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Standard Practice for Testing Engine Coolants in Car and Light Truck Service[1]

This standard is issued under the fixed designation D2847; 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 practice covers an updated procedure for evaluating corrosion protection and performance of an engine coolant in passenger car, light and heavy duty truck service that closely imitates current vehicle and engine manufacturers practices.

NOTE 1—Coolant evaluation in vehicle service may require considerable time and expense; therefore, the product should be pretested in the laboratory for general acceptability. Typical tests vary from small, closely controlled tests, to large tests where close control is not always practical. The most often referenced protocols for laboratory testing are defined in Specifications D3306, D6210, D7517, D7518, D7714, and D7715.

1.2 The units quoted in this practice are to be regarded as standard. The values given in parentheses are approximate equivalents 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.* Specific precautionary statements are given in Section 7.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1121 Test Method for Reserve Alkalinity of Engine Coolants and Antirusts

D1287 Test Method for pH of Engine Coolants and Antirusts

D2809 Test Method for Cavitation Corrosion and Erosion-Corrosion Characteristics of Aluminum Pumps With Engine Coolants

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

D4725 Terminology for Engine Coolants and Related Fluids

D5827 Test Method for Analysis of Engine Coolant for Chloride and Other Anions by Ion Chromatography

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

D7517 Specification for Fully-Formulated 1,3 Propanediol (PDO) Base Engine Coolant for Heavy-Duty Engines

D7518 Specification for 1,3 Propanediol (PDO) Base Engine Coolant for Automobile and Light-Duty Service

D7714 Specification for Glycerin Base Engine Coolant for Automobile and Light-Duty Service

D7715 Specification for Fully-Formulated Glycerin Base Engine Coolant for Heavy-Duty Engines

3. Terminology

3.1 *Definitions*—Refer to Terminology D4725.

4. Summary of Practice

4.1 Test coolant shall be a new coolant. The coolant is tested at the recommended concentration in an aqueous solution made with water that complies with the water recommendation published in Specifications D3306 and D6210. A minimum of five test vehicles per coolant are required, ten are recommended, but this number may be adjusted by agreement between customer and supplier. The test vehicles shall have been in service less than 3 months, 3000 miles, 5000 km, or 500 operating hours. Alternate specific requirements may always be agreed between customer and supplier. Customer and supplier may also choose to follow requirements published in Original Engine Manufacturer (OEM) specifications. The cooling system components and coolant are inspected according to a prescribed schedule to provide the basis for coolant performance evaluation.

4.2 A detailed cleaning and conditioning procedure is essential to obtain statistically significant and reproducible results.

5. Significance and Use

5.1 The data obtained from the use of this practice will provide a basis for the evaluation of coolant performance in

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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.

passenger car. light and heavy duty truck service (according to the test vehicles chosen). The data obtained may also be used to provide added significance to the data obtained from simulated service and engine dynamometer tests.

6. Apparatus

6.1 *Test Vehicles*—In selecting vehicles, refer to OEM recommendations. Consideration should be given to the current range of cooling system designs and materials. Engines specified should be reasonably available for the test, which is to say of current production design and materials. A matrix including every possible variable combination of such features is not required.

7. Safety Precautions

7.1 All coolant concentrates and their solutions should be considered harmful or fatal if swallowed.

7.2 (**Warning—**Do not remove pressure caps from systems when the engine is hot.)

7.3 All installations shall be made with the engine cooled to ambient air temperature to avoid burns.

7.4 Disconnect the hot (positive) battery lead to prevent the engine from starting to avoid hand injury by drive belts or fan blades.

7.5 The engine exhaust should be vented when the engine is run indoors at normal temperatures to check for cooling system leaks.

8. Sampling

8.1 Coolant samples may be removed from the test vehicle by any convenient means, such as a bulb and pipette. The 100-mL (~3.5 oz) coolant samples are kept in polyethylene bottles equipped with screw caps and suitable labels. A reserve supply of pre-mixed coolant is used to replace the coolant samples. Coolant added to the system for any reason is recorded in the test vehicle log.

9. Preparation of Apparatus

9.1 Obtain an initial sample of the coolant for laboratory analysis. This is the "0" miles sample. Record the odometer reading, date and time of initial sampling. Record other data as agreed between customer and supplier. Follow OEM or manual instruction, or both, for deaeration to ensure engine is properly deaerated at start of the field test.

9.2 Label the radiator and expansion reservoir fill caps conspicuously to show a coolant test is being conducted, and include instructions with whom to contact in case coolant additions are needed or other problems occur.

10. Procedure

10.1 Test the coolant being evaluated in a minimum of five vehicles at the recommended concentration (typically 50 % antifreeze and 50 % water as recommended in Specifications D3306, D6210 but may be adjusted as agreed between customer and supplier).

