
Z01-4577 - Reduction and Oxidation Behavior of Rust Layers Under Aqueous Solution Films with Different Thicknesses



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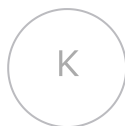
Abstract

It is well known that steel materials widely used in infrastructures corrode rapidly in atmospheric environments. As a result of corrosion, rust layers form on steel surfaces exposed to repeated wet and dry environments. In such wet and dry environments, redox reactions of rust layer may occur and accelerates the corrosion of steels. Such redox behavior can strongly depend on the composition of rust layer and the thickness of the solution film that is present on the surface in the wet stage. In this study, we investigated the effect of solution film thickness on the redox behavior of two types of rust layers with different compositions, i.e. FeOOH-rich and Fe₃O₄-rich rust layers.

Specimens used were carbon steels, on the surfaces of which either of rust layers was present, that is, FeOOH-rich or Fe₃O₄-rich rust layers. FeOOH-rich rust layers were produced through atmospheric exposure of carbon steel for 3 months. On the other hand, Fe₃O₄-rich rust layers were produced by dipping of FeOOH-rich rust layers in 0.1M Na₂SO₄ solution of pH 5 at 50 °C for 24 h. The specimens were subjected to the solution film test in which the rust layers were covered with 0.1M Na₂SO₄ solution film with various thicknesses. To avoid evaporation of the solution film, the specimens were put into tightly sealed container and kept in a thermostatic chamber at 50 °C for 24 h. After the test, the solution films on the specimen surfaces were removed and then dried at 60 °C and 50% R.H. for 6 h.

X-ray diffraction pattern obtained for the specimens indicated that main rust constituents in each specimen were Fe₃O₄, α-FeOOH, and γ-FeOOH. The mass fraction of each rust constituent was calculated from the peak intensity of the X-ray diffraction and based on the calculation, the Fe²⁺/Fe³⁺ ratios in the rust layers were estimated. The Fe²⁺/Fe³⁺ ratio in the FeOOH-rich rust layer increased after the solution film test and the increase varied depending on the solution film thickness. In the thinner range than 200 μm, the increase of the Fe²⁺/Fe³⁺ after the test was relatively low whereas in the thicker range than 200 μm, the increase was significantly large, indicating that the reduction of FeOOH predominantly occurred under thick solution film. The Fe²⁺/Fe³⁺ ratio in the Fe₃O₄-rich rust layer tended to decrease with decreasing the solution film thickness. These imply that the reduction and oxidation of rust layers depend not only on the thickness of the solution film present above rust layer but also its composition.

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