Designation: D3306 – 14

Standard Specification for Glycol Base Engine Coolant for Automobile and Light-Duty Service[1]

This standard is issued under the fixed designation D3306; 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 specification covers the requirements for ethylene glycol or propylene glycol base engine coolants used in automobiles or other light duty service cooling systems. When concentrates are used at 40 to 70 % concentration by volume in water, or when prediluted glycol base engine coolants 50 volume % or higher engine coolant concentrate are used without further dilution, they will function effectively to provide protection against freezing, boiling, and corrosion.

1.2 The coolants governed by this specification are categorized as follows:

Coolant Type	Description
I	Ethylene glycol base concentrate
II	Propylene glycol base concentrate
V	Ethylene glycol base concentrate containing glycerin
III	Ethylene glycol predilute 50 volume % or higher engine coolant concentrate
IV	Propylene glycol predilute 50 volume % or higher engine coolant concentrate
VI	Ethylene glycol base predilute containing glycerin 50 volume % or higher engine coolant concentrate

NOTE 1—This specification is based on the knowledge of the performance of engine coolants prepared from new or virgin ingredients. This specification shall also apply to engine coolants prepared using glycol generated from recycled or reprocessed used coolant or reprocessed industrial-source glycol, provided that said glycol meets the requirements of Specification E1177. Separate specifications (D6471 and D6472) exist for engine coolants prepared from recycled or reprocessed used coolant or reprocessed industrial-source glycol that does not meet the requirements established in Specification E1177. This specification shall also apply to glycol based engine coolants prepared using fully refined glycerin provided that said glycerin meets the requirements for Specification D7640.

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

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 and health practices and determine the applicability of regulatory limitations prior to use.*

NOTE 2—This specification applies to glycol base engine coolant for automobiles and light duty service. Specifications D4985 and D6210 exist for heavy duty engine service.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D512 Test Methods for Chloride Ion In Water
D516 Test Method for Sulfate Ion in Water
D1119 Test Method for Percent Ash Content of Engine Coolants
D1120 Test Method for Boiling Point of Engine Coolants
D1121 Test Method for Reserve Alkalinity of Engine Coolants and Antirusts
D1122 Test Method for Density or Relative Density of Engine Coolant Concentrates and Engine Coolants By The Hydrometer
D1123 Test Methods for Water in Engine Coolant Concentrate by the Karl Fischer Reagent Method
D1126 Test Method for Hardness in Water
D1177 Test Method for Freezing Point of Aqueous Engine Coolants
D1287 Test Method for pH of Engine Coolants and Antirusts
D1293 Test Methods for pH of Water
D1384 Test Method for Corrosion Test for Engine Coolants in Glassware
D1881 Test Method for Foaming Tendencies of Engine Coolants in Glassware
D1882 Test Method for Effect of Cooling System Chemical Solutions on Organic Finishes for Automotive Vehicles
D2570 Test Method for Simulated Service Corrosion Testing of Engine Coolants

[1] This specification is under the jurisdiction of ASTM Committee D15 on Engine Coolants and Related Fluids and is the direct responsibility of Subcommittee D15.07 on Specifications.

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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.