10.2 Vehicle operating conditions may vary considerably in any test fleet. Record the type of service for each vehicle. Mileage accumulation rates may vary considerably. Therefore, the recommended inspections in 10.5 may be difficult to schedule. Alternative inspection and sampling schedules may be developed as agreed between customer and supplier.

10.3 All tests to determine the necessity of adding SCA or an extender should be logged as well as the addition of the SCA or an extender. Field testing can be done by using Test Strips.

10.4 Use water that complies with Specifications D3306, D6210 to dilute the antifreeze (field testing can be done with water quality test strips), and blend the test coolant. Additions to the cooling system during the test should be the prescribed mixture of 50 % coolant meeting Specifications D3306, D6210, and volumes added shall be recorded in the vehicle test log.

TABLE 1 Periodic Inspections

Occurrence	Operational Sequence
Initial 15 to 30 min and 10 h or 800 km (500 miles), Light & Medium Duty: 5000 miles or 8000 km thereafter Heavy Duty: 20 000 miles or 32 000 km thereafter	Take a 100-mL (~3.5 oz) coolant sample and replace with reserve coolant. Analyze the samples for pH (Test Method D1287), reserve alkalinity (Test Method D1121), inhibitor concentrations (Test Methods D5827, D6130, etc.) and freezing protection. (Test Method D3321) FP by refractometer for field use. Perform other tests as agreed between customer and supplier.
After each refueling	Without opening the system, and only if possible, visually check coolant level at operating temperature. If required, allow the system to cool to ambient temperature. Adjust to proper level in coolant reservoir and record the volume of coolant added in the vehicle test log. Do not overfill the cooling system.
At OEM recommended filter change interval	Inspect filter media for rust, debris or other deposits (may require to cut the filter canister)
At the end of test or as agreed between customer and supplier) Follow OEM's recommendation	Terminate test. Check cooling system for aeration and cylinder head gasket failure. Retain a 4-L (1-gal) coolant sample. Remove and retain all radiator and heater hoses. Remove and retain coolant (water) pump and inspect these and the visible interior surface of the engine. Remove and retain the radiator. As agreed between customer and supplier, a more extensive inspection and analysis may be performed on the engine components. Record necessary vehicle data and finalize maintenance records in the test vehicle log. See 11.1 – 11.3.

10.5 Perform periodic inspections throughout the test per minimum requirements as given in Table 1 or recommendations of OEM or agreed to by customers and supplier.

11. Inspection

11.1 Harvest three tubes from the top, center and bottom of the radiator. Open the tubes by removing one edge and "butterflying" the tube. Inspect and photograph the tubes. Record observations. As agreed between customer and supplier, a more extensive inspection and analysis may be performed on the radiator components.

11.2 Inspect, rate and photograph the water pump. Refer to Test Method D2809 for inspection and rating guidelines. Water pumps differ in construction and materials, so the exact procedures in Test Method D2809 may need to be adjusted as agreed between customer and supplier.

11.3 Harvest sections from the radiator and heater hoses. Open the hoses and spread the tubes to permit interior inspection. Inspect and photograph the hose materials. Record observations. As agreed between customer and supplier, a more extensive inspection and analysis may be performed on the hose components.

11.4 In heavy duty engines equipped with wet sleeve cylinder liners, the liners must be inspected for pitting corrosion, - Rated - Pass/Fail per agreement of customer and supplier.

11.5 Additional engine inspections may be performed as agreed between customer and supplier (water passages in block/heads, and thermostats/thermostat housing for rust/corrosion or deposits, or both).

12. Report

12.1 *Test Equipment and Operating Conditions:*

12.1.1 Test period and location.

12.1.2 Vehicle make, model, and type service.

12.1.3 Engine displacement, coolant capacity, condition of cooling system and points of inspection, metallurgy of engine and cooling system components, and relevant inspection data.

12.1.4 Radiator make, model, and its condition after fleet test. Document final condition with photographs.

12.1.5 Radiator hose make and type and its condition after test. Document final condition with photographs.

12.1.6 Initial and final odometer readings.

12.1.7 Initial and final engine hour totalizer readings (if used).

12.1.8 Any relevant remarks regarding unusual cooling system maintenance or vehicle use.

12.1.9 Initial and final pressure test data on cap and system (optional).

12.1.10 Coolant temperature and operating conditions (optional).

12.2 *Coolant Information:*

12.2.1 Freezing point (or concentration of products other than antifreeze).

12.2.2 pH of all samples.

