



Standard Test Methods for Polyurethane Raw Materials: Determination of Specific Gravity of Isocyanates¹

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1. Scope*

1.1 These test methods determine the specific gravity of toluenediisocyanate and crude methylene-bis-(4-phenylisocyanate). These test methods also are applicable to many other liquids. (See Note 1.)

1.1.1 *Test Method A*—Specific gravity by pycnometer, for high-accuracy determination.

1.1.2 *Test Method B*—Specific gravity by hydrometer, for a less accurate, but rapid, determination.

1.2 The values stated in SI units are to be regarded as the standard. The values given in brackets are for information only.

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 specific warning and precautionary statements see Notes 2 and 3.*

NOTE 1—There is no equivalent ISO standard.

2. Referenced Documents

2.1 ASTM Standards:²

D 883 Terminology Relating to Plastics

D 891 Test Methods for Specific Gravity, Apparent, of Liquid Industrial Chemicals

D 1193 Specification for Reagent Water

E 1 Specification for ASTM Thermometers

E 100 Specification for ASTM Hydrometers

E 202 Test Methods for Analysis of Ethylene Glycols and Propylene Glycols

¹ These test methods are under the jurisdiction of ASTM Committee D20 on Plastics and are the direct responsibility of Subcommittee D20.22 on Cellular Plastics.

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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.

3. Terminology

3.1 Definitions:

3.1.1 For definitions of terms used in these test methods see Terminology D 883.

3.2 Description of Term Specific to This Standard:

3.2.1 *specific gravity*—the ratio of the weight in air of a given volume of the material at a stated temperature to the weight in air of an equal volume of water at a stated temperature. It shall be expressed as specific gravity, 25/25°C, indicating that the sample and reference water were both measured at 25°C.

4. Significance and Use

4.1 These test methods can be used for research or for quality control to characterize isocyanates used in polyurethane products.

TEST METHOD A—SPECIFIC GRAVITY BY PYCNOMETER

5. Apparatus

5.1 *Pycnometer*, of 25 or 50-mL capacity, conical shape with a capillary side arm overflow tube having a standard-taper 5/12 ground-glass joint and a ground-glass vented cap. A thermometer graduated from 12 to 38°C in 0.2° divisions attached to the neck of the flask by a standard-taper 10/18 ground-glass joint. This thermometer should be calibrated using the ASTM thermometer specified in 5.3.

5.2 *Water Bath*—A water bath maintained at $25 \pm 0.05^\circ\text{C}$.

5.3 *Thermometer*—An ASTM low-softening point thermometer, calibrated from -2 to $+80^\circ\text{C}$, which meets the requirements for Thermometer 15C in Specification E 1.

5.4 *Analytical Balance*—A balance having a sensitivity of at least 0.1 mg.

6. Reagents and Materials

6.1 *Purity of Reagents*—Use reagent grade chemicals in all tests. Unless otherwise indicated, it is intended that all reagents conform to the specifications of the Committee on Analytical

Reagents of the American Chemical Society where such specifications are available.³ Other grades may be used, provided it is ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

6.2 Purity of Water—Unless otherwise indicated, references to water shall be understood to mean reagent water as defined by Type IV or better of Specification D 1193.

6.3 Chromic Acid Cleaning Solution—Prepare a saturated solution of chromic acid (CrO₃) in concentrated sulfuric acid (H₂SO₄, sp gr 1.84).

7. Sampling

7.1 Since organic isocyanates react with atmospheric moisture, take special precautions in sampling **Warning**—Organic isocyanates are toxic when they are absorbed through the skin, or when the vapors are breathed. **Precaution**—Provide adequate ventilation and wear protective gloves and eyeglasses.. Usual sampling methods (for example, sampling an open drum with a thief), even when carried out rapidly, can cause contamination of the sample with insoluble urea. Therefore, blanket the sample with dry air or nitrogen at all times.

8. Test Conditions

8.1 Since isocyanates react with moisture, keep laboratory humidity low, preferably around 50 % relative humidity.

9. Procedure

9.1 Clean the pycnometer by filling it with chromic acid cleaning solution and by allowing it to stand for a few hours. Empty the pycnometer and rinse well with distilled water.

9.2 Fill the pycnometer with freshly boiled distilled water that has been cooled to 22 to 24°C. Insert the thermometer into the pycnometer without trapping air bubbles. Place the pycnometer in a water bath at 25 ± 0.05°C and allow it and its contents to equilibrate for at least 30 min. Wipe the overflow from the side-arm capillary and cover it with the vented cap. Remove the pycnometer from the bath, wipe dry, and weigh.

9.3 Empty the pycnometer and rinse it with alcohol, then with ether. Remove the ether and dry the pycnometer under vacuum for 15 min. Weigh the pycnometer. Determine the weight, *W*, of the water at 25.0°C in air by subtracting the weight of the empty pycnometer from the weight of the pycnometer filled with water.

NOTE 2—Other drying techniques may be used if ether is to be avoided. It must be established that for any alternative drying method, a clean and dry pycnometer results.

9.4 Carry out the rest of the procedure in a ventilated hood. The sample for testing must be completely liquid. If the sample contains solid toluene diisocyanate, warm it in its original

container until it becomes liquid. Rapidly cool the liquid to 22 to 24°C and fill the pycnometer, while minimizing exposure of the sample to air.

