No. 2318

Development of High Corrosion Resistant Self-Healing Coatings with Nanofiber Network Structure

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Summary

Carbon steel is used for seawater piping in salt production plants, and corrosion protection by painting or coating was conducted to prevent damage by corrosion. Corrosion inhibitor pigments are generally added in the coatings to prevent corrosion. However, when defects occur in the coatings, corrosion occurred. To prevent the progression of corrosion caused by the defects, a self-healing corrosion prevention coating is effective, in which a protective film is formed automatically in the defect portion. We have revealed that the polymer coating added of a corrosion inhibitor and cellulose nanofibers showed high self-healing properties by the cellulose nanofibers to act as a release pathway for the corrosion inhibitor and rapid release of a large amount of the corrosion inhibitor.

In this study, network structures in corrosion prevention polymer coatings with cellulose nanofibers were investigated. In order to gain a deeper understanding of the advantages of the network structure by the nanofibers, a particle network was used as a comparative material. In the experiment, the release of corrosion inhibitor and the self-healing performance by electrochemical equipment was measured for the coatings with particle network by a large amount of corrosion inhibitor particles and the coatings with fiber network by cellulose nanofibers, using the coating with a low concentration of corrosion inhibitor particles as a standard. The goal was to develop a high corrosion resistant self-healing coating using nanofibers by comprehensively evaluating the results of these tests.

The test results showed that particle network structure could be formed in coating with 30wt% magnesium phosphate as a corrosion inhibitor, and showed high polarization resistance. Fiber network structure could be formed in the coating with 5wt% magnesium phosphate and 1wt% cellulose nanofiber, and showed high polarization resistance. The release behavior of magnesium phosphate from these coatings was measured, and the network structure caused sustained release. Furthermore, a cost comparison showed that the addition of cellulose nanofibers in the coating was cost-effective, because the amount of cellulose nanofibers added is small, although the unit cost is high.