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Standard Test Method for Coolant Compatibility of Way Lubricants [1]

This standard is issued under the fixed designation D6553; 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 test method measures the ability of single-use way lubricants to separate from metalworking coolants (synthetic coolants, semisynthetic coolants, and soluble oils) or other alkaline aqueous fluids.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are 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.* For specific warning statements, see Section 7.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1193 Specification for Reagent Water

D1401 Test Method for Water Separability of Petroleum Oils and Synthetic Fluids

D4057 Practice for Manual Sampling of Petroleum and Petroleum Products

3. Terminology

3.1 *Definitions:*

3.1.1 *cuff*—a layer between the way oil layer and the coolant or buffer layer that contains significant amounts of both. In describing this intermediate layer, *cuff* is preferred to *emulsion* since many of the coolants are themselves emulsions.

4. Summary of Test Method

4.1 This test procedure is essentially identical to Test Method D1401, with the actual coolant or an alkaline buffer replacing the distilled water of that test method. A 40-mL sample and 40 mL of either actual coolant or a pH 9.0 buffer solution (see Note 1) are stirred for 5 min at 54°C (see Note 2) in a graduated cylinder. The time required for the separation of the emulsion thus formed is recorded. If complete separation or emulsion reduction to 3 mL or less does not occur after standing for 30 min, the volumes of oil (or fluid), water, and emulsion remaining at the time are reported.

NOTE 1—Distilled water is not a satisfactory aqueous phase for testing the ability of way lubricants to separate from coolants because distilled water gives different results from coolants. The best procedure is to use the actual coolant that the way lubricant will contaminate. A buffer solution of pH 9.0 may be used in place of a specific coolant to predict the separability from alkaline coolants in general.

NOTE 2—It is recommended, however, that the test temperature be raised to 82 ± 1°C when testing way lubricants more viscous than 90 cSt (mm 2/s) at 40°C.

5. Significance and Use

In the normal use of a way lubricant in a machine tool, the way lubricant eventually becomes a contaminant that may emulsify into the coolant. It is generally desirable to remove this contaminant by skimming; otherwise, the coolant lifetime may be significantly shortened. This test method provides a guide for determining the separability characteristics of way lubricants that are expected to get into aqueous alkaline metalworking coolants. It is used for specification of new oils and might be useful in monitoring of in-service oils.

6. Apparatus

6.1 *Cylinder*, 100 mL, graduated from 5 to 100 mL in 1.0-mL divisions, made of glass, heat-resistant glass, or a chemical equivalent. The inside diameter shall be no less than 27 mm and no more than 30 mm throughout its length, measured from the top to a point 6 mm from the bottom of the cylinder. The overall length of the cylinder shall be 225 to 260 mm. The graduation shall not be in error by more than 1 mL at any point on the scale.

6.2 *Heating Bath*, sufficiently large and deep enough to permit the immersion of at least two test cylinders in the bath liquid up to their 85-mL graduations. The bath shall be capable of being maintained at a temperature of 54 ± 1°C (see Note 2), and shall be fitted with clamps, which hold the cylinder in a position so that the longitudinal axis of the paddle corresponds to the vertical center line of the cylinder during the stirring

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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.

operation. The clamps shall hold the cylinder securely while its contents are being stirred.

6.3 *Stirring Paddle*, made of chromium-plated or stainless steel and conforming to the following dimensions: length, 120 ± 1.5 mm (4¾ ± 1⁄16 in.); width, 19 ± 0.5 mm (¾ ± 1⁄64 in.); thickness, 1.5 mm (1⁄16 in.). It is mounted on a vertical shaft of similar metal, approximately 6 mm (¼ in.) in diameter, connected to a drive mechanism that rotates the paddle on its longitudinal axis at 1500 ± 15 rpm. The apparatus is of such design that, when the cylinder is clamped in position and the paddle assembly is lowered into the cylinder, a positive stop engages and holds the assembly when the lower edge of the paddle is 6 mm from the bottom of the cylinder. During the operation of the stirrer, the center of the bottom edge of the paddle shall not deviate more than 1 mm from the axis of rotation. When not in operation, the paddle assembly can be lifted vertically to clear the top of the graduated cylinder.

