

Evaluation of the Corrosion inhibiting properties of MCIs vs. Protectosil CIT

Background: Cortec's migrating corrosion inhibitor (MCI) technology provides proven protection against chlorides and other corrosive elements to steel reinforcement in concrete. Protectosil CIT, an organosilane sealer manufactured by Degussa, claims that it 'provides organofunctional molecule to inhibit the electrochemical corrosion process between the rebar and the chloride ions, oxygen and moisture'*, and is promoted as a direct competitor to Cortec MCI products.
 * Claim from the Protectosil® Data Sheet

Purpose: To compare the effectiveness of Cortec's surface-applied MCI-2020M and MCI-2019 to Protectosil CIT manufactured by Degussa to determine which of the products provide better corrosion protection when applied directly to carbon steel in the chloride environment.

Materials: MCI-2019
 MCI-2020M
 Protectosil CIT
 Electrochemistry Kit
 Working Electrode made from carbon steel SAE 1018
 Sodium Chloride, lab grade.
 Methanol

Method: Polarization curves (Tafel plots).

Procedure: The following procedure was followed:
 1) Solution of 5%NaCl in de-ionized water was prepared.
 2) Polarization curves (Tafel plots) were obtained according to the standard procedure at ambient conditions and based on them corrosion rate was determined.

Results: The following results were found:

| Material | Corrosion rate, mmpy, $\times 10^{-3}$ | Z, % protection power* |
|--------------------|--|------------------------|
| 1% Protectosil CIT | 5367 | -.** |
| 1% MCI-2020M | 4.102 | 99.7 |
| 1% MCI-2019 | 273.7 | 85.3 |
| Control (5%NaCl) | 1861 | - |

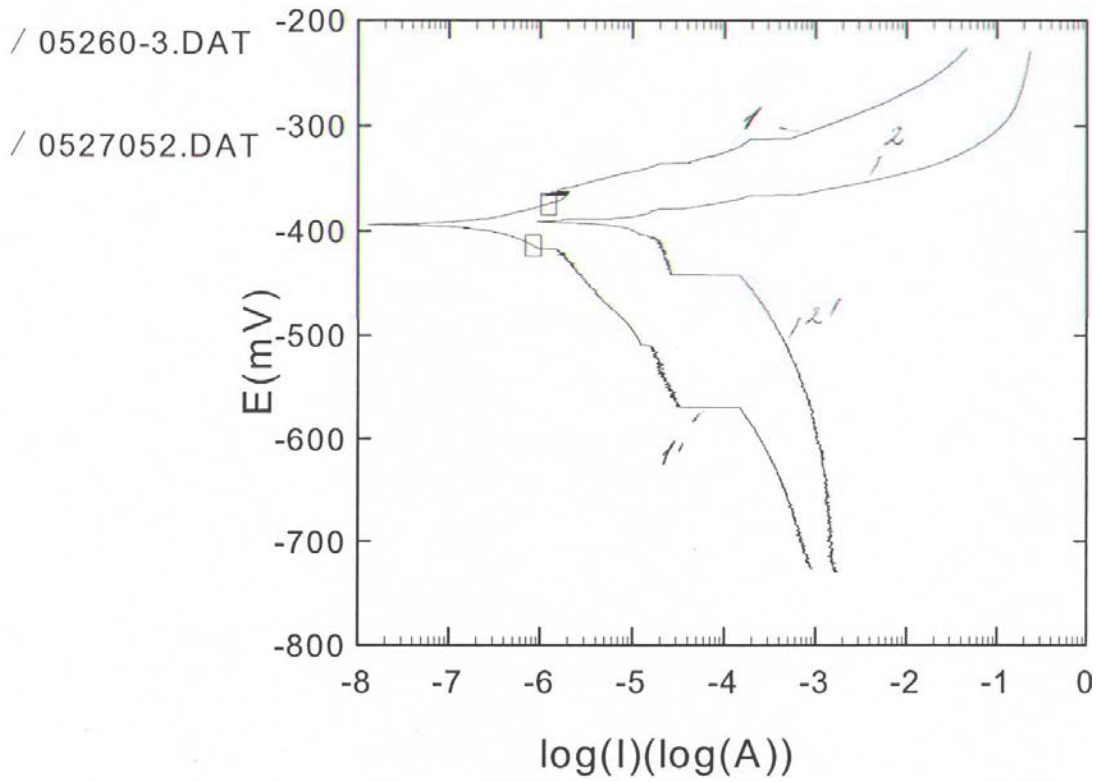
* $Z = 100 \times (C_c - C_i) / C_c$, where C_c –corrosion rate in the 'Control' electrolyte, C_i –corrosion rate in the electrolyte containing an inhibitor.