***A Summary of Changes section appears at the end of this standard**

D2809 Test Method for Cavitation Corrosion and Erosion-Corrosion Characteristics of Aluminum Pumps With Engine Coolants
D3321 Test Method for Use of the Refractometer for Field Test Determination of the Freezing Point of Aqueous Engine Coolants
D3634 Test Method for Trace Chloride Ion in Engine Coolants
D4327 Test Method for Anions in Water by Suppressed Ion Chromatography
D4340 Test Method for Corrosion of Cast Aluminum Alloys in Engine Coolants Under Heat-Rejecting Conditions
D4725 Terminology for Engine Coolants and Related Fluids
D4985 Specification for Low Silicate Ethylene Glycol Base Engine Coolant for Heavy Duty Engines Requiring a Pre-Charge of Supplemental Coolant Additive (SCA)
D5827 Test Method for Analysis of Engine Coolant for Chloride and Other Anions by Ion Chromatography
D5931 Test Method for Density and Relative Density of Engine Coolant Concentrates and Aqueous Engine Coolants by Digital Density Meter
D6130 Test Method for Determination of Silicon and Other Elements in Engine Coolant by Inductively Coupled Plasma-Atomic Emission Spectroscopy
D6210 Specification for Fully-Formulated Glycol Base Engine Coolant for Heavy-Duty Engines
D6471 Specification for Recycled Prediluted Aqueous Glycol Base Engine Coolant (50 Volume % Minimum) for Automobile and Light-Duty Service
D6472 Specification for Recycled Glycol Base Engine Coolant Concentrate for Automobile and Light-Duty Service
D6660 Test Method for Freezing Point of Aqueous Ethylene Glycol Base Engine Coolants by Automatic Phase Transition Method
D7640 Specification for Engine Coolant Grade Glycerin
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
E394 Test Method for Iron in Trace Quantities Using the 1,10-Phenanthroline Method
E1177 Specification for Engine Coolant Grade Glycol

2.2 *Other Documents:*
Federal Method 2540B Total Dissolved Solids Dried at 103–105°C[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *glycerin*—Specification D7640 grade glycerin for engine coolant.

3.1.2 *other glycols, n—in ethylene glycol base engine coolant*, diethylene glycol, triethylene glycol, tetraethylene glycol, propylene glycol, dipropylene glycol, tripropylene glycol, and 1,3-propanediol.

3.1.3 *other glycols, n—in propylene glycol base engine coolant*, ethylene glycol, diethylene glycol, triethylene glycol, tetraethylene glycol, dipropylene glycol, tripropylene glycol, and 1,3-propanediol.

3.1.4 For definitions of other terms used in this specification, refer to Terminology D4725.

4. General Requirements

4.1 Engine coolant concentrates or prediluted glycol base engine coolants shall be formulated with either ethylene glycol or propylene glycol meeting Specification E1177, water, and shall contain suitable corrosion inhibitors, dye, and a foam suppressor.

4.2 Ethylene glycol base engine coolant concentrates (Type I) may contain a maximum of 15 % other glycols, as long as the physical, chemical, and performance requirements of this specification can be met. Similarly, prediluted ethylene glycol base coolants (Type III) may contain a maximum of 7.5 % other glycols as long as all of the requirements of this specification can be met.

4.3 Propylene glycol base engine coolant concentrates (Type II) may contain a combined maximum of 1 % other glycols (less than 0.5 % for prediluted propylene glycol base coolants, Type IV) and all of the physical, chemical, and performance requirements of this specification must be met.

4.4 Ethylene glycol base coolant concentrates (Type V) may contain glycerin as long as the physical, chemical and performance requirements of this specification can be met. Glycerin blended into Type V coolant concentrates shall be in accordance with Specification D7640.

4.5 All engine coolant concentrates or prediluted glycol base engine coolants shall conform to the general requirements given in Table 1.

4.6 Prediluted glycol base engine coolants shall be formulated using water that meets the following requirements:

Property	Specific Values	ASTM Test Method
Chlorides, µg/g (ppm (grains/gal))	25 (1.5) max	D5827, D512, D4327
Sulfate, µg/g (ppm (grains/gal))	50 (3.0) max	D5827, D516, D4327
Hardness, as $CaCO_3$, µg/g (ppm (grains/gal))	20 (1.2) max	D6130, D1126
pH	5.5 to 8.5	D1287, D1293
Iron, µg/g (ppm (grains/gal))	1.0 (0.06) max	D6130, E394

NOTE 3—Prediluted coolants are intended for direct addition to an engine cooling system with no further dilution. However, if circumstances require addition and prediluted aqueous engine coolant is not available, use the appropriate engine coolant concentrate (Type I, II, or V) diluted to 50 volume % with water of at least the quality outlined in Table X1.1.

