Designation: D4627 – 12

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

This standard is issued under the fixed designation D4627; 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–miscible metalworking fluids.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.2.1 *Exception*—Note 1 contains inch-pound units since the drill sizes and feed rates do not have readily available metric equivalents.

1.2.2 *Exception*—U.S. Standard sieve sizes include mesh values.

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. Terminology

2.1 *Definitions:*

2.1.1 *rust, n*—corrosion product consisting primarily of hydrated iron oxides.

2.2 *Definitions of Terms Specific to This Standard:*

2.2.1 *breakpoint, n*—weakest concentration of the water-miscible metalworking fluid tested that leaves no rust stain on the filter paper.

3. Summary of Test Method

3.1 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.

4. Significance and Use

4.1 The results obtained by this test are a useful guideline in determining the ability of water-miscible 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.

5. Apparatus

5.1 *Disposable Petri Dishes,* 35 by 10 mm plastic, with lids.

5.2 *Glass-Fiber Filter Paper,* 1.5 µm particle retention rating, 3.2-cm diameter.

5.3 *Glass Stirring Rod.*

5.4 *Spatula.*

5.5 *Pipettes,* 5 mL.

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

5.7 *Balance,* accurate to 1 mg.

5.8 *Graduated Cylinder,* 50 mL.

5.9 *Volumetric Flask,* 1 L.

5.10 *Forceps.*

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

6. Reagents and Materials

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

NOTE 1—The chips are made from Class 30 gray cast iron (UNS F10006), 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

[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.L0.01 on Metal Removal Fluids and Lubricants.

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[2] Iron chips produced and packaged according to the directions given in Note 1 are commercially available.

*A Summary of Changes section appears at the end of this standard

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.

6.2 *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.

6.3 *Metalworking Fluid of Interest.*

7. Preparation of Diluted Metalworking Fluid

7.1 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 8.1. Always add the metalworking fluid concentrates into the water.

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

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

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

7.3 Cap the bottle (5.6) and shake vigorously until dispersion is complete.

8. Procedure

8.1 Make the test in a room free from corrosive fumes, away from direct sunlight, and a room temperature of 20°C to 25°C.

8.2 Sieve the cast iron chips (6.1) on the 18-mesh screen (5.11), 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 airtight glass bottle.

8.3 Using forceps (5.10), place the filter paper (5.2) in the bottom half of a clean, dry petri dish (5.1). Place the smooth side of the paper down and the rough side up to contact the chips.

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

8.5 Using the spatula (5.4) to handle the chips, weigh 4.0 ± 0.1 g of cast iron chips and sprinkle into the petri dish. Use the stirring rod (5.3) to be certain all chips are submerged, all air bubbles released, and the chips are evenly distributed.

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

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

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

8.9 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.

8.10 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.

9. Report

9.1 Report as "breakpoint" the weakest concentration tested that left no rust stain on the filter paper.

9.2 Report the estimated percentage of rust stain on the filter paper for each concentration tested.

10. Precision and Bias[3]

10.1 *Precision*—The precision of this test method as determined by the statistical examination of interlaboratory test results is as follows (see Table 1):

10.2 *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.

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

10.3 *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.

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

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

11. Keywords

11.1 corrosion test; ferrous corrosion test; iron chip corrosion test; metalworking fluid corrosion test; water-miscible fluids corrosion test

[3] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1746.