Designation: D 2847 – 99

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

This standard is issued under the fixed designation D 2847; 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 the procedure for evaluating corrosion protection and performance of an engine coolant in passenger car and light truck service.

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. Tests may vary from small, closely controlled tests, to large tests where close control is not always practical.

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 and Note A1.1.

2. Referenced Documents

2.1 *ASTM Standards:*

D 1121 Test Method for Reserve Alkalinity of Engine Coolants and Antirusts[2]

D 1287 Test Method for pH of Engine Coolants and Antirusts[2]

D 1384 Test Method for Corrosion Test for Engine Coolants in Glassware[2]

D 1881 Test Method for Foaming Tendencies of Engine Coolants in Glassware[2]

3. Terminology

3.1 *Definitions:*

3.1.1 *engine coolant*—a heat exchange fluid with good low-temperature properties used to transfer heat from an engine to the radiator, usually containing specific amounts of glycols, water, corrosion inhibitors, and a foam suppressor.

4. Summary of Practice

4.1 Standard metal corrosion specimens, mounted in special holders, are installed in the coolant flow of the test vehicles. The coolant is tested at the recommended concentration in a specified test water. A minimum of five test vehicles per coolant is required. The test duration in terms of time or mileage should be consistent with the recommended service life of the coolant. The vehicle, corrosion specimens, and coolant are inspected according to a prescribed schedule to provide the basis for coolant evaluation.

4.2 A detailed cleaning and conditioning procedure is essential to obtain statistically significant and reproducible results. New, or nearly new, vehicles are preferred for field tests.

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 passenger car and light truck service. 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 to be used to conduct field tests of coolants intended for automobiles and light trucks, consideration should be given to the current range of cooling system designs and materials. It is advisable to include both brazed aluminum and soldered copper/brass radiators as well as engines made of cast iron and those with aluminum heads or blocks, or both. A matrix including every possible variable combination of such features is not required, especially if vehicles representing the extremes are included in the field tests. This includes aluminum engine with aluminum radiator and heater core, cast iron engine with copper/brass radiator and heater core, and a cast iron engine with an aluminum radiator and a copper/brass heater core. Pressurized surge tanks as well as unpressurized coolant overflow reservoirs should be tested. Select vehicles that will be subjected to a wide range of operating schedules. These ranges should include high-usage vehicles which accumulate miles rapidly, vehicles operationally biased toward higher temperatures, and low-mileage vehicles (<1000 miles/month) that can develop accelerated localized corrosion due to non-flowing coolant. No single operating schedule is preferred over another. New, or nearly new, vehicles are preferred because of possible difficulties, explained in 9.2.1, in cleaning older cooling systems prior to test.

6.2 *Metal Corrosion Specimens*—The description, specification, preparation, cleaning, and weighing of the metal

[1] This practice is under the jurisdiction of ASTM Committee D-15 on Engine Coolants and is the direct responsibility of Subcommittee D15.10 on Dynamometer and Road Tests.

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

corrosion specimens used in this practice are given in detail in Test Method D 1384. The metal specimens are assembled for test as shown in Fig. 1. Each set of specimens is mounted in a canvas reinforced phenolic tube illustrated in Fig. 2. The specimen and tube assembly are placed in a capsule which is mounted in the vehicle cooling system. Two types of specimen capsules may be used; the by-pass (partial-flow) heater circuit type (Fig. 3) is the standard capsule, and the full-flow type (Fig. 4) is optional. The partial-flow heater circuit capsule is located between the heater supply and the heater-return line and shall contain two or more sets of specimens. The full-flow capsule is installed in the upper radiator hose and contains one or more sets of specimens.

6.2.1 The schematic of the specimen holder installation is shown in Fig. 5. Fig. 6 is a photograph of a typical installation of test capsules. The optional full-flow capsule should be mounted as low as possible in the upper radiator hose to ensure coolant coverage of the metal specimens when the vehicle is not in use. The partial-flow capsule must be mounted vertically to avoid trapped air. A pair of fabricated copper tees with ⅜-in (9.5-mm) outside diameter copper tubing side taps (Fig. 7) are spliced into the heater hose lines to provide a constant bypass flow through the specimen capsule. The circuit must be so arranged that coolant flows through the capsule whenever the vehicle is in operation. On air-conditioned vehicles with a vacuum-operated heater flow control valve, the by-pass tee must be installed ahead of the flow control valve to insure constant flow.

