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Oxides of UNS S30400 Stainless Steel Formed in Offshore Environment

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Abstract – Thick corrosion products of austenitic stainless steel obtained from a structure of steam turbine exposed in offshore environment were studied by stereo-optical microscopy, X-ray diffraction and Mössbauer spectroscopy. Room temperature Mössbauer experiments have revealed high content of akaganeite in external surface and a mixture of akaganeite and hematite in inner surface. In these results, the akaganeite occurs due to chloride presence. The low temperature Mössbauer experiments shown the presence of superparamagnetic nanosized particles of akaganeite in external surface, which do not block even at 4.2K.

Stainless steel has a composition with a minimum of circa 11% in mass of chromium. This amount is sufficient to form a thin layer of chromium oxide that protects the metal from further oxidation in diverse environments [1]. Generally the localized corrosion is a common form of corrosion that attacks the metal. On the other hand, when the conditions are very aggressive to the stainless steel the uniform corrosion can take place and the material is attacked as a low alloy steel. Thus, the corrosion resistant alloy such as UNS S30400 is usually not expected to present this kind of corrosion process; consequently, the number of works devoted to physical characterization of stainless steel is limited.

Thick corrosion product of stainless steel were scratched from a steam exit exposed in offshore environment for two decades. The rust products were characterized by stereo-optical microscopy, x-ray diffraction and Mössbauer spectroscopy. The conjoint findings of x-ray diffraction and the Mössbauer spectroscopy indicate a high content of akaganeite on external surface while in the internal surface a high amount of hematite is observed. The high concentration of akaganeite on external surface that was exposed in a marine environment is due to the chloride ion. The relatively high amount of akaganeite (~26%) found in the inner surface is somewhat unexpected, since it is protected from marine environment. Low temperature Mossbauer experiments have shown the presence of nanosized particles of akaganeite in both surfaces. A fraction of nanosized particles of external surface do not block even at 4.2K.

[1] Corrosion, vol. 13, ASM: 1996