity graduated in 0.25-ml intervals.
   b. Sheeting assembly.
   c. Dough cutter.
   d. Alveograph proper (actual bubble-blowing portion).
   e. Manometric recorder with recording drum having peripheral linear speed of 5.5 ± 0.1 mm/sec.
   f. Conversion scale and planimeter scale for alveogram interpretation (available from manufacturer).

Alveograph with airflow controlled by air pump has a built-in flowmeter with needle valve and potentiometer to control air pressure. Nosepiece holder and nosepiece No. 12C, used for calibrating alveograph, are supplied with apparatus.

2. Balance, accurate to 0.5 g.
3. Timer.

Reagents

1. NaCl solution. Dissolve 25 g NaCl (analytical grade) in distilled water and make up to 1,000 ml.

2. Paraffin oil (light mineral oil) with acid value not more 0.05 and viscosity not more than 60 cP at 20°; or oleic vegetable oil, such as peanut oil, with acid value less than 0.4.

Procedure

Adjustment of apparatus

1. Apparatus should be used in room with constant temperature between 18 and 22° and relative humidity of 65 ± 15%.

2. Before each test, check that temperatures of mixer and alveograph are 24.0 ± 0.2° and 25.0 ± 0.2°, respectively. If adjustment of temperature of mixer is

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necessary, turn rheostat (see instruction manual) in direction of arrow to increase temperature or in opposite direction to lower temperature. Similarly, adjust temperature of alveograph. Control light will serve as guide. If maintaining required temperature appears difficult, use thermostatically controlled circulating water bath.

3. Sheeting assembly should have the following characteristics:

Dimension	*Size (mm)*
Height of sheeting guides	12.0 ± 0.1
Diameters of sheeting roller	
Large	40.0 ± 0.1
Small	33.3 ± 0.1
Inner diameter of dough cutter	46.0 ± 0.5

Calibration of alveograph

Two calibrations, of air generator flow and of flowmeter, are essential for proper functioning.

a. Install nosepiece and prepare manometer. Put nosepiece holder and nosepiece in place of stopper D and ring C (Fig. 1). By lowering upper plate B, make assembly airtight and open tap F. Place diagram sheet on drum of manometer and trace zero line. Remove sheet and draw two lines parallel to zero line: one at 60 mm, the other at 92 mm. Place sheet back on drum.

b. Calibrate air generator. Open valve H. Switch knob A on alveograph to position 3. Pen of manometer must draw line superimposed on 92-mm calibration line. If it does not, turn potentiometer of air pump I until the two lines are brought together.

c. Calibrate flowmeter. By closing needle valve H of flowmeter, bring pen to 60-mm line. This calibration should be done at least once daily before using alveograph.

Mixing of dough

1. Determine moisture content of flour (Method **44-15.02**). Based on moisture content, determine necessary quantity of NaCl solution either from Table I or directly from mixer burette.

2. Fill mixer burette with NaCl solution. If necessary, bring flour temperature to 20 ± 2°.

3. Place 250 ± 0.5 g flour in mixer. Start motor and timer, and add required quantity of NaCl solution from mixer burette through hole in mixer lid. Addition should be completed within 20 sec from starting of mixer. Let dough form for 1 min, including the 20 sec for adding salt solution.

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4. Stop mixer and remove lid. Scrape down sides of bowl and lid with plastic spatula so that all dough undergoes hydration. Operation should be completed in 1 min.

5. After this 1-min period (total of 2 min), restart mixer and allow mixing to continue 6 min. After total of 8 min, stop mixing and proceed with extrusion of test pieces.