** Corrosion rate of the electrode in this solution was higher than in 'Control' (See attached tables and graph)

Conclusion:

1. MCI-2019 and MCI-2020M contain very effective corrosion inhibitors which readily adsorb onto the metal surfaces to provide corrosion protection to carbon steel.
2. In this test Protectosil CIT has worse corrosion than the control sample. It is concluded that the Protectosil CIT does not contain ingredients that would adsorb onto carbon steel to inhibit electrochemical corrosion caused by chlorides, oxygen, and moisture.





1. 1% mCI 2020M
- 2) 1% Protectosil CIT

1/2 mci 2019

352 SoftCorr III Corrosion Measurement Software for Windows, v. 3.06
Filename: F:\PUBLIC\TOWNHALL\EISFOL-1\0527052.DAT
Pstat: VStat[] Ver 2
TA TAFEL
File Status: NORMAL
Date Run: 05-27-05
Time Run: 10:42:49
Cond. Time CT pass s
Initial Pot. IP -250.0E-3 V oc
Cond. Pot. CP pass V
Final Pot. FP 250.0E-3 V oc
Initial Delay ID 900 s
Scan Rate SR 166.0E-3 mV/s
Curr. Range CR Auto
Scan Incr. SI 500.0E-3 mV
Step Time ST 3.012 s
No. of Points NP 1000
GI Time Const. TC Off
Line Sync. LS no
IR Mode IR none
Rise Time RT high stability
Filter FL Off
Working Elec. WE Solid
Ref. Elec. RE User 0.0000 V
Sample Area AR 3.000 cm²
Equiv. Wt. EW 28.00 g
Density DE 7.850 g/ml
AUX A/D AU no
Open Circuit OC -480.0E-3 V
Comment: 5%NaCl+1%2019
Rp CALCULATIONS:
Corrosion Rate = 273.7E-3 mmpy
Correlation = -872.8E-3
Rp = 308.4 Ohms
E(I=0) = -395.5 mV
Icorr(R) = 70.42 uA
Beta Anodic = 100.0E-3
Beta Cathodic = 100.0E-3 V/decade
Begin = -412.0 mV
End = -372.0 mV

Control

352 SoftCorr III Corrosion Measurement Software for Windows, v. 3.06
Filename: F:\PUBLIC\TOWNHALL\EISFOL~1\0527051.DAT
Pstat: VStat[] Ver 2
TA TAFEL
File Status: NORMAL
Date Run: 05-27-05
Time Run: 09:10:45

| | | | |
|----------------|----|----------------|-----------------|
| Cond. Time | CT | pass | s |
| Initial Pot. | IP | -250.0E-3 | V oc |
| Cond. Pot. | CP | pass | V |
| Final Pot. | FP | 250.0E-3 | V oc |
| Initial Delay | ID | 900 | s |
| Scan Rate | SR | 166.0E-3 | mV/s |
| Curr. Range | CR | Auto | |
| Scan Incr. | SI | 500.0E-3 | mV |
| Step Time | ST | 3.012 | s |
| No. of Points | NP | 1000 | |
| GI Time Const. | TC | Off | |
| Line Sync. | LS | no | |
| IR Mode | IR | none | |
| Rise Time | RT | high stability | |
| Filter | FL | Off | |
| Working Elec. | WE | Solid | |
| Ref. Elec. | RE | User 0.0000 | V |
| Sample Area | AR | 3.000 | cm ² |
| Equiv. Wt. | EW | 28.00 | g |
| Density | DE | 7.850 | g/ml |
| AUX A/D | AU | no | |
| Open Circuit | OC | -557.0E-3 | V |

