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Standard Specification for Fully-Formulated Glycerin Base Engine Coolant for Heavy-Duty Engines[1]

This standard is issued under the fixed designation D7715; 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.

ε[1] NOTE—Caution statement in X3.1.4 was changed to a Warning and editorial changes were made throughout in May 2016.

1. Scope

1.1 This specification covers the requirements for fully-formulated glycerin base coolants for cooling systems of heavy-duty engines. When concentrates are used at 40 to 60 % glycerin concentration by volume in water of suitable quality (see Appendix X1), or when prediluted glycerin base engine coolants (50 volume % min) 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 This specification is intended to cover the requirements for engine coolants prepared from virgin glycerin.

NOTE 1—This specification is based on the knowledge of the performance of engine coolants prepared from new or virgin ingredients that comply with Specification D7714.

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

Coolant Type	Description
V-FF	Glycerin base concentrate
VI-FF	Glycerin predilute (50 vol %)

1.4 Coolant concentrates meeting this specification do not require 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.

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

1.6 *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]

D1126 Test Method for Hardness in Water
D1293 Test Methods for pH of Water
D3306 Specification for Glycol Base Engine Coolant for Automobile and Light-Duty Service
D3321 Test Method for Use of the Refractometer for Field Test Determination of the Freezing Point of Aqueous Engine Coolants
D4327 Test Method for Anions in Water by Suppressed Ion Chromatography
D4725 Terminology for Engine Coolants and Related Fluids
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
D7583 Test Method for John Deere Coolant Cavitation Test
D7714 Specification for Glycerin Base Engine Coolant for Automobile and Light-Duty Service
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

2.2 *Other Standards:*[3]

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

[1] This specification is under the jurisdiction of ASTM Committee D15 on Engine Coolants and Related Fluids and is the direct responsibility of Subcommittee D15.93 on Research and Long Range Planning.

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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, 801 I Street, NW, Washington, DC 20001, http://www.apha.org.

3. Terminology

3.1 *Definitions:*

3.1.1 *glycerin base engine coolant, n*—engine coolant in which the freeze point depressant is 1,2,3 propane triol, with inhibitors to minimize foaming and corrosion.

3.1.2 *supplemental coolant additive (SCA), n*—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.

3.1.3 For other definitions and terms used in this specification, refer to Terminology D4725.

4. General Requirements

4.1 Concentrated and prediluted coolants shall meet all of the physical, chemical and performance requirements of Specification D7714, Tables 1, 2, and 3.

4.2 The coolant concentrate mixed with water or the prediluted coolant, when maintained with maintenance doses 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 (Test Method D7583).

5.2 Lack of compatibility between the coolant and SCA product's chemistry may cause the solute to precipitate out of solution, with potential adverse effects in the vehicle or engine cooling system. A test procedure for compatibility (Test Method D5828) has been developed and approved. The compatibility of SCA and coolant concentrate solutions meeting this specification shall be determined using (Test Method D5828) and the results reported.

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

6. Keywords

6.1 cavitation; fully-formulated heavy-duty engine coolant; glycerin; supplemental coolant additive maintenance dose

ANNEX

(Mandatory Information)

A1. 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 (see Table A1.1).

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

TABLE A1.1 Cavitation Protection Options Meeting the Requirements of Annex A1

Utilize One of the Following	Predilute or Concentrate	Acceptance Criteria
In-service test	Per agreement	Agreement between engine manufacturer and coolant supplier for test criteria
Laboratory test (Test Method D7583)	Per tested formulation	200 pit count measured per Test Method D7583, max
Chemical composition nitrite formulation	Predilute	Nnitrite (as NO_2^-) of 1200 µg/g (ppm), min
Nitrite formulation	Concentrate	Nitrite (as NO_2^-) of 2400 µg/g (ppm), min
Combined nitrite and molybdate formulation	Predilute	Combined concentration of nitrite (as NO_2^-) plus molybdate as (MoO_4^{-2}) of 780 µg/g (ppm), min (at least 300 µg/g (ppm) each of NO_2^- and MoO_4^{-2} must be present)
Combined nitrite and molybdate formulation	Concentrate	Combined concentration of nitrite (as NO_2^-) plus molybdate (as MoO_4^{-2}) of 1560 µg/g (ppm), min (at least 600 µg/g (ppm) each of NO_2^- and MoO_4^{-2} must be present)

engines" or in engines fully integrated into an application, such as a vehicle, a power boat, or a stationary power source. One such test has been developed.[4]

A1.1.2 Coolants that have completed Test Method D7583 with a maximum pit count of 200 are regarded as passing the requirements of Annex A1.

