

Atmospheric corrosion rates of three different steels have been monitored in four different sites in Japan. A newly developed probe electrodes consisting of a pair of identical specimens embedded in epoxy resin, as shown in Fig.1, were used for the corrosion monitoring. A carbon steel (CS), ordinary weathering steel (WS) and marine weathering steel (3NiWS) containing 3 mass% Ni were used as specimens.

Two frequency impedances at high and low frequencies (10 kHz and 10 mHz) were measured every 30 min. Since the high frequency impedance Z_H corresponds to a solution resistance, "time of wetness"(TOW) of each specimen was determined from the monitoring of Z_H in this study, which is defined as the time period when a specimen surface is wet due to rainfall and dew condensation. Meanwhile, a polarization resistance R_p , which can be obtained from subtracting the Z_H from the low frequency impedance Z_L , was employed for estimating the instantaneous corrosion rate of specimens.

Impedance measurements in corrosion monitoring were carried out using a remote-controlled AC Corrosion Monitor (Riken Denshi Co., Ltd. CT-7). The corrosion monitor was placed close to the exposure test racks and remote-controlled by a personal computer in laboratory. The remote control and data transmission between the exposure site and laboratory were performed through cellular phones. For four exposure sites selected in this study, sites A, B and C were marine atmosphere and site D was rural atmosphere.

It was found that the TOW can be evaluated from continuous measurements of high frequency impedance. As can be seen in Fig.2, the TOW decreased slightly in order of CS, WS and 3NiWS. This may be attributed to difference in thickness and porosity of the rusts formed on the probe specimen surfaces. Accordingly, this probe is very useful for measuring the actual TOW value of steel itself.

Figure 3 shows amount of corrosion Q_{corr} each month measured with three different steel probes at site A and site D. The monitoring started from September,18, 2003 for site A and December, 5, 2003 for site D. The Q_{corr} was obtained by integration of the monitored R_p^{-1} with time. According to Stern-Geary equation, the i_{corr} will be obtained by multiplying the Q_{corr} by a proportional constant k . The k value is unknown in atmospheric corrosion systems so far. Thus the Q_{corr} was used as an index of amount of corrosion.

For all steels, the amount of corrosion for site D (rural) was much smaller than that for other three sites (marine). Particularly, the Q_{corr} showed a maximum at site A where amount of airborne salts was greatest among them. These results indicate that aggressiveness of the environment may be monitored by continuous measurement of the Q_{corr} . On the other hand, since the monitored amount of corrosion showed a tendency to increase in order of 3NiWS, WS and CS at marine atmospheres (site A, B and C), the difference of corrosion resistance among the three steels can be also evaluated by this monitoring system.

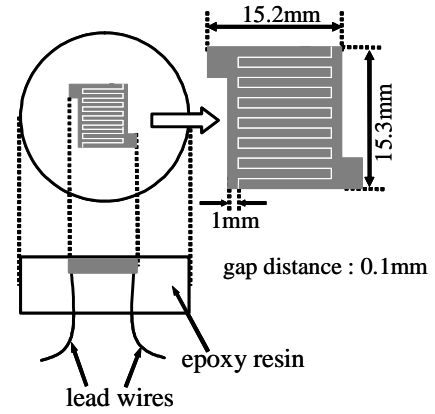


Fig. 1 Schematic diagram of electrochemical impedance probe for atmospheric corrosion monitoring

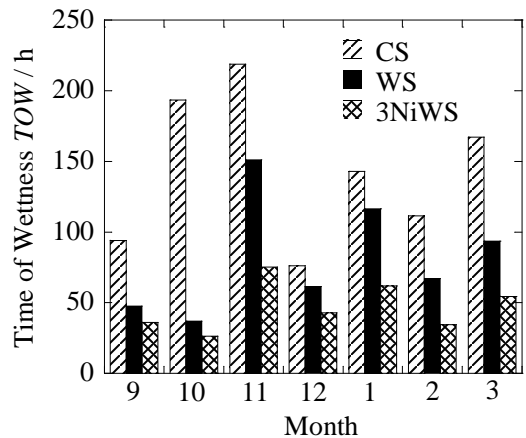


Fig. 2 TOW measured with CS (carbon steel), WS (weathering steel) and 3NiWS (marine weathering steel) probes from high frequency impedance at site A

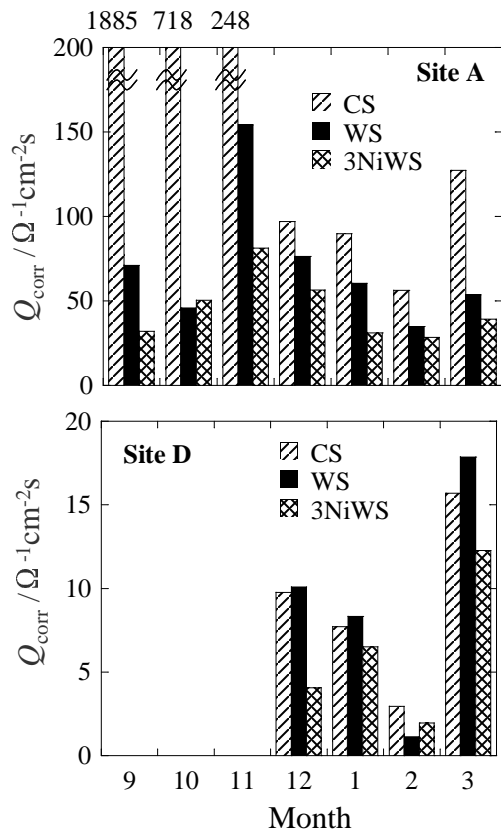


Fig.3 Amount of corrosion Q_{corr} of three steels at site A (marine) and site D (rural)