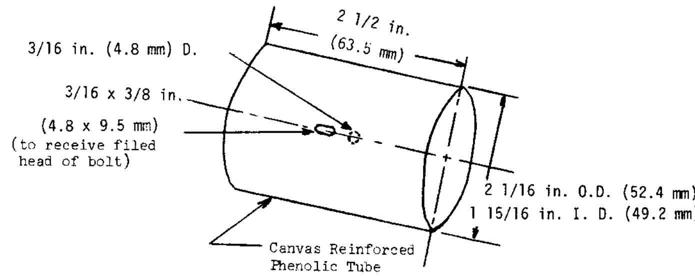


FIG. 2 Specimen Bundle Sleeve

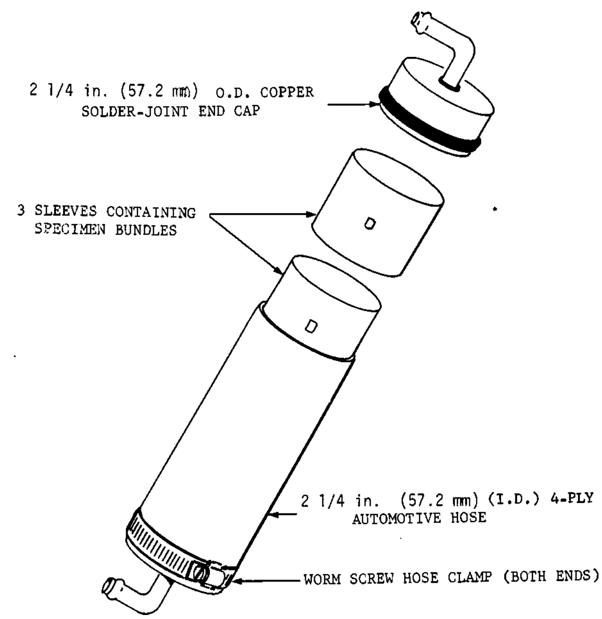


FIG. 3 By-Pass (Heater Circuit) Specimen Capsule

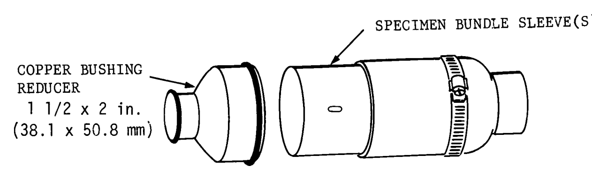


FIG. 4 Full-Flow Specimen Capsule

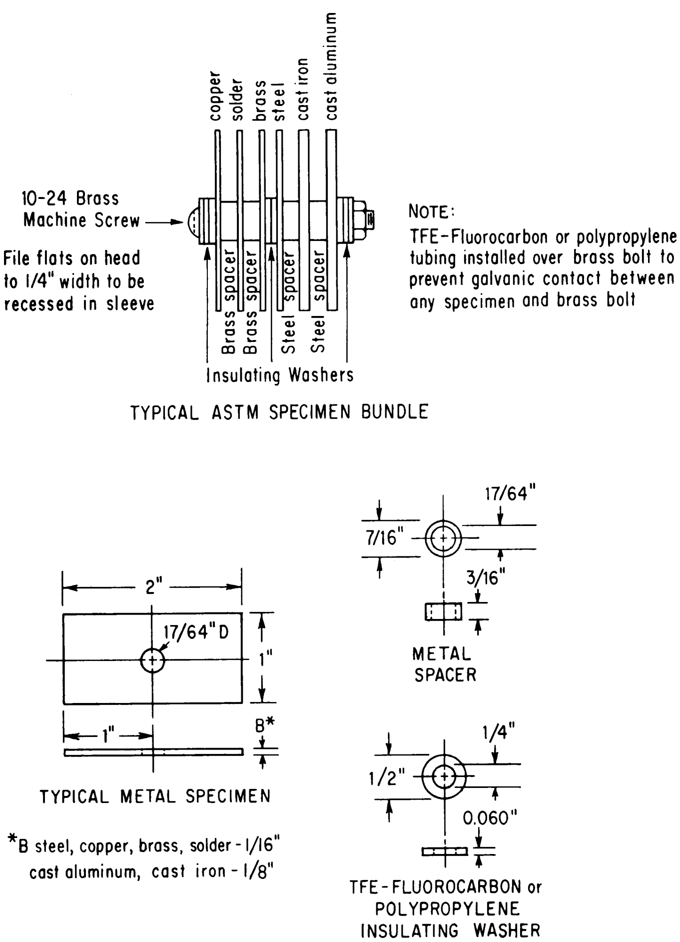


FIG. 1 Corrosion Specimen Bundle

7. Safety Precautions

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

7.2 Caution should be used when removing the radiator cap from a hot cooling system.

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 are removed from the test vehicle

