Application of AC Impedance Method to Atmospheric Corrosion Monitoring of Low Alloy Steels

Hideki KATAYAMA, Akira TAHARA,
Kazuhiko NODA and Hiroyuki MASUDA

National Institute for Materials Science (NIMS)
Sengen 1-2-1, Tsukuba, Ibaraki 305-0047, Japan

Atmospheric corrosion is greatly influenced by the various environmental factors such as temperature, relative humidity, rainfall, airborne sea salt and so on. Therefore, in order to clarify an atmospheric corrosion in detail, it is very important to monitor the corrosion rate of the materials and the effect of the environmental factors in actual environment. In this study, electrochemical impedance method has been applied to monitor the corrosion rate of iron based binary alloys exposed to outdoor environment. Furthermore, the utility of electrochemical impedance method in atmospheric corrosion monitoring was examined by comparison of the corrosion loss and the impedance data.

Pure iron, Fe-Ni alloy and Fe-Cr alloy were used as specimens, and they were prepared in the size of 150 x 50 x 5 (mm) for the exposure test. The two kinds of exposure tests, the ordinary and the sheltered exposure test, were conducted at Tsukuba (rural site), Choshi (marine site) and Miyakojima (marine site). The appearance of the exposure test at Tsukuba is shown in Fig.1, and the environmental data of each exposure test site are shown in Table 1. Corrosion loss was measured by gravimetric method after removing the rust layer by sulfuric acid solution with inhibitor. On the other hand, the corrosion monitoring was carried out using the concentric ring-type corrosion sensor consisting of the pin and ring electrodes. The corrosion sensors were installed under outdoor environment at Tsukuba, and the droplet of artificial seawater was previously added on the corrosion sensor. The atmospheric corrosion rate of the corrosion sensors was monitored by the continuous impedance measurement at 10kHz and 10mHz.

As for all specimens, the corrosion loss at Miyakojima was much larger than that at Tsukuba. Furthermore, regardless of the kind of the exposure test, the corrosion loss decreased with increasing the amount of Ni and Cr content.

All specimens gave the high corrosion rate in the night, and the corrosion rate decreased as the relative humidity decreased in the daytime. The corrosion rate of the iron based binary alloys is lower than that of the pure iron. In addition, the tendency grows with the increase in the amount of additional elements. It is concluded that the addition of Cr and Ni inhibits the atmospheric corrosion of steels.

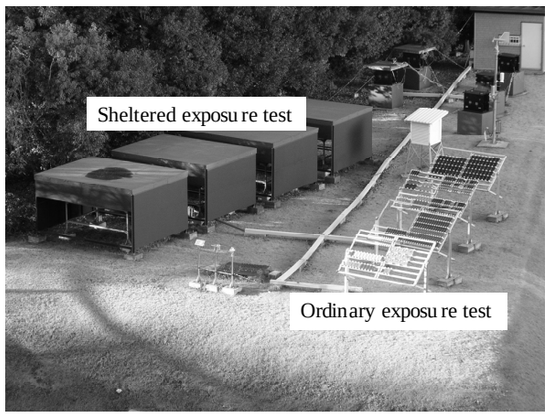

Fig.1 Appearance of the exposure test at Tsukuba.

Table 1 Environmental factors of each exposure site.

Site	Tsukuba	Choshi	Miyako-jima
Latitude (North)	36° 4’	35° 43’	24° 44’
Longitude (East)	140° 7’	140° 45’	125° 19’
Air temperature (K)	289.3	287.9	296.7
Relative humidity (%)	75	78	81
Chloride deposition rate ($mg/100cm^2 \cdot d$)	0.031	0.291	0.352