9.5 Insert the thermometer into the pycnometer without trapping air bubbles. Cover the side arm with the vented cap and allow the pycnometer to equilibrate in the water bath for at least 30 min. Wipe the overflow from the side arm capillary and cover it with the cap vented. Remove the pycnometer from the bath, wipe dry, and weigh. To obtain the weight, *S*, of the sample at 25.0°C, subtract the weight of the empty pycnometer from the weight when filled with sample.

10. Calculation

10.1 Calculate the specific gravity at 25/25°C as follows:

$$\text{Specific gravity, 25/25°C} = \frac{S}{W}$$

where:

S = sample used, g (see 9.5), and

W = water in the pycnometer, g (see 9.3).

11. Precision and Bias

11.1 Attempts to develop a precision and bias statement for this test method have not been successful. Data on precision and bias cannot be given for this reason. Anyone wishing to participate in the development of precision and bias data should contact the Chairman, Subcommittee D20.22 (Section D20.22.01), ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

11.2 Test Method E 202 is similar and does include precision data. Precision statements from E 202 are restated below as an estimate of the precision for this test method.

11.2.1 Repeatability—It has been estimated that duplicate results by the same analyst should be considered suspect if they differ by 0.0002 units.

11.2.2 Reproducibility—It has been estimated that results reported by different laboratories should be considered suspect if they differ by 0.0008 units.

11.3 Bias—There are no recognized standards by which to estimate the bias of this test method.

TEST METHOD B—SPECIFIC GRAVITY BY HYDROMETER

12. Apparatus

12.1 Hydrometer—An ASTM hydrometer with a specific gravity range from 1.195 to 1.255 at 15.6/15.6°C conforming to the requirements for Hydrometer 115H in Specification E 100.

12.2 Hydrometer Cylinder—A clear glass cylinder with an inside diameter at least 25.4 mm [1 in.] larger than the hydrometer and tall enough so that there is at least 1 in. between the bottom of the cylinder and the bottom of the hydrometer after equilibration at 25°C.

12.3 Thermometer—See 5.3.

12.4 Water Bath—See 5.2.

13. Procedure (See Warning statement below.)

13.1 The sample for test must be completely liquid. If the sample is turbid, warm it in its original container until it

³ *Reagent Chemicals, American Chemical Society Specifications*, American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmaceutical Convention, Inc. (USPC), Rockville, MD.

becomes clear, then cool it to 22 to 24°C. **Warning**—Carry out this entire procedure in a well-ventilated hood.

13.2 To avoid forming air bubbles, slowly pour the sample into the dry hydrometer cylinder. Remove any air bubbles adhering to the surface by touching them with a piece of clean filter paper. Place the cylinder in the water bath. Stir the contents of the cylinder, being careful to avoid formation of air bubbles. When the temperature of the sample is 24.8°C, slowly and carefully lower the hydrometer into the sample liquid to a level two small scale divisions below that at which it will float and then release the hydrometer. Allow the hydrometer to come to rest and make sure it does not touch the walls of the cylinder. When the temperature of the sample reaches 25.0°C, read the gravity by sighting below the level of the liquid and slowly raising up until the surface of the sample, first seen as a distorted ellipse, seems to become a straight line cutting the hydrometer scale.

13.3 Determine the temperature of the sample just before and just after reading the hydrometer.

14. Calculation

14.1 Calculate the specific gravity at 25/25°C as follows (Note 3):

$$\text{Specific gravity, 25/25°C} = \text{observed value} + 0.0021$$

NOTE 3—The correction factor +0.0021 is applied to correct the reading

to 25/25°C because the hydrometer was standardized at 15.6/15.6°C.

15. Precision and Bias

15.1 Attempts to develop a precision and bias statement for this test method have not been successful. Data on precision and bias cannot be given for this reason. Anyone wishing to participate in the development of precision and bias data should contact the Chairman, Subcommittee D20.22 (Section D20.22.01), ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

15.2 Test Method D 891 is similar and does include precision data. Precision statements from D 891 are restated below as an estimate of the precision for this test method.

15.2.1 *Repeatability*—It has been estimated that duplicate results by the same analyst should be considered suspect if they differ by 0.0005 units.

15.2.2 *Reproducibility*—It has been estimated that results reported by different laboratories should be considered suspect if they differ by 0.0021 units.

15.3 There are no recognized standards by which to estimate the bias of this test method.

16. Keywords

16.1 density; hydrometer; isocyanates; polyurethane raw materials; pycnometer; specific gravity

SUMMARY OF CHANGES

This section identifies the location of selected changes to these test methods. For the convenience of the user, Committee D20 has highlighted those changes that may impact the use of these test methods. This section may also include descriptions of the changes or reasons for the changes, or both.

D 4659 – 03:

(1) Added Note 2.

D 4659 – 98:

(1) *Section 1.1*—Modified the scope to include both toluene-diisocyanate and methylene-bis-(4-phenylisocyanate).

(2) *Section 2.1*—Added references to Test Methods D 891 and E 202.

(3) *Footnotes*—Inserted footnote 5 and renumbered subsequent footnote.

(4) *Section 6.2*—Changed the requirement from “Type I” to “Type IV or better” water.

(5) *Section 11*—Replaced the precision and bias statement with quote and reference to the precision and bias statement of Test Methods E 202.

(6) *Section 15*—Replaced the precision and bias statement with quote and reference to the precision and bias statement of Test Methods D 891.

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