7. Reagents and Materials

7.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available.[3] Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.2 *Purity of Water*—Unless otherwise indicated, reference to water shall be understood to mean reagent water as defined by Type II of Specification D1193.

7.3 *Buffer Solution*—A buffer solution of the desired pH may be prepared using reagent-grade chemicals and reagent water.

7.4 *Cleaning Solvents, Light-hydrocarbon*, such as precipitation naphtha (**Warning**—Health hazard.) for petroleum oils. Use other appropriate solvents for dissolving synthetic fluids.

7.5 *Acetone*. (**Warning**—Health hazard. Flammable.)

7.6 *Cleaning Reagent*—Cleaning by either hot NOCHROMIX (**Warning**—Corrosive. Health hazard. Oxidizer.) or a 24-hr soak at room temperature in MICRO solution gave acceptable, statistically equivalent results in roun robin testing.

8. Sampling

8.1 The test method is very sensitive to small amounts of contamination. Take samples in accordance with Practice D4057.

9. Preparation of Apparatus

9.1 Clean the graduated cylinder by removing any film of oil (or fluid) with cleaning solvent, followed by a wash first with acetone and then with tap water. The glassware shall be further cleaned with a suitable cleaning reagent. Rinse thoroughly with tap water and then with reagent water. Inspect the cylinders for any residue or water droplets adhering to the inside walls. Both conditions indicate a need for additional cleaning.

9.2 Clean the stirring paddle and shaft with absorbent cotton or tissue wet with cleaning solvent and air dry. Care must be taken not to bend or misalign the paddle assembly during the cleaning operation.

10. Procedure

10.1 Heat the bath liquid to 54 ± 1°C (see Note 2) and maintain it at that temperature throughout the test. Add coolant or buffer (see Note 3) to the graduated cylinder up to the 40-mL mark, and then add to the same cylinder a representative sample of the oil (or fluid) under test until the top level of the oil reaches the 80-mL mark on the cylinder. Place the cylinder in the bath, and allow the contents to reach bath temperature. Normally this will require about 10 min.

NOTE 3—If initial volumetric measurements are made at room temperature, expansion occurring at the elevated test temperature will have to be considered. For example, there will be a total volumetric expansion of about 2 to 3 mL at 82°C. Corrections to each volume reading at 82°C, therefore, should be made so that the total of the volume readings made for oils (or fluid), water, and emulsion does not exceed 80 mL. An alternative procedure, which would avoid the corrections, is to make the initial volumetric measurements at the test temperature.

10.2 Clamp the cylinder in place directly under the stirring paddle. Lower the paddle into the cylinder until the stop engages at the required depth. Start the stirrer and a stop watch simultaneously, and adjust the stirrer, as required, to a speed of 1500 ± 15 rpm. At the end of 5 min, stop the stirrer and raise the stirring assembly until it is just clear of the graduate. Wipe the paddle with a policeman (see Note 4), allowing the liquid thus removed to drop back into the cylinder. Remove the cylinder from the retaining clamps and transfer it carefully to another section of the bath. At 5-min intervals, lift the cylinder out of the bath, inspect, and record the volumes of the way oil layer, coolant or buffer layer, and cuff layer.

NOTE 4—The policeman should be made of material resistant to the oil or fluid.

11. Report

11.1 Record the time (at 5-min intervals) until either (**a**) the product passes the coolant separability requirements it is being tested against or (**b**) the test limit for coolant separability is exceeded (usually 3-mL cuff or less for 30 min at 54°C and 60 min at 82°C). The maximum volume to be reported as the oil layer is 43 mL (see Note 5). For uniformity, report the test results in the manner shown in the following examples:

NOTE 5—Certain way oils may produce a hazy oil layer. In situations in which the measurement of the oil layer and coolant or buffer layer indicates essentially complete separation, the upper layer should be reported as oil. If there are two layers and if the upper layer is more than 43 mL, this layer should be considered the cuff.