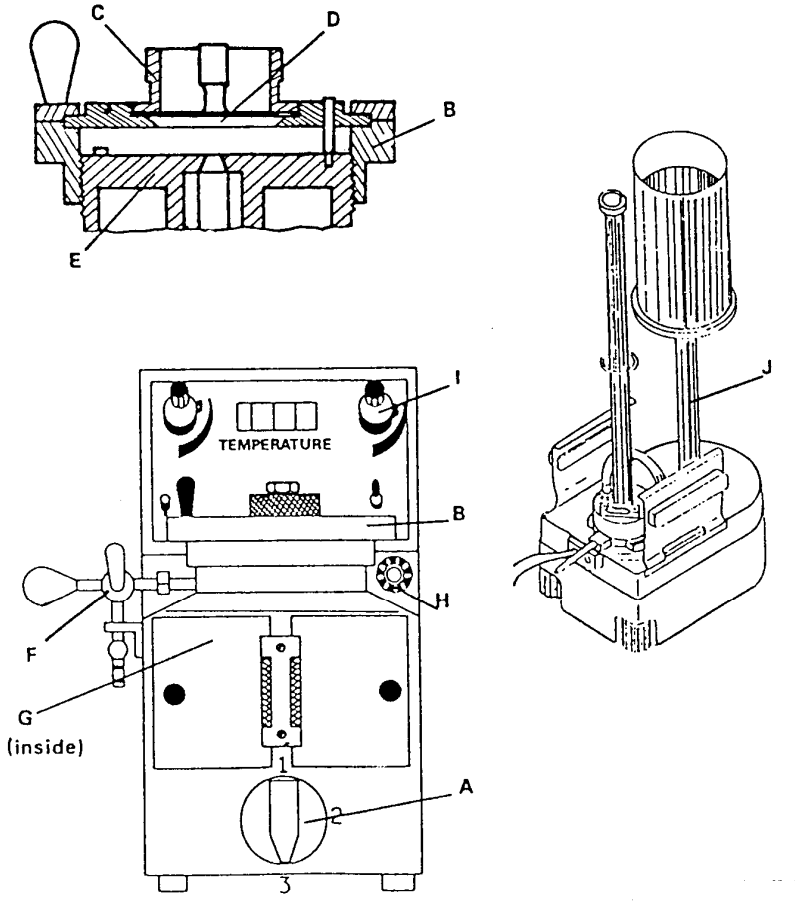

Fig. 1. A = switch knob, B = upper plate, C = ring, D = stopper, E = fixed plate, F = tap, G = air pump (inside), H = valve of flowmeter, I = air generator, J = manometer.

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TABLE I
Volume of NaCl Solution to Be Added to 250 g Flour, Based on Flour Moisture Content[a]

Flour Moisture, %	NaCl, ml	Flour Moisture, %	NaCl, ml	Flour Moisture, %	NaCl, ml
5.0	169.6	10.0	147.2	15.0	125.0
5.1	169.2	10.1	146.8	15.1	124.6
5.2	168.7	10.2	146.3	15.2	124.1
5.3	168.3	10.3	145.9	15.3	123.7
5.4	167.8	10.4	145.5	15.4	123.2
5.5	167.4	10.5	145.1	15.5	122.8
5.6	166.9	10.6	144.6	15.6	122.3
5.7	166.5	10.7	144.2	15.7	121.9
5.8	166.0	10.8	143.7	15.8	121.4
5.9	165.6	10.9	143.3	15.9	121.0
6.0	165.1	11.0	142.8	16.0	120.6
6.1	164.7	11.1	142.4	16.1	120.2
6.2	164.2	11.2	141.9	16.2	119.7
6.3	163.8	11.3	141.5	16.3	119.3
6.4	163.3	11.4	141.0	16.4	118.8
6.5	162.9	11.5	140.6	16.5	118.4
6.6	162.4	11.6	140.1	16.6	117.9
6.7	162.0	11.7	139.7	16.7	117.5
6.8	161.5	11.8	139.2	16.8	117.0
6.9	161.1	11.9	138.8	16.9	116.6
7.0	160.6	12.0	138.3	17.0	116.1
7.1	160.2	12.1	137.9	17.1	115.7
7.2	159.7	12.2	137.5	17.2	115.2
7.3	159.3	12.3	137.1	17.3	114.8
7.4	158.8	12.4	136.6	17.4	114.3
7.5	158.4	12.5	136.2	17.5	113.9
7.6	157.9	12.6	135.7	17.6	113.4
7.7	157.5	12.7	135.3	17.7	113.0
7.8	157.0	12.8	134.8	17.8	112.5
7.9	156.6	12.9	134.4	17.9	112.1
8.0	156.1	13.0	133.9	18.0	111.7
8.1	155.7	13.1	133.5	18.1	111.3
8.2	155.2	13.2	133.0	18.2	110.8
8.3	154.8	13.3	132.6	18.3	110.4
8.4	154.4	13.4	132.1	18.4	109.9
8.5	153.9	13.5	131.7	18.5	109.5
8.6	153.5	13.6	131.2	18.6	109.0
8.7	153.1	13.7	130.8	18.7	108.6
8.8	152.6	13.8	130.3	18.8	108.1
8.9	152.2	13.9	129.9	18.9	107.7
9.0	151.7	14.0	129.4	19.0	107.2
9.1	151.3	14.1	128.9	19.1	106.8
9.2	150.8	14.2	128.6	19.2	106.3
9.3	150.4	14.3	128.2	19.3	105.9
9.4	149.9	14.4	127.7	19.4	105.4
9.5	149.5	14.5	127.3	19.5	105.0
9.6	149.0	14.6	126.8	19.6	104.5
9.7	148.6	14.7	126.4	19.7	104.1
9.8	148.1	14.8	125.9	19.8	103.7
9.9	147.7	14.9	125.5	19.9	103.3

