Determination of Corrosion Rates of Reinforcement Steel in Silo Concrete by Electrochemical Method

Haeryong Jung, Sung-Bok Lee, Jin Beak Park and Eunyong Lee
Korea Radioactive Waste Management Corporation, *1045, Daedeokdaero, Yuseong-gu, Daejeon 305-353, South Korea*
nohul@krmc.or.kr

1. Introduction

A number of processes are responsible for concrete degradation in the subsurface environment. In general, the major degradation processes include acid attack, sulfate attack, the corrosion of reinforcement steel induced by chloride attack, calcium hydroxide leaching, alkali-aggregate reaction, and carbonation. Among them, the corrosion of reinforcement steel induced by chloride attack would be a main cause of the concrete degradation. Chloride ion plays a role to corrode the reinforcement steel in concrete, although the surface of the reinforcement steel in concrete is passivated due to high pH condition. In the chloride-induced corrosion of the reinforcement steel, chloride ingress into the reinforcement steel has been explained by Fick's 2nd law.

This paper briefly discusses electrochemical experiments to estimate the corrosion rate of the reinforcement steel in silo concrete.

2. Conservative assumption of corrosion rate

US DOE (2006) measured the corrosion rate of reinforcement steel for concrete vault contained radioactive waste. The average corrosion rate ranged from 5.59×10-9 to 1.34×10-7 m/yr. However, they applied a conservative rate for the reinforcement corrosion of 10-5 m/yr for concrete vault due to the limited data.

3. Experimental measurement

A series of electrochemical experiments were carried out to estimate the corrosion rate of carbon steel in the environmentof low dissolved oxygen concentration of approximately 1.0 mg/L. The groundwater sample in the LILW disposal facility in subsurface shows low concentration of dissolved oxygen because it is constructed below 80 m of ground surface.

Tafel extrapolarization method was used to estimate the corrosion current of the carbon steel. Nitrogen gas was continuouslyinjected into a reactor to reduce the concentration of dissolved oxygen below approximately 1.0 mg/L during the experiments. pH level was kept at approximately 8.0, and the different amount of chloride ion was added as a corrosive agent.

4. Results and Discussion

The corrosion current density was measured using the Tafel extrapolarization method. Then, the corrosion current density was applied to estimate the corrosion rate of the carbon steel. Fig. 1 illustrates the corrosion rate of the carbon steel at approximately 1.0 mg/L of dissolved oxygen concentration. The corrosion rate ranged from 3.63×10-8 to 2.18×10-7 m/yr. These values show a good agreement with US DOE (2006) data which were measured at the field site. However, US DOE (2006) applied a conservative corrosion rate of 10-5 m/yrin the estimation of concrete service life. This approach would be reasonable because there are lots of unknown corrosive parameters which are not considered in this study.

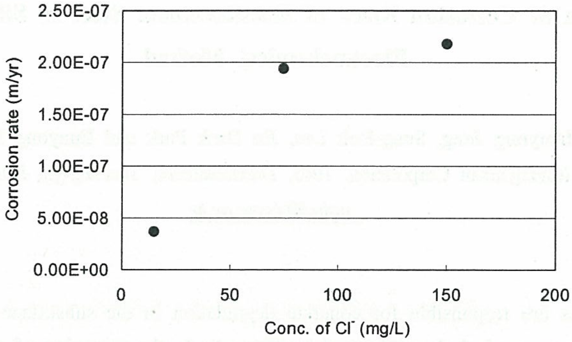

Fig. 1. Corrosion rate of carbon steel at different concentration of Cl-
(pH=8 and conc. of dissolved oxygen=~1.0 mg/L).

5. Conclusion

Models on the corrosion rate of the reinforcement steel were briefly reviewed. The corrosion rate of carbon steel was also estimated at the similar condition of groundwater surrounding the silo using Tafel extrapolarization method. Its corrosion rate was in the range of 3.63×10-8 ~ 2.18×10-7 m/yr. These values are in a good agreement with the field data which was measured at Idahotank facility of US DOE (2006).

REFERENCES

US DOE, U. S. Nuclear regulatory commission technical evaluation report for the U.S. DoE Idaho national laboratory site draft section 3116, waste determination for Idaho nuclear technology and engineering center tank farm facility (2006).