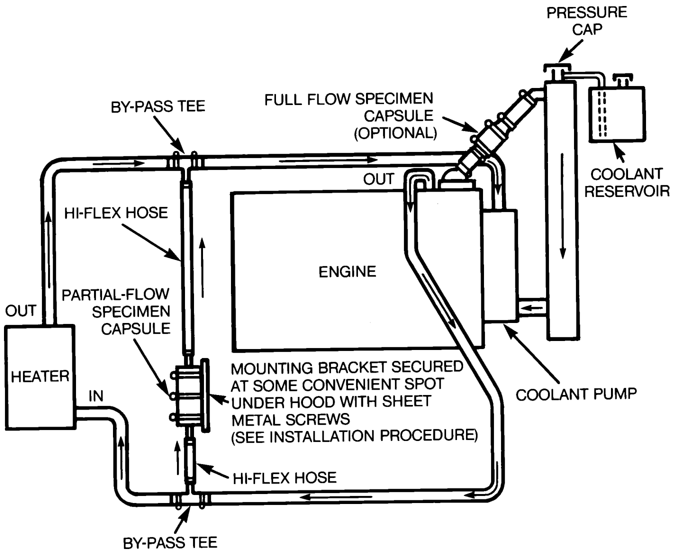


FIG. 5 Schematic of Specimen Capsule Installation

through the sample valve mounted on the partial-flow capsule. The 6-oz (180-mL) 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. If foaming tendency is not checked, a 2-oz (60-mL) sample is adequate.

9. Preparation of Apparatus

9.1 *Engine Reconditioning*:

9.1.1 Inspect the engine of the test vehicle carefully and complete any necessary repairs. Check the cooling system for the following common defects: cylinder head gasket failure resulting in exhaust gas contamination of the coolant, and air inducted into the coolant due to a worn coolant pump face seal or defective lower radiator hose connection.

9.2 *Cooling System Preparation*:

9.2.1 Vehicles subject to field tests must have cooling systems that can be satisfactorily cleaned initially with mild chelate or detergent type commercial cleansers. Such cleaners may allow small concentrations of some chemicals to carry over into the coolant to be tested, and this factor may be appraised from analyses of the initial and periodic coolant samples. New, or nearly new, vehicles are preferred to minimize cleaning and possible carryover problems. It is possible to clean older cooling systems with oxalic acid, and a procedure for that alternative is included in the appendixes. However, considerable caution must be exercised in cleaning, neutralizing, and inspecting systems cleaned with oxalic acid. Some researchers have reported deleterious carryover effects that persist during tests conducted after oxalic acid cleaning. Engines that have cooling systems that are heavily rusted, pitted, or porous are more susceptible to such carryover. The presence of oil or grease accumulations in the cooling system may justify exclusion of the vehicle from test if the oil cannot be removed by the cleaner selected.

9.2.2 In addition to monitoring changes in the properties of the coolant and measuring corrosion rates by means of the metal coupons, an appraisal of the long term effects on the cooling system parts may be an added objective. This may include an evaluation of radiator tube plugging, solder blooming, seal leakage, accumulations of sediment and the effects on iron and aluminum engine parts subjected to higher thermal stress than on the corresponding metal coupons. Parts of the cooling system of particular interest may appropriately be replaced with new parts during the initial preparations.

9.2.2.1 A Cooling System Flush and Fill Kit[3] (see Fig. A1.1) will permit quick and effective flushing of the system.

9.2.2.2 With system filled with tap water, pressure test to check for external leaks.

9.2.2.3 Pressure test radiator cap and examine radiator filler neck seat for dents or nicks. The pressure rating of the cap and filler neck combination may be tested by removing the temperature sensing unit and attaching the pressure tester to a suitable threaded fitting.

9.2.2.4 Drain cooling system as thoroughly as possible.

9.2.2.5 Repair any leaks. Examine radiator, heater, and coolant recovery reservoir hoses, and replace if necessary. Install new hose for evaluation of coolant effects on elastomeric materials.

9.2.2.6 Install the by-pass tees, the extra hoses and the full and partial flow capsules, but not the coupons, as illustrated in Fig. 5 and Fig. 7. This will allow cleaning of these components at the same time the rest of the cooling system is cleaned.

9.2.2.7 Clean the cooling system with a commercial automotive chelate or detergent-type cleaner, following the manufacturer's directions. The expansion reservoir must also be drained and cleaned. Follow this by flushing the system twice with distilled or deionized water. Then drain the cooling system as completely as possible. By opening appropriate hose connections, the heater core and the by-pass capsule hoses may be blown out with dry, oil free, compressed air. Inspect the interior surfaces of the cooling system. This may require some disassembly such as removal of the coolant outlet, the coolant pump, and accessible core hole plugs. Fiber optic inspection equipment may be useful. The extent of such inspections shall be commensurate with the test requirements and must necessarily be in accordance with agreement of the parties involved.

9.2.2.8 Remove the flushing tee and reassemble the cooling system for normal operation. The preweighed metal coupons should be installed in the full flow and partial flow capsules.

