



Designation: D3609 – 22

Standard Practice for Calibration Techniques Using Permeation Tubes¹

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1. Scope

1.1 This practice describes a means for using permeation tubes for dynamically calibrating instruments, analyzers, and analytical procedures used in measuring concentrations of gases or vapors in atmospheres (1, 2).²

1.2 Typical materials that may be sealed in permeation tubes include: sulfur dioxide, nitrogen dioxide, hydrogen sulfide, chlorine, ammonia, propane, and butane (1).

1.3 The values stated in SI units are to be regarded as standard.

1.4 *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.*

1.5 *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:*³

D1356 Terminology Relating to Sampling and Analysis of Atmospheres

D3195 Practice for Rotameter Calibration

E1 Specification for ASTM Liquid-in-Glass Thermometers

E2251 Specification for Liquid-in-Glass ASTM Thermometers with Low-Hazard Precision Liquids

3. Terminology

3.1 *Definitions*—Refer to Terminology D1356.

¹ This practice is under the jurisdiction of ASTM Committee D22 on Air Quality and is the direct responsibility of Subcommittee D22.01 on Quality Control.

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² The boldface numbers in parentheses refer to a list of references at the end of this standard.

³ 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.

4. Summary of Practice

4.1 A liquefiable gas, when enclosed in an inert plastic tube, escapes by permeating the tubing wall at a constant, reproducible, temperature-dependent rate.

4.2 Permeation tubes are calibrated gravimetrically, with the weight loss of the tube equated to the weight of the escaping material.

4.3 Permeation tubes are held at constant temperature in a carrier-gas stream of dry air or nitrogen to produce a gas concentration dependent on the permeation rate and the flow of the carrier gas.

5. Significance and Use

5.1 Most analytical methods used in air pollutant measurements are comparative in nature and require calibration or standardization, or both, often with known blends of the gas of interest. Since many of the important air pollutants are reactive and unstable, it is difficult to store them as standard mixtures of known concentration for extended calibration purposes. An alternative is to prepare dynamically standard blends as required. This procedure is simplified if a constant source of the gas of interest can be provided. Permeation tubes provide this constant source, if properly calibrated and if maintained at constant temperature. Permeation tubes have been specified as reference calibration sources, for certain analytical procedures, by the Environmental Protection Agency (3).

6. Interferences and Precautions

6.1 Permeation tubes are essentially devices to provide a constant rate of emission of a specific gaseous substance over period of time. They consist of a two-phase (gas-liquid) system to maintain a constant vapor pressure (at constant temperature) which is the driving force for emission of the gas through a semipermeable membrane (tube walls). They can be expected to maintain a constant emission rate that is temperature dependent as long as a significant amount of liquid is present in the device. The liquid shall be pure, else its composition may change during the life time of the tube, due to differential evaporation, with consequent vapor pressure changes. Care must also be exercised that the diffusion membrane (tube walls) is not damaged or altered during use. The contents of permeation tubes are under relatively high pressure. Accordingly, there is the possibility of violent rupture of tube