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Standard Specification for Fully-Formulated 1,3 Propanediol (PDO) Base Engine Coolant for Heavy-Duty Engines[1]

This standard is issued under the fixed designation D7517; 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 fully-formulated glycol base coolants for cooling systems of heavy-duty engines. When concentrates are used at 40 to 60 % PDO concentration by volume in water of suitable quality, (see Appendix X1), or when prediluted PDO base engine coolants (50 volume % minimum) are used without further dilution, they will function effectively during both winter and summer to provide protection against corrosion, cavitation, freezing, and boiling.

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

Coolant Type	Description
I-FF	1,3 Propanediol base concentrate
II-FF	1,3 Propanediol predilute (50 vol %)

1.3 Coolant concentrates meeting this specification do not require any addition of Supplemental Coolant Additive (SCA) until the first maintenance interval when a maintenance dose of SCA is required to continue protection in certain heavy-duty engine cooling systems, particularly those of the wet cylinder liner-in-block design. The SCA additions are defined by and are the primary responsibility of the engine manufacturer or vehicle manufacturer. If they provide no instructions, follow the SCA supplier's instructions.

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

1.5 *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]

D512 Test Methods for Chloride Ion In Water
D516 Test Method for Sulfate Ion in Water
D1126 Test Method for Hardness in Water
D1287 Test Method for pH of Engine Coolants and Antirusts
D1293 Test Methods for pH of Water
D4327 Test Method for Anions in Water by Suppressed Ion Chromatography
D4725 Terminology for Engine Coolants and Related Fluids
D5827 Test Method for Analysis of Engine Coolant for Chloride and Other Anions by Ion Chromatography
D5828 Test Method for Compatibility of Supplemental Coolant Additives (SCAs) and Engine Coolant Concentrates
D6130 Test Method for Determination of Silicon and Other Elements in Engine Coolant by Inductively Coupled Plasma-Atomic Emission Spectroscopy
D7518 Specification for 1,3 Propanediol (PDO) Base Engine Coolant for Automobile and Light-Duty Service
E394 Test Method for Iron in Trace Quantities Using the 1,10-Phenanthroline Method

2.2 *Other Documents*[3]

Federal Method 2540B Total Dissolved Solids Dried at 103-105°C

3. Terminology

3.1 *Definitions:*

3.1.1 *supplemental coolant additive (SCA), n*—an additive used in conventionally inhibited heavy-duty engine coolants required to maintain protection against general corrosion, cylinder liner pitting, and scaling in heavy-duty engines.

3.1.2 For other definitions used in this specification, refer to Terminology D4725.

[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.

[3] Standard Method for the Examination of Water and Wastewater, American Public Health Association, et al, 1015 15th Street, N.W. Washington, DC 20005.

4. General Requirements

4.1 Concentrated and prediluted coolants shall meet all of the respective requirements of Specification D7518.

4.2 The coolant concentrate mixed with water or the prediluted coolant, when maintained with maintenance does of SCA in accordance with the engine manufacturer's recommendations, and those on the product label, shall be suitable for use in a properly maintained cooling system in normal service for a minimum of two years (See Appendix X1).

5. Additional Requirements

5.1 The coolant concentrate or prediluted coolant additionally shall provide protection in operating engines against cavitation corrosion (also termed liner pitting) and against scaling of internal engine hot surfaces. Hot surfaces typically are within the engine head, head spacer, upper cylinder liner, or liquid cooled exhaust manifold. ASTM has test methods under development for both cavitation corrosion and hot surface scaling. Until these procedures are approved as ASTM standards, the mandatory requirements of Annex A1 shall apply.

5.2 Both the concentrated and prediluted coolants shall contain less than 50 µg/g sulfate ion.

6. Keywords

6.1 1,3-propanediol; cavitation; fully-formulated heavy-duty engine coolant; maintenance dose; PDO; supplemental coolant additive

ANNEX

A1. CHEMICAL REQUIREMENTS FOR FULLY FORMULATED HEAVY-DUTY ENGINE COOLANT

A1.1 Laboratory data or in-service experience demonstrating a positive influence on reducing cavitation corrosion in an operating engine is required.

A1.1.1 In-service qualification tests may consist of single- or multiple-cylinder engine tests. At the option of the engine or vehicle manufacturer, such testing may be conducted in "loose engines (that is, engines modified to induce liner cavitation)" or in engines fully integrated into an application, such as a vehicle, a powerboat, or a stationary power source. One such test has been developed.[4]

A1.2 Several chemical compositions have been tested extensively by producers and users and satisfactorily minimize cylinder liner cavitation in actual test engines. Coolants meeting either of the following compositions are regarded as passing the requirements of A1.1.

A1.2.1 A minimum concentration of nitrite (as NO_2^-) of 1200 µg/g in the 50 volume % predilute coolant, or

A1.2.2 A minimum combined concentration of nitrite (as NO_2^-) plus molybdate (as MoO_4^{-2}) in the 50 volume % predilute coolant of 780 µg/g. At lest 300 µg/g each of NO_2^- and MoO_4^{-2} must be present.

A1.2.3 The above concentrations are doubled for coolant temperature.

A1.3 Chemical composition requirements for cavitation corrosion protection will be removed from this specification and replaced with an ASTM test method when a test method is developed and adopted.

A1.4 Both concentrated and prediluted coolants under this specification must contain additives to minimize hot surface scaling deposits. Certain additives (polyacrylate and other types) minimize the deposition of calcium and magnesium compounds on heat rejecting surfaces. No specific chemical requirements for hot surface scaling and deposits resistance have been established at this time. A test procedure is under development and will be incorporated into the specification when a procedure is approved by ASTM.