9.2.2.9 Fill the cooling system with test coolant prepared with glycol antifreeze and corrosive water as described in Test Method D 1384. The glycol concentration should give a freeze point of -20 ± 2°F (-29 ± 1°C), which corresponds to 44 % by volume of ethylene glycol (or other percentages of other glycols) unless climatic extremes require lower freeze points. The expansion reservoir shall be filled to the marked level with the same coolant solution. Run the engine long enough to ensure that any air trapped in the system is expelled, and check the system for leaks. Upon cool down, the coolant level in the expansion reservoir will need to be checked and brought to the proper level.

9.2.2.10 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

[3] "Prestone" Flush and Fill Kit, or equivalent.

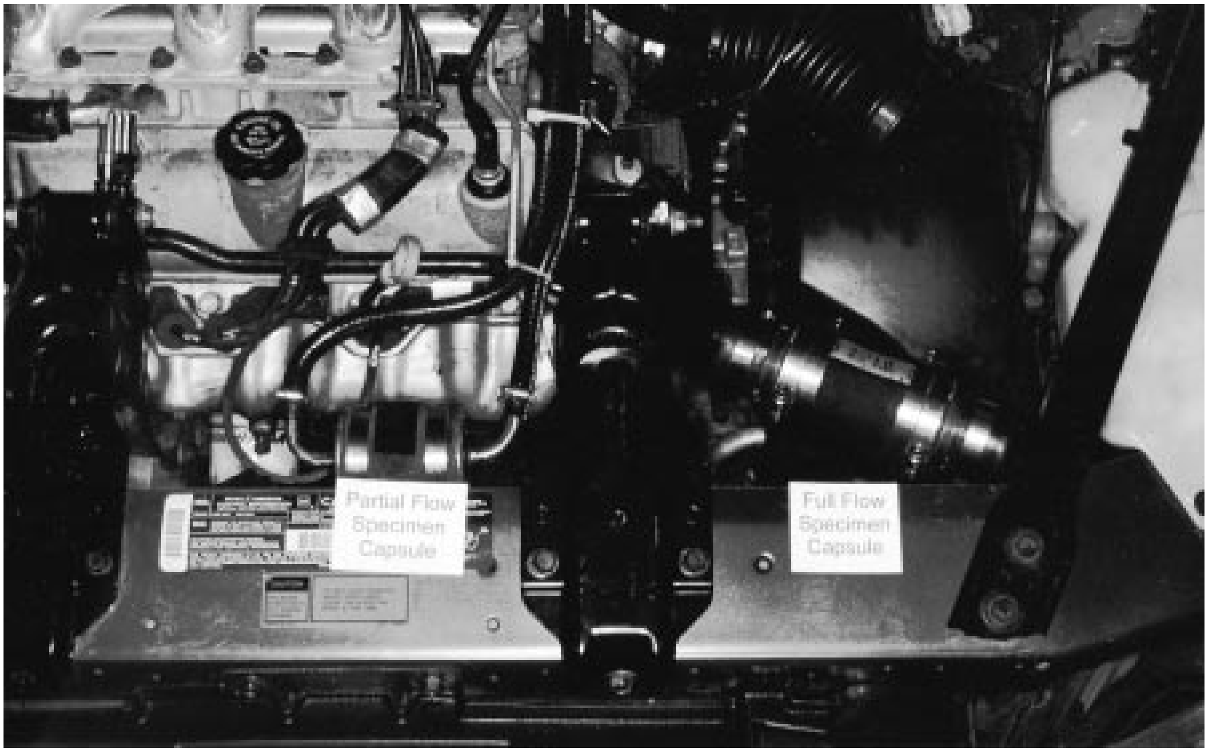
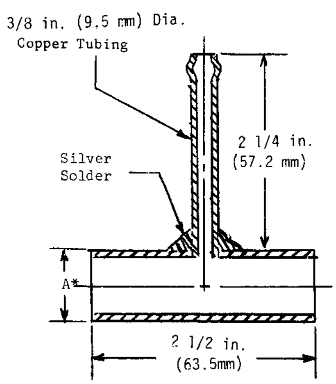


FIG. 6 Full-Flow and Partial-Flow Specimen Capsules



NOTE 1—Dimension A is 19.1 or 16.0 mm (¾or ⅝ in.) diameter depending on size of heater hose.

FIG. 7 By-Pass Tee

additions are needed or other problems occur. Obtain the initial coolant sample and record the start-of-test date, odometer reading, and engine hour reading.

10. Procedure

10.1 Test the coolant being evaluated in a minimum of five vehicles at the recommended concentration.

10.2 Vehicle operating conditions may vary considerably in any test fleet; therefore, 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 to suit the needs and circumstances of the test.

