CATHODIC DELAMINATION TESTS DURING THE INITIAL STAGE OF COATING CURE IN SEAWATER PERFORMED UNDER VARIOUS POLARIZATION REGIMES

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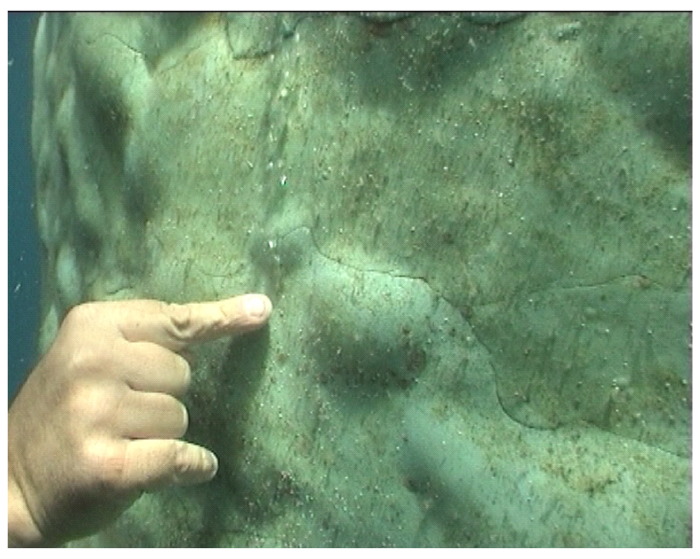
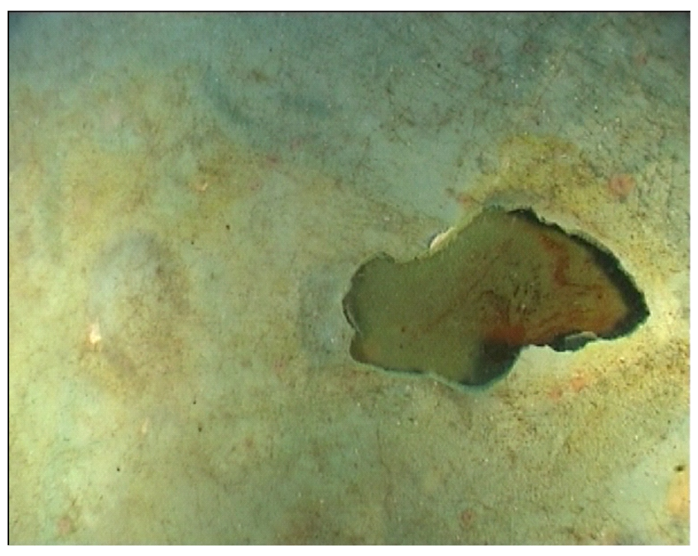
Introduction

Corrosion of submerged and splash zone steel structures exposed to the seawater is one of the major problems of petroleum industry. Cathodic protection in combination with protective coatings are often used on submerged structures as the most effective and economic protection method. Coating presence reduces the area of the metal exposed to the seawater and lowers the current demand for cathodic protection. However, coated structure subjected to cathodic protection is influenced by the strong electric force which changes chemical and dynamic conditions that may affect the coating performance. Influence of the electric strain may be extremely harmful when excessive cathodic potentials are applied. Consequences may be visible after few month or years in the form of blistering and cathodic delamination. In order to preserve submerged structures by applying combination of the coating and cathodic protection unique design, careful installation and maintenance is needed.

When coatings are applied on site below the waterline, a common dilemma is whether cathodic protection should be on or out of service during the coating application period. In the present study, the effects of various cathodic polarization regimes during the initial stage of coating cure in seawater were investigated. The objective was to determine whether the investigated coating could withstand cathodic polarization during its application without delamination and/or blister development.

