

# Ion selective permeability of rust layers formed by corrosion cycle tests and exposure tests

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## Abstract

Rust layers on weathering steels have a roll of protection against the atmospheric corrosive environment. An investigation of characteristics of mass transfer passing the rust film is important to understand effect of anticorrosion. The ion selectivity is considered as one of the decision factor of the corrosion. The ion selective permeability of rust layers on carbon steel and Fe-Co and Fe-Ni low alloy steel was investigated by measurement of membrane potential in order to evaluate the characteristics of rust films on low alloy steels.

Samples are Fe-1mass%Co, Fe-3mass%Co and Fe-3mass%Ni low alloy steel. Carbon steel was used as the comparative material. The preparation of samples and the measuring system of membrane potential is shown in Fig.1. The membrane potential of a rust film formed by the corrosion cycle test and the exposure test was measured to evaluate corrosion resistance. In the corrosion cycle test, the dropping the NaCl solution and the drying process from wet condition at 25 °C, the relative humidity of 60%RH for 12 hours was involved in a cycle. A rust film was formed on the two kinds of the low alloy steels (Fe-Co and Fe-Ni steel) by corrosion cycle tests that simulated the atmospheric corrosion environment. In the exposure test, steel samples were set on Choshi in Japan. A rust film was kept so that both sides of a rust film might be next to the KCl solution which had different concentration each other as shown in Fig.1 and then, the membrane potential measurement between both rust sides was carried out. Drying weight of the sample was measured in each cycle, and corrosion rate was determined from the weight change.

The corrosion rate of low alloy steels (Fe-Co, Fe-Ni alloy steel) was shown in Fig.2 when the corrosion rate of carbon steel was made 100%. The corrosion rate of the Fe-Ni and Fe-Co low alloy steel was about 70% in comparison with the case of the carbon steel.

Figure 3 shows the results of membrane potential measurement of rust layers formed by the corrosion cycle test and exposure test on the carbon steel. In the case of the carbon steel, the rust layer on it had anion selective permeability. Therefore, chloride was passed through the rust layer on the carbon steel to the metal surface and corrosion was progressed. The addition of a few Co was effective for decreasing the corrosion rate, because the rust layer of cation selective was obstructed the permeation of chloride ion. However, the corrosion rate of the Fe-Ni low alloy steel became 70%, anion permeability was shown from the fructification of the membrane potential measurement of the rust layer that it was formed on the Fe-3% Ni. The tendency of the membrane potential measurement of rust layers on all samples formed by corrosion cycle test was same as the case of rust films formed by exposure tests. The corrosion cycle test was effective for the study on the rust layer of low alloy weathering steels.

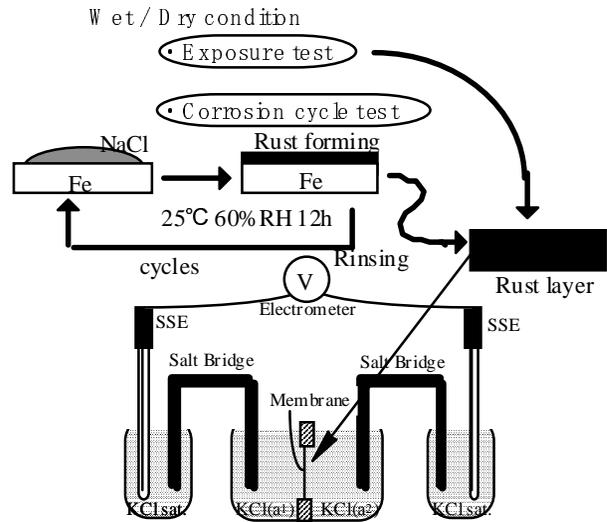


Fig.1 Schematic diagram of measuring membrane potential and preparation of rust layers.

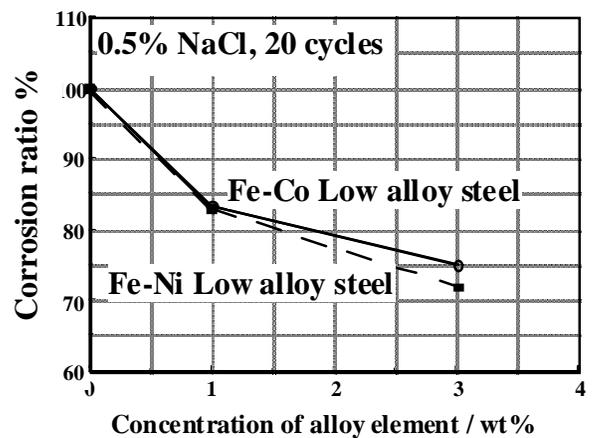


Fig.2 Corrosion rate of low alloy steels (Fe-Ni, Fe-Co) under corrosion cycle tests. The corrosion rate of the carbon steel is made 100%.

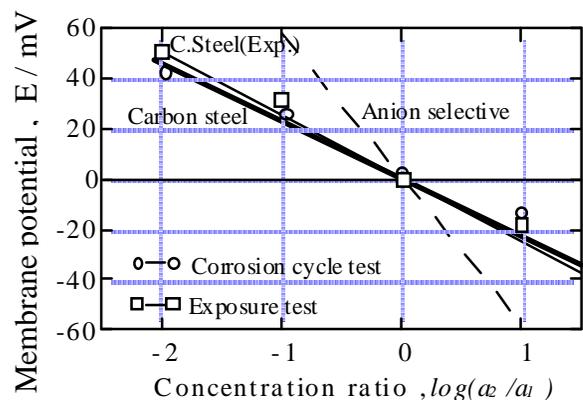


Fig.3 Membrane potential of rust layers formed in wet / dry environment.