4.7 When diluting engine coolant concentrates for actual service, use deionized (demineralized) or distilled water, municipal (treated) water, or a low mineral content well water (see

TABLE 1 General Requirements

Property	Specified Values	ASTM Test Method
Color	Distinctive	. . .
Effect on nonmetals	No adverse effect	Under consideration

[3] Standard Method for the Examination of Water and Wastewater. American Public Health Association, et al, 800 I Street, N.W. Washington, DC 20001–3710, http://www.apha.org.

Appendix X1, Table X1.1). This procedure will minimize the formation of hard water scale and avoid the introduction of mineral components, such as chlorides and sulfates, which can increase the corrosion rate of aluminum and iron.

4.8 When installed in accordance with the vehicle manufacturer's recommendations and those on the product label, engine coolant concentrates or prediluted glycol base engine coolants shall be suitable for use in a properly maintained cooling system (Appendix X1) in normal light-duty service for a minimum of one year without adversely affecting fluid flow and heat transfer.

5. Detailed Requirements

5.1 Glycol base coolant concentrates and prediluted coolants shall conform to the physical and chemical requirements prescribed in Table 2 and Table 3 depending on coolant type (see 1.2).

5.2 The requirements listed in Table 2 and Table 3 for prediluted coolants (Types III, IV, and VI) are prescribed for the coolant as packaged, without further dilution or adjustment.

5.3 All coolant concentrates and prediluted coolants shall conform to the performance requirements listed in Table 4.

5.4 Coolant concentrates shall be diluted for performance testing as described in the individual ASTM test methods.

5.5 If the freezing point of the prediluted product is below –36.4°C (for Type III and VI) or –31.0°C (for Type IV) adjust with deionized water before proceeding with performance testing. The freezing point of prediluted ethylene glycol base coolants (Type III) and prediluted ethylene glycol base coolants containing glycerin (Type VI) shall be –36.4°C (–33.5°F) and that of prediluted propylene glycol base coolants (Type IV) shall be –31.0°C (–23.8°F).

5.6 Adjusted, prediluted engine coolant performance test solutions shall be prepared as described in Table 4, Footnotes B through F.

6. Keywords

6.1 engine coolant; engine coolant concentrate; ethylene glycol; glycerine; glycerol; light duty engine coolant; prediluted engine coolant; propylene glycol; 1,2,3-propane diol

TABLE 2 Physical and Chemical Requirements for Concentrates

Property	Type I	Type II	Type V	ASTM Test Method
Relative density 15.5/15.5°C (60/60°F)	1.110 to 1.145	1.030 to 1.065	1.110 to 1.160[A]	D1122, D5931
Freezing point,[B,C] °C (°F), 50 vol % in DI water	–36.4 (–33.5) max	–31.0 (–23.8) max	–36.4 (–33.5) max	D1177, D6660
Boiling point,[B,D] °C (°F), 50 vol % in DI water	108 (226) min	104 (219) min	108 (226) min	D1120
Ash content, mass %	5 max	5 max	5 max	D1119
pH, 50 vol % in DI water	7.5 to 11	7.5 to 11	7.5 to 11	D1287
Chloride, µg/g	25 max	25 max	25 max	D3634, D5827[E]
Water, mass %	5 max	5 max	5 max	D1123
Reserve alkalinity, mL	report[F]	report[F]	report[F]	D1121
Effect on automotive finish (use clear coat thermoset urethane or acrylic urethane finish)	no effect	no effect	no effect	D1882[G]

[A] Type V engine coolant is ethylene glycol base containing glycerin. Other ingredients that do not meet Specifications E1177 and D7640 shall not be substituted in this blend.
[B] For purposes of determining conformance with this specification, an observed value shall be rounded "to the nearest unit" in the last right-hand digit used in expressing the specification limit, in accordance with the rounding method of Practice E29.
[C] Test Methods D1177 and D6660 work with glycol/glycerin mixtures. Field test devices based on refractive index and density are under development.
[D] Some precipitate may be observed at the end of the test. This should not be cause for rejection.
[E] In case of dispute, D3634 shall be the preferred test method.
[F] Value as agreed upon between the supplier and the customer.
[G] Currently, many vehicle manufacturers prepare test panels using the specific paint finishes employed on their actual products. Coolant suppliers and vehicle manufacturers should agree on the exact test procedures and acceptance criteria on an individual basis.