A1.5 Lack of compatibility between the coolant and SCA product's chemistry results in chemical ingredient dropout from solution, with potential adverse effects in the vehicle or engine cooling system. A test procedure for compatibility (Test Method D5828) has been approved and will be incorporated into the specification when limits are determined.

[4] "A Comparison of Engine Coolant in an Accelerated Heavy-Duty Engine Cavitation Test," SAE Technical Paper 960883, SAE International, 400 Commonwealth Drive, Warrendale, PA 15096–0001.

APPENDIX

X1. COOLANT MAINTENANCE FOR HEAVY-DUTY ENGINES

X1.1 *Engine Coolant*—Cooling system fill for a heavy-duty engine consists of water and fully formulated heavy-duty coolant concentrate or fully formulated prediluted heavy-duty coolant.

X1.1.1 *Water:*

X1.1.1.1 Water quality affects the efficiency of coolant additives. When untreated, all water is corrosive. Water having a high mineral content or corrosive materials is unfit for cooling system use.

X1.1.1.2 When preparing coolant mixtures, 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 analysis if there is a question on water quality.

X1.1.2 *Coolant Concentrates:*

X1.1.2.1 The coolant concentration should be maintained between 40 and 60 % PDO by volume, depending on the engine operating environment. Freeze protection will be provided in accordance with Table X1.2.

X1.1.3 *Prediluted Engine Coolants:*

X1.1.3.1 Prediluted glycol base engine coolants (50 volume % minimum) should be used without further dilution. If additional freeze protection is required, coolant concentrate may be added to the prediluted engine coolant to increase the total glycol content in the cooling system (see Table X1.2).

X1.1.4 *Supplemental Coolant Additive:*

X1.1.4.1 SCAs extend the life of the coolant by replenishing the additives that deplete during normal operation. SCAs, however, do not extend the freeze protection provided by the coolant concentrate.

X1.1.4.2 Heavy-duty engine users experience has shown that compositions below those defined in A1.2 may not provide long-term protection against cavitation corrosion (liner pitting). User experience and published information shows the presence of nitrite in an SCA or fully-formulated heavy-duty coolant is particularly effective in providing maximum protection.

X1.1.4.3 New technology consisting of other chemistries may provide satisfactory protection. Such chemistries can be established by agreement between producers and users upon demonstration of performance. Such demonstrations can consist of comparative laboratory cavitation tests or comparative damage rating from testing in operating engines. One or both of these options may be applied as determined in a specific agreement between parties. An engine test has been developed.[4]

TABLE X1.1 Suggested Water Quality Limits[A]

Property	Specific Values	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
Chloride (Cl), µg/g (ppm, grains/gal)	40 (2.4) max	D5827, D512, D4327
Sulfate (SO_4), µg/g (ppm, grains/gal)	100 (5.9) max	D5827, D516, D4327
pH	5.5 – 9.00	D1287, D1293
Iron (Fe), µg/g (ppm, gal)	1.0 (0.6) max	D6130, E394

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

TABLE X1.2 Freeze Protection

Approximate Freeze Protection Temperature, °C (°F)	
Glycol Content, %	Coolant Type I-FF
40	−18 (−1)
50	−28 (−18)
60	−44 (−47)

X1.2 *Coolant Maintenance Recommendations*:

X1.2.1 If any of the following recommendations differ, follow the engine or vehicle manufacturer's recommendations.

X1.2.2 Use the coolant concentration recommended in this specification.

X1.2.3 Drain and flush the cooling system as recommended by the engine or vehicle manufacturer.

X1.2.4 Use water that meets the requirement of Table X1.1.

X1.2.5 Use accurate, reliable equipment, such as a refractometer, to measure coolant concentrate levels for freeze protection.

X1.2.6 Use the SCA manufacturer's recommended test kit when testing the coolant for proper additive concentration. Test kits shall indicate the degree of liner pitting protection present in the coolant.

X1.2.7 Check freezing point at two different levels when coolant concentrate and water is premixed and stored in bulk or drums to be sure mixing is complete before use.

X1.2.8 Use coolant mixed at the desired proportions for make-up.

X1.2.9 Use SCAs at the recommended maintenance dosage and intervals to control deposits, corrosion, water pump damage, and liner pitting.

X1.2.10 Periodically check bulk premixed coolant storage tanks for separation of chemicals and contamination.

X1.2.11 DO NOT add undiluted coolant concentrate as make-up coolant for coolant Types I-FF and II-FF.

X1.2.12 DO NOT add plain water as make-up coolant.

X1.2.13 DO NOT exceed 60 % coolant concentrate in Type I-FF and Type II-FF coolants. The maximum recommended coolant concentrate level is 60 % which provides the freeze protection shown in X1.1.2.

X1.2.14 DO NOT exceed the manufacturer's recommended dosage of SCA or the recommended concentration of coolant

concentrate. Over-concentration can result in plugged radiators, heater cores, and charge air coolers and can also cause water pump seal leaks.

X1.2.15 DO NOT reuse coolant that has been drained from a vehicle.

X1.2.16 DO NOT precharge the cooling system with SCA when using fully-formulated heavy-duty engine coolant.

X1.2.17 DO NOT use soluble oil additives.

X1.2.18 DO NOT use methyl alcohol or methoxypropanol base coolant concentrates.

X1.2.19 DO NOT use anti-leak additives if engine cooling system is equipped with a coolant filter, as this may plug the filter element. For all other cooling systems, follow the recommendations of the engine or vehicle manufacturer.