Designation: D 2780 – 92 (Reapproved 2007)

An American National Standard

Standard Test Method for Solubility of Fixed Gases in Liquids[1]

This standard is issued under the fixed designation D 2780; 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 solubility of fixed gases in liquids. It is suitable for gases and liquids that do not react with each other and are compatible with borosilicate glass, mercury, stainless steel, PTFE (polytetrafluoroethylene), and FPM (vinylidene fluoride-hexafluoro propylene copolymer) under the conditions of the test. This test method also covers the determination of the concentration of fixed gases in solutions which are not saturated with the gas.

1.2 *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 specific hazard statements see 6.1, 6.2, 8.3, 8.4.2, and 9.3.

1.3 The values stated in SI units are to be regarded as the standard. The values in parentheses are for information only.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 831 Test Method for Gas Content of Cable and Capacitor Oils

D 2883 Test Method for Reaction Threshold Temperature of Liquid and Solid Materials

D 4057 Practice for Manual Sampling of Petroleum and Petroleum Products

E 260 Practice for Packed Column Gas Chromatography

3. Summary of Test Method

3.1 A specimen of the test liquid is saturated with a fixed gas under specified conditions of temperature and pressure. The saturation step may be eliminated if it is desired to determine the concentration of fixed gas in a liquid sample suitably presented for analysis. A portion of the solution of gas in liquid is transferred to a gas extraction apparatus in which the fixed gas is quantitatively removed from the liquid. The separated gas is transferred to a gas buret in which its volume is determined.

4. Significance and Use

4.1 The solubility of fixed gases in liquids is an important engineering parameter in the design of hydraulic systems. It is a measure of the amount of gas which can be released from solution when a system undergoes changes in pressure and temperature. Theoretical considerations permit approximate values of gas solubility to be computed with reasonable accuracy. In this test method, dissolved gases are separated physically from a liquid and measured volumetrically. The test method permits subsequent analysis of separated gases by any appropriate method.

5. Apparatus

5.1 *Ambient Pressure Saturator*, suitable for the saturation of liquids with fixed gases at various temperatures at ambient pressure is shown in Fig. 1. The system comprises four parts:

5.1.1 *Gas Supply and Pressure Regulator*,

5.1.2 *Gas Dispersion Element*,

5.1.3 *Heating Mantle*, to fit 1000-mL separatory funnel (Fig. 1), and

5.1.4 *Temperature Measurement and Control Devices*.

NOTE 1—In the event that it is desired to saturate a liquid with a toxic or flammable gas, the use of this system is not recommended, unless suitable means are provided for the collection and disposal of the escaping gas.

5.2 *Elevated Pressure Saturator*, used to saturate liquids with gases at pressures other than ambient. A suitable vessel, usable at pressures up to 608 kPa (6 atm), is illustrated in Fig. 2. The vessel consists of a 2.5 L stainless steel bomb with a thermostatic control jacket. A valve at one end is connected to a pressure gage and gas supply. A valve at the other end is provided with a fitting that connects directly to the gas extraction apparatus.

5.2.1 *Thermostatic Control*, for jacket of saturator.

5.2.2 *Shaker*, reciprocating, horizontal.

5.2.3 *Vacuum Pump*, rotary.

[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.11 on Engineering Sciences of High Performance Fluids and Solids.

Current edition approved May 1, 2007. Published June 2007. Originally approved in 1969. Last previous edition approved in 2002 as D 2780 – 92 (2002)$^{\epsilon 1}$.

[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.

