

## Interfacial disbondment of epoxy coating on carbon in flowing NaCl solution

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**Abstract** Coating disbondment has been recognized of one of the main coating degradation mode in NaCl solution under cathodic protection, owing to the occurrence of water reduction and oxygen evolution reactions. Previous research works on coating disbondment mostly concern with static fluid. It has been revealed that for a given coating thickness and cathodic potential level, the cathodic disbondment rate is controlled by the mass transfer of cations from the defect position to the disbondment front [1]. As a result, the rate of cathodic disbondment is correlated to the diffusion coefficient of electrolyte cations  $D$  and the immersion time  $t$ . The disbondment length follows parabolic kinetics with respect to time and diffusion coefficient [2].

In this work, we studied the coating degradation mechanism in flowing NaCl fluids by using Wire Beam Electrode (WBE) and Electrochemical Impedance Spectroscopy (EIS). WBE results showed that coating disbondment is accelerated in a flowing fluid compared to a static fluid. In high-speed flowing fluid, the parabolic kinetics between disbondment length and time switches to linear kinetics. EIS results showed that coating capacitance decreases with fluid speed, indicating a higher ion diffusion rate through epoxy coating, which causes a larger electric field at coating/substrate interface. As a result, the mass transfer of sodium ions from defect position to disbondment front is not only governed by diffusion, but also by electromigration. A numerical model based on the Nernst-Planck-Poisson equation was developed to simulate the disbondment rate based on the mass transfer of sodium ions at coating-substrate interface. The model also confirmed that mass transfer of sodium ions accelerates with high negative charge at the interface. Electromigration plays a more important role during the process with high charge density. The model was able to explain the influence of a flowing fluid on the mass transfer rate of sodium ions and chloride ions. This work indicate that the mass transfer through epoxy coating and the interaction of cation and anions also need to be considered in coating disbondment mechanism.

**Keywords** Cathodic Disbondment, Epoxy Coating, Flow fluid

**Reference**

[1] Xu, M., et al., *Evaluation of the cathodic disbondment resistance of pipeline coatings—A review*. Progress in Organic Coatings, 2020. 146: p. 105728.

[2] Sørensen, P.A., et al., *Cathodic delamination: Quantification of ionic transport rates along coating–steel interfaces*. Progress in Organic Coatings, 2010. 68(1-2): p. 70-78.