A1.1.3 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 Annex A1:

A1.1.3.1 A minimum concentration of nitrite (as NO_2^-) of 1200 µg/g (ppm) in the 50 volume % prediluted coolant, or

A1.1.3.2 A minimum combined concentration of nitrite (as NO_2^-) plus molybdate (as MoO_4^{-2} in the 50 volume % prediluted coolant of 780 µg/g (ppm). At least 300 µg/g (ppm) each of NO_2^- and MoO_4^{-2} must be present.

A1.1.3.3 The above concentrations are doubled for coolant concentrates.

A1.2 Both concentrated and prediluted coolants under this specification shall 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 by ASTM Committee D15 and will be incorporated into the specification when approved.

[4] "A Comparison of Engine Coolant in an Accelerated Heavy-Duty Engine Cavitation Test," SAE Technical Paper 960883, SAE International, 400 Commonwealth Dr., Warrendale, PA 15096, http://www.sae.org.

APPENDIXES

(Nonmandatory Information)

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 manufacture, 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 50 and 60 % glycerin by volume, depending on the engine operating environment. Freeze protection shall be provided in accordance with Table X1.2.

X1.1.3 *Prediluted Engine Coolants:*

X1.1.3.1 Prediluted glycerin 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 glycerin 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 coolants not meeting the criteria specified in Annex A1 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

TABLE X1.1 Suggested Water Quality Limits[A]

Property	Specific Values	Test Method
Total solids, µg/g (ppm (grains/gal))	340 (20) max	Fed Method 2540B
Total hardness, µg/g (ppm (grains/gal))	170 (10) max	D1126
Chloride (Cl), µg/g (ppm (grains/gal))	40 (2.4) max	D4327
Sulfate (SO_4), µg/g (ppm (grains/gal))	100 (5.9) max	D4327
pH	5.5 to 9.0	D1293

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

TABLE X1.2 Freeze Protection

Approximate Freeze Protection Temperature, °C (°F)	
Glycerin Content, %[A]	Coolant Type V-FF
40	–18.0 (–0.0)
50	–27.0 (–16.6)
60	–44.0 (–42.0)

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

demonstration of performance utilizing Test Method D7583. Optionally, such demonstrations can consist of 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.

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 in Table X1.1.

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

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 Type V-FF.

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

X1.2.13 DO NOT exceed 60 % coolant concentrate in Type V-FF coolant. A coolant concentrate level greater than 63 % actually reduces freeze protection in glycerin base 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.

X2. DETERMINATION OF FREEZE POINT

X2.1 If gycerin, 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 relative density of EG base coolants. These hydrometers cannot be used to determine the freeze point of glycerin or 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 glycerin or PG shall be used to determine the freezing point of Ggycerin or PG base coolants. A convenient and preferred means of determining the freeze points for glycerin coolants or mixtures of glycerin, PG and EG coolants is by the refractometer (see Test Method D3321). Table X2.1 lists methods for determining the freeze point of glycerin base engine coolants when used either alone in the cooling system or mixed with PG or EG base coolants. The refractometer provides the most accurate method for measuring freeze points in the field. Hand held refractometers are available for glycerin, propylene glycol and ethylene glycol base coolants. Dip–and-read test strips will provide only an approximation of freeze point for glycols. Additional field instruments are under development for glycerin base coolants and glycerin/glycol.

TABLE X2.1 Methods for Determining Freeze Points

Method	Glycerin
Refractometer [A, B]	yes
Hydrometer	no
Test strips	no

[A] Shall be a refractometer with a glycerin freeze point scale.
[B] Test methods have been developed to measure the freeze points in mixtures. Refractometers are being developed by coolant producers and automotive dealers to measure glycol/glycerin coolant blends.

X2.2 It is recommended that glycerin base coolant (either Type V or VI) containers be labeled with an appropriate cautionary statement to alert the user to the differences described in X1.1.1. 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 glycerin base coolant.

X3. LABELING

X3.1 It is recommended that prediluted engine coolants (Type II) meeting this specification have the following information on the package label:

X3.1.1 Prediluted engine coolant,

X3.1.2 Ready for use, do not add water, and

X3.1.3 **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.

X3.1.4 **Warning—**Contains glycerin base coolant.

X4. HANDLING

X4.1 Glycerin concentrate (Type I) engine coolant has a much higher viscosity than traditional glycol base engine coolants. It is recommended that the coolant manufacturer provide guidelines to the customer on proper handling and storage. In general, steaming bulk Type V glycerin concentrate to 110 to 120°F or putting packaged product in a hot room will allow the product to be pumped into finished formulations containing water.