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An American National Standard

Standard Test Method for Iron Chip Corrosion for Water–Dilutable Metalworking Fluids[1]

This standard is issued under the fixed designation D 4627; 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 covers evaluation of the ferrous corrosion control characteristics of water–dilutable metalworking 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.*

2. Summary of Test Method

2.1 Cast iron chips are placed in a petri dish containing a filter paper and diluted metalworking fluid. The dish is covered and allowed to stand overnight. The amount of rust stain on the filter paper is an indication of the corrosion control provided by the fluid.

3. Significance and Use

3.1 The results obtained by this test are a useful guideline in determining the ability of water diluted metalworking fluids to prevent or minimize rust under specific conditions. There is usually a relationship between the results of this test and a similar ability of the subject coolant to prevent rust on nested parts or in drilled holes containing chips, etc. It must be understood, however, that conditions, metal types, etc. found in practice will not correlate quantitatively with these controlled laboratory conditions. The procedure may not be able to differentiate between two products with poor rust control due to the wide spacing between test dilutions.

4. Apparatus

4.1 *Disposable Petri Dishes*, 35 by 10 mm plastic, with lids No. 8-757-100A.

4.2 *Glass-Fiber Filter Paper*, Whatman No. 934-AH, 3.2-cm diameter.

4.3 *Glass Stirring Rod*.

4.4 *Spatula*.

4.5 *Pipettes*, 5 mL.

4.6 *Glass Bottle*, 4-oz. with cap.

4.7 *Balance*, accurate to one mg.

4.8 *Graduated Cylinder*, 50 mL.

4.9 *Volumetric Flask*, 1 L.

4.10 *Forceps*.

4.11 *U.S. Standard Sieve*, 18 mesh (1.0 mm sieve openings), stainless steel.

5. Reagents and Materials

5.1 *Gray Cast Iron Drilling Chips*. [2]

NOTE 1—The chips are made from Class 30 gray cast iron, as cast. The structure is mostly pearlite with small amounts of ferrite and type A graphite. Brinell hardness is 179–217. The chips are made using a clean, oil free jobbers length high speed drill of 29/64 in. diameter with 118° plain point, 29° helix and 12–15° clearance. Rotational speed should be 500 rpm at a feed rate of 0.015 in./rev. Hand feeding is not permissible. The chips are sieved on 5 and 18-mesh sieves and those retained on the 18-mesh sieve are immediately stored in airtight pint glass bottles. Each drilling is given a batch number. The bottle labels bear this batch number and the date of filling.

5.2 *Synthetic Hard Water*, 20,000 mg/L stock solution prepared by dissolving 29.4 g reagent grade (ACS standard) $CaCl_2 \cdot 2H_2O$ in 1 L of freshly boiled distilled water. A moderate hardness water is necessary in this test (100 ppm as $CaCO_3$, 71 mg/L as chloride), and can be prepared at the time of the test by diluting the stock hard water 0.5 % in distilled water.

5.3 *Metalworking Fluid of Interest*.

6. Preparation of Diluted Metalworking Fluid

6.1 Prepare 50 mL of fluid at each desired concentration by weight % in the 100 mg/L hardness water described above. The water must be at room temperature as described in 7.1. Always add the metalworking fluid concentrates into the water.

6.2 The dilutions tested will be in weight % as follows:

0.5, 1, 1.5, 2, 2.5, 3, 4, 5, 7 and 10 %

[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.L0 on Industrial Lubricants.

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[2] The sole source of supply of the drilling chips known to the committee at this time is Techsolve, Technical Center, 1111 Edison Drive, Cincinnati, OH 45216-2265. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee [1], which you may attend.

