



Designation: **D5228 – 92 (Reapproved 2015) D5228 – 16**

Standard Test Method for Determination of Butane Working Capacity of Activated Carbon¹

This standard is issued under the fixed designation D5228; 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 butane working capacity (BWC) of new granular activated carbon. The BWC is defined as the difference between the butane adsorbed at saturation and the butane retained per unit volume of carbon after a specified purge. The test method also produces a butane activity value that is defined as the total amount of butane adsorbed on the carbon sample and is expressed as a mass of butane per unit weight or volume of carbon.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this 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.* For a specific hazard statement, see 7.1.

2. Referenced Documents

2.1 *ASTM Standards:*²

[D2652 Terminology Relating to Activated Carbon](#)

[D2854 Test Method for Apparent Density of Activated Carbon](#)

[D2867 Test Methods for Moisture in Activated Carbon](#)

[D3195 Practice for Rotameter Calibration](#)

[E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods](#)

[E300 Practice for Sampling Industrial Chemicals](#)

[E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method](#)

3. Terminology

3.1 *Definitions*— For definitions of terms used in this test method, refer to Terminology [D2652](#).

4. Summary of Test Method

4.1 An activated carbon bed of known volume and mass is saturated with butane vapor. The mass adsorbed at saturation is noted. The carbon bed is then purged under prescribed conditions with dry hydrocarbon free air. The loss of mass is the BWC and is expressed as mass of butane per unit volume of carbon.

5. Significance and Use

5.1 The BWC, as determined by this test method, is a measure of the ability of an activated carbon to adsorb and desorb butane from dry air under specified conditions. It is useful for quality control and evaluation of granular activated carbons that are used in applications where the adsorption of butane and desorption with dry air are of interest. The BWC can also provide a relative measure of the effectiveness of the tested activated carbons on other adsorbates.

5.2 The butane activity and retentivity can also be determined under the conditions of the test. The butane activity is an indication of the micropore volume of the activated carbon sample. The butane retentivity is an indication of the pore structure of the activated carbon sample.

¹ This test method is under the jurisdiction of ASTM Committee [D28](#) on Activated Carbon and is the direct responsibility of Subcommittee [D28.04](#) on Gas Phase Evaluation Tests.

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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.

6. Apparatus

6.1 *Water Bath*, capable of maintaining a temperature of $25 \pm 0.2^\circ\text{C}$ and of sufficient depth so the entire carbon bed in the sample tube is immersed in the water. A 6-mm OD copper tube with an immersed length of 1.9 m (Fig. 1) provides adequate heat transfer for gas temperature control.

6.2 *Sample Tube*, as shown in Fig. 2. The glass plate with holes is preferred to a fritted disk to support the carbon, since fritted disks can vary widely in pressure drop.

6.3 *Flow Meters*, one capable of delivering air at 0 to 500 mL/min, and one capable of delivering butane at 0 to 500 mL/min, both calibrated in accordance with Practice D3195.

6.4 *Balance*, capable of weighing to within ± 0.01 g.

6.5 *Fill Device*—The vibration feed device used in Test Method D2854, Figs. 1 through 4, is preferred.

6.6 *Buret*, Class A, 25 mL capacity.

6.7 *Apparatus Assembly* shown in Fig. 1.

7. Reagents

7.1 *n-Butane*, C. P. Grade. (**Warning**—Butane is a flammable gas with a flash point of -138°C and a boiling point of 0.5°C . Its specific gravity is 2.046 relative to air. Butane may be narcotic in high concentrations and is considered a simple asphyxiant. If the entire apparatus is not set up in a fume hood, provision must be made to vent the gas coming from the discharge stem of the sample tube.)

7.2 *Dry Air*, free of organics, with a dew point no higher than -32°C .

8. Sampling

8.1 For guidance in sampling granular activated carbon, refer to Practice E300.

9. Calibration of a Sample Tube

9.1 Clean and dry the sample tube to prevent any water droplets from adhering to the inner surface of the tube.

9.2 Using distilled water, carefully fill the sample tube through the narrow side stem to prevent the introduction of any air bubbles.

9.2.1 Hold the sample tube upright while slowly introducing the distilled water. Air bubbles have a tendency to form directly below the retainer plate of the tube.

