学 位 論 文 内 容 の 要 旨

博士の専攻分野の名称　博士（工学）　氏名　Hubby ‘Izzuddin

学 位 論 文 題 名

Study on High-Temperature Corrosion of Ni-based Alloys in Atmosphere Containing Alkali Metal Chloride Vapor

(アルカリ塩化物蒸気を含有する雰囲気中における Ni 基合金の高温腐食挙動に関する研究)

In the waste incineration environments, the corrosion become the major problem due to high chlorine concentration in waste and its ability to cause rapid corrosion of components such as boiler tubes and heat exchanger tubes during the combustion process. During combustion, alkali salts are released into the oxidizing environments and react with the metallic component. The chlorine from salts strongly accelerates the corrosion and results in faster degradation of materials. Thus, improving the corrosion resistance of the material used in the boiler component directly links to the lifetime of the plants. Ni based alloys and coatings are widely used for the boiler component because their excellent corrosion performance. Mo and Fe are widely used as alloying elements to improve the corrosion performance, however, the effect of those elements on the corrosion behavior of alloys in atmosphere containing alkali metal chlorides has not been fully understood, yet. Thus, in this study, the corrosion behavior of Ni20Cr-based alloy with Mo or Fe additions in atmospheres containing air and salt-vapor was evaluated.

This thesis consists of seven chapters in total. Chapter 1 introduced the research background, the literature studies, the scope and aims of research study, and the outline of study.

Chapter 2 described the details of experimental methods. Ni20Cr-based alloy were used with variations of Mo (0, 1, 3, 7 in wt.%) and Fe (0, 4, 30 in wt.%) additions. The corrosion was performed at 570 ℃ in oxidizing atmosphere (air with salt vapor) and low oxidizing atmosphere (Ar with salt vapor).

Chapter 3 investigated the corrosion performance of Ni-Cr alloys with combinations of Mo and Fe addition and evaluated the effect of each combination on corrosion performance. The results showed that combination of Mo and Fe addition gives better corrosion resistance to the Ni20Cr-based alloys. The corrosion performance was found to be improved with increased both Mo and Fe contents.

Chapter 4 investigated the effects of Mo addition on the corrosion behavior of Ni20Cr-based alloy in oxidizing-chlorine containing atmosphere. The Ni20Cr-based alloy corroded with a high corrosion rate due to a formation of chromates. Chromate formation was considered to be the main reason to increase the corrosion rate, since it caused breakdown of the protective Cr_2O_3 scale accompanied with generation of chlorine. The Mo addition has given better corrosion performance because it promoted NiO scale formation, which was able to suppress the chromate formation.

Chapter 5 investigated the effects of Mo on the corrosion behavior of Ni20Cr-based alloy in the low oxidizing atmosphere in order to confirm the mechanism proposed in the chapter 1. The corrosion mass gain of Mo-free Ni20Cr-based alloy decreased significantly comparing to that in the oxidizing-chlorine containing atmosphere. But the corrosion rate of the Mo-containing alloys was found to increase. Decreasing the corrosion rate in the Mo-free alloy was attributed by less chromate formation, by which the corrosion mechanism proposed in chapter 4 was confirmed.

Chapter 6 investigated the effects of Fe on the corrosion behavior of Ni20Cr-based alloy in the oxidizing atmosphere. Fe addition to Ni20Cr-based alloy improved the corrosion resistance in the oxidizing-chlorine containing atmosphere. Although the oxide scale structure formed on the Fe containing alloys were similar to that formed on the Fe-free alloy. Lesser extent of chromate formation due to the Fe oxide formation resulted in thinner internal Cr-chloride penetration and Cr-depleted zone. Thus, a continuous Cr_2O_3 scale was able to protect the alloy substrate.

In Chapter 7, the main conclusion of the research was discussed.