Designation: D 3306 – 03

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

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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 % minimum) 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
III	Ethylene glycol predilute (50 vol %)
IV	Propylene glycol predilute (50 vol %)

NOTE 1—This specification is based on the knowledge of the performance of engine coolants prepared from new or virgin ingredients. Separate specifications exist for engine coolants prepared from recycled or reprocessed used coolant or reprocessed industrial-source glycols.

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 automobiles and light duty service. Specifications D 4985 and D 6210 exist for heavy duty engine service.

2. Referenced Documents

2.1 *ASTM Standards:*

D 512 Test Methods for Chloride Ion in Water[2]

D 516 Test Methods for Sulfate Ion in Water[2]

TABLE 1 General Requirements

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

D 1119 Test Method for Percent Ash Content of Engine Coolants and Antirusts[3]

D 1120 Test Method for Boiling Point of Engine Coolants[3]

D 1121 Test Method for Reserve Alkalinity of Engine Coolants and Antirusts[3]

D 1122 Test Method for Density and Relative Density of Engine Coolant Concentrates and Engine Coolants by the Hydrometer[3]

D 1123 Test Methods for Water in Engine Coolant Concentrate by the Karl Fischer Reagent Method[3]

D 1126 Test Method for Hardness in Water[2]

D 1177 Test Method for Freezing Point of Aqueous Engine Coolants[3]

D 1193 Specification for Reagent Water[2]

D 1287 Test Method for pH of Engine Coolants and Antirusts[3]

D 1293 Test Methods for pH of Water[2]

D 1384 Test Method for Corrosion Test for Engine Coolants in Glassware[3]

D 1881 Test Method for Foaming Tendencies of Engine Coolants in Glassware[3]

D 1882 Test Method for Effect of Cooling System Chemical Solutions on Organic Finishes for Automotive Vehicles[3]

D 1888 Test Methods for Particulate and Dissolved Matter, Solids, or Residue in Water[4]

D 2570 Test Method for Simulated Service Corrosion Testing of Engine Coolants[3]

D 2809 Test Method for Cavitation Corrosion and Erosion-Corrosion Characteristics of Aluminum Pumps with Engine Coolants[3]

D 3321 Test Method for Use of the Refractometer for Field Test Determination of the Freezing Point of Aqueous Engine Coolants[3]

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

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[2] *Annual Book of ASTM Standards*, Vol 11.01.

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

[4] Discontinued—See *1990 Annual Book of ASTM Standards*, Vol 11.01.

TABLE 2 Physical and Chemical Requirements

Property	Type I	Type II	Type III	Type IV	ASTM Test Method
Relative density 15.5/15.5°C (60/60°F)	1.110 to 1.145	1.030 to 1.065	1.065 min	1.025 min	D 1122, D 5931
Freezing point, °C (°F):					D 1177, D 6660
50 vol % in DI water	−37 (−34) max	−32 (−26) max			
Undiluted			−37 (−34) max	−32 (−26) max	
Boiling point,[A] °C (°F):					D 1120
50 vol % in DI water	108 (226) min	104 (219) min			
Undiluted	163 (325) min	152 (305 min)	108 (226) min	104 (219) min	
Ash content, mass %	5 max	5 max	2.5 max	2.5 max	D 1119
pH:					D 1287
50 vol % in DI water	7.5 to 11	7.5 to 11			
Undiluted			7.5 to 11	7.5 to 11	
Chloride, ppm	25 max	25 max	25 max	25 max	D 3634, D 5827
Water, mass %	5 max	5 max	not applicable	not applicable	D 1123
Reserve alkalinity, mL	report[B]	report[B]	report[B]	report[B]	D 1121
Effect on automotive finish (use clear coat thermoset urethane or acrylic urethane finish)	no effect	no effect	no effect	no effect	D 1882[C]

[A] Some precipitate may be observed at the end of the test. This should not be cause for rejection.
[B] Value as agreed upon between the supplier and the customer.
[C] 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 Performance Requirements[A]

Property	Specific Values	ASTM Test Method	Test Solution Concentration, vol % Glycol
Corrosion in glassware		D 1384[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		D 2570[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	D 4340[D]	25
Foaming		D 1881[E]	33
Volume, mL	150 max		
Break time, s	5 max		
Cavitation-Erosion	8 min	D 2809[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 4.6) 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 4.6) 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 4.6) 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 4.6) 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 4.6) 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.

D 3634 Test Method for Trace Chloride Ion in Engine Coolants[3]
D 4327 Test Method for Anions in Water by Chemically Supressed Ion Chromatography[2]
D 4340 Test Method for Corrosion of Cast Aluminum Alloys in Engine Coolants Under Heat-Rejecting Conditions[3]
D 4725 Terminology for Engine Coolants[3]
D 4985 Specification for Low Silicate Ethylene Glycol Base Engine Coolants for Heavy Duty Engines Requiring a Pre-Charge of Supplemental Coolant Additive (SCA)[3]
D 5827 Test Method for Determination of Chloride in Engine Coolant by Ion Chromatography[3]
D 5931 Test Method for Density and Relative Density of Engine Coolant Concentrates and Aqueous Engine Coolants by Digital Density Meter[3]
D 6210 Specification for Fully Formulated Glycol Base Engine Coolant for Heavy Duty Engines[3]
D 6660 Test Method for Freezing Point of Aqueous Ehtylene Glycol Base Engine Coolants by Automatic Phase Transition Method[3]
E 394 Test Method for Iron in Trace Quantities Using the 1,10-Phenanthroline Method[3]
E 1177 Specification for Engine Coolant Grade Glycol[3]