11.1.1 *40-40-0 (20)*—Complete separation occurred in 20 min. More than 3 mL of cuff had remained at 15 min.

11.1.2 *39-38-3 (20)*—Complete separation had not occurred, but the cuff reduced to 3 mL, so the test was ended.

[3] *Reagent Chemicals, American Chemical Society Specifications*, American Chemical Society, Washington, DC. For Suggestions on the testing of reagents not listed by the American Chemical Society, see *Annual Standards for Laboratory Chemicals,* BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary,* U.S. Pharmacopeial Convention, Inc. (USPC), Rockville, MD.

TABLE 1 Coolant Compatibility Round Robin Results

Waylube #	Aq. Phase	Minutes to 3 mL Emulsion Remaining											
Cooperator:		1	1	3	3	4	4	5	5	6	6	8	8
Date:		Nov 26		Sep 17		Sep 30		Oct 10		Aug 20			
9707221	DEI water	13	12	15	15	15	15	10	15	10	10		
9707221	buffer	60+	60+	60+	60+	60+	60+	60+	60+	60+			
	(mL after 1 h	49	46	56	56	60	60	56	58	50	47		)
9707222	DEI water	17	17	20	15	20	20	15	20	20	15		
9707222	buffer	60+	60+	60+	60+	60+	60+	60+	60+	60+	60+		
	(mL after 1 h	47	46	59	59	59	55	58	54	50	50		)
9707223	DEI water	17	18	15	15	20	25	15	15	25	25		
9707223	buffer	60+	60+	25	20	60+	60+	20	20	25	25		
	(mL after 1 h	11	6	0	0	9	11	<1	<1	<1	<1		)
9707224	DEI water	20	23	15	20	30	30	15	10	30	30		
9707224	buffer	21	21	60+	60+	60+	60+	15	15	15	30		
	(mL after 1 h	1	1	16	9	18	18	<2	<2	0	3		)

11.1.3 *39-35-6 (60)*—More than 3 mL of cuff remained after 60 min—39 mL of oil, 35 mL of water, and 6 mL of cuff.

11.1.4 *41-37-2 (20)*—Complete separation had not occurred, but the cuff layer reduced to 3 mL or less after 20 min.

11.1.5 *43-37-0 (30)*—The cuff layer reduced to 3 mL or less after 30 min. The cuff layer at 25 min exceeded 3 mL, for example, 0-36-44 or 43-33-4.

11.2 The appearance of each layer may optionally be described in the following terms:

11.2.1 *Way Oil Layer*:

11.2.1.1 Clear.

11.2.1.2 Hazy

NOTE 6—A hazy layer is defined as being translucent.

11.2.1.3 Cloudy (or milky).

NOTE 7—A cloudy layer is defined as being opaque.

11.2.1.4 Combinations of 11.2.1.1-11.2.1.3.

11.2.2 *Coolant or Buffer Layer*:

11.2.2.1 Clear.

11.2.2.2 Lacy or bubbles present, or both.

11.2.2.3 Hazy (see Note 6).

11.2.2.4 Cloudy (or milky) (see Note 7).

11.2.2.5 Combinations of 11.2.2.1-11.2.2.4.

11.3 Report the test temperature if other than 54°C and the identification of the coolant or buffer if other than pH 9.0 buffer.

12. Precision and Bias

12.1 *Precision*—The precision of this test method is as illustrated by the round robin results shown in Table 1.

12.2 *Bias*—The procedure in this test method for measuring water separability has no bias because the value for coolant separability is defined only in terms of this test method.

13. Keywords

13.1 coolant separability; cuff; emulsification; semisynthetic coolants; soluble oil coolants; synthetic coolants; way lubricants