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Evaluation of Water-Soluble Oil with M-435

Purpose: To find an additive for the water-soluble oil Relubro 71 provided by Carte Dozio to improve corrosion protection on cast iron metals. This water-soluble oil is typically used at a concentration of 6% in water.

Materials:
Submitted sample of water-soluble oil Relubro 71
M-435
Disposable Petri Dishes (35mm by 10mm plastic)
Whatman Filter Paper #934-AH
Gray Cast Iron Drilling Chips
CaCl2 - 2H2O (ACS standard)
Cast Iron panels

Method:
Standard Compatibility Test
ASTM-D 4627-86 Iron Chip Corrosion Test
ASTM D 1748-83 Humidity Chamber test

Procedure: The following procedure was followed for the Standard Compatibility Test

1) Prepare a sample containing 6% of the water-soluble oil in water.
2) Add 2% of M-435 to the 6% water-soluble oil solution.
3) Mix the sample thoroughly, then put in a refrigerator set at a temperature of 7°C +/- 3°C for 8 hours.
4) Remove the samples from the fridge, inspect for compatibility, and then place the in an oven set at 80°C +/- 2°C for 16 hours.
5) After 16 hours the samples are removed from the oven and inspected for compatibility. This constitutes as one cycle and the samples are cycled three times for this test.

The following procedure was followed for ASTM-D 4627-86:

1) Prepare a 'synthetic hard water' solution by dissolving 29.4g of reagent grade (ACS standard) CaCl2 - 2H2O in 1 liter of DI water.
2) The 'synthetic hard water' solution is then diluted to a concentration of 0.5% in DI. This is the 'hard water' that will be used for this test. It consists of 100ppm CaCO3.
3) Using the hard water solution, dilute the water-soluble oil to concentrations ranging from 1.5% to 0.75%
4) 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.
5) Weigh 5 grams of the prepared sample in the Petri dish.

6) Weigh 4 grams of cast iron chips and sprinkle into the Petri dish. Be sure that all chips are submerged, all air bubbles are released, and all the chips are evenly distributed.
7) Cover the dish with its lid and allow to stand for 20-24 hours.
8) Drain the fluid from the dish and invert the dish on its lid and tap to remove the chips.
9) Rinse the filter paper with running tap water for 5 seconds to remove any discoloration due to the fluid.
10) Visually examine the side of the filter paper that was in contact with the cast iron chips. The results will either be pass or fail. A pass will show white filter paper, a fail will be considered any color change that would have been caused by the rusting chips.

The following procedure was followed for ASTM D 1748-83:
1) One cast iron panel was dipped in the solution of 6% water-soluble oil. Another cast iron panel was dipped in the solution of 6% water-soluble oil with 2% M-435.
2) Both of the treated cast iron panels were hung to dry for 4 hours then placed in the environmental chamber per ASTM D 1748-83 (120 deg F, ~100% R.H.)
3) The panels were visually inspected and taken out of the chamber after corrosion started on the second sample.

Results: The following results were found for the Standard Compatibility Test:

Material	Compatibility (yes or no)
2% M-435 in the 6% water-soluble oil	Yes

The following results were found for ASTM-D 4627-86:

Material	Results
1.5% water-soluble oil in 'hard water'	Pass
0.75% water-soluble oil in 'hard water'	Fail
0.75% water-soluble oil in 'hard water' + 0.25% M-435	Pass

The following results were found for ASTM D 1748-83 (after 24 hours):

Material	Time before corrosion
6% water-soluble oil in the water	8 hours
6% water-soluble oil + 2% M-435	18 hours
5% EcoLine Cutting Fluid	48 hours *

*typical result

Conclusion: At a concentration of 2%, M-435 proved to be compatible and also improves corrosion protection of cast iron when added to the 6% water-soluble oil solution. Cortec's EcoLine Cutting Fluid (5% concentration in the water) is a very good replacement for the tested oil, based on the results of Humidity Chamber. EcoLine Cutting Fluid is also environmentally and user friendly product

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Estimated Cost of Project: 4 hours

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After 18 hours in ASTM D 1748

Control with 2% M-435