2.2 *Other Documents*

SAE HS40 Maintenance of Automotive Engine Cooling Systems[5]
ASTM MNL 6 Manual on the Selection and Use of Engine Coolants and Cooling System Chemicals[6]

3. General Requirements

3.1 Engine coolant concentrates or prediluted glycol base engine coolants shall be formulated with either ethylene glycol or propylene glycol meeting Specification E 1177, water, and shall contain suitable corrosion inhibitors, dye, and a foam suppressor.

3.2 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.

3.3 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.

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

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

Property	Specific Values	ASTM Test Method
Chlorides, ppm (grains/gal)	25 (1.5) max	D 512, D 4327
Sulfate, ppm (grains/gal)	50 (3.0) max	D 516, D 4327
Hardness, as $CaCO_3$, ppm (grains/gal)	20 (1.2) max	D 1126
pH	5.5 to 8.5	D 1293
Iron, ppm (grains/gal)	1.0 (0.06) max	E 394

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 or II) diluted to 50 volume % with water of at least the quality outlined in Table X1.1.

3.6 When diluting engine coolant concentrates for actual service, use a municipal (treated) water, or a low-mineral content well water (see Appendix X1, Table X1.1). If such water is not available, use deionized (demineralized) or distilled water. This procedure will minimize the formation of hard water scale and avoid the introduction of mineral components, such as chlorides and sulfates, that can increase the corrosion rate of aluminum and iron.

3.7 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.

4. Detailed Requirements

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

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

4.3 All coolant concentrates and prediluted coolants shall conform to the performance requirements listed in Table 3.

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

4.5 If necessary, the freezing point of prediluted coolants shall be adjusted with deionized water before proceeding with performance testing. The freezing point of prediluted ethylene glycol base coolants (Type III) shall be −37°C (−34°F) and that of prediluted propylene glycol base coolants (Type IV) shall be −32°C (−26°F).

4.6 Adjusted, prediluted engine coolant performance test solutions shall be prepared as described in Table 3, Footnotes B through F.

5. Keywords

5.1 engine coolant; engine coolant concentrate; ethylene glycol; light duty engine coolant; prediluted engine coolant; propylene glycol

[5] SAE Handbook, available from Society of Automotive Engineers, 400 Commonwealth Dr., Warrendale, PA 15096.
[6] Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428.

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 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 is 40 to 70 %.

X1.2 *Essential Cooling System Service:*[7]

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).

[7] *Engine Coolant System Care*, Chemical Specialties Manufacturers Association (CSMA), Washington, DC, Ninth revision, 1984. Available from CSMA, 1913 I St. NW, Washington, DC 20006.

TABLE X1.1 Suggested Water Quality Limits[A]

Property	Specific Values	ASTM Test Method
Total solids, ppm (grains/gal)	340 (20) max	D 1888
Total hardness, ppm (grains/gal)	170 (10) max	D 1126
Chlorides, ppm (grains/gal)	40 (2.4) max	D 512, D 4327
Sulfate, ppm (grains/gal)	100 (5.9) max	D 516, D 4327
pH	5.5–9.0	D 1293

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

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.

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. ASTM MNL 6 provides suggestions for proper water quality limits.

X1.5 *Caution*—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.

X1.6 Additional information can be found in ASTM MNL 6.

X1.7 Other sources of information are SAE HS40 and *Engine Cooling System Care*,[7] published by the Chemical Specialties Manufacturers Association.

X2. DETERMINATION OF FREEZE POINT

X2.1 If propylene glycol (PG) base coolants and ethylene glycol (EG) base coolants 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 PG base engine coolants or mixtures of 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 (e.g., 80/20), which, in turn may cause engine and cooling system problems. A hydrometer specifically calibrated to the relative density of PG must be used to determine the freezing point of PG base coolants. A convenient and preferred means of determining the freeze points for PG coolants or mixtures of PG and EG coolants is by the refractometer. Table X2.1 lists methods for determining the freeze point of PG base engine 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 be labeled with an appropriate cautionary

TABLE X2.1 Methods for Determining Freeze Points

Method	Base Glycol		
	Ethylene	Propylene	Mixture
Refractometer	yes	yes[A]	yes[B]
Hydrometer	yes[C]	yes[D]	no
Test Strips	yes	yes	yes

[A] Must be a refractometer with either a PG freeze point scale or a dual scale with both PG and EG.

[B] 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.

[C] Conventional field service hydrometers calibrated for use with ethylene glycol base coolants.

[D] Hydrometer shall be specifically calibrated for use with PG base coolants.

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.

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 does 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 recycled or reprocessed used coolant or reprocessed industrial-sourced glycols.

X3.2 Committee D15 has investigated the effects of potential contaminants and has established separate specifications for recycled and reformulated coolants.

X3.3 Users of this specification should be aware that it applies only to coolants manufactured from new or virgin ingredients.

X4. LABELING

X4.1 It is recommended that prediluted engine coolants (Type III and IV) 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.