TABLE 1 Replicate Results

REPLICATE RESULTS_____ Data_____ Program_____

Form A
Page__of__
Date____
Instructions:
X_1 is 1st result
X_2 is 2nd result
Sum total labs
m = 10
Sum total samples
n = 6

LABORATORY NUMBER (i)			SAMPLE NUMBER (j) 1	2	3	4	5	6	7	8	9	10
	1	X_1	5 %	10 %	2 %	2 %	3 %	>10 %				
		X_2	5 %	10 %	2.5 %	2.5 %	4 %	10 %				
	2	X_1	10 %	7 %	3 %	3 %	4 %	>10 %				
		X_2	10 %	7 %	3 %	4 %	4 %	>10 %				
	3	X_1	2.5 %	10 %	3 %	3 %	5 %	>10 %				
		X_2	...	...	...	...	...	...				
	4	X_1	3 %	7 %	2.5 %	3 %	3 %	>10 %				
		X_2	3 %	7 %	2.5 %	3 %	4 %	>10 %				
	5	X_1	2 %	5 %	2.5 %	2.5 %	4 %	10 %				
		X_2	2.5 %	10 %	2.5 %	2.5 %	4 %	10 %				
	6	X_1	2.5 %	10 %	3 %	2.5 %	5 %	>10 %				
		X_2	3 %	10 %	3 %	3 %	5 %	>10 %				
	7	X_1	2 %	10 %	3 %	2 %	3 %	10 %				
		X_2	2.5 %	>10 %	2.5 %	2 %	3 %	>10 %				
	8	X_1	2.5 %	5 %	3 %	3 %	2.5 %	7 %				
		X_2	3 %	7 %	2.5 %	4 %	3 %	10 %				
	9	X_1	2.5 %	5 %	2.5 %	2.5 %	4 %	10 %				
		X_2	2 %	7 %	2.5 %	2.5 %	4 %	10 %				
	10	X_1	2 %	10 %	3 %	3 %	3 %	>10 %				
		X_2	2.5 %	10 %	3 %	3 %	3 %	>10 %				

Each dilution must be separately prepared. Stock emulsions subsequently diluted must not be used.

6.3 Cap the bottle and shake vigorously until dispersion is complete.

7. Procedure

7.1 Make the test in a room free from corrosive fumes, away from direct sunlight, and a room temperature of 20°C to 25°C (68°F to 77°F).

7.2 Sieve the cast iron chips on the 18-mesh screen, rejecting the fines and any chips showing signs of rust.

NOTE 2—Do not allow the chips to come in contact with the skin.

NOTE 3—Store the chips in an air-tight glass bottle.

7.3 Using forceps, place the filter paper in the bottom half of a clean, dry petri dish. Place the smooth side of the paper down, and the rough side up to contact the chips.

7.4 Measure 5.0 mL of diluted metalworking fluid into the dish.

7.5 Weigh 4.0 ± 0.1 g of cast iron chips and sprinkle into the petri dish. Use the stirring rod to be certain all chips are submerged, all air bubbles released, and the chips are evenly distributed.

7.6 Cover the dish with its lid and allow to stand for 20–24 h.

7.7 Drain the fluid from the dish. Invert the dish on its lid and tap to remove the chips.

7.8 Rinse the filter paper with running tap water for about 5 s to remove any discoloration due to the fluid.

7.9 After rinsing, estimate the percent of the filter paper area which was stained by rusting chips. This is done by visual examination (without magnification) of the side of the paper that was in contact with the chips.

7.10 The "breakpoint" is defined as the weakest concentration tested that left no rust stain on the filter paper. This value may be used to compare the rust inhibiting properties of various fluids.

8. Precision and Bias

8.1 *Precision*—The precision of this test method as determined by the statistical examination of interlaboratory test results is as follows:

8.2 *Repeatability*—The difference between two successive test results obtained by the same operator with the same apparatus under constant operating conditions on identical test material would, in the long run, in the normal and correct operation of the test method exceed the following values only in one case in twenty.

$$\text{Repeatability} = 0.64 \text{ for sample Nos. 1, 3, 4, and 5} \quad (1)$$

8.3 *Reproducibility*—The difference between two single and independent results obtained by different operators working in different laboratories on identical test material would, in the long run, exceed the following values only in one case in twenty.

$$\text{Reproducibility} = 1.85 \text{ for sample Nos. 1, 3, 4, and 5} \quad (2)$$

8.4 *Bias*—The procedure in this test method for iron chip corrosion test for water–dilutable metalworking fluids has no bias because the Corrosion Values can be defined only in terms of a test method.

9. Keywords

9.1 corrosion test; ferrous corrosion test; iron chip corrosion test; metalworking fluid corrosion test; water dilutable fluids corrosion test