# Standard Test Method for Use of the Refractometer for Field Test Determination of the Freezing Point of Aqueous Engine Coolants[1]

This standard is issued under the fixed designation D 3321; 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 use of a portable refractometer for determining the approximate freezing protection provided by ethylene and propylene glycol-based coolant solutions as used in engine cooling systems and special applications.

NOTE 1—Some instruments have a supplementary freezing protection scale for methoxypropanol coolants. Others carry a supplemental scale calibrated in density or specific gravity readings of sulfuric acid solutions so that the refractometer can be used to determine the charged condition of lead acid storage batteries.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses 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.*

## 2. Referenced Documents

2.1 *ASTM Standards:*

D 1177 Test Method for Freezing Point of Aqueous Engine Coolants[2]

## 3. Summary of Test Method

3.1 These coolant testers[3] are critical-angle refractometers designed for rapid, approximate measurement of ethylene and propylene glycol coolant freezing point protection. Only a few drops of test solution are required. Some testers automatically correct for ambient air temperature and the temperature of the solution being tested. The instrument is rugged, simple to read, and easy to clean and maintain.

3.2 The coolant freezing point readings are taken at points where the dividing line between light and dark crosses the scales. Some refractometers have a coolant scale for indicating the freezing point of aqueous ethylene glycol coolants only, while other refractometers also have a scale for indicating the freezing point of aqueous propylene glycol coolants. The range of the scales varies from one device to another.

3.3 Freezing point measurements are concentration-related values and are in turn directly related to refractive index. It has been empirically determined that freezing point measurements are accurate within 1°C (2°F).

## 4. Significance and Use

4.1 This practice is commonly used by vehicle service personnel to determine the freezing point, in degrees Celsius or Fahrenheit, of aqueous solutions of commercial ethylene and propylene glycol-based coolant. A durable hand-held refractometer is available that reads the freezing point, directly, in degrees Celsius or Fahrenheit, when a few drops of engine coolant are properly placed on the temperature-compensated prism surface of the refractometer. This refractometer is for glycol and water solutions, and is not suitable for other coolant solutions.

4.2 The hand-held refractometer should be calibrated before use (see Section 7).

4.3 Care must be taken to use the correct glycol freezing point scale for the glycol type being measured. Use of the wrong glycol scale can result in freezing point errors of 18 and more degrees Fahrenheit.

4.4 Ethylene glycol/propylene glycol mixtures will result in inaccurate freezing point measurements using either freezing point scale.

## 5. Interferences

5.1 Interference can occur if the mixture is contaminated or if the prism surface is not clean. The presence of other glycols such as diethylene glycol in small amounts will not cause interference.

## 6. Apparatus

6.1 The hand-held critical angle refractometer is a rugged die-cast portable instrument that is covered with a high-impact plastic to minimize damage to the eyepiece lens if dropped. A polished glass prism is opposite the viewing end. A hinged plastic cover is moved over the prism (sampling end) to allow

[1] This test method is under the jurisdiction of ASTM Committee D15 on Engine Coolants and is the direct responsibility of Subcommittee D15.03 on Physical Properties.

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[2] *Annual Book of ASTM Standards*, Vol 15.05.

[3] Coolant testers are available from Leica Inc., P.O. Box 123, Buffalo, NY 14240 and Misco Products, 3401 Virginia Rd., Cleveland, OH 44122.

for even sample distribution and prevent liquid sample spillage during the test. No eyepiece or prism adjustments are required for sample testing.

6.2 The telescopic recessed eyepiece is located at one end and the graduated, translucent prism on the opposite end (see Fig. 1).

## 7. Calibration

7.1 Calibration of these coolant testers should periodically be verified by testing a water sample in accordance with the procedure outlined in Section 8.

7.2 If the sample tested deviates from 0°C (+32°F) the coolant tester is out of calibration and should be recalibrated.

7.3 This calibration test is best performed with the coolant tester and water sample at room temperature. If the instrument used is designed to be automatically temperature compensated, work within the stated temperature-compensated range.

## 8. Procedure

8.1 *Cleaning*—Before using, swing back the plastic cover at the slanted end of the tester exposing both the measuring window and the bottom of the plastic cover. *Wipe both clean and dry* with tissue or clean soft cloth. Close the plastic cover (see Fig. 2).

8.2 *Testing Coolant Solution*—Commercial instruments are usually equipped with a small suction pipet for sampling solutions. This tube should be used to remove a sample (from below the coolant surface) and eject a few drops on the measuring window (see Fig. 3). Flush suction pipet with test solution before withdrawing sample for testing.

8.3 *Readings*:

8.3.1 Point the instrument toward any light source (for example, a headlight) and look into the eyepiece (Fig. 4).

8.3.2 The freeze point protection is the point where the dividing line between light and dark (edge of the shadow) crosses the scale; read the scale marked for the type of coolant being tested (see Fig. 5).

NOTE 2—Tester temperature scales are reversed from standard thermometer scales. Below zero readings are located on upper half of scale.

8.3.3 A little experience is required to obtain the best contrast between the light and dark portions of the scale. Tilt the instrument towards the light source until best results are obtained.

NOTE 3—Refractometer freezing point scales are available in °C and °F for both propylene glycol and ethylene glycol-base coolants.

8.3.4 If the *edge of the shadow* is not sharp, the measuring surfaces were not sufficiently well cleaned or dried or an insufficient amount of coolant sample was used. Clean and dry the window. Conduct a new test.

