Application of AC Impedance Method to Corrosion Rate Monitoring of Carbon Steel under Outdoor Environment

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It is necessary to examine in detail the relationship between environmental factors and corrosion behavior in order to clarify atmospheric corrosion mechanism, because the atmospheric corrosion is greatly influenced by various environmental factors. Most of the research for atmospheric corrosion has been carried out by the field test. Although corrosion loss for long period can be easily estimated by the test, it is impossible to obtain the change of corrosion behavior in the short period. In this study, in order to examine in detail the atmospheric corrosion process of carbon steel, we developed a concentric-ring corrosion sensor, which has been proven to be more suited for outdoor monitoring. And the atmospheric corrosion rate monitoring of carbon steel in outdoor environment was carried out by AC impedance method using this sensor.

Figure 1 shows the scheme of corrosion sensor used in this study. The sensor consists of two identical metals embedded concentrically in the epoxy resin. The diluted artificial seawater 1600 μ L was previously dropped on the corrosion sensor installed in outdoor. The impedance was measured by an AC impedance corrosion monitor controlled by a computer. The system allowed to measure continuously the impedance values at two different frequencies of 10kHz and 10mHz.

The change in the response of corrosion sensor in a sunny day is shown in Fig.2. The changes in temperature and relative humidity are also shown in the figure. The values of R_s and R_p correspond to the solution resistance and the polarization resistance, respectively. In the daytime in which the relative humidity lowers with increasing the temperature, both resistances also showed the high values. This is indicated that the corrosion does not progress in daytime. On the other hand, in the night, the temperature is low and the relative humidity is high, and then both resistances give the low values. This is attributed to the dew condensation, indicating the progress of corrosion. Thus, it is found that the impedances of the sensor sensitively change for the environmental factor.

The cumulative values of impedance measured on the sensors correspond to corrosion loss. The corrosion loss was compared with that estimated by the surface roughness using a laser microscope. A linear relationship was observed between two values. It indicates that the monitoring system by means of the concentric ring type sensor is effective in the estimation of atmospheric corrosion rate of carbon steels.

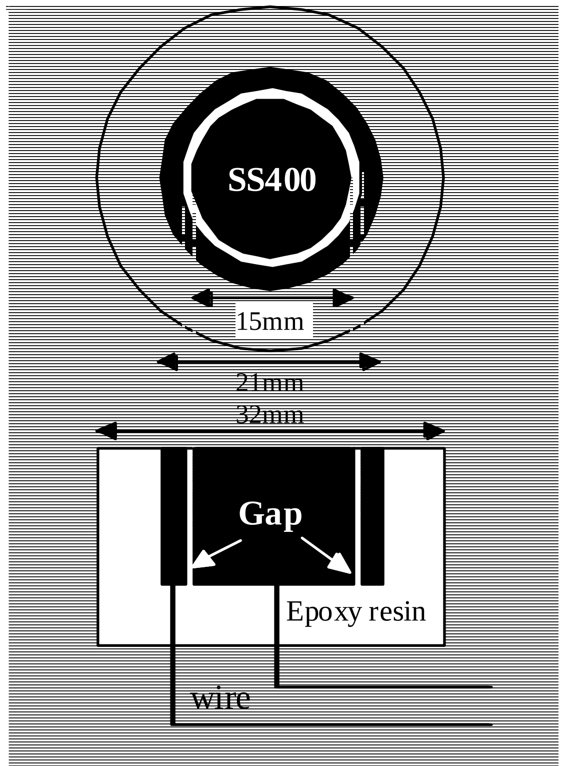

Fig.1 Scheme of concentric ring type atmospheric corrosion monitoring sensor.

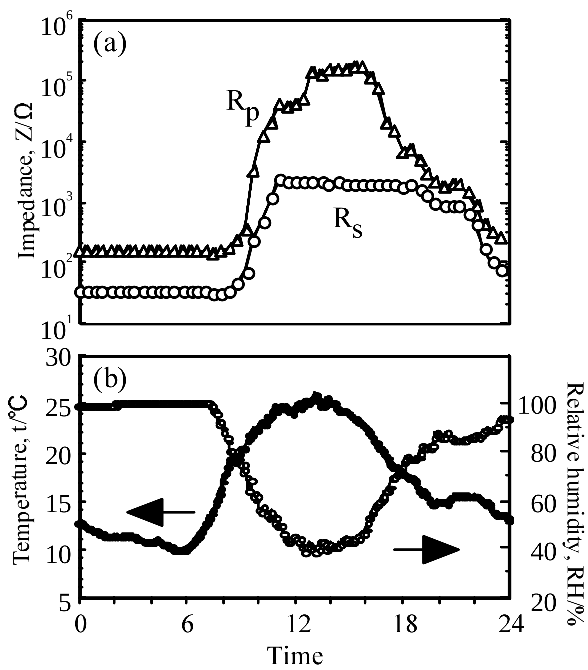

Fig.2 Change in polarization and solution resistances of corrosion sensor with 1mg/cm^2 sea salt deposition (a), and change in relative humidity and temperature (b) in a sunny day.