TABLE 3 Physical and Chemical Requirements for Predilute

Property	Type III	Type IV	Type VI	ASTM Test Method
Relative density 15.5/15.5°C (60/60°F)	1.065 min	1.025 min	1.065 min[A]	D1122, D5931
Freezing point,[B,C] °C (°F), undiluted	–36.4 (–33.5) max	–31.0 (–23.8) max	–36.4 (–33.5 (max)	D1177, D6660
Boiling point,[B,D] °C (°F), undiluted	108 (226) min	104 (219) min	108 (226) min	D1120
Ash content, mass %	2.5 max	2.5 max	2.5 max	D1119
pH, undiluted	7.5 to 11	7.5 to 11	7.5 to 11	D1287
Chloride, µg/g	25 max	25 max	25 max	D3634, D5827[E]
Water, mass %	not applicable	not applicable	not applicable	D1123
Reserve alkalinity, mL	report[F]	report[F]	report[F]	D1121
Effect on automotive finish (use clear coat thermoset urethane or acrylic urethane finish)	no effect	no effect	no effect	D1882[G]

[A] Type VI engine coolant is ethylene glycol base containing glycerin. Other ingredients that do not meet Specifications E1177 and D7640 shall not be substituted in this blend.
[B] For purposes of determining conformance with this specification, an observed value shall be rounded "to the nearest unit" in the last right-hand digit used in expressing the specification limit, in accordance with the rounding method of Practice E29.
[C] Test Methods D1177 and D6660 work with glycol/glycerin mixtures. Field test devices based on refractive index and density are under development.
[D] Some precipitate may be observed at the end of the test. This should not be cause for rejection.
[E] In case of dispute, D3634 shall be the preferred test method.
[F] Value as agreed upon between the supplier and the customer.
[G] Currently, many vehicle manufacturers prepare test panels using the specific paint finishes employed on their actual products. Coolant suppliers and vehicle manufacturers should agree on the exact test procedures and acceptance criteria on an individual basis.

TABLE 4 Performance Requirements[A]

Property	Specific Values	ASTM Test Method	Test Solution Concentration, vol % Product
Corrosion in glassware		D1384[B]	33
Weight loss, mg/specimen			
copper	10 max		
solder	30 max		
brass	10 max		
steel	10 max		
cast iron	10 max		
aluminum	30 max		
Simulated service test		D2570[C]	44
Weight loss, mg/specimen			
copper	20 max		
solder	60 max		
brass	20 max		
steel	20 max		
cast iron	20 max		
aluminum	60 max		
Corrosion of Cast Aluminum Alloys at Heat-Rejecting Surfaces, mg/cm^2/week	1.0 max	D4340[D]	25
Foaming		D1881[E]	33
Volume, mL	150 max		
Break time, s	5 max		
Cavitation-Erosion	8 min	D2809[F]	17
Rating for pitting, cavitation, and erosion of the water pump			