10.3 The recommended concentration for coolant is listed below. Weather conditions in Northern areas may require testing at a higher concentration. Evaluate other cooling system products at the recommended or implied concentration, in the product use directions. Coolant concentrations and normal coolant operating temperature ranges are as follows:

Concentration, volume %, or	44
Freezing point, °F (°C)	−20 (−29)
Range for normal operating temperature of engine coolant, °F (°C)	180 to 235 (82 to 113)

10.4 Use a synthetic corrosive water as described in Annex A2 to dilute the coolant. Additions to the cooling system during the test should be the prescribed mixture of coolant and corrosive water.

10.5 Perform periodic inspections throughout the test as given in Table 1.

11. Calculation

11.1 Record the corrosion data in milligrams per specimen. If it is desired to convert these values to millimetres of metal penetration for the given period of test, use the following formula and the densities listed for the metals used in the test. This calculation is based upon the assumption that uniform corrosion occurred over the entire exposed surface.

$$\text{Millimetres penetration per total time of test exposure (Note 2)} = (\text{metal weight loss, mg/ mm}^3/\text{metal density, mg/mm}^3)$$

Density of metals meeting the requirements of Test Method D 1384, in milligrams per cubic millimetre, are as follows:

Copper	8.9
Solder (Note 4)	9.7
Brass	8.5
Steel	7.9
Cast iron	7.2
Aluminum	2.7

TABLE 1 Periodic Inspections

Occurrence	Operational Sequence
Initial 15 to 30 min, 10 h or 500 miles (800 km), 100 engine hours or 5 000 miles (8 000 km) thereafter	Take a 6-oz (180-mm) coolant sample [2 oz (60 mL)] if foaming tendency is not measured) and replace with reserve coolant. Analyze the samples for pH (Test Method D 1287), reserve alkalinity (Test Method D 1121), foaming tendencies,[A] and freezing protection.[B]
After each 50 engine hours or 2 500 miles (4 000 km)	Check coolant level at operating temperature and, if required, adjust to proper level in coolant reservoir.
After each 100 engine hours or 5 000 miles (8 000 km)	Remove the 5 000-mile (8 000-km) set of corrosion specimens (upstream set in the bypass capsule) and replace with a weighed new set which will be removed at the end of the next 5 000-mile (8 000-km) accumulation.
At the end of test or at approximately 600 engine hours or 30 000 miles (48 000 km)	Terminate test. Check cooling system for aeration and cylinder head gasket failure. Retain a 1-gal (4-L) coolant sample. Remove all corrosion test specimens. Remove test sections of radiator hose. Remove coolant outlet and coolant pump and inspect these and the visible interior surface of the engine. Inspect the radiator. If warranted by the objectives of the test, a more extensive inspection and analysis can be performed on the engine components. Record necessary vehicle data and review maintenance records. See 11.1, 11.2, and 11.3.

[A] Test Method D 1881. This laboratory test may be omitted if desired.
[B] Several methods are available: specific gravity, direct freezing, refractive index, or Karl Fischer water determination.

NOTE 2—Millimetres penetration can be converted to inches penetration by dividing the millimetre penetration figure by 25.4.

NOTE 3—When solder-coated brass is used, the density given is not valid if solder coating is penetrated by corrosion. Solders of different compositions are used in industry. The density varies according to the following tabulation:

Lead %	Tin %	Density mg/mm^3
50	50	8.9
70	30	9.7
80	20	10.2
95	5	11.0

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, aluminum engine accessories, and relevant inspection data.

12.1.4 Radiator make, model, and its condition after fleet test.

12.1.5 Radiator hose make and type and its condition after test.

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.

12.1.10 Coolant temperature and operating conditions.

12.2 *Coolant Information*:

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

NOTE 4—Methods of determination based on refractive index, relative density, or Karl Fischer water may be used.

12.2.2 pH of all samples.

12.2.3 Reserve alkalinity of all samples.

12.2.4 Foaming tendency of all 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.

12.3 *Corrosion 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 Determine the average cleaning loss for each metal in one set of unused corrosion specimens. These cleaning losses are subtracted from the total losses of the exposed test specimens to establish net weight losses due to corrosion.

12.3.4 Report metal corrosion in milligrams per specimen. Uniform corrosion may be calculated and reported as millimetres penetration per test period. Gains in weight are reported.

12.3.5 Where the data are contradictory, discard the inconsistent data only with sufficient justification.

12.4 *Cleaning Procedure*—If the recommended cleaning procedure is not followed, the exact cleaning procedure shall be described.

