

THE ELECTROCHEMICAL CORROSION BEHAVIOR OF 27SiMn LOW-ALLOY STEEL IN AN ENVIRONMENT OF A LIGNITE COALPIT

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ABSTRACT The electrochemical corrosion behavior of 27SiMn low-alloy steel in an environment Of a lignite coalpit was studied in this paper. The result indicates that a mixture composed of the lignite and mine water behaves acidic which accelerates the electrochemical corrosion of 27SiMn

low-alloy, though the mine water formerly belongs to a neutral solution.

KEY WORDS low-alloy steel, lignite, electrochemical corrosion

27SiMn is a kind of important materials used in hydraulic support in lignite coalpits. The hydraulic supports are soaked in mine water and solution of lignite or imbedded in the saturated water lignite as a result of the actual situation and technological requirements of coal mining process. The positions of the hydraulic supports where they come into touch with above environments are corroded seriously. There is a great deal of carboxyl oxy-group in lignite, but in traditional corrosion inhibitor, carboxyl oxy-group is often used. The electrochemical corrosion behavior of 27SiMn low-alloy steel in an environment of a lignite coalpit was studied in this paper.

1. Experiment

The lignite samples come from PingZhuang coal mine in Neimenggu of China. The grain size of them is less than 1.5mm after been dried and screened out. The mine water is taken from the water used in coal mining process. In order to obtain lignite solution and saturated water of lignite samples, add 360g of these samples to 1000ml mine water and stir the mixture adequately. After clarified, we get lignite solution and a kind of deposition at the bottom, the later is called saturated lignite. Then we measure the polarization curves of 27SiMn in mine water, lignite solution and saturated lignite.

2. Results and Discussion

Chemical analysis of lignite nature shows that: water content 16.92%, ash content 17.96%, volatile content 42.62%, carboxyl 0.25mmol/g; the relative component of elements content is: 71.09%C, 4.46%H, 0.9%N, 20.30%O, 3.25%S; and the relative component of ash is: 46.98% SiO₂, 18.21% Al₂O₃, 11.97% Fe₂O₃, 0.91% TiO₂, 7.53% CaO, 2.12% MnO, 7.48% SO₃, 1.65% K₂O, 1.93% Na₂O, 1.22% MgO.

The ions concentration (mg/L) of mine water are: 3~10Cl⁻, 3~14SO₄²⁻, 19~97HCO₃⁻, 5~

$15\text{K}^+ + \text{Na}^+$, $5 \sim 14\text{Mg}^{2+}$, $8 \sim 27\text{Ca}^{2+}$.

In Fig.1 infrared spectrum of the lignite samples is determined. It shows that there is carboxyl Coal-COOH absorption peak obviously near the wave number 1700cm^{-1} .

Fig.2 displays the pH level measure results of the mixture of lignite samples and neutral mine water. It shows that when lignite is more than $400\text{g} / 1$, the pH level of the solution at static state keeps 5, and the steady pH level becomes 3.8 after the solution is stirred. As the actual pH level of the environment of $^{27}\text{SiMn}$ in coal mine is $5.1 \sim 5.4$, the polarization curves are measured in the medium of lignite and coal mine water ($360\text{g} / 1$) at pH 5.1.

Fig.3 shows the polarization curves of $^{27}\text{SiMn}$ in coal mine water, lignite solution and saturated lignite. Three of the electrochemical corrossions are all decided by cathodic control. We can see that lignite activates the anodic process of $^{27}\text{SiMn}$ in coal mine water.