[A] For engine coolant concentrates, test solutions shall be prepared in accordance with the directions provided in the individual ASTM test methods noted. For prediluted engine coolants, prepare test solutions using the directions provided in Footnotes B through F.
[B] For prediluted coolants, prepare the test solution by mixing 67 volume % of the adjusted (see 5.5) prediluted product with 33 volume % ASTM Type IV reagent water. Add 99 mg of sodium sulfate, 110 mg of sodium chloride, and 92 mg of sodium bicarbonate per litre of test solution.
[C] For prediluted coolants, prepare the test solution by mixing 88 volume % of the adjusted (see 5.5) prediluted product with 12 volume % ASTM Type IV reagent water. Add 83 mg of sodium sulfate, 92 mg of sodium chloride, and 77 mg of sodium bicarbonate per litre of test solution.
[D] For prediluted coolants, prepare the test solution by mixing 50 volume % of the adjusted (see 5.5) prediluted product with 50 volume % ASTM Type IV reagent water. Add 165 mg of sodium chloride per litre of test solution.
[E] For prediluted coolants, prepare the test solution by mixing 67 volume % of the adjusted (see 5.5) prediluted product with 33 volume % ASTM Type II reagent water.
[F] For prediluted coolants, prepare the test solution by mixing 33 volume % of the adjusted (see 5.5) prediluted product with 67 volume % ASTM Type IV reagent water. Add 123 mg of sodium sulfate, 137 mg of sodium chloride, and 115 mg of sodium bicarbonate per litre of test solution.

APPENDIXES

(Nonmandatory Information)

X1. COOLING SYSTEM MAINTENANCE

X1.1 *Filling the Cooling System*:

X1.1.1 Before installing engine coolant, the cooling system should be inspected and necessary service work completed.

X1.1.2 Cooling system fill should consist of coolant concentrate and water or prediluted glycol or glycol/glycerin blend base engine coolant (50 volume % minimum).

X1.1.3 When preparing solutions, the water should be of such quality that it does not contain excessive solids, hardness salts, sulfates, or chlorides. In the absence of specific recommendations from the engine or vehicle manufacturer, see Table X1.1. Contact your local water department, the responsible government agency, or submit a water sample for analyses, if there is a question on water quality.

X1.1.4 The recommended coolant concentration range is 40 to 70 %.

TABLE X1.1 Suggested Water Quality Limits[A]

Property	Specific Values	ASTM Test Method
Total solids, µg/g (ppm (grains/gal))	340 (20) max	Federal Method 2540B
Total hardness, µg/g (ppm (grains/gal))	170 (10) max	D6130, D1126
Chlorides, µg/g (ppm (grains/gal))	40 (2.4) max	D5827, D512, D4327
Sulfate, µg/g (ppm (grains/gal))	100 (5.9) max	D5827, D516, D4327
pH	5.5–9.0	D1287, D1293

[A] Adopted from a survey by the Committee D15 Water Quality Task Force.

X1.2 *Essential Cooling System Service:*

X1.2.1 Check coolant concentration (freeze point). The most accurate and preferred means of determining coolant concentration is by the refractometer. (See X2.1 and Table X2.1.)

X1.2.2 Check coolant level and condition. Replace coolant at service intervals recommended by the engine manufacturer, vehicle manufacturer, or designated service organization. Follow recommended practices.

X1.2.3 Pressure test system for leaks (preferably when cold).

X1.2.4 Test pressure cap and inspect radiator filler neck.

X1.2.5 Inspect hoses and tighten hose connections.

X1.2.6 Inspect drive belts and check for proper tension.

X1.2.7 Test thermostat if the engine is running too hot or too cold. Replace with a thermostat recommended by the manufacturer or equivalent.

X1.3 Premix coolant concentrate and water before adding to the cooling system.

X1.4 When preparing additions or when replacing the coolant in the engine system, use only clean, low mineral content water.

X1.5 **Warning—**Do not remove the radiator pressure cap when the engine is hot. The cooling system will likely be under pressure. When the engine has cooled, carefully turn to the first notch to vent the system pressure, then remove. If coolant overflows when the cap is vented, immediately retighten and permit the system to cool further.