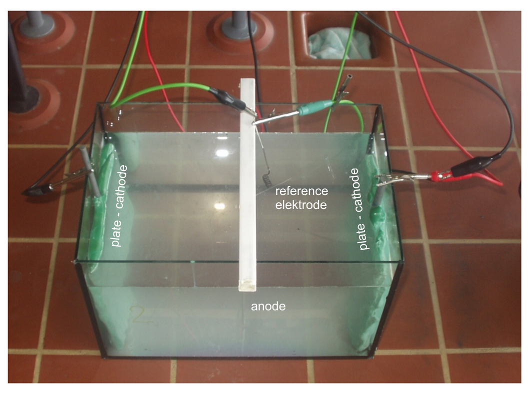
Surface of the coated pilar





Experimental setup

Electrode: carbon steel
Coating: 100% solids, solvent free, epoxy polyamide coating
Electrolyte: seawater
Techniques: instant off potential method,
cathodic linear polarization,
OCP measurement,
short-term test (2 hours) of cathodic delamination
long - term test (30 days) of cathodic delamination

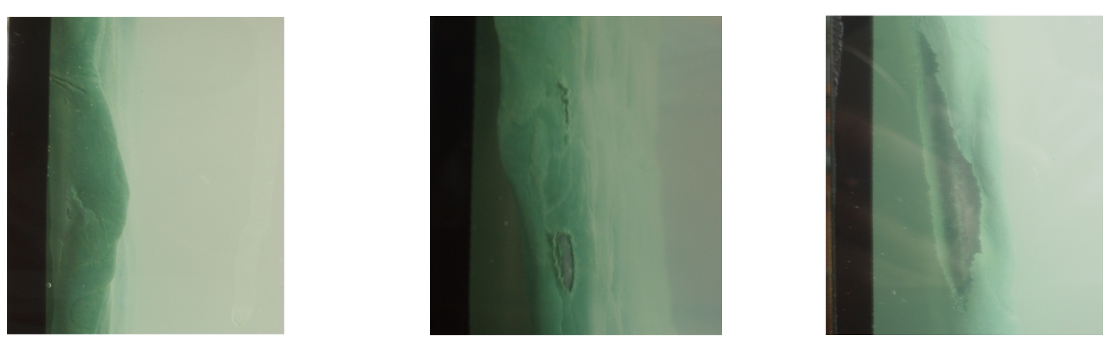


Short-term test of the cathodic delamination

Table 1. Polarization parameters measured after 2 hours of cathodic polarization of samples instantly after the application of coating and immersion into the seawater.

Sample Number	E_{app} / V	U_{ext} / V	I_{ext} / mA
1	-0.98	2.05	4.0
2	-1.10	2.58	10.0
3	-1.40	3.38	153.0

Figure 5. Coated plates after 2 hours of cathodic polarization instantly after the application of coating and immersion into the seawater.



