Corrosion Monitoring of Steels Based on Electrochemical Noise Impedance

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Introduction

The corrosion rate of carbon steel in moderate corrosive environments was estimated using electrochemical noise impedance. For correct electrode impedance estimation, it was emphasized that data to be analyzed have a good correlations between the potential and current noises both in time and frequency domains [1].

Experimental Method

The electrochemical noise measurement was carried out employing a nanovoltmeter to measure electrode potential noise and a picoammeter to measure the short-circuit current between two working electrodes. The experimental set-up is shown in **Figure 1**. Three identical electrodes were made of carbon steel (SM400B) and the surface area of electrode was 0.5cm^2. A 0.5M solution NaCl was used as corrosive medium.

The electrochemical impedance calculated from the noise analysis was compared with that measured by AC impedance method. AC impedance was measured with a frequency response analyzer and potentiostat just after the electrochemical noise measurement.

Results and Discussion

Figure 2 shows typical potential and current noises which had a high correlation coefficient between them. These data were offset by d-c trend and processed according to moving average method. There was a positive correlation between the potential and current noises in time domain, and the correlation coefficient was 0.73.

Figure 3 shows the impedance and coherence calculated from five sequences of data with a high correlation coefficient. For comparison, the result obtained by AC impedance measurement is also shown in **Fig. 3**. In the frequency range lower than 10mHz, the coherence was high and there was good correlation between the potential and current noises in frequency domain. The magnitude of impedance at the minimum frequency employed (1mHz) was about 3000Ω. Moreover, the impedance calculated by electrochemical noise impedance agreed well with the result (2400Ω) obtained by AC impedance measurement in the low frequency. When both the correlation coefficient and coherence function were sufficiently high, the impedance at very low frequency obtained by electrochemical noise impedance agreed well with that obtained by AC impedance measurement. Thus, the polarization resistance, the reciprocal of which is proportional to the corrosion current, will be estimated by electrochemical noise impedance technique, if the potential and current noise data with high correlation coefficient and coherence function are employed.

Conclusions

In the measurement of electrochemical noise for monitoring of the corrosion rate of carbon steel in a moderate corrosive environment, the polarization resistance should be calculated by using a set of potential and current noise data which had good correlations both in time and frequency domains.

Reference

[1] T. Tsuru and M. Yaginuma, *Zairyo-to-Kankyo*, **52**, 488-495 (2003)

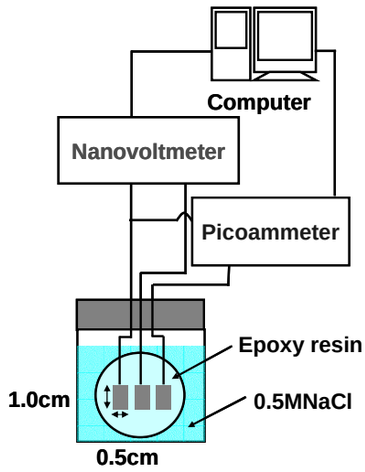

Fig.1 Schematic illustration of an electrochemical noise measurement system.

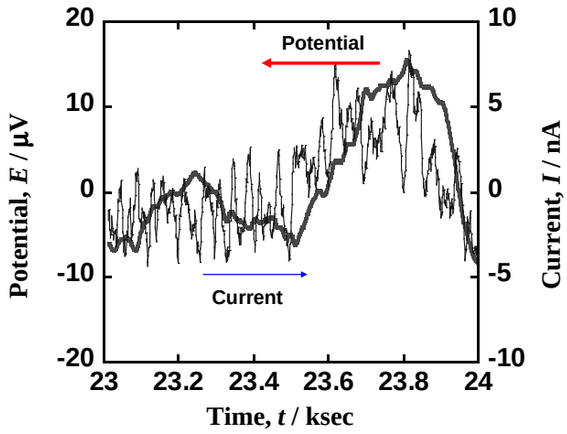

Fig.2 Potential and current noises of carbon steel in 0.5M NaCl solution at immersion time of 72 days. Correlation coefficient between potential and current noise is 0.73.

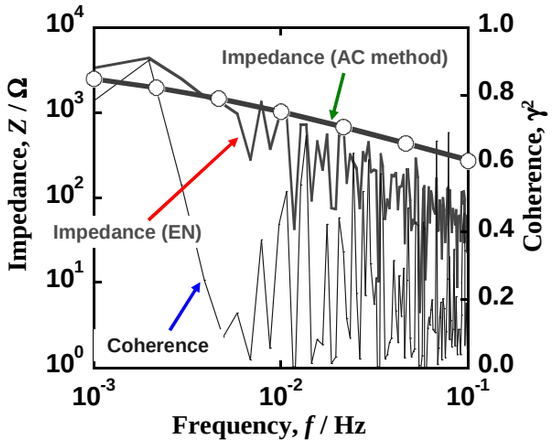

Fig.3 Impedance and coherence calculated from potential and current noises and impedance obtained by AC method of carbon steel in 0.5MNaCl solution at immersion time of 72 days.