Comment: 5%NaCl
Rp CALCULATIONS:
Corrosion Rate = 1.861 mmpy
Correlation = -874.0E-3
Rp = 45.33 Ohms
E(I=0) = -406.9 mV
Icorr(R) = 479.0 uA
Beta Anodic = 100.0E-3
Beta Cathodic = 100.0E-3 V/decade
Begin = -429.0 mV
End = -389.0 mV

1% Protectosil CIF

352 SoftCorr III Corrosion Measurement Software for Windows, v. 3.06

Filename: F:\PUBLIC\TOWNHALL\EISFOL~1\0526052.DAT

Pstat: VStat[] Ver 2

TA TAFEL

File Status: NORMAL

Date Run: 05-26-05

Time Run: 11:09:39

| | | | |
|----------------|----|----------------|-----------------|
| Cond. Time | CT | pass | s |
| Initial Pot. | IP | -250.0E-3 | V oc |
| Cond. Pot. | CP | pass | V |
| Final Pot. | FP | 250.0E-3 | V oc |
| Initial Delay | ID | 900 | s |
| Scan Rate | SR | 166.0E-3 | mV/s |
| Curr. Range | CR | Auto | |
| Scan Incr. | SI | 500.0E-3 | mV |
| Step Time | ST | 3.012 | s |
| No. of Points | NP | 1000 | |
| GI Time Const. | TC | Off | |
| Line Sync. | LS | no | |
| IR Mode | IR | none | |
| Rise Time | RT | high stability | |
| Filter | FL | Off | |
| Working Elec. | WE | Solid | |
| Ref. Elec. | RE | User 0.0000 | V |
| Sample Area | AR | 3.000 | cm ² |
| Equiv. Wt. | EW | 28.00 | g |
| Density | DE | 7.800 | g/ml |
| AUX A/D | AU | no | |
| Open Circuit | OC | -470.0E-3 | V |

Comment: 1% Protectosil in 5%NaCl with st

Rp CALCULATIONS:

Corrosion Rate = 5.367 mmpy

Correlation = -759.6E-3

Rp = 15.82 Ohms

E(I=0) = -422.9 mV

Icorr(R) = 1.372 mA

Beta Anodic = 100.0E-3

Beta Cathodic = 100.0E-3 V/decade

Begin = -439.5 mV

End = -399.5 mV

1% 2020M

352 SoftCorr III Corrosion Measurement Software for Windows, v. 3.06
Filename: F:\PUBLIC\TOWNHALL\EISFOL-1\05260-3.DAT
Pstat: VStat[] Ver 2

TA TAFEL

File Status: NORMAL

Date Run: 05-26-05

Time Run: 14:26:45

| | | | |
|----------------|----|----------------|-----------------|
| Cond. Time | CT | pass | s |
| Initial Pot. | IP | -250.0E-3 | V oc |
| Cond. Pot. | CP | pass | V |
| Final Pot. | FP | 250.0E-3 | V oc |
| Initial Delay | ID | 900 | s |
| Scan Rate | SR | 166.0E-3 | mV/s |
| Curr. Range | CR | Auto | |
| Scan Incr. | SI | 500.0E-3 | mV |
| Step Time | ST | 3.012 | s |
| No. of Points | NP | 1000 | |
| GI Time Const. | TC | Off | |
| Line Sync. | LS | no | |
| IR Mode | IR | none | |
| Rise Time | RT | high stability | |
| Filter | FL | Off | |
| Working Elec. | WE | Solid | |
| Ref. Elec. | RE | User 0.0000 | V |
| Sample Area | AR | 3.000 | cm ² |
| Equiv. Wt. | EW | 28.00 | g |
| Density | DE | 7.800 | g/ml |
| AUX A/D | AU | no | |
| Open Circuit | OC | -477.0E-3 | V |

Comment: 1% MCI 2020M in 5%NaCl with stir

Rp CALCULATIONS:

Corrosion Rate = 4.102E-3 mmpy

Correlation = -993.9E-3

Rp = 20.71 kOhms

E(I=0) = -395.6 mV

Icorr(R) = 1.049 uA

Beta Anodic = 100.0E-3

Beta Cathodic = 100.0E-3 V/decade

Begin = -415.0 mV

End = -375.0 mV