E_{app} = - 0.98 V　E_{app} = - 1.10 V　E_{app} = - 1.40 V

Time dependency of the OCP

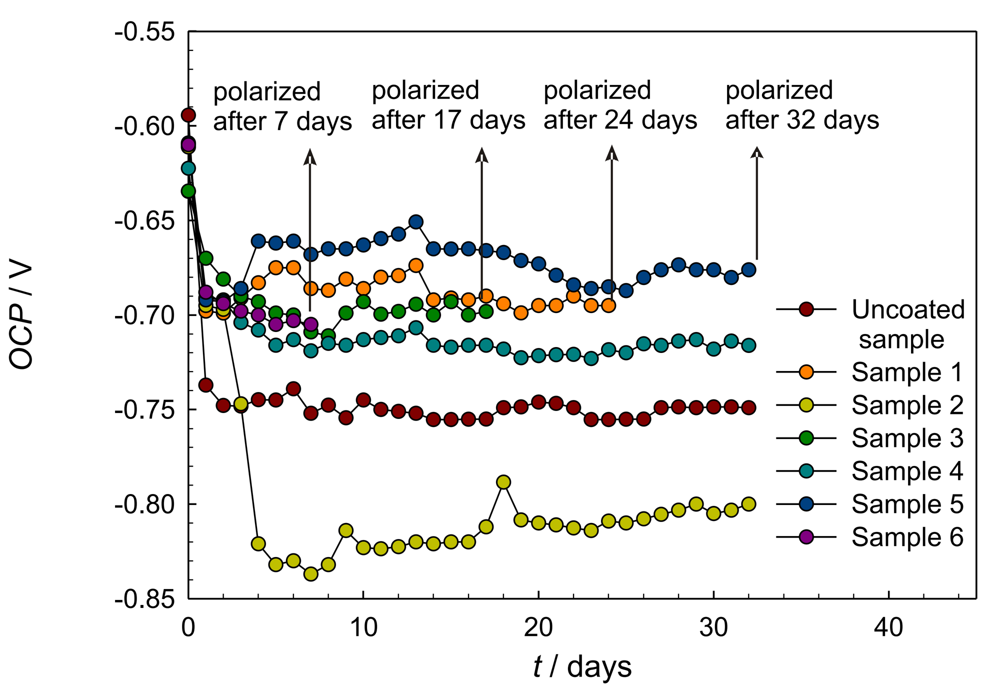


Figure 6. Time dependence of the OCP of the uncoate steel plate and the coated samples immersed in the seawater.

Cathodic polarization of samples in seawater

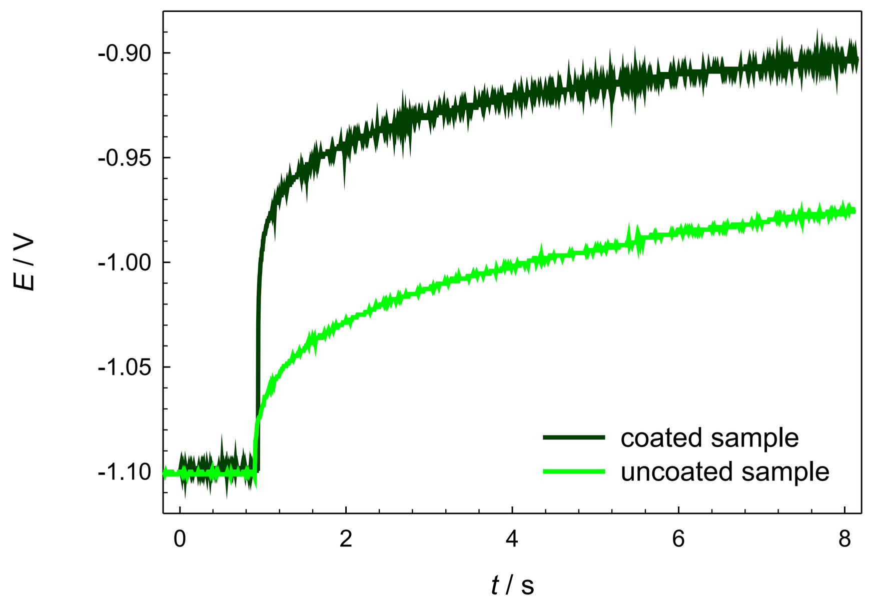


Figure 1. Off potential transients measured at the uncoated and coated electrode after the cathodic potential of -1.1V had been applied.