[a]Values have been calculated to obtain constant hydration, i.e., that of dough made from 50 ml NaCl solution and 100 g flour with moisture content of 15%.

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Preparation of test pieces

1. While dough is being mixed, use eyedropper to place 4 drops of oil on receiving plate attached to extrusion gate, 16 drops of oil on each glass plate of sheeting plates (8 drops for each extruded strip of dough), 5 drops on roller, and 5 drops on each resting plate. Spread oil uniformly across all surfaces with thick brush.

2. After stopping mixer, open extrusion aperture by raising slide of shutter. Switch on mixer with reversed direction of mixing blade rotation. Dough will extrude in strip. Cut off and discard first 2 cm of dough.

3. When strip of extruded dough reaches line indicated by small indented notches on plate, rapidly cut dough with backwards-and-forwards movement of knife against guide (apparatus is supplied with special knife-spatula). Pull out receiving plate and slide dough onto previously oiled glass plate of sheeting assembly. Similarly prepare three more pieces of dough. Place two dough pieces on each of the two glass plates. Extrude one more piece of dough and leave it on receiving plate.

4. When dough pieces have been placed on plate of first sheeting assembly, sheet them by means of previously oiled roller, running it along rails 12 times in succession (three rapid backward-and-forward movements followed by three slow ones). Repeat operation with two other pieces of dough on second sheeting assembly.

5. Cut dough test pieces in clean movement from sheeted dough, using circular cutter. Cut away surplus dough. Lift cutter containing dough test piece and, by gently tapping on cutter, transfer dough piece onto resting plate. If dough piece sticks to glass plate, lift it up slightly and slide resting plate under it.

6. Immediately place each resting plate into resting compartment of alveograph (at 25.0 ± 0.2°). Proceed in order of extrusion, first piece being placed on top.

7. Remove fifth dough piece from receiving plate and repeat these operations.

8. After some experience is attained, it is possible to carry out operations described in steps 3–6 continuously while strip of dough is being extruded.

Stretching of dough pieces

1. While dough is resting in compartment, prepare recorder by placing sheet of recording paper on recording drum, filling pen with ink, tracing zero pressure line, and returning drum to starting position.

2. Start determination 28 min after mixing began.

   a. Form test "patty." Switch knob A on alveograph (Fig. 1) to position 1. Raise upper plate B by rotating it through two revolutions. Remove ring C and stopper D. Oil fixed plate E and inner face of stopper D. Slide dough test piece to center of E. If dough piece does not slide freely, push

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it by gently touching edge of dough piece without deforming it. Never tap resting plate on beveled edge of press. Replace stopper D and ring C. Flatten dough test piece by slowly lowering upper plate (two turns in 20 sec). Wait 5 sec. Remove ring C and stopper D to free dough piece.

b. Detach dough "patty." Switch knob A to position 2. Open tap F, squeeze rubber bulb between thumb and index finger, and maintain pressure. Dough test piece will detach itself from plate. Close tap F and release bulb.

c. Inflate dough "patty." Switch knob A to position 3. Dough test piece starts to inflate and recording drum starts to revolve. As soon as dough bubble ruptures, turn knob A to position 1, which stops pump and recording drum. Return recording drum to original position.