13. Keywords

13.1 coolant evaluation; metal corrosion; vehicle service

ANNEXES

(Mandatory Information)

A1. DETECTION OF EXHAUST GAS LEAKAGE AND AIR SUCTION

A1.1 Detection of Cylinder Head Gasket Failure (Exhaust Gas Leakage Test):

A1.1.1 Cylinder head gasket failure resulting in exhaust gas contamination of the coolant may be detected with a carbon monoxide detector. The carbon monoxide detector is used for checking gases deaerating from the coolant after operation of the engine at road loads for at least 15 min. With the radiator cap off, gas samples can be taken near the surface of the coolant in the top tank. The following“ quick-check” can be performed for confirmation or as an alternative.

A1.1.2 Start the "quick-check" test with the engine cold. Remove the fan belt from the drive pulley, or disconnect the water pump coupling, to prevent pump operation. Drain the system until the coolant is approximately level with the top of the engine block. Remove the upper radiator hose, thermostat housing, and thermostat. With the thermostat housing either removed or in place, fill the block completely by pouring water into the radiator to remove trapped air. To load engine: (*1*) On cars with manual transmission, jack up the rear wheels, run the engine in high gear, and load by gradually applying throttle and brakes simultaneously. (*2*) On cars with automatic transmissions, set the parking brake firmly, block the wheels, place the selector lever in drive position, apply the foot brake, and intermittently load engine by depressing the accelerator.

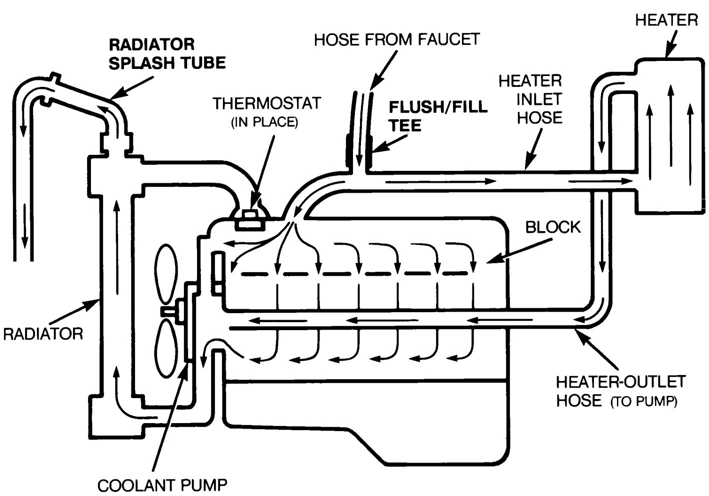


FIG. A1.1 Cooling System Flush Schematic

NOTE A1.1—**Caution:** The engine should not be loaded in drive for more than 15 s at a time or for more than two sequences. Disregarding this warning may result in overheating of the transmission fluid with possible damage to the seals and other transmission parts. *Do not allow anyone in front of the car while making this test!*

A1.1.3 Appearance of bubbles or a sudden rise of liquid at the block outlet to the radiator indicates exhaust gas leakage.

A1.1.4 Conduct the test quickly before boiling starts since steam bubbles give misleading results.

A1.2 Detection of Worn Coolant Pump Thrust Seal (Air Suction Test)

A1.2.1 Adjust the liquid level in the radiator, allowing room for expansion, to avoid any overflow loss during the test. For test purposes, replace the pressure cap with a plain, airtight cap. Attach a length of rubber tube to the lower end of the overflow pipe. Radiator cap, overflow pipe, and rubber tube connections must be airtight. Run the engine in neutral gear at safe, high speed until the temperature gage stops rising and remains stationary. Without changing the engine speed or temperature, put the end of the rubber tube into a bottle of water, avoiding kinks or loops that might block the flow of air. Watch the water for a continuous stream of bubbles in the water bottle, which indicates that air is being drawn into the cooling system.

A2. PREPARATION OF CORROSIVE WATER

A2.1 The specified corrosive water can be prepared by dissolving the following amounts of anhydrous sodium salts in a quality of distilled or deionized water:

sodium sulfate	0.148 g
sodium chloride	0.165 g
sodium bicarbonate	0.138 g

The resulting solution should be made up to a volume of 1 L with distilled or deionized water at 20°C.

A2.2 If relatively large amounts of corrosive water are needed for testing, a concentrate may be prepared by dissolving ten times the above amounts of the three chemicals, in distilled or deionized water, and adjusting the total volume to 1 L by further additions of distilled or deionized water. When needed, the corrosive water concentrate is diluted to the ratio of one part by volume of concentrate to nine parts of distilled or deionized water.

APPENDIXES

(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 for over 30 years by some 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 D-15 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, D 2847, and to incorporate a very significant cleaning and conditioning procedure recommended by a member.

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 corrosive water[4,5] to prepare coolants for use in vehicles that accumulate service exposure provides a practical method for obtaining data. Procedures are provided for detecting and repairing or otherwise eliminating undesirable defects[6] from the test vehicles used for coolant evaluation.