12.2.3 Reserve alkalinity of all samples.

12.2.4 Foaming tendency of final samples (optional).

12.2.5 Required additions of test coolant.

12.2.6 Change in solution appearance, that is, dye fading, accumulation of rust, sediment, etc.

12.2.7 Odor development.

12.2.8 Copper, Lead, Aluminum and Iron concentration.

12.2.9 Corrosion inhibitors concentrated.

12.3 *Corrosion Inhibitor Data:*

12.3.1 Record any pitting, etching, copper plating, metal surface phenomena, erosion, cavitation, or crevice corrosion.

12.3.2 Record any visible corrosion in the radiator and engine interior; also, any visible corrosion, erosion, or cavitation damage of the coolant pump and coolant outlet.

12.3.3 Report and plot behavior of additive concentrations plots time or miles.

12.3.4 Calculate and report percent of additive depleted, correcting for additions of coolant during the test period.

12.4 *Cleaning Procedure*—The exact cleaning procedure of any components shall be described.

13. Keywords

13.1 antifreeze; coolant evaluation; metal corrosion; vehicle service

APPENDIX

(Nonmandatory Information)

X1. NOTES ON THE DEVELOPMENT, SIGNIFICANCE, INTERPRETATION, REPEATABILITY, AND REPRODUCIBILITY OF THE PRACTICE FOR THE EVALUATION OF COOLANTS IN VEHICLE SERVICE

X1.1 Historical Background

X1.1.1 This practice is representative of the basic procedures used by major producers and users of automotive coolant. Evolutionary improvements in technology, apparatus design, and the basic concept of testing coolants have resulted in the publication of this practice. The concentrated and cooperative efforts of Committee D15 have for many years used extensive coolant vehicle test data for the development of useful and significant laboratory and simulated service test methods. These laboratory methods are widely used, by producers and users, as quality control and specification tests. In 1962, it was agreed that a study group should be formed for the specific purpose of developing a recommended practice, or method, for the evaluation of automotive coolants in vehicle

service. The method developed was to be useful and practical to those concerned with the development, selling, purchasing, and use of antifreeze and automotive coolants. This development, therefore, involved the selection of the most important testing parameters for inclusion in the test method. The members of the study group on vehicle testing believed they had accomplished these objectives. In 1982, it was decided to update this practice, D2847, and to incorporate a very significant cleaning and conditioning procedure recommended by a member. In 2013 the method was again dramatically revised to represent the methods practiced in the 21st century, particularly useful for evaluating extended service coolant formulations.

X1.2 Significance

X1.2.1 The severity of this test is justifiable because it is designed to distinguish between coolants that are deficient, adequate, or superior. The use of "recommended coolant concentrations" allows for variations in antifreeze formulations and mixtures that may be appropriate in different climates and global operating environments. Procedures are necessarily flexible to provide meaningful determinations as defined by agreement between customers and suppliers. It is noted that this is a test method only, and no "pass/fail" parameters exist for Practice D2847. Given the open nature and variability provided for in this method, it would be grossly inappropriate for any entity to make a statement or claim such as "passes Practice D2847."

X1.3 Interpretation of Results

X1.3.1 When a coolant is evaluated by this practice, the test results will provide an evaluation of corrosion protection and coolant performance in the vehicles tested. The conclusions derived from the evaluation are expected to confirm the preliminary conclusions derived from pretesting the coolant in laboratory simulated service tests. Simulated service in engine dynamometer tests usually provides good correlation with field service data, provided the same test parameters are used. It may be expected that vehicle service will encounter a wider variation in test results for a given set of test conditions due to the increased number of variables.

X1.3.2 Where corrosion is uniform, the corrosion data will be more easily interpreted if expressed as inches of metal penetration. The investigator can then consider the percentage decrease in the as-manufactured metal thickness. Consideration of the reduction in metal thickness is particularly significant when the original metal thickness is about 0.0045 in. (0.1 mm), such as in the radiator.

X1.3.3 The type and nature of corrosion product accumulating on heat-transfer surfaces of the cooling system should also be given due consideration. The fouling of heat transfer surfaces with substantial corrosion deposits can result in engine malfunctions. Therefore, the coolant investigator is advised to give sufficient consideration to both the tabulated data and the detailed observation of the engine components.

X1.3.4 Various published ASTM analytical methods are useful in monitoring depletion of inhibitors.

X1.3.5 When the accumulated data indicate that a given coolant property has reached an unsatisfactory condition, a Weibull plot of the failures may aid in the interpretation of the data. Thus the data may be useful in predicting failure rates. at any selected time.

X1.4 Accuracy, Precision, Repeatability, and Reproducibility

X1.4.1 The objective of this practice is to provide a procedure for testing the corrosion protection and performance of an engine coolant in vehicle service. Because of the many test variables involved and the random nature of corrosion data, it is difficult to assess the repeatability and reproducibility of results. However, this practice should distinguish between coolants that are adequate, within the range of service stress incorporated into the test program, and those that are deficient or superior.