9.3 Clamp the filled sample tube in an upright position to a ring stand and stopper the narrow side stem.

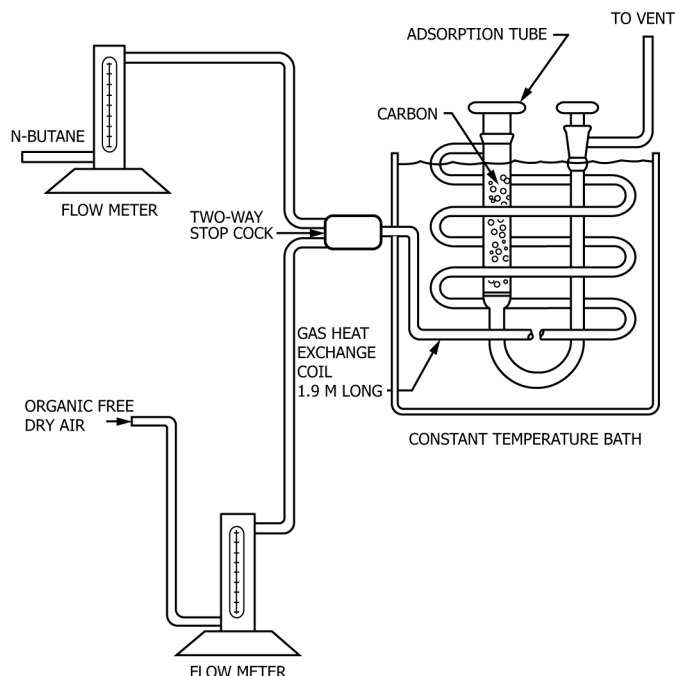
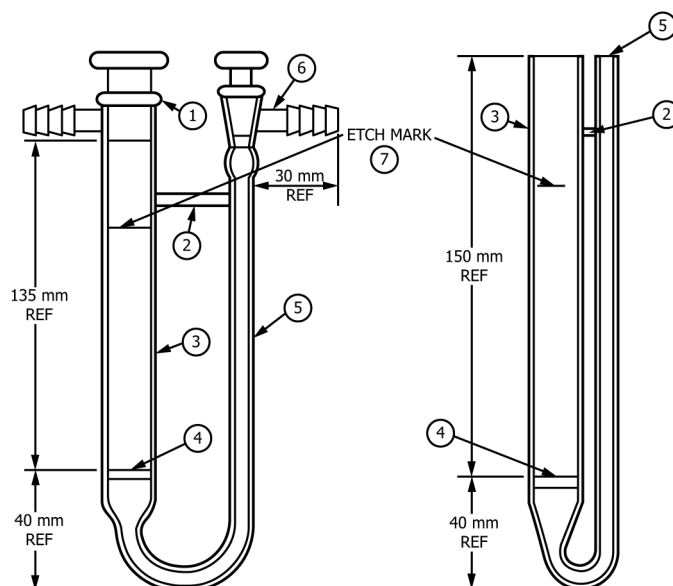


FIG. 1 Butane Working Capacity Apparatus Schematic



- 1— Ground glass stopper, hollow, medium length, 14/20, from Kontes Catalog No. K-89100 Schwartz adsorption tube, or equivalent.
- 2— 5-mm rod, brace.
- 3— 17-mm O.D. × 1.2 mm standard wall tubing.
- 4— Coor's perforated porcelain disk or extra coarse fritted disk, or equivalent.
- 5— 10-mm O.D. × 1.0 mm standard wall tubing.
- 6— Right angle stopcock, Kontes Catalog No. K-84700, size 4, 10 mm O.D. stem, with Kontes Catalog No. K-89340 size B serrated hose connector, or equivalent.
- 7— Dimension corresponding to a volume of 16.7 mL above the retainer plate.

FIG. 2 Butane Working Capacity Sample Tube

9.4 Using a pipet, carefully remove the water from the sample tube to the top of the retainer plate. Caution must be taken so no water is removed from below the retainer plate creating air bubbles that would result in a spurious calibration of the sample tube. If this occurs, the tube must be refilled by repeating 9.1 through 9.3.

9.5 Using the buret, fill the sample tube with 16.7 ± 0.05 mL of water, then etch the tube at the level of the meniscus.

10. Maintenance of Bath Water

10.1 In order to prevent mold formation, the bath water should be changed periodically.

11. Procedure

11.1 Dry an adequate sample as prescribed in Test Methods D2867, Section 4.

11.2 Determine the apparent density in accordance with Test Method D2854 and record.

11.3 Accurately weigh the empty, dry sample tube and stoppers to the nearest 0.01 g and record.

11.4 Fill the adsorption tube with carbon to the etch mark at a rate of 0.35 to 1.0 mL/s using the vibrating feeder apparatus described in Test Method D2854 with a funnel modified to accommodate the adsorption tube. Larger particles will require the slower fill rate to achieve the required packing density.

11.5 Weigh the filled sample tube and stoppers to the nearest 0.01 g and record.

11.5.1 The sample packing density, carbon weight/16.7, must be equal to at least 94 % of its dry apparent density if the result of the determination is to be reproducible. Otherwise, the ratio of purge air volume to sample volume will vary, and the quantity of butane purged will also vary from one determination to the next. If the specified packing density is not achieved in the first attempt, the filling procedure must be repeated until the tube is packed to the required density. If after several attempts the desired packing density cannot be achieved, the percentage should be noted and the procedure continued.

11.6 Set the water bath control to maintain a temperature of $25 \pm 0.2^\circ\text{C}$.

11.7 Clamp the sample tube in a vertical position in the $25 \pm 0.2^\circ\text{C}$ water bath and attach the tube to the output of the flow meter. If the entire apparatus is not in a hood, attach a short length of tubing from the effluent side of the sample tube to an exhaust vent.

11.8 Regulate the flow to pass butane through the carbon bed at 250 ± 5 mL/min. Continue the flow of butane for at least 900 s.