Evaluation of electrochemical impedance behavior on cavitation-corrosion damage parts for aluminum-bronze

Jae-Cheul Park+, Seong-Jong Kim1

It was evaluated the corrosion resistance by measuring the polarization resistance (R_p) of the ALBC3 parent material with cavitation time in sea water environment. The result of EIS performed every five hours. The EIS results at each condition were presented in the bode plot and nyquist plot. The overall tendency showed that the polarization resistance was higher than the parent material except at the 35 hours. This because the applied environment was sea water and the corrosion matter formed on the surface by the corrosive effect of chloride ions and cavitation played the role of oxide film, and thus the corrosion resistance became relatively high. Bronze alloy surface exposed to corrosive environment consists of oxide, chloride, hydroxide and cuprous oxide (Cu_2O) is known as the oxide to maintain maintains stable state[1]. Since oxides formed on the surface can great affect the corrosion resistance of a material, It was measured the resistance values of the individual factors by applying the equivalent circuit and performing fitting of the EIS experimental data[2]. The highest polarization resistance was found at the condition of five hours of cavitation, and the lowest was found at the condition of 35 hours of cavitation. Among the cavitation time variables, the values at 5, 10, 15, and 20 hours were different from those at 25, 30, and 35 hours to some extent. The nyquist plot showed that the polarization resistance was drastically reduced at the cavitation time of 25 hours or more. The individual resistance elements presented in the equivalent circuit are R_s(solution resistance), R_f (film resistance), and R_{ct}(charge transfer resistance). The R_s and R_f had relatively small and values. In particular, the R_s was similar under all the conditions. However, the R_f was significantly higher than that of the parent material between 5 hours to 20 hours, which because of the protective film effect of the corrosion matters generated by the cavitation damage with immersion[3]. The R_f was dramatically reduced to the values similar to that of the parent material from 25 hours and later, which because the film was destructed by the continued cavitation damage. On the contrary, the R_{ct} and R_p values were decreased as the cavitation application time was increased and they became similar to those of the parent material from 25 hours and later in particular. This tendency because the surface of the ALBC3 parent material was damaged by the cavitation impact pressure that was directly imposed as the protective film was destructed, which closely related to the result that the damage on the specimen surface was found from 25 hours or later during the test.

Reference

[1] J. J. Shim, et.al., Corrosion characteristics of copper pipe in potable water system. Korean journals of metal and material, 41, 12, 902-908, 2003

[2] J. A. Wharton et.al., The corrosion of nickel-aluminum-bronzein seawater, Corrosion science. 47, 3336-3367, 2005

[3] Florian mansefld, Electrochemical impedance spectroscopy as a new tool for investigating methods of corrosion protection, ElectrochimicaActa, 35, 10, 1533-1544, 1990

Acknowledgment

This research was financially supported by the Ministry of Education, Science Technology (MEST) and Korea Industrial Technology Foundation (KOTEF) through the Human Resource Training Project for Regional Innovation)

+ 박재철(목포해양대학교 기관시스템공학부 대학원),E-mail:romagain@mmu.ac.kr, Tel: 061)240-7471

1 김성종(목포해양대학교 기관시스템공학부)