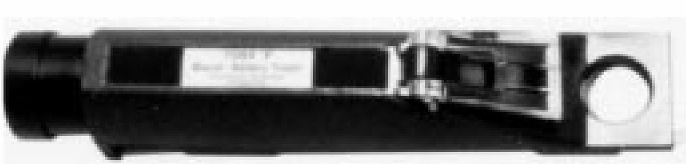


**FIG. 1 Hand-Held Critical Angle Refractometer**

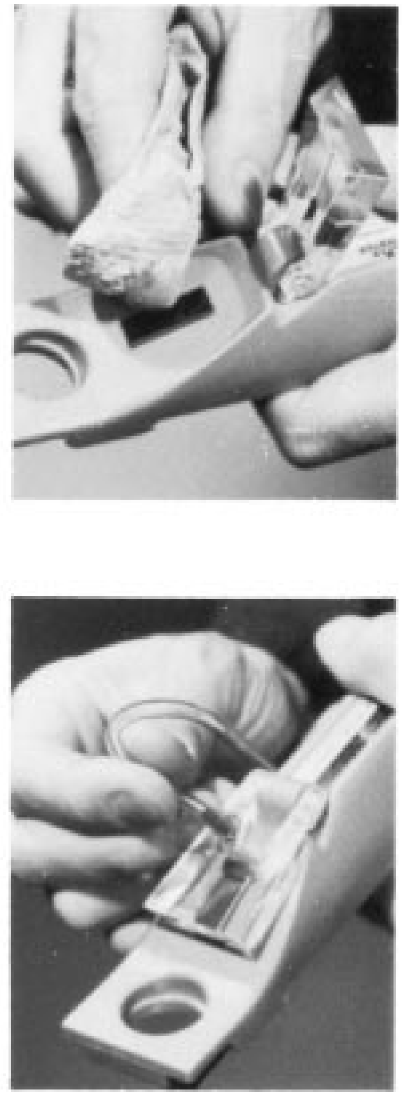


**FIG. 2 Cleaning**

NOTE 4—Oil contamination will reduce the sharpness of the dividing line.

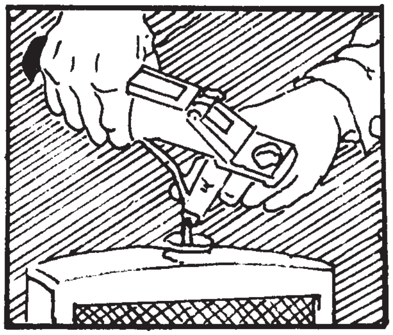
8.3.5 A completely dark scale indicates insufficient coolant sample was used. Completely light scale indicates that the coolant freezing point is below the scale range.

8.3.6 There is a danger of the loss of water vapor from the mixture, due to the small amount of sample required, if the solution is sampled at elevated temperatures. Under these circumstances the reading should be taken immediately. More accurate readings are obtained when testing at ambient temperature.

## 9. Precision and Bias [4]

9.1 *Precision*—The precision of this test method, as determined by the examination of the interlaboratory test results, is as follows:

[4] Supporting data are available from ASTM Headquarters. Request RR:D15-1012.



NOTE 1—Do not remove clear plastic pump from tester. Release tip of pump from tester housing and insert into radiator filler neck or coolant reservoir tank. Be sure to insert well below level of fluid. Press and release bulb to draw up a sample of coolant. Eject the liquid to flush the tube. Repeat filling to obtain sample. Bend plastic tube around tester so that tip can be inserted in cover plate opening. Eject a few drops of coolant onto measuring surface by pressing bulb. Ensure that the sample is not contaminated with oil.

**FIG. 3 Sampling**

**FIG. 4 Reading**

9.1.1 For different test operators using the specified equipment and the procedure in Section 8, the results should not vary more than 0.5°C (1.0°F) when the temperature of the coolant solution is 24°C (75°F) or more than 1°C (2°F) from the average value when the coolant solution temperature is 82°C (180°F).

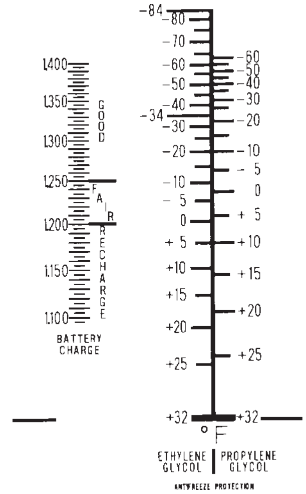



**FIG. 5 Tester Temperature Scale**

9.1.2 Table 1 lists the freezing points obtained by Test Method D 1177 and the refractometer for representative glycol antifreeze/coolant mixtures and water.

9.2 *Bias*—Since there is no acceptable reference material suitable for determining the bias for this test method, bias has not been determined.

## 10. Keywords

10.1 engine coolants; freezing point; refractometer

**TABLE 1 Comparison of Freezing Points by Refractometer versus Test Method D 1177**

| Base Glycol Mixture | Freezing Point 50/50 Aqueous Solution | |
|---|---|---|
| | Refractometer, °C (°F) | Test Method D 1177, °C (°F) |
| 95 % Ethylene glycol<br>5 % $H_2O$ | −33; −34 (−28; −29) | −34 (−30) |
| 90 % Ethylene glycol<br>5 % Propylene glycol<br>5 % $H_2O$ | −34; −35 (−30; −31) | −34; −35 (−30;−31) |
| 90 % Ethylene glycol<br>5 % Diethylene glycol<br>5 % $H_2O$ | −34; −34 (−30; −30) | −35 (−31) |
| 90 % Ethylene glycol<br>2.5 % Propylene glycol<br>2.5 % Diethylene glycol<br>5 % $H_2O$ | −34; −34 (−29; −29) | −34 (−30) |