Designation: C181 – 11

Standard Test Method for Workability Index of Fireclay and High-Alumina Refractory Plastics[1]

This standard is issued under the fixed designation C181; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the determination of the workability index of fireclay and high-alumina refractory plastics by measuring the plastic deformation of a molded test specimen when subjected to impacts.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D2906 Practice for Statements on Precision and Bias for Textiles (Withdrawn 2008)[3]

3. Significance and Use

3.1 Workability index serves as a measure of the facility with which refractory plastic materials can be rammed, gunned, or vibrated into place.

3.2 Workability index is commonly used to control consistency of plastics during manufacture. It has also been found useful for specification acceptance by the consumer.

3.3 The workability index determination can provide information for developing a plastic body. When a sample splits under impact at various water contents, it is an indication that the material is "short" or lacking in plasticity.

3.4 Determinations on samples that split during impact will be difficult to reproduce. If the sample splits, the measurement is not a true indication of deformation. This should be noted in the report.

4. Apparatus

4.1 *Rammer*—The apparatus shall consist of the device known as the sand rammer for refractories (see Fig. 1). It shall consist essentially of a steel cylindrical mold (specimen tube) 2.00 in. (50.8 mm) in inside diameter and 4.75 in. (120.6 mm) in length, supported in a vertical position on the same axis as a shaft to which shall be fastened a plunger that fits inside the mold. A 14-lb (6.4-kg) cylindrical weight slides on the same shaft and is arranged to fall a distance of 2 in. (51 mm) before engaging a collar fastened to the shaft. As shown in Fig. 1, the weight may be raised by a manually rotated cam. Provision shall be made by the equipment manufacturer to support the weight, thereby removing the load from the vertical shaft (example shown in Fig. 2). The sand rammer will include a linear scale capable of measuring sample height to 0.02 in. (0.5 mm) with a typical range of 1.7–2.5 in. (Note 1). The portion of the scale to be used shall be adjusted so that when the vertical shaft is measuring a 3.00 in. standard, 3.00 in. is read on the scale.

NOTE 1—The apparatus as described in this section is capable of measuring workabilities up to about 32 %. For products of higher workability a suitable spacer block may be installed under the specimen.

4.1.1 *Mounting for Rammer*—It is recommended the rammer be mounted on sand rammer base sold by the manufacturer or a concrete column to isolate the rammer from vibration variations. The rammer is to be secured onto the base or column using steel bolts. Variable results are obtained from the test unless the described mounting or an acceptable alternative mounting is used for the rammer. An acceptable mounting method is one that can be calibrated using the manufacturer's calibration rings described below in 4.1.2.

[1] This test method is under the jurisdiction of ASTM Committee C08 on Refractories and is the direct responsibility of Subcommittee C08.09 on Monolithics.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

