**Electrochemical corrosion mechanism of Q235A steel in the treated water containing halide (F-, Cl-) ions from nonferrous industry**

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**Abstract:** Contemporarily, the only way to solve the discharge of heavy metal-containing wastewater from the nonferrous metallurgical industry is to improve the recycling ratio of the treated water and achieve the objective of zero discharge. Whereas, another question is if the Q235A steel pipeline will corrode as a result of the water impurities that contain fluoride and/or chloride ions during the entire recycling process. Accordingly, it is significative to investigate the corrosion mechanism of the pipeline induced by chloride ion and/or fluoride ion in the treated water.

**Keywords:** Q235A steel; chloride; fluoride; electrochemical corrosion mechanism; electrochemical impedance spectroscopy (EIS)

# 1. INTRODUCTION

Solving the issue of waste of resources and environmental pollution caused by the discharge of heavy metal-containing wastewater from the nonferrous metallurgical industry is of utmost importance given the growing number of environmental protection legislation. At the moment, the only solution is to increase the recycling rate of treated water and reach the zero discharge [1-3]. However, there arises another question whether the water impurities with Cl- and/or F- ion will result in the corrosion of the pipeline made of Q235A steel during the whole recycling process [4-11]. Thus, it is significative to investigate the corrosion mechanism of the pipeline induced by F- and/or Cl- ion.

# 2. MATERIALS AND METHODS

**2.1. Samples**

The working electrode was made from the Q235A steel with the size of 4 mm×4 mm prepared in a smelter of Hunan province, China.

The OCP controlled in this study was -0.691 V vs. SCE.

# 3. ELECTROCHEMICAL IMPEDANCE SPECTROSCOPIC

The obtained EIS, at OCP, of Q235A steel exposed to the simulated water amended with F-, Cl- ions were presented in the form of Bode plots (Fig. 1). The initial impedance (Z) drifted continuously toward an increasing value indicating a decrease in the corrosion rate of Q235A steel with time. There existed two phase maxima from the respective phase angle Bode plots, the major one at lower frequencies and the other at intermediate frequencies, which indicated the presence of two relaxation time constants represent two variables in the electrode process.

According to the theory of EIS [15], when there are two state variables in the electrode process, the system could be expressed as the following equation:

 (1)

where *YF。*is the Faradic admittance, S; *Rt* is the electrochemical resistance, Ω; *ω* is the angular frequency (*ω=2πf*, *f* is the frequency in Hz), rad·s-1; *B* and *a* are the two parameters determined by the electrochemical reactive system.



Fig. 1 Bode plots of Q235A steel electrode exposed to the simulated water

# 4. CONCLUSIONS

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