Designation: D6646 – 03 (Reapproved 2022)

Standard Test Method for Determination of the Accelerated Hydrogen Sulfide Breakthrough Capacity of Granular and Pelletized Activated Carbon[1]

This standard is issued under the fixed designation D6646; 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 is intended to evaluate the performance of virgin, newly impregnated or in-service, granular or pelletized activated carbon for the removal of hydrogen sulfide from an air stream, under the laboratory test conditions described herein. A humidified air stream containing 1 % (by volume) hydrogen sulfide is passed through a carbon bed until 50 ppm breakthrough of H_2S is observed. The H_2S adsorption capacity of the carbon per unit volume at 99.5 % removal efficiency (g H_2S/cm^3 carbon) is then calculated. This test is not necessarily applicable to non-carbon adsorptive materials.

1.2 This standard as written is applicable only to granular and pelletized activated carbons with mean particle diameters (MPD) less than 2.5 mm. See paragraph 5.3 if activated carbons with larger MPDs are to be tested.

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]

D2652 Terminology Relating to Activated Carbon

D2854 Test Method for Apparent Density of Activated Carbon

D2867 Test Methods for Moisture in Activated Carbon

E300 Practice for Sampling Industrial Chemicals

3. Terminology

3.1 Terms relating to this standard are defined in D2652.

4. Summary of Test Method

4.1 Breakthrough capacity is determined by passing a stream of humidified air containing 1 volume % hydrogen sulfide through a sample of granular or pelletized activated carbon of known volume under specified conditions until the concentration of hydrogen sulfide in the effluent gas reaches 50 ppmv.

5. Significance and Use

5.1 This method compares the performance of granular or pelletized activated carbons used in odor control applications, such as sewage treatment plants, pump stations, etc. The method determines the relative breakthrough performance of activated carbon for removing hydrogen sulfide from a humidified gas stream. Other organic contaminants present in field operations may affect the H_2S breakthrough capacity of the carbon; these are not addressed by this test. This test does not simulate actual conditions encountered in an odor control application, and is therefore meant only to compare the hydrogen sulfide breakthrough capacities of different carbons under the conditions of the laboratory test.

5.2 This test does not duplicate conditions that an adsorber would encounter in practical service. The mass transfer zone in the 23 cm column used in this test is proportionally much larger than that in the typical bed used in industrial applications. This difference favors a carbon that functions more rapidly for removal of H_2S over a carbon with slower kinetics. Also, the 1 % H_2S challenge gas concentration used here engenders a significant temperature rise in the carbon bed. This effect may also differentiate between carbons in a way that is not reflected in the conditions of practical service.

5.3 This standard as written is applicable only to granular and pelletized activated carbons with mean particle diameters

[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.

less than 2.5 mm. Application of this standard to activated carbons with mean particle diameters (MPD) greater than 2.5 mm will require a larger diameter adsorption column. The ratio of column inside diameter to MPD should be greater than 10 in order to avoid wall effects. In these cases it is suggested that bed superficial velocity and contact time be held invariant at the conditions specified in this standard (4.77 cm/s and 4.8 s). Although not covered by this standard, data obtained from these tests may be reported as in paragraph 12 along with additional information about column diameter, volume of carbon, and volumetric flow rate used.

5.4 For pelletized carbons, it is felt that the equivalent spherical diameter of the pellet is the most suitable parameter for determining the appropriate adsorption column inside diameter. The equivalent spherical diameter is calculated according to the following equation.

$$D_{eqv} = \frac{3\,X\,d\,X\,h}{d+2\,X\,h} \quad (1)$$

where:

d = the diameter, and
h = the length of the pellet in mm.

An average of 50 to 100 measurements is recommended to determine the average length of a pellet. Annex A3 is a table to guide the user in selecting bed diameter and flow rates from typical equivalent diameters (or MPD) of pelletized carbon.

6. Apparatus and Materials

6.1 *(5±1) % Hydrogen Sulfide in Nitrogen Mixture*—The concentration of hydrogen sulfide in the gas test mixture must be known. It is recommended that gas cylinders specifically manufactured for holding hydrogen sulfide gas be used. Analyzed and certified hydrogen sulfide in nitrogen gas mixtures can be purchased from specialty gas suppliers. Annex A1 and Annex A2 present methods that may be used to check the hydrogen sulfide concentration of hydrogen sulfide/nitrogen gas mixtures. It is recommended that the hydrogen sulfide concentration be checked if gas cylinders are stored for more than three months, particularly after being partially depleted. Other organic contaminants that may be present in the hydrogen sulfide tank can affect the adsorption capacity of the carbon being tested.

