Designation: C604 – 18 (Reapproved 2023)

Standard Test Method for True Specific Gravity of Refractory Materials by Gas-Comparison Pycnometer[1]

This standard is issued under the fixed designation C604; 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 true specific gravity of solid materials, and is particularly useful for materials that easily hydrate which are not suitable for test with Test Method C135. This test method may be used as an alternate for Test Methods C135, C128, and C188 for determining true specific gravity.

1.2 *Units*—The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.2.1 *Exception*—In 7.3, the equivalent SI unit is expressed in parentheses.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C128 Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate

C135 Test Method for True Specific Gravity of Refractory Materials by Water Immersion

C188 Test Method for Density of Hydraulic Cement

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Summary of Test Method

3.1 The sample is powdered to ensure permeation of gas into all pores. For practical purposes, this is assumed to be true when the sample passes a No. 325 (45 µm) U.S. sieve as specified in Specification E11. The volume of a carefully weighed powdered sample, which has first been heated to drive off moisture and undesired combined water, is measured by the gas-comparison pycnometer. Density is calculated from the sample weight in grams divided by its volume in cubic centimetres. This is also the specific gravity of the sample at room temperature compared to water at 4 °C.

3.2 The principle of the gas-comparison pycnometer is as follows: There are two chambers and two pistons as sketched in Fig. 1. For purposes of illustration, the chambers are assumed to be equal in volume, and there is no sample in either cylinder. Under these conditions, with the coupling valve closed, any change in the position of one piston must be duplicated by an identical stroke in the other in order to maintain the same pressure on each side of the differential pressure indicator.

3.3 If a sample, V_x, is inserted into chamber *B*, the coupling valve closed and both pistons advanced the same amount from position *1* to position *2*, the pressures will not remain the same. However, the pressures can be maintained equal if piston *B* instead is moved only to position *3*. Then the remaining displacement d_x, from position *3* to position *2*, is equal to the volume of the sample, V_x. If piston *A* always is advanced exactly the same distance each time a measurement is made, the distance that piston *B* differs from position *2*, when the pressures in both cylinders are equal, will always be proportional to the volume, V_x. The distance (d_x) between positions *2* and *3* can be calibrated and made to read directly in terms of cubic centimetres, employing a digital counter.

4. Significance and Use

4.1 The true specific gravity of a material is the ratio of its true density, determined at a specific temperature, to the true

[1] This test method is under the jurisdiction of ASTM Committee C08 on Refractories and is the direct responsibility of Subcommittee C08.03 on Physical Properties.

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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.

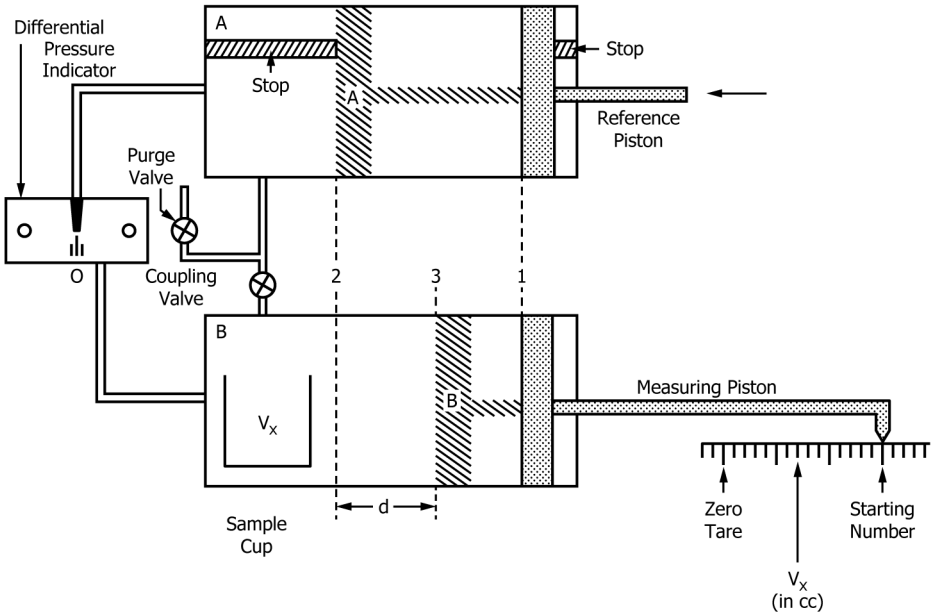

FIG. 1 Simplified Schematic Diagram

density of water, determined at a specific temperature. Thus, the true specific gravity of a material is a primary property which is related to chemical and mineralogical composition.

4.2 This test method is particularly useful for hydratable materials that are not suitable for test with Test Method C135.

4.3 For refractory raw materials and products, the true specific gravity is a useful value for: classification, detecting differences in chemical composition between supposedly like samples, indicating mineralogical phases or phase changes, calculating total porosity when the bulk density is known, and for any other test method that requires this value for the calculation of results.

4.4 This test method is a primary standard method which is suitable for use in specifications, quality control, and research and development. It can also serve as a referee test method in purchasing contracts or agreements.

4.5 Fundamental assumptions inherent in this test method are the following:

4.5.1 The sample is representative of the material in general,

4.5.2 The total sample has been reduced to the particle size specified,

4.5.3 No contamination has been introduced during processing of the sample,

4.5.4 The ignition of the sample has eliminated all free or combined water without inducing sintering or alteration,

4.5.5 An inert gas (helium) has been used in the test, and

4.5.6 The test method has been conducted in a meticulous manner.

4.5.7 Deviation from any of these assumptions negates the usefulness of the results.

4.6 In interpreting the results of this test method, it must be recognized that the specified sample particle size is significantly finer than specified for Test Method C135. Even this finer particle size for the sample does not preclude the presence of some closed pores, and the amount of residual closed pores may vary between materials or even between samples of the same or like materials. The values generated by this test method may, therefore, be very close approximations rather than accurate representations of true specific gravities. Thus, comparisons of results should only be judiciously made between like materials tested by this test method or with full recognition of potentially inherent differences between the materials being compared or the test method used.

5. Apparatus

5.1 *Analytical Balance,* 200 g capacity, minimum sensitivity 10 mg.

5.2 *Desiccator,* charged with magnesium perchlorate.

5.3 *Muffle Furnace,* capable of heating to 1000 °C.

5.4 *Cylinder of Dry Helium Gas,* with regulator and gauge.

5.5 *Equipment for Grinding Sample,* to pass a No. 325 (45 µm) sieve without contamination.

5.6 *Gas-Comparison Pycnometer,* equipped with external purge manifold.

6. Sample Preparation

6.1 Grind a sufficient representative sample for three determinations to pass a No. 325 (45 µm) sieve. Using a gas-comparison pycnometer, the quantity needed is approximately 150 cm^3.

6.2 After grinding, ignite the total sample at a temperature sufficient to drive off free moisture and any undesired combined water, organic matter, etc., without inducing sintering of the powder. In the case of refractory materials that hydrate, the ignition temperature is a minimum of 600 °C for 3 h.

6.3 After ignition, place the powdered sample in a desiccator charged with magnesium perchlorate and allow to cool to room temperature.