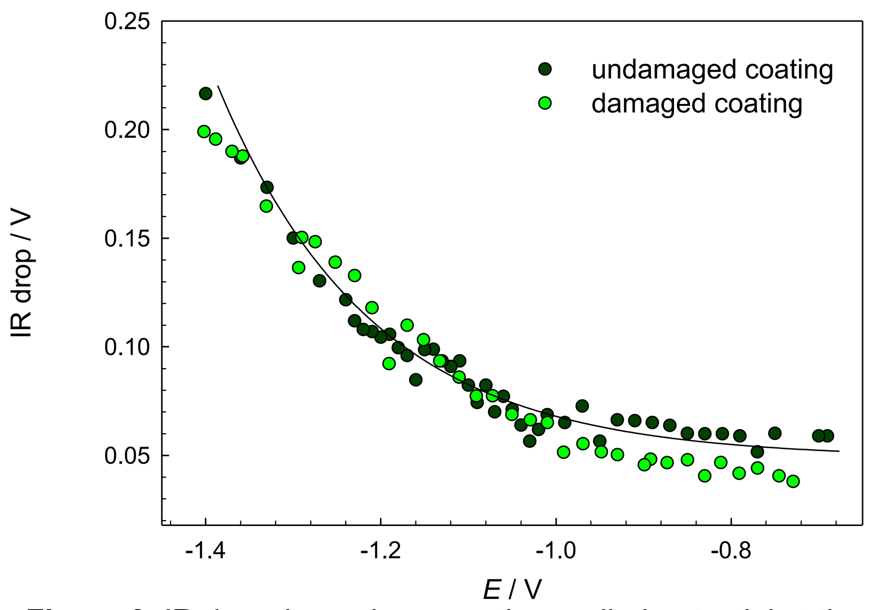


Figure 2. IR drop dependence on the applied potential at the coated electrode with and without the circular defect.

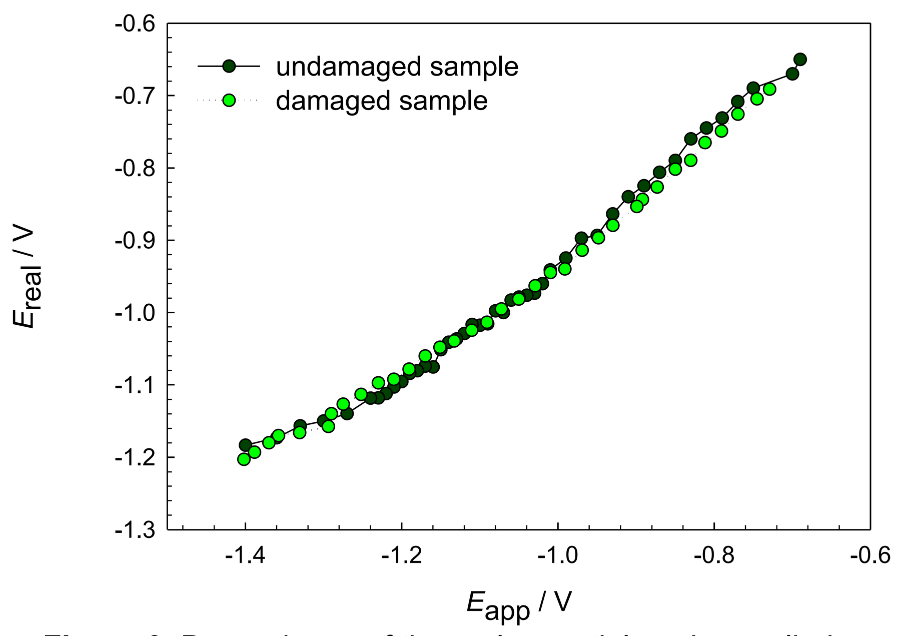


Figure 3. Dependence of the real potential on the applied potential of the coated electrode with and without the circular defect.

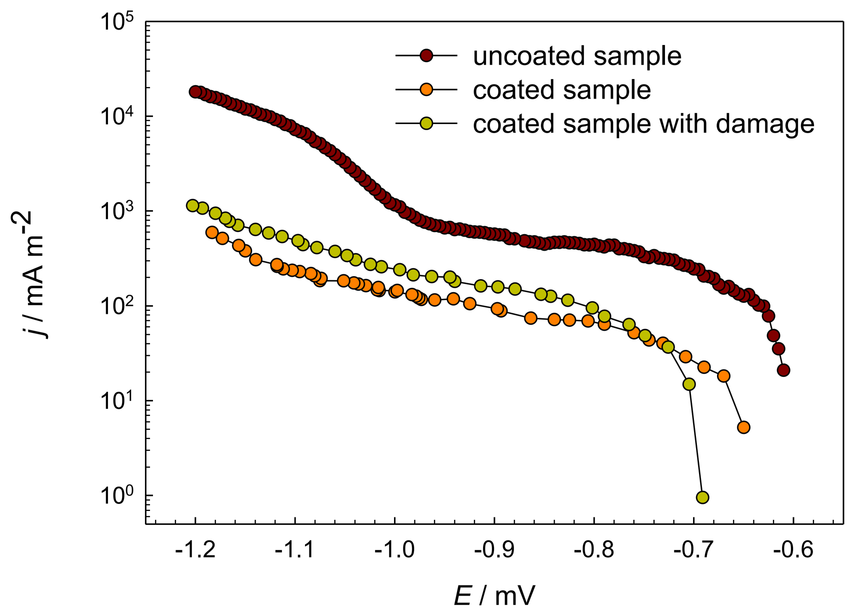


Figure 4. IR corrected polarization curves of the uncoated electrode and coated electrodes with and without the circular defect.