3. Repeat operations described under steps a to c on four remaining dough pieces. Thus, five curves with same origin are obtained.

Interpretation

Results are measured or calculated from the five curves obtained. However, if one curve deviates greatly from other four, particularly because of premature rupture of bubble, it must not be taken into account in expression of results (Fig. 2). Measurements are:

1. Maximum overpressure, *P*. This is average of maximum ordinates, measured in mm and multiplied by 1.1. It is expressed to nearest unit (without decimal fraction of mm). It relates to resistance of dough to deformation.

2. Average abscissa at rupture, *L*. Abscissa at rupture of each curve is measured in mm on zero line, from origin of curve to point corresponding vertically

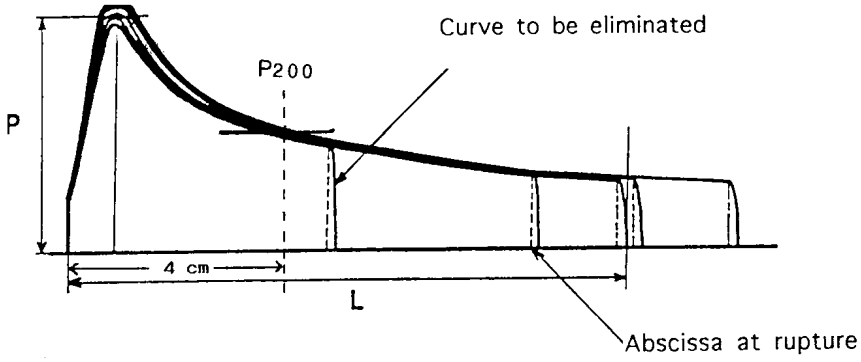

Fig. 2. Alveograph curves obtained from testing one sample of flour. The outlying curve was eliminated before *L* was calculated. *P* = average of maximum ordinates, *L* = average abscissa at rupture.

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with clear drop due to rupture of bubble. Average of abscissae at rupture points of curves, expressed to nearest unit (without decimal fraction of mm), represents length.

3. Index of swelling, *G*. This is average of swelling indices read from swelling scale of conversion scale (supplied with apparatus). Its value is square root of volume of air, expressed in ml, necessary to inflate bubble until it ruptures (not including volume of air necessary to detach dough test piece). Value is reported to nearest 0.5 unit.

4. Curve configuration ratio, *P*/*L*.

5. Deformation energy of dough, *W*. Average curve is drawn based on average of ordinates up to *L*. If curves are close to one another, visual estimate of position of average curve is sufficient. If curves are dispersed, average ordinates must be calculated for at least two points spread over abscissa between point of maximum overpressure *P* and average abscissa of rupture *L* (Fig. 2). Area under curve, *S*, in square centimeters, is measured with planimetric scale (supplied with apparatus) or with planimeter.

W, related to 1 g of dough and expressed in 10^{-4} J, is calculated as:

$$W = 1.32\left(\frac{V}{L}\right) \times S$$

where *V* = volume of air, in ml, equal to square of *G*, *L* = average abscissa at rupture, in mm, *S* = area under curve in cm^2. For flours with *G* between 12 and 26, use of simplified formula is advised (practical calculation):

$$W = 6.54 \times S$$

Coefficient 6.54 is valid only for a) drum rotation time of 55 sec from stop to stop and b) setting of airflow to 60 mm on manometer.

W is reported to nearest 5 units for flours with values of *W* less than 200 or to nearest 10 units for flours with values of *W* greater than 200.

The manometer is commonly replaced by a calculator, which supplies automatically, at the end of five tests, averages of *W*, *P*, *L*, and *P*/*L* values and five alveographic curves, using printer connected to the calculator.

6. Elasticity index, *P*200/*P*. *P*200 is measured after 200 ml of air is blown into dough, which corresponds to *P* value at 4 cm from origin of curve. Ratio *P*200/*P* relates to elasticity of the dough and has been useful in distinguishing cultivars of wheat with excess elasticity.

Notes

1. For satisfactory performance, routine maintenance of instrument is essential. For details, follow instruction manual.

2. Daily calibration is recommended (see *Calibration of alveograph*).

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Video: Alveograph Method for Soft and Hard Wheat Flour