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. 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 Induction coupled plasma spectroscopy is especially 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[7,8] 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.

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[4] The U.S. Geological Survey Water-Supply Paper No. 1299 (1952) shows that only 1.2 % of the major population areas surveyed are supplied with water containing more than 100 ppm each of bicarbonate and chloride. The majority of this type water was reported for the States of California and Texas.

[5] Boehmer, M. A., and Compton, J. W., "The Effects of Water Quality on Auto Cooling System Corrosion in Glycol Antifreeze Solutions," *Soap & Chemical Specialities*, Vol 35, June 1969, pp. 93–99, and July 1959, p. 83.

[6] ASTM Manual Series: MNL6, "Engine Coolants and Cooling System Chemicals," 1989.

[7] Weibull, W., "A Statistical Distribution Function of Wide Applicability," *Journal of Applied Mechanics*, September 1951, pp. 293–297.

[8] Johnson, L. G., *Theory and Technique of Variation Research*, Elsevier Publishing Co., Amsterdam, The Netherlands; New York, 1964.

X2. ALTERNATE PRETEST COOLING SYSTEM CLEANING PROCEDURE

X2.1 *General*—The following procedure is intended for use in cleaning older cooling systems that may be heavily rusted. This method uses oxalic acid, which may be more effective than milder cleaners, but caution must be exercised, as noted in 9.2.1, since carryover effects may possibly occur.

X2.2 *Cooling System Cleaning Procedure*—The cleaning procedure removes inhibitors and deposition, resulting from prior coolant usage, and establishes a conditioned surface on cooling system components. It is essential to complete the portion of the procedure from X2.2.4-X2.2.7 without interruption to minimize corrosion before the conditioning coolant is installed.

X2.2.1 Drain cooling system. Do not close radiator drain. Remove thermostat housing and inspect coolant passage in cylinder head to verify that the cooling system is free of heavy rust and scale. Reinstall thermostat and thermostat housing.

X2.2.2 Install a flushing tee in heater inlet hose. Install empty bypass specimen capsule, including inlet and outlet hoses. Install bypass capsule tee in heater outlet hose and connect to separate outlet hose. Open sample valve.

X2.2.3 Remove radiator cap and install a suitable deflector in radiator filled neck. Remove coolant recovery system hose from radiator vent fitting and remove reservoir from vehicle.

X2.2.4 Set heater control on heat, temperature control on hot, and fan on off. Connect garden hose to flushing tee and turn on water. Start engine and operate at fast idle (about 1500 r/min). Flush system until water is clear.

X2.2.5 Shut off engine. Shut off water and disconnect garden hose from flushing tee. Remove flushing tee. Install bypass capsule tee in place of flushing tee and connect capsule inlet hose.

X2.2.6 Close radiator drain. Remove deflector from radiator filled neck. Fill cooling system with water until level is just covering radiator tubes. Add oxalic acid cooling system cleaner[9] to radiator (use concentration of 9 oz (225 g) of cleaner for 16 qt (15.1 L) of cooling system capacity—use partial can if necessary). *Neutralizer must not be used.*

X2.2.7 Start engine and operate at fast idle (about 1500 r/min). Close sample valve when liquid flow appears. Add water to cooling system as necessary to maintain a level just covering radiator tubes.

X2.2.8 After thermostat opens, add water to fill cooling system completely. Insert a thermometer into radiator filler neck and record stabilized coolant temperature. Check for coolant flow through heater and bypass specimen capsule (are hoses hot?).

X2.2.9 Run engine for 1 h after thermostat opens. Shut down engine. Open radiator drain. Open sample valve.

X2.2.10 Remove bypass capsule inlet tee from heater inlet hose and install flushing tee in the same place. Connect garden hose to flushing tee. Install deflector in radiator filler neck. When cooling system has finished draining, turn on water.

X2.2.11 Start engine and operate at fast idle (about 1500 r/min). Flush system until water is clear.

X2.2.12 Close the radiator drain. Pinch the bypass capsule outlet hose shut using hose pinch pliers. Shut off water. Continue to operate engine at fast idle until the thermostat opens.

X2.2.13 Turn on water. Remove pinch pliers. Flush system until water is clear.

X2.2.14 Pinch the bypass capsule outlet hose shut using pinch pliers. Shut off water. Continue to operate engine at fast idle until the thermostat opens.

X2.2.15 Turn on water. Remove pinch pliers. Open radiator drain. Flush system until water is clear. Shut down engine. Shut off water.

X2.2.16 Remove flush tee and install the bypass capsule inlet tee in the same place. When system has finished draining close radiator drain.