Long term (30 days) test of the cathodic delamination

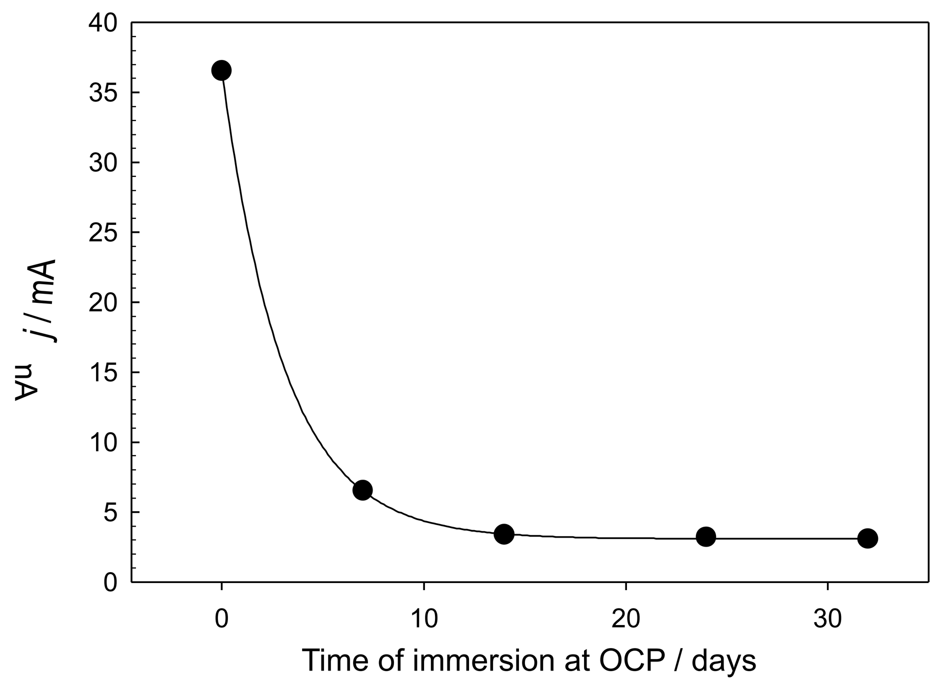


Figure 7. Initial protection currents at the polarization potential of -1.2 V after various times of sample immersion at the OCP.

