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ISO AGS AMERICAN GLOBAL STANDARDS 17025™ ACCREDITED

Evaluation of Chemtool Watertool 4451 vs. VpCI-649BD

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ISO 9001 QUALITY SYSTEM REGISTERED
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Test Goal: Compare the corrosion protection of Chemtool Watertool 4451 and VpCI-649BD at the suggested recommended concentration of 3% to 5%.

Sample Received: 100ml of Chemtool Watertool 4451

Method: ASTM G31, Standard Guide for Immersion Corrosion Testing of Metals

Materials:
VpCI-649BD (batch #117022)
Steel panels (1" X 4" X 0.0625"), SAE 1008/1010 (Q-Panel stock #RS-14)
Methanol, ACS grade
DI water
Morton TFC Purex® Salt
8oz sample jars
40˚C oven (oven #10)
Hydrochloric acid, 36.5-38% (lot #2020011684)
Hexamethylene Tetramine, ACS Grade 99+% (lot #SZBC2720V)
Kimwipes
Timer
Scale I (0.0g)
Scale J (0.0000g)

Procedure:
The following procedure was followed for Immersion and Hydrotesting:

1. Clean the steel panels by immersing in methanol for five minutes. Dry with Kimwipes and weigh each panel for testing.
2. Make the test solution, 0.1% NaCl (diluting by weight) with DI water.
3. Pour 200g of test solution into an 8oz jar and immerse one panel in the solution.
4. Seal jars shut with the jar lids and place the jars in a 40˚C oven.
5. After 285 hours, take the jars out of the oven.
6. Clean the panels according to ASTM G1:
    a. The loose corrosion products are mechanically removed by scrubbing the panel with a sponge and water. The heavy corrosion is cleaned chemically according to ASTM G1, C3.5.
    b. Cleaning liquid: 500 mL hydrochloric acid (HCl, sp gr 1.19), 3.5 g hexamethylene tetramine, using DI water to make 1000 ml. Temperature of solution should be 20 to 25˚C before using.
    c. Soaking in Cleaning liquid: the panels are soaked in the acid cleaning liquid for 10 minutes.
    d. After being removed from the acid cleaning liquid, the panels are rinsed in DI water (2-3X), and immediately dried with Kimwipes thoroughly.
    e. A cleaning "control" panel (an uncorroded panel of the same size) is used to monitor the weight change due to the cleaning. This "control" weight loss is deducted when calculating immersion weight loss of each panel that is cleaned with the same procedure.
7. Calculate the corrosion rate according to the following equation:

    $Corrosion\ rate\ (mpy) = (3.45 \times 10^6 \times W) / (A \times T \times D)$

    T= Time of exposure to the nearest 0.1 h (tested for 285 hours)

A= area in cm^2 to the nearest 0.1 cm^2 (total surface area = 55.7cm^2)
W= mass loss in g, to the nearest 1 mg
D= density in g/cm^3 (steel panels = 7.85 g/cm^3)

For the hydrotesting, steel panels were dipped in the solutions to be tested and then sealed in a jar along with 1ml of test solution and then tested at 40˚C.

Results: The following results were found from the immersion testing:

Sample	Start Weight	End Weight	Weight Loss	Average Weight Loss
Untested Steel Panel (cleaned only)	31.610g	31.608g	-0.002g	-0.002g
	31.356g	31.354g	-0.002g	

Sample	Start Weight	End Weight	Weight Loss	Weight loss adjusted for cleaning	Corrosion Rate (mpy)	**Corrosion Rate (average of two)**
1000ppm NaCl in DI water (control)	31.485g	31.434g	0.051g	0.049g	1.36	**1.39 MPY**
	31.359g	31.306g	0.053g	0.051g	1.41	
1000ppm NaCl in DI water + 3% Chemtool Watertool 4451	31.228g	31.203g	0.025g	0.023g	0.64	**0.61 MPY**
	31.184g	31.161g	0.023g	0.021g	0.58	
1000ppm NaCl in DI water + 3% VpCI-649BD	31.198g	31.196g	0.002g	0.000g	0	**0 MPY**
	31.296g	31.294g	0.002g	0.000g	0	

Testing started on 10-12-22 @ 3pm Testing ended on 10-24-22 @ 12pm (285 hours total)

Results: The following results were found from the hydrotesting:

Steel Panel Dipped in:	Results
1000ppm NaCl in DI water (control)	Flash corrosion occurred within 5 minutes
1000ppm NaCl in DI water + 3% Chemtool Watertool 4451	Corrosion started to appear within 1 hour
1000ppm NaCl in DI water + 3% VpCI-649BD	No corrosion after 285 hours

Testing started on 10-12-22 @ 3pm Testing ended on 10-24-22 @ 12pm

Photo after 285 hours of Hydrotesting:

Control | 3% Chemtool Watertool 4451 | 3% VpCI-649BD

Interpretations: The results of the immersion test and hydrotesting shows that VpCI-649BD provides better corrosion protection than Chemtool Watertool 4451 when tested at the same 3% concentration.