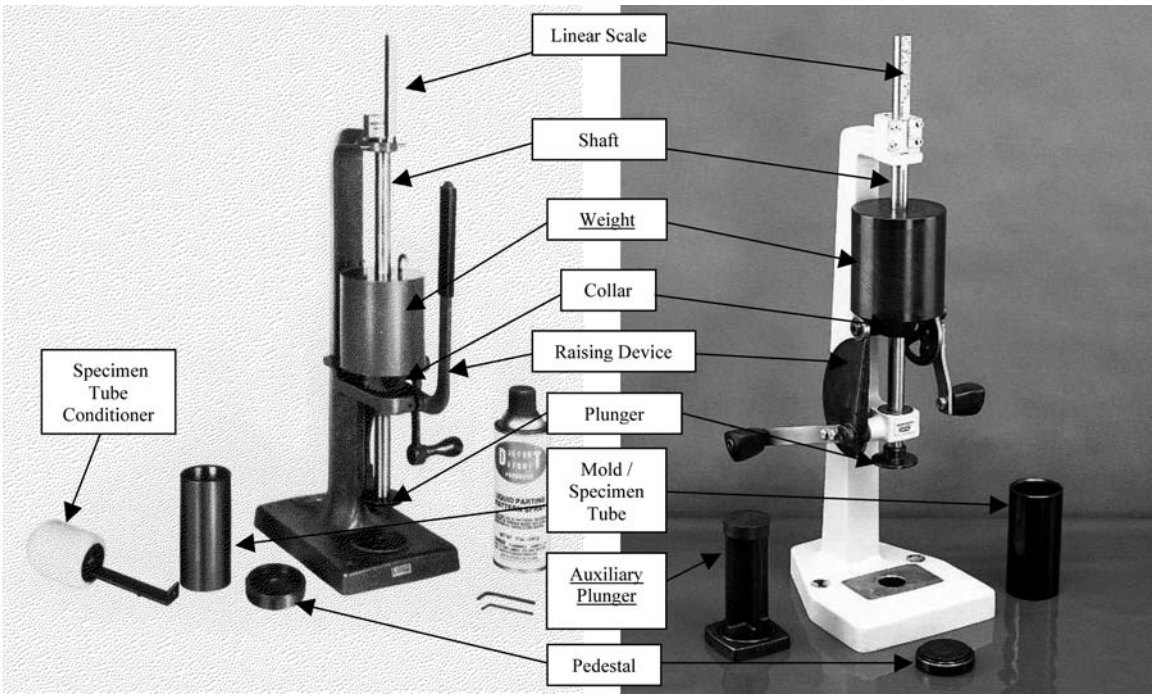

FIG. 1 Apparatus for Workability-Index Test

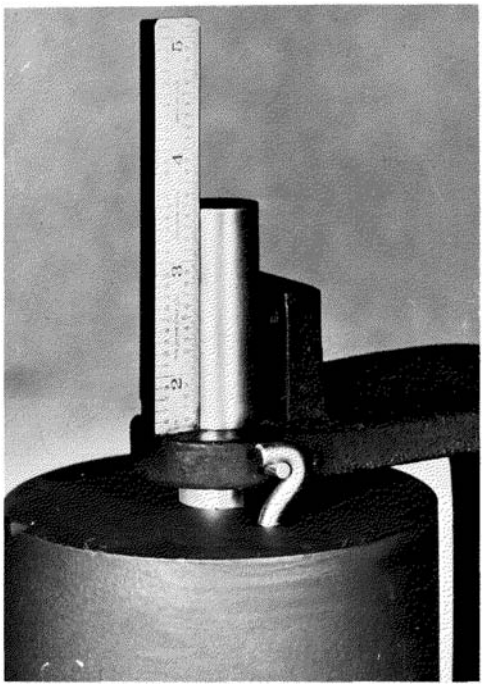

FIG. 2 Example of Provision to Suspend Weight

4.1.2 *Maintenance and Calibration*—As needed, depending on use, clean all moving parts and lubricate with SAE 10 oil. Make periodic checks of the height that the weight drops to insure the weight is being raised 2 in. (51 mm). Inspect the rammer to determine whether it and the foundation are producing full ramming energy. This is accomplished by using calibrated impact rings.[4] Inspect the specimen tube (Note 2).

NOTE 2—Variation in the smoothness and dimensions of the specimen tube may cause variation in workability values. For referee testing the specimen tube may require periodic comparison with a master precision specimen tube sold by manufacturer.

5. Test Specimens

5.1 *Temperature of Refractory Plastic*— Since the workability index may vary with a wide spread of temperature, the temperature of the material to be tested must be between 65 and 75°F (18 and 24°C) to reduce this variable. Record the temperature of material before forming the cylinder.

NOTE 3—As much as a 3-point change in the workability index may occur within the 10°F (6°C) stated range.

5.2 *Number of Specimens*—Five cylindrical test specimens shall be molded from the sample of refractory plastic.

5.3 *Molding of Specimens*—The interior of the mold shall be cleaned and coated with a light film of suitable parting agent prior to the preparation of each specimen. To facilitate filling the mold, the sample shall be broken into pieces varying in size, the largest dimension being about 1 in. (25 mm). The sample weight shall be chosen to provide a sample height of

[4] Manufacturer's calibration rings consist of a set of precision steel rings that deform within a specified range to determine full ramming energy; the anvil is positioned in the specimen tube locating hole in the base of the rammer. A test ring is then placed in the center of the anvil with the axis of the ring being horizontal. The ring is then subjected to 3 impacts of the rammer head. A measurement across the center of the deformed ring is then made and compared to the limits specified on the box containing the rings. Detailed instructions are included in the calibration kit.

2.5 ± 0.1 in. (64 ± 3 mm). For a super-duty plastic, the sample weight is approximately 300 g; for an 85 to 90 % alumina plastic, approximately 375 g. After placing the material in the mold, it shall be subjected to ten impacts by turning the handle, which causes the weight to be raised 2 in. (51 mm) and then dropped upon the collar attached to the plunger shaft. The mold containing the sample shall then be upended and an additional ten impacts given to the specimen. The formed test specimen shall then be extruded from the mold by the use of a suitable auxiliary plunger.

6. Procedure

6.1 Remove the load on the plunger of the mold by suspending the weight from the framework in accordance with the manufacturer's instruction. Typically this is done by slightly rotating the weight while engaging the hooks on the pins (Fig. 2) or engaging the screw head into the slot in the framework. Raise the vertical shaft using raising device (Fig. 1), place the test specimen on the bottom of the mold and lower the shaft until the plunger is in firm contact with the specimen. Obtain the length of the specimen to the nearest 0.02 in. (0.5 mm) by sighting on the rule and the end of the shaft. Disengage the weight from its support and carefully lower it until it is at rest in its normal position. Then apply three impacts from the weight to the test specimen. Read the final length of the specimen from the scale, and record the difference in inches or millimeters between the two measurements.

7. Calculation and Report

7.1 Calculate the percentage deformation for each of the five test specimens on the basis of the original length and report the average value as the workability index. The workability index shall be calculated by the following equation, and shall be rounded off to one decimal place.

$$W = \frac{L - L_1}{L} \times 100$$

where

L = length of specimen prior to deformation,
L_1 = length of specimen after deformation, and
W = workability index.

7.2 State the temperature of the sample, the specimen weight used, and whether any test specimen crumbled as a result of the three impacts.

8. Precision and Bias

8.1 *Interlaboratory Test Data*[5]—An interlaboratory test was run in 1975, in which two laboratories each tested ten specimens from each of two plastic materials: a super-duty and a high-alumina phosphate-bonded plastic. Samples were selected from the same container of plastic and tested in each laboratory at the same time. The components of variance for workability index results calculated by the procedures given in Practice D2906 are as follows:

Within-laboratory component 4.1 % of the average
Between-laboratory component 5.1 % of the average

8.2 *Precision*—For the components of variance given in 8.1, two averages of test values should be considered significantly different at the 95 % probability level if the difference equals or exceeds the critical difference listed as follows (for t = 1.96):

	Critical Difference, % of Grand Average of Workability Index	
Number of Samples in Each Average	Within-Laboratory Precision	Between-Laboratory Precision
3	6.6	15.6
5	5.1	15.0
10	3.6	14.6
15	2.9	14.3

8.3 *Bias*—No justifiable statement on bias is possible since the true value of the workability index cannot be established by an accepted reference material.

9. Keywords

9.1 refractories; refractory plastic; workability

[5] Supporting data are available from ASTM International Headquarters. Request RR: C8 – 1003.