TABLE X2.1 Methods for Determining Freeze Points

Method	Glycol		Mixtures	
	Ethylene	Propylene	EG, PG	EG, Glycerin[A]
Refractometer	yes	yes[B]	yes[C]	no
Hydrometer	yes[D]	yes[E]	no	no
Test Strips	yes	yes	yes	no

[A] Test Methods D1177 and D6660 work with glycol/glycerin mixtures. Refractometers are being developed by coolant producers and automotive dealers to measure glycol/glycerin coolant blends.
[B] Must be a refractometer with either a PG freeze point scale or a dual scale with both PG and EG.
[C] Approximate freeze point determinations can be made for mixtures of EG and PG base coolants by calculating the average of readings on each scale. The freeze point determined by this method will be within ±4°C (7°F), regardless of whether the coolant is all EG, PG, or a mixture of both.
[D] Conventional field service hydrometers calibrated for use with ethylene glycol base coolants.
[E] Hydrometer shall be specifically calibrated for use with PG base coolants.

X2. DETERMINATION OF FREEZE POINT

X2.1 If propylene glycol (PG) base coolants and ethylene glycol (EG) base coolants or EG base coolants containing glycerin are mixed in a cooling system, problems may result when attempting to determine the freezing point in the field. The hydrometers used in North America are calibrated to the higher relative density of EG base coolants. These hydrometers cannot be used to determine the freeze point of glycerin, PG base engine coolants or mixtures of glycerin, PG and EG coolants. Using this type of hydrometer to determine the freeze point is likely to result in a high coolant to water mix ratio (for example, 80/20), which, in turn may cause engine and cooling system problems. A hydrometer specifically calibrated to the relative density of PG or EG base coolants containing glycerin must be used to determine the freezing point of PG or EG base coolants containing glycerin. A convenient and preferred means of determining the freeze points for PG coolants or mixtures of PG and EG coolants or EG coolants containing glycerin is by the refractometer (see Test Method D3321). Table X2.1 lists methods for determining the freeze point of EG base engine coolants, EG base coolants containing glycerin and PG base coolants when used either alone in the cooling system or mixed with EG base coolants. The refractometer provides the most accurate method for measuring freeze points in the field. Dip–and-read test strips will provide only an approximation of freeze point.

X2.2 It is recommended that PG base coolant (either Type II or IV) containers and EG base coolants containing glycerin (Type V or VI) be labeled with an appropriate cautionary statement to alert the user to the differences described in X1.1. It is also recommended that a peel-off label be attached to the filler-neck of the radiator to advise the user that the system has been charged with a PG base coolant or EG base coolant containing glycerin.

X3. VIRGIN COOLANT ADVISORY

X3.1 Current coolant product specifications are based on performance experience developed when these products are prepared from new or virgin ingredients. Therefore, this specification may not take into account the effect(s), if any, of any elements or chemical compounds that may have been added or may be residual, if the coolant product is prepared from glycol generated from recycled or reprocessed used coolant or reprocessed industrial-sourced glycol that does not meet the requirements established by Specification E1177.

X3.2 Committee D15 has investigated the effects of potential contaminants and has established separate specifications (D6471 and D6472) for recycled and reformulated coolants made using glycol that does not meet the requirements of E1177.

X3.3 Users of this specification should be aware that it applies only to coolants manufactured from new or virgin ingredients or coolants made from glycol generated by recycling or reprocessing used coolants or reprocessed industrial-source glycol that meets Specification E1177 or glycol meeting Specification E1177 blended with glycerin meeting Specification D7640.

X4. LABELING

X4.1 It is recommended that prediluted engine coolants (Type III, IV, and VI) meeting this specification have the following information on the package label:

X4.1.1 Prediluted engine coolant,

X4.1.2 Ready for use, do not add water, and

X4.1.3 **Warning**—The freezing point of the final coolant in the cooling system is determined by the extent of dilution of this product with any liquid remaining in the cooling system at the time of filling.

SUMMARY OF CHANGES

Committee D15 has identified the location of selected changes to this standard since the last issue (D3306-11) that may impact the use of this standard. (Approved April 15, 2014.)

(1) Revised 1.1, 1.2, and 5.5.

(2) Revised Footnotes B through F in Table 4.