Corrosion of Buried Plumbing Materials by Soil Chemistry and Leakage Current

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1. Introduction

While the main material for service water pipe in Europe and North America is copper (over 80%), it is stainless steel in Seoul (over 90%). Among the many different types of stainless steel, STS304 is predominantly used in Seoul as service water pipe due to excellent corrosion resistance. Although the service life of stainless steel is 30 years, it can be corroded in a few years according to the conditions. The mechanism behind the corrosion of stainless steel is still debatable (Figure 1).

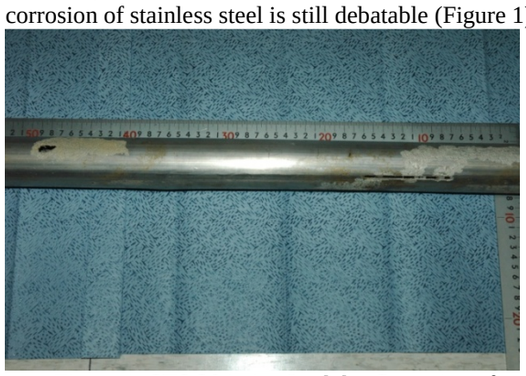


Figure 1. STS 304 pipe Leak by Corrosion after 2 Years of Service.

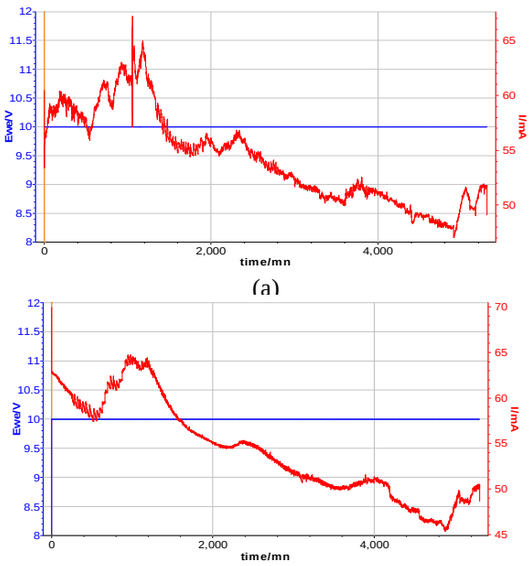
As Seoul is a big metropolice and has complex web of subway and train lines, it is suggested that the leaked current from the power for the subway and the train be the reason of corrosion. We tried to investigate the corrosion mechanism of stainless steel and cast iron, main pipe materials, through electrolysis study.

2. Experiment

The VMP4 Potentiostat/Galvanostat device (Princeton Applied Research) was used for electrolysis study with the chronoamperometry method as the application program (EC Lab v.10.0). Two-electrode (i.e., cathode and anode) method was used for electrolysis while three-electrode (i.e., reference, counter, and working electrode) approach for the measurement of corrosion potential. SCE electrode was used as the reference electrode for corrosion potential measurement. The electrolyte were composed of NaCl and $NaHCO_3$ and the concentrations of Cl^- and CO_3^{2-} were controlled to be 2,000 and 500 mg/L each. The current and weight loss were measured for 120 hours to investigate the corrosion by electrolysis in the solution with chloride and carbonate ions under 10 V potentiostatic condition.

3. Results and discussion

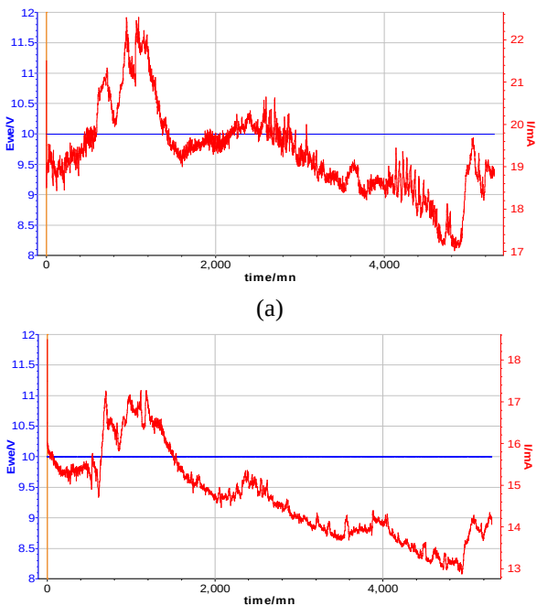
For STS 304 sample with 2,000 mg/L of chloride ions and 10 V, current of 47~65 mA and 0.21% of weight loss were measured while 22.5~28 mA and 0.002% with 2,000 mg/L of carbonate ions. With 500 mg/L of chloride ions, current and weight loss were 17~22.5 mA and 0.15%, while 6~9.4 mA and 0.002% with 500 mg/L of carbonate ions. It could be concluded that the main factor in corrosion of stainless steel was chloride ion, under the testing conditions.



(a)

(b)

Figure 2. Current Comparison with Plumbing Materials in 2000ppm Cl^- Solution ; (a) STS 304 and (b) Cast Iron.



(a)

(b)

Figure 3. Current Comparison with Plumbing Mmaterials in in 500ppm Cl^- Solution; (a) STS 304 and (b) Cast Iron.

For cast iron with 2,000 mg/L of chloride ions and 10 V, current was 46~65 mA and weight loss was 2.44% while 22.5~34 mA and 1.73% with 2,000 mg/L of carbonate ions. When the concentrations of the ions were reduced to 500 mg/L, the current was 13~17 mA and the weight loss was 0.52% with chloride ions while 5.4~7.5 mA and 0.88% with carbonate ions.

It was concluded that stainless steel was more resistive to corrosion than cast iron in the solution of NaCl and $NaHCO_3$, and the main factor affecting corrosion of stainless steel was chloride ion.

Reference

1. Ministry of Public Administration and Security, Article 19(1), Enforcement Rule of the Local Public Enterprises, 2011.
2. American Society for Testing and Materials, G 5-94(1996).