



Designation: E 126 – 05

Standard Test Method for Inspection and Verification of Hydrometers¹

This standard is issued under the fixed designation E 126; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This test method describes the principles, apparatus, and procedures for the inspection and verification of glass hydrometers of the constant-mass, variable-displacement type. It is intended to apply to ASTM hydrometers as well as to glass hydrometers in general.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard. The metric equivalents of inch-pound units may be approximate.

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.*

2. Referenced Documents

2.1 *ASTM Standards:*²

D 1265 Practice for Sampling Liquefied Petroleum (LP) Gases—Manual Method

E 77 Test Method for Inspection and Verification of Thermometers

E 344 Terminology Relating to Thermometry and Hydrometry

3. Terminology

3.1 *Definitions:*

3.1.1 The definitions given in Terminology **E 344** apply.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *API gravity, n*—gravity obtained from the following relationship:

$$\text{API Gravity, deg} = 141.5/(\text{sp gr } 60/60^\circ\text{F}) - 131.5 \quad (1)$$

3.2.2 *density, n*—mass of a unit volume of material.

3.2.3 *specific gravity, n*—ratio of the mass of a given volume of material at a stated temperature to the mass of an equal volume of gas-free distilled water at a stated temperature, expressed by

$$\text{Specific Gravity } x/x_F \text{ (or } y/y_C) \quad (2)$$

where x is usually 60° and y is usually 15.56°C .

3.2.4 *thermo-hydrometer, n*—glass hydrometer having a thermometer combined with a hydrometer in one instrument.

3.2.5 Other descriptions of terms relating to thermometers are included in Test Method **E 77**.

4. Significance and Use

4.1 The purpose of this test method is to establish a common method by which manufacturers and users of hydrometers may make tests to establish the validity of their readings in use or as a standard for comparison of hydrometer performance for evaluation or selection purposes, or both.

4.2 The goal is to provide a standard method that is simple, easily understood, and which can be performed by the end user in the hope that it will result in a better understanding of hydrometers.

5. Apparatus

5.1 *Graduated Metal Scales*, of the conventional type, for checking linear dimensions. If more convenient, metal templates may be used on which lines are ruled at suitable distances from reference points corresponding to the maximum and minimum values of the specified dimensions.

5.2 *Micrometers*, of the conventional type, for checking diameters.

5.3 *Comparators*, for the verification of hydrometers. Suitable types are described in **Appendix X1**.

5.4 *Equipment* for checking the thermometers of thermo-hydrometers is described in Test Method **E 77**.

6. Reference Standards

6.1 *Primary Standard Hydrometers*—Primary standard hydrometers should have similar dimensions and shape to the instruments to be tested, but more finely subdivided. For example, if the instruments to be tested are subdivided to

¹ This test method is under the jurisdiction of ASTM Committee E20 on Temperature Measurement and is the direct responsibility of Subcommittee E20.05 on Liquid-in-Glass Thermometers and Hydrometers.

Current edition approved June 15, 2005. Published June 2005. Originally approved in 1959. Last previous edition approved in 1998 as E 126 – 92 (1998).

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.

0.0005 sp gr, the primary standards would have graduations of 0.0002 or 0.0001 sp gr. Primary standards must be calibrated by a laboratory (such as the National Institute of Standards and Technology) capable of testing instruments of such precision. Corrections must be stated to one tenth of a scale division. Primary standards should be reverified at regular intervals.

NOTE 1—The specific gravities of liquids used in testing hydrometers may be obtained by hydrostatic weighing instead of by the use of primary standards as described above. Details of the hydrostatic weighing apparatus can be found in the *Dictionary of Applied Physics*³ or *Density of Solids and Liquids*.⁴

6.2 *Secondary Standard Hydrometers*—Secondary standard hydrometers are more suitable and have adequate sensitivity for most work. These standards should have similar dimensions and shape to the instruments to be verified, and should have the same graduation interval. Thus, one standard may be used to check the entire range of the instrument to be tested. Secondary standards shall be verified against primary standards by a laboratory competent to conduct such tests, with corrections stated to one-tenth scale division. Reverification should be done at regular intervals.