6.2 *Hydrogen Sulfide Detector*—The hydrogen sulfide detector used in this test must be demonstrated to reliably detect 50 ppm hydrogen sulfide in a humidified air stream. In addition to certain "solid state" detectors, electrochemical type hydrogen sulfide sensors, for example, Ecolyzer Model 6400 or Interscan LD-17, have been evaluated and fit this requirement. Other means of hydrogen sulfide detection may be selected, as long as they are carefully calibrated and evaluated for this application.

6.3 *Adsorption Tube*—The adsorption tube is shown in Fig. 1. Adsorption tubes are not commercially available; however, they can be custom fabricated by a scientific glassblower. The perforated support shown is necessary to support the carbon bed and to enhance diffusion of the gases. (Adjust dimensions accordingly from Annex A3, specifically diameter.)

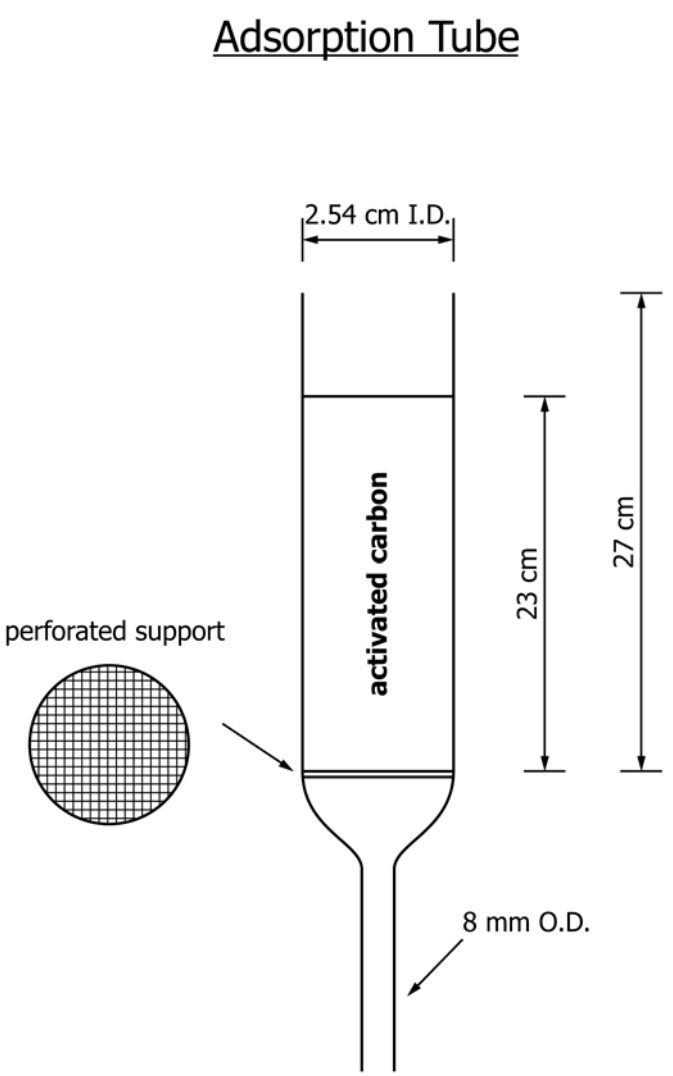

FIG. 1 Schematic of Adsorption Tube

6.4 *Flowmeter (0-500 mL/min Nitrogen; see Annex A3 for Guide to Higher Flow Range for Particles > 2.5 mm MPD)*—For hydrogen sulfide/N_2 control, it is recommended that the wettable parts of this flow meter be made of PTFE or other corrosion resistant material. Rotameter floats should be made from non-metallic materials such as glass or sapphire.

6.5 *Flowmeter (0-2000 mL/min Air; see Annex A3 for Guide to Higher Flow Range for Particles > 2.5 mm MPD)*—

NOTE 1—Mass flow controllers have been found to be more reliable than flowmeters and are highly recommended due to their ability to automatically maintain precise gas flow rates. Rotameters are satisfactory for this method, but may require more frequent attention in maintaining proper test gas flows for the duration of the test.

6.6 *Two Stage Cylinder Regulator, Suitable for Corrosive Gas Service, for Hydrogen Sulfide Gas Cylinder.*

6.7 *Air Line Pressure Regulator—Low Pressure*—To maintain up to 10 psig pressure for up to 2 liters of air/min flow rate (see Annex A3 for guide to airflow for tubes used for particles >2.5 mm MPD)