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Experience with Weld Overlay and Solid Alloy Tubing Materials in Waste to Energy Plants

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1.0 Introduction

Corrosive conditions in waste to energy boilers produce rapid wastage rates of traditional boiler tube materials. It is not unusual to see corrosion rates in the range of 1 to 3 mm/y (40-120 mpy) on carbon steel boiler tubes and occasionally corrosion occurs at even higher rates. In the mid1980's there were several boilers that experienced corrosion failures of carbon steel waterwall tubes in less than 6 months of service (1,2). Because of this experience, it has become accepted that some type of corrosion protection is required for boiler tubes in refuse-to-energy boilers. Over the years, many different alloys have been evaluated to improve tube life in waste-to-energy boilers. The most successful materials used for corrosion protection are nickel alloys.

Waterwall tubes are generally attacked by molten chloride salts (3) and superheat tubes appear to be attacked by a combination of molten chloride/sulfate salts as well as gaseous chloride constituents (primarily HCl) (4-7). Figure 1 shows the corrosion rates of carbon steel as a function of temperature for various corrosion mechanisms. The corrosion due to gaseous chloride atmospheres increases steadily with temperature. Corrosion produced by chloride rich deposits or salts increases rapidly once the melting point of the salts is reached; corrosion rates continue to increase with temperature until the chloride salt becomes hot enough to vaporize, after which corrosion decreases. Likewise for sulfate rich deposits or salts: the onset of melting sharply increases corrosion rates and vaporization of the sulfates at even higher temperatures results in a decrease of corrosion. These various corrosion mechanisms give rise to somewhat different alloy requirements, depending on the temperature of the metal in the refuse-fired boiler

The main corrosion mechanism which occurs on water wall tubes, which typically operate in the 200-315°C (400-600°F) range, is corrosion by molten chloride salts. The most successful alloys used for waterwall tubes are generally high in nickel and molybdenum with moderate amounts of chromium, such as Alloy 625 and Alloy 50 (a recently introduced alloy from ThyssenKrupp VDM). These alloys are applied to waterwall tubes as a weld overlay.

Because of the mixed corrosion modes in the superheater region, the selection of alloys is more complicated. Figure 2 shows a photomicrograph of a Fe-Ni-Co-Cr alloy that was exposed in a refuse boiler at approximately 900°C (1650°F) (8). Figure 2 shows that multiple corrosion mechanisms are active at this temperature; both sulfidation (evidenced by the chromium rich sulfides) and chloride attack (evidenced by the internal voids caused by volatile metal chlorides) are observed. In this case, a material not only requires a high nickel content to resist chloride attack (both gaseous and molten salts), but also requires