学　位　論　文　内　容　の　要　旨

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学　位　論　文　題　名

Effects of Metal Cations on Steels Corrosion in Chloride Aqueous Solution
(塩化物水溶液中の鋼の腐食に及ぼす金属カチオンの影響)

Steels are very common materials that are abundantly used and play a major role in daily, constructional and industrial life. One of the serious problems of using steel objects is corrosion. Peoples are very much concern about the corrosion of steels and several safety measures are taken to control the corrosion. Using inhibitors is one of the common methods to control the corrosion of steels. The usage of environmentally friendly and low-cost materials as corrosion inhibitors is gaining large preference. Moreover, many environmental laws were imposed to divert researchers on the use of nontoxic and low-cost materials as corrosion inhibitors. This diversity has encouraged the appearance of many researchers to find some inhibitors that will have extensive attention due to their properties of environment-friendly, low influence on the human body, low-cost, easy to handle, and renewability. This research aims to clarify the inhibition of steels corrosion in chloride aqueous solutions by metal cations at room temperature and elevated temperatures with the consideration of pH and chloride ions concentration.

Very few research has been carried out focusing on the effect of metal cations on the corrosion of steels in aqueous environments. It is needed to clarify in details the corrosion behavior of different types of steels in chloride aqueous solutions at room temperature along with elevated temperatures under the consideration of pH and chloride ions concentration. It is also needed to clarify the relationship between the hardness of metal cation (X) and the corrosion behavior of steels in the chloride aqueous environment. It is also needed to clarify the corrosion inhibition mechanisms of metal cations under the comparative conditions in the chloride aqueous environment. The clarification of the metal cation concentration effect on the corrosion is also needed.

In chapter 1, the corrosions of metals in chloride aqueous environment have been discussed regarding the oxide film structure. An equation has been introduced to calculate the corrosion rate of metals. Different factors of corrosion have been discussed together with the effect of metal cation hardness and types of corrosion inhibitors have been discussed. Present research trend and purpose of the research also have been discussed in this chapter.

In chapter 2, the corrosion behaviors of mild steel in chloride aqueous solutions have been investigated. The extent of brown corrosion products observed in the solutions was different by the kind of metal cations. Zn ions containing solution showed the lowest corrosion rate as compared to the other metal cations containing solutions. It was also found that the metal cation hardness, X is not closely related to the corrosion rate. The mechanisms of corrosion inhibition effect of metal cations have been clarified in this chapter.

In chapter 3, the corrosion behaviors of SUS304 in 0.5 M chloride aqueous solution have been

studied. X has been introduced to explain the corrosion inhibition effect of metal cations based on the HSAB concept. It was found that Zn ions and Al ions were existed on the steel surface as oxides/hydroxides and formed a layer with oxide films through the de-hydroxylation process.

It is considered that metal cations significantly inhibited the corrosion of steels in chloride aqueous solutions. It is further needed to clarify the effects of metal cations on steel corrosion in concentrated chloride aqueous solutions. In chapter 4, the role of metal cations on corrosion of coated steel substrate in concentrated chloride aqueous solutions has been elucidated by immersion tests and electrochemical tests. Zn ions containing solution showed the highest corrosion inhibition efficiency among the used solutions. The mechanisms of corrosion inhibition effect have been explained in this chapter.

In chapter 5, the effects of metal cations on mild steel corrosion in chloride aqueous solutions have been explored at different temperatures (25, 50 and 80-degree C). The corrosion rate was increased with temperatures. However, Zn ions containing solution showed the lowest corrosion rate as compared to the other solutions at the experimental temperatures. The corrosion inhibition mechanisms of metal cations at different temperatures also have been proposed based on the experimental results.

In the previous chapter, it was suggested that Zn ions effectively inhibited the corrosion of steel in chloride aqueous solutions. Therefore, it is needed to clarify the effects of Zn ions concentration on steel corrosion in chloride aqueous solutions. In chapter 6, the effects of Zn ions concentration on the mild steel corrosion in chloride aqueous solutions were clarified based on the electrochemical tests and immersion tests followed by surface analysis techniques. The corrosion inhibition efficiencies were elucidated regarding the Zn ions concentration. It is found that the corrosion inhibition efficiency is increased with the Zn ions concentration in the solutions.

In chapter 7, the experimental findings of chapter-2 to chapter-6 have been summarized.