7. Procedure

7.1 Dimensional Inspection:

7.1.1 Check the lineal dimensions and diameters by comparing the hydrometer with the appropriate device described in 5.1 and 5.2.

7.1.2 Inspect the hydrometers for correctness of graduation spacing. API and Baumé hydrometers are graduated with equal spacing. The interval between graduations of density and specific gravity hydrometers is smaller near the bottom of the scale. The proper spacing can be obtained from the following formula:

$$l = L \times d_2/d \times (d - d_1)/(d_2 - d_1) \quad (3)$$

where:

l = distance from the top line to any line, d , between the top and the bottom,

L = distance between the top and the bottom graduations of the scale,

d_2 = density, or specific gravity, of the bottom line, and

d_1 = density, or specific gravity, of the top line.

7.1.3 Check the scale of alcoholometers graduated to read percent of alcohol by weight or by volume by comparison with the values for master scales given in the *Standard Density and Volumetric Tables*.⁵

7.2 Verification:

7.2.1 *General Considerations*—The details of procedure described in the following paragraphs are, in general, the ones employed at the National Institute of Standards and Technology in calibrating hydrometers, and it will be helpful to follow them to such extent as the need for accuracy requires.

7.2.1.1 In order that readings shall be uniform and reproducible, the hydrometer must be clean, dry, and at the temperature of the liquid before immersing to take a reading. It is particularly important that the stem be clean so that the liquid will rise uniformly around the stem and merge into an imperceptible film on the stem.

7.2.1.2 *Cleanliness*—The readiness with which proper cleanliness can be obtained depends somewhat on the character of the liquid. Certain liquids, such as mineral oils and strong alcoholic mixtures, adhere to the stem very readily. In such cases, wiping with a lint-free cloth moistened with acetone or alcohol and drying immediately before each reading is usually sufficient. On the other hand, with weak aqueous solutions of sugar, salts, acids, and alcohol, scrupulous cleaning of the stem is required. For such liquids, two methods for preparing instruments for testing are in common use. In one method, hydrometers are dipped in a mixture of one part concentrated sulfuric acid and two parts fuming sulfuric acid, thoroughly rinsed with water, and dried by wiping with a clean cloth. In the other method, hydrometers are washed with soap and water, dried, and wiped with a cloth moistened with alcohol to remove any residual soap film. The stems can usually be kept clean during the testing by wiping with a lint-free cloth moistened with alcohol (preferably absolute) and drying before each reading.

7.2.1.3 *Influence of Temperature*—In order that a hydrometer may correctly indicate the density or strength of a specified liquid, it is essential that the liquid be uniform throughout and at the temperature specified on the instrument. In comparing two hydrometers having the same standard temperature and made of the same type of glass, however, the temperature of the liquid need not be considered since the correction required due to variation from the standard temperature is the same for both instruments. But the temperatures of the liquid, the hydrometers, and the surrounding atmosphere should be nearly equal during the observation; otherwise, the temperature of the liquid will be changing, causing differences in density. To ensure uniformity in the liquid, thorough mixing is required shortly before the observations are made.

7.2.1.4 *Influence of Surface Tension*—When a hydrometer is floated in a liquid, a small quantity of the liquid rises about the stem to form a meniscus. This liquid adhering to the stem above the general level of the liquid in which the instrument is floating has the same effect as adding to the mass of the hydrometer, thus increasing the depth of immersion.

7.2.1.5 Because a hydrometer will indicate differently in two liquids having the same density but different surface tensions, and since surface tension is a specific property of liquids, it is necessary to specify the liquid for which a hydrometer is intended. Although hydrometers of equivalent dimensions may be compared, without error, in a liquid differing in surface tension from the specified liquid, the results of comparisons of dissimilar instruments in such a liquid must be corrected for the effect of the surface tension.

7.2.1.6 In many liquids spontaneous changes in surface tension occur due to the formation of surface films of impurities, which may come from the apparatus, the liquid, or the air. Errors from this cause may be avoided by the use of liquids and

³ *Dictionary of Applied Physics*, MacMillan and Co., London, Vol 3, p. 439.

⁴ "Density of Solids and Liquids," National Institute of Standards and Technology, *Circular No. 487*.

⁵ "Standard Density and Volumetric Tables," National Institute of Standards and Technology, *Circular, No. 19*.