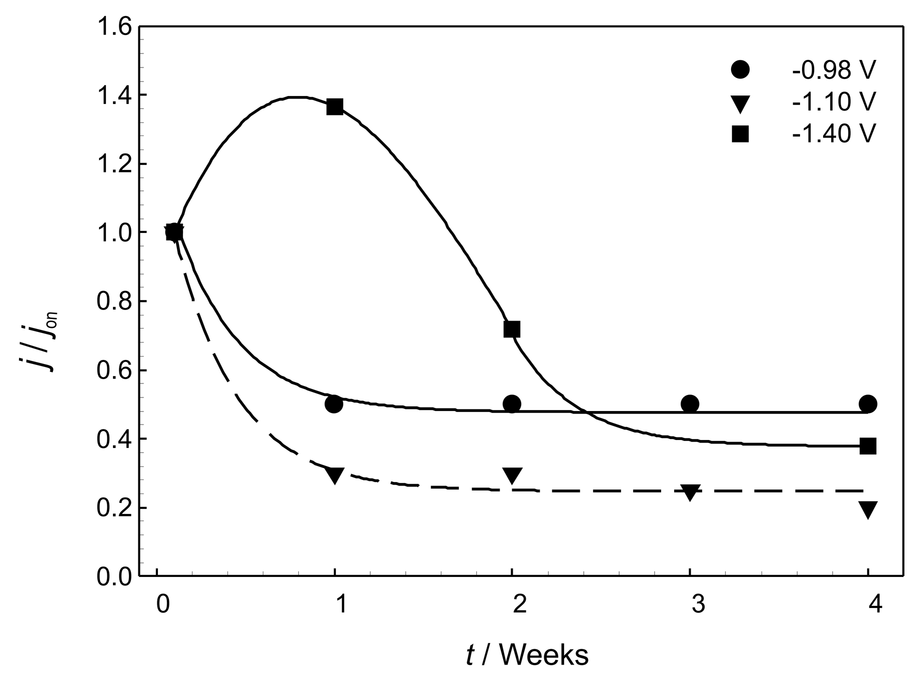


Figure 8. Ratio of the measured and initial protection current for three polarization potentials.

E_{app} = - 0.98 V　E_{app} = - 1.10 V　E_{app} = - 1.40 V

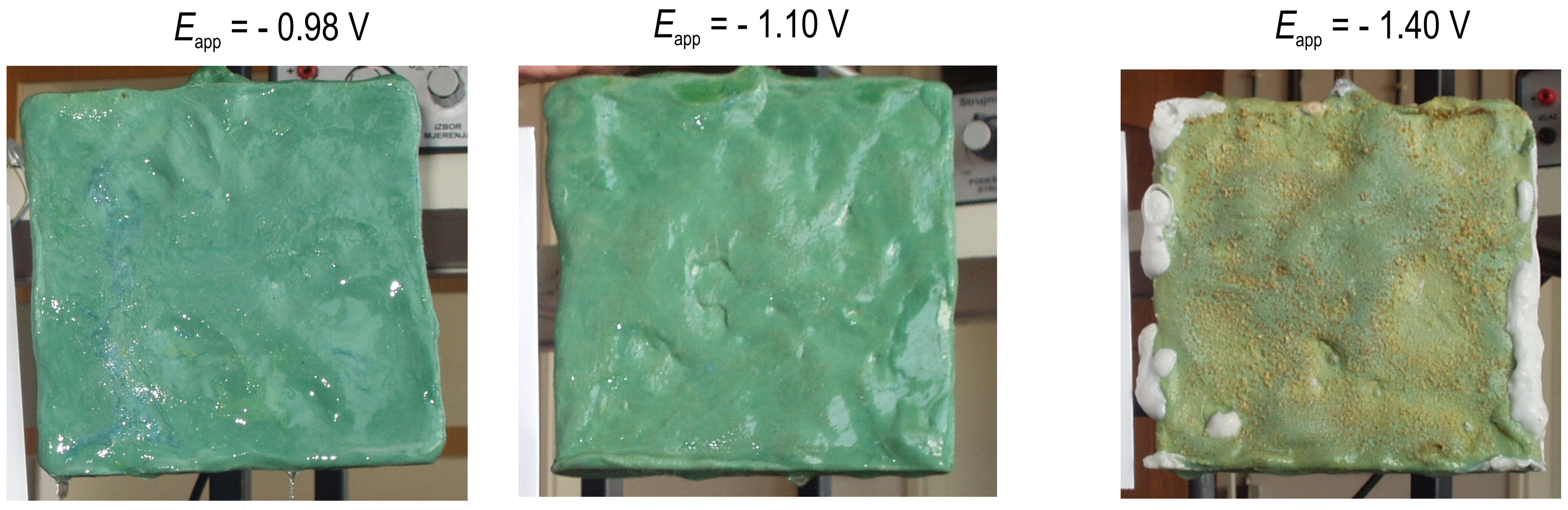


Figure 9. Coated steel plates after 32 days of polarization under the potentials of -0.98 V, -1.10 V and -1.4 V.

Conclusions:

The investigated coating may be applied under cathodic protection if thepolarization potential is sufficiently positive (- 0.98 V) and if care is taken to apply the coating at the prescribed thickness. If the construction includes sharp edges, cathodic protection should be off during coating application. After the coating has solidified, more negative polarization potentials from -1.1 to -1.2 V may be applied in order to attain optimal protective characteristics of the calcerous deposits.