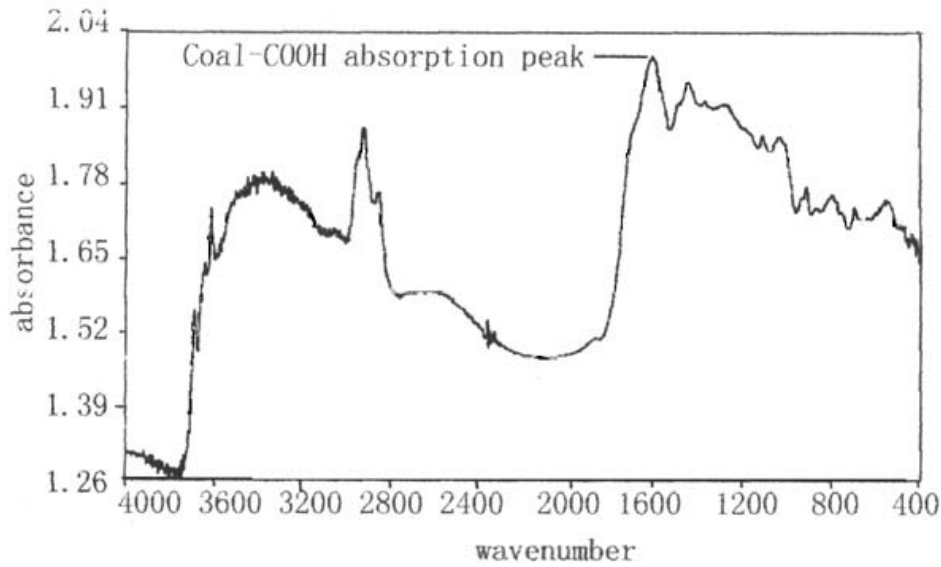


Fig.1 Infrared Spectrum of the Lignite Samples

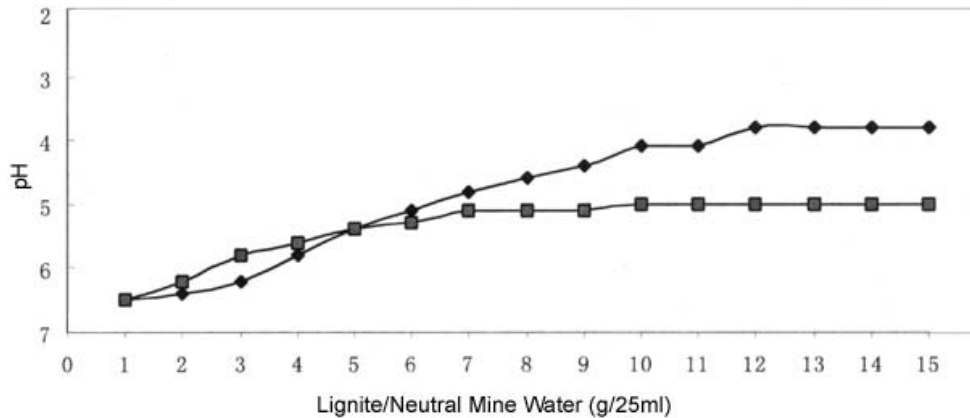


Fig.2 pH Level of the Mixture of Lignite Samples and Neutral Mine Water.

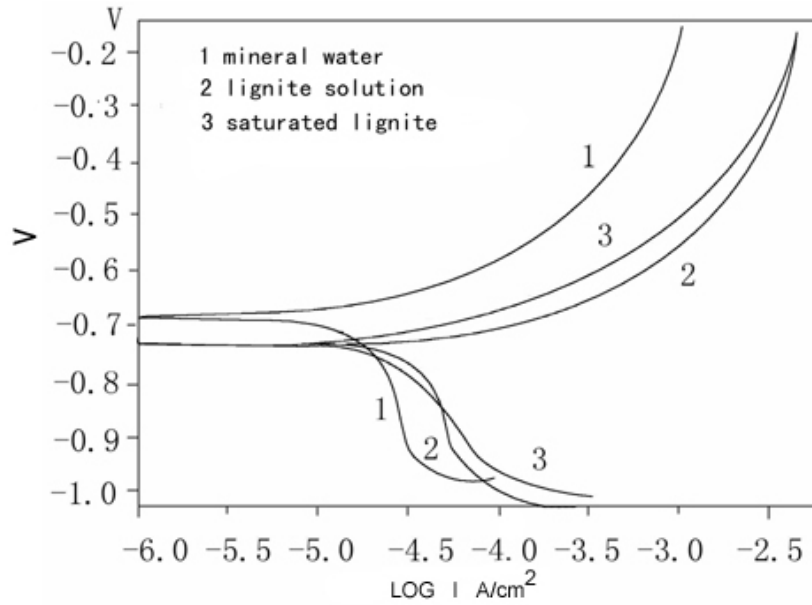
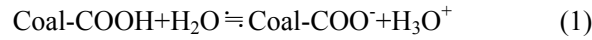


Fig.3 Polarization Curves of 27SiMn

The following ionization equilibrium exists in lignite solution containing carboxyl:



The anions that the carboxyl ionized overlap with the P orbital of the two oxygen atoms on the P orbital of carbon atoms, the negative charge disperses on the two oxygen atoms.

$$K_a = [\text{Coal-COO}^-][\text{H}_3\text{O}^+] / [\text{Coal-COOH}] \quad (2)$$

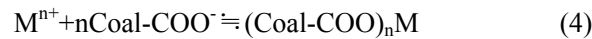
The value of K_a reflects the intensity of carboxyl acidity. The higher the value of K_a is, the more intense the acidity. When the mixture is stirred, the concentration of reacting Coal-COOH increases, and reaction (1) moves right. As a result, the acidity of the mixture increases (as shown in Fig.2).

As shown in Fig.3, lignite have cathodic depolarization on 27SiMn in coal mine water, and this effect has a relationship with eqn(1). Hydrogen releasing on cathode:



This effect is more obvious in saturated lignite because the pH level is higher.

Carboxyl in lignite has a very strong chemical absorbability of metallic ions, and the eqn is:



The product of anode reacts as follows:

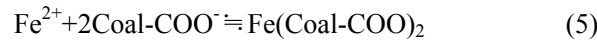


Fig.3 shows that the product $\text{Fe}(\text{Coal-COO})_2$ can't form a film to protect the surface of anode, and hydrogen releasing on cathode accelerates the dissolution of anode, and quickens the corrosion of 27SiMn.

The conditional carboxylic acid corrosion inhibitor belongs to polarity absorbability corrosion inhibitor. It can combine with water into hydrated ion and free and disperse into solution in water. When the concentration of carboxylic acid gets to a certain degree, a compact

absorbed layer is formed at the surface of the metal. It hinders the corrosion matter from touching the surface of the metal. In the mixture of lignite and mine water, because of grain shaped lignite, it is impossible for the carboxyl to form free state. Although a few little lignite molecules can form free state, their concentration is too low to form absorbability preservative. So in Fig 3, lignite accelerates the process at both anode and cathode, among which, the anode in lignite solution (Curve.2) dissolve faster than that in saturated water of lignite samples (Curve.3). And at the cathode, because in saturated water of lignite samples the concentration of hydrion is high and the velocity of discharge is high, as a result, the depolarization degree at the negative pole is higher than that in lignite solution (Curve.2). In a word, lignite accelerates the corrosion of 27SiMn.

3. Conclusions

Mine water is of neutral solution. After mine water mixed with lignite, the mixture shows acid. As a result, corrosion is accelerated by water lignite samples contact with 27SiMn, while there isn't any inhibitor action for carboxyl in lignite to deal with anode process of 27SiMn.

Reference

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