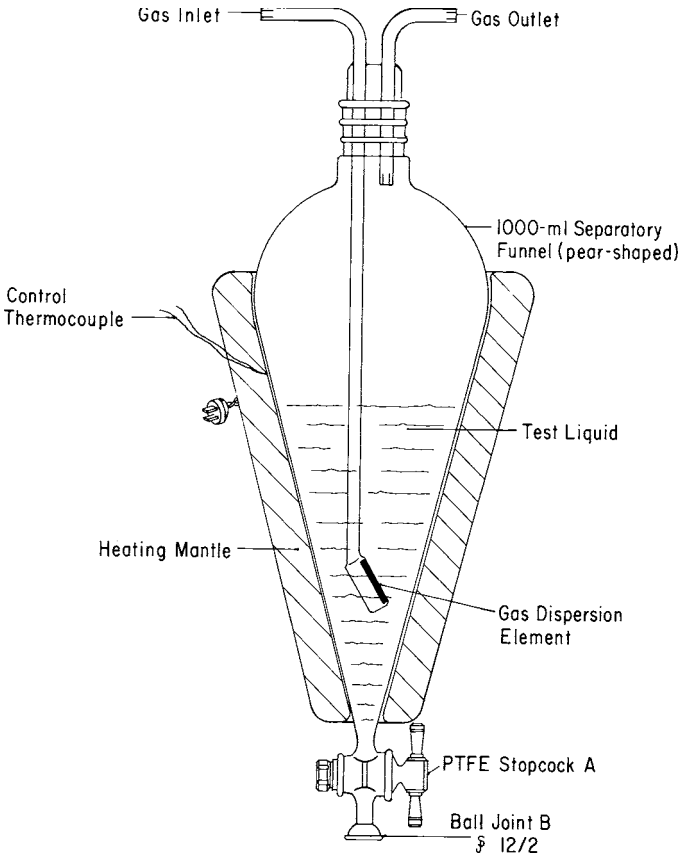

FIG. 1 Ambient Pressure Saturator

5.2.4 *Transfer Line*, with two male socket joint 12/2 fittings.

5.3 *Gas Extraction System*, [3] as shown schematically in Fig. 3. A detailed drawing of the extraction chamber is shown in Fig. 4. The apparatus provides for the separation of dissolved gases from a liquid by repeatedly forcing the liquid containing gas to pass through a narrow annular passage under reduced pressure. Gas removed in this manner is stored and measured in a gas buret. Provision is made for heating the extraction chamber by means of a condensing vapor bath. The gas buret is jacketed. Cooling water may be circulated through the jacket if it is necessary to reduce the temperature of the contents of the buret. A manometer is attached to the manifold connecting the saturation system, gas extractor, and gas buret. Grease-free stopcocks and ball joints are used throughout the system (Note 2). All tubing and connections are 1 mm inside diameter.

NOTE 2—PTFE stopcocks are satisfactory for most purposes. However, for greatest precision construct the apparatus with stopcocks and joints which are fitted with O-ring seals.

6. Reagents and Materials

6.1 *Mercury*, triple-distilled, instrument-grade, sufficient amount to fill extraction apparatus, gas buret, and leveling bulbs. (**Warning**—Poison can be harmful if inhaled or swallowed. Vapor harmful, emits toxic fumes when heated. Vapor pressure at normal room temperature exceeds threshold limit value for occupational exposure. See A1.1.)

6.2 *Compressed Gases*, as required for saturating liquids to be studied. (**Warning**—Compressed gas under high pressure. Gas reduces oxygen available for breathing. See A1.2.)

7. Sampling

7.1 To obtain specimens for total gas solubility measurements, collect samples in accordance with Practice D 4057. For the determination of the concentration of fixed gases in solutions which are not saturated with the gas, take samples in accordance with the procedure described in Section 3 of Test Method D 831.

8. Procedure A

8.1 Procedure A covers the determination of the solubility of fixed gases in liquids at ambient pressure.

8.2 Add to the ambient pressure saturator (Fig. 1) a sufficient amount of the liquid to cover the gas dispersion element with at least 50 to 80 mm of liquid. Bring the cell to temperature equilibrium at whatever temperature is desired for the determination.

8.3 Saturate the liquid with the test gas (**Warning**—See 6.2) by bubbling the gas through the liquid. Adjust the gas flow rate so that the gas stream causes thorough but not violent agitation of the liquid. If saturation is to be carried out at an elevated temperature, it may be necessary to reestablish temperature equilibrium after the start of gas flow. (**Warning**—Be certain

[3] The gas extraction system is similar to that described by J. H. D. Hooper, API *Proceedings*, 1948.