X2.2.17 Fill cooling system with a 50 % solution of conditioning coolant and tap water. Thoroughly clean or replace coolant reservoir. Install coolant reservoir and connect hose to radiator vent fitting. Fill coolant reservoir with 50 % conditioning coolant and tap water.

X2.2.18 Start engine and operate at fast idle (about 1500 r/min). Close sample valve when liquid flow appears. After thermostat opens, fill cooling system completely with 50 % conditioning coolant and tap water. Check for flow through heater core and bypass specimen capsule. Install OEM radiator cap. Shut down engine.

X2.3 *Cooling System Conditioning and Test Coolant Installation Procedures*:

X2.3.1 After the final step in engine cooling system cleaning procedure, operate vehicle in normal road use fashion.

X2.3.2 Use 50 % conditioning coolant and tap water makeup solution to maintain coolant level in coolant reservoir if necessary.

X2.3.3 Conclude conditioning procedure after approximately 700 miles (1125 km) or a maximum of one week of operating time.

NOTE X2.1—Alternative cleaning procedures may be used that do not require the long conditioning period, but in that event the test results must be accompanied by a complete description of the cleaning procedure indicating that it is an alternative to that which is recommended.

X2.4 *Installation of Test Coolant After Cleaning and Conditioning Procedures*:

X2.4.1 Open radiator drain. Remove radiator cap. Disconnect coolant reservoir hose from radiator vent fitting. Drain coolant reservoir, flush reservoir with water, and drain completely.

X2.4.2 Remove bypass capsule tee from heater inlet hose and install a flushing tee in the same place. Install a suitable deflector in radiator filler neck. Open coolant sample valve.

X2.4.3 Set heater control on heat, temperature control on hot, and fan on off.

X2.4.4 Connect garden hose to flushing tee. Turn on water.

[9] PRESTONE Cooling System Heavy Duty Cleaner or equivalent.

Start engine and operate at fast idle (about 1500 r/min). Flush system until water is clear.

X2.4.5 Close radiator drain. Pinch bypass capsule outlet hose shut using hose pinch pliers. Shut off water. Continue to operate engine at fast idle until the thermostat opens.

X2.4.6 After the thermostat opens, turn on water. Remove pinch pliers. Flush system until water is clear.

X2.4.7 Pinch bypass capsule outlet hose shut using pinch pliers. Shut off water. Continue to operate engine at fast idle until the thermostat opens.

X2.4.8 After the thermostat opens, turn on water. Remove pinch pliers. Open radiator drain valve. Flush system until water is clear.

X2.4.9 Shut off engine. Turn off water. Remove block drain plug. Disconnect the garden hose. Remove flushing tee. Remove deflector from filler neck. Disconnect heater hose from bypass capsule tee.

X2.4.10 Alternately reverse and forward flush heater core until water is clear. Carefully blow water out of heater core using compressed air.

X2.4.11 Blow water out of bypass specimen capsule using compressed air. Blow water out of engine block using compressed air.

X2.4.12 Remove thermostat housing and thermostat. Inspect interior of radiator inlet (top) tank and header plate for deposits and ends of radiator tubes for solder bloom. Inspect coolant passage in cylinder head behind thermostat location for deposition or rust, or both. Record inspection results.

X2.4.13 Install the thermostat and a new or reconditioned thermostat housing. Install specimen bundles in bypass capsule. Connect heater hoses to correct bypass capsule tees. Install block drain plug. Close radiator drain. Connect coolant reservoir hose to radiator vent fitting.

X2.4.14 Fill the cooling system with a 44 % solution of test coolant and ASTM corrosive water. Start engine and operate at a fast idle (about 1500 r/min). Close sample valve when liquid flow appears.

X2.4.15 After the thermostat opens fill the cooling system to overflowing with a 44 % solution of test coolant and ASTM corrosive water. Install radiator cap. Fill coolant reservoir with 44 to 50 % solution of test coolant and ASTM corrosive water.

X2.4.16 Check for coolant flow through heater core and bypass specimen capsules (are hoses hot?). Continue to operate engine at a fast idle for 15 min.

X2.4.17 Take initial coolant sample (see Table 1). Check cooling system for leakage. Shut off engine and again check for leakage. Record odometer reading and engine-hour totalizer reading as required.

X2.4.18 With the engine cold, remove radiator cap to be sure radiator is full. Add test coolant to radiator or coolant reservoir if required. Safety wire radiator cap and install lead seal to prevent unauthorized removal of cap.

X2.4.19 Label the radiator top tank or pressure cap conspicuously to show that a coolant test is being conducted. A cloth mail bag may be used as a convenient label and sealing device by placing it over the cap and filler neck and tightly drawing up and knotting the drawstrings.

X2.4.20 Place test instructions in underhood area to alert driver of the test in progress, with advice on who to contact if problems occur with the cooling system.