The Behavior and Mechanism of High Temperature Corrosion of SCH2 Heat Resistant Cast Steel Grate Bars in a Public Waste Incinerator

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1. Introduction

Incineration temperatures in public waste incinerators have increased because of increases in plastic and vinyl chloride volumes in waste and to reduce the formation of dioxins. It is predicted that the lifetime of grate bars in waste incineration furnaces will decrease. The Fe-26Cr-1Ni-0.3C heat resistant cast steel (JIS SCH2) is commonly used as a grate bar of waste incineration furnaces. But the corrosion behavior and mechanism are not well known. This study investigated the corrosion behavior and mechanism of a Fe-26Cr-1Ni-0.3C heat resistant cast steel (JIS SCH2) in a waste incinerator. The effect of addition of Nb on the intergranular corrosion behavior was investigated.

2. Experimental

The specimens under examination were prepared from commercial SCH2 ferric cast steel. Specimens were placed at the bottom of a furnace where waste was continuously burned for about 16,000hours. Laboratory tests were conducted to establish the mechanism of the intergranular corrosion behavior. To clarify the changes in microstructure by heat treatment, specimens were heat treated at 1373K for 86.4ks.
Scanning electron microscopy (SEM) and electron probe microanalysis (EPMA) were used for the cross sectional analysis.

3. Results and discussion

3-1 Corrosion morphology of a SCH2 exposed sample

The cross-sectional microstructure of a corroded sample exposed for 16,000 hours in the waste incinerator is shown in Fig.1. A network of intergranular corrosion beneath the outer scale developed toward the inside of the alloy. The corrosion front was well linked to the precipitates that developed inside of the alloy.

3-2 Changes in Microstructure by heat treatment

The microstructure of an as received SCH2 and the heat treated specimen are shown in Fig.2. There was a network type structure on the as received sample as shown in Fig.2(a), that was identified as Cr-Fe carbide (Cr7C3) by X-ray diffraction. There was a similar network type microstructure on the heat treated sample as shown in Fig.2(b) and this was identified as Cr carbide (Cr23C6). This shows that a network type Cr carbide microstructure developed both on the as received sample and the heat treated SCH2 alloys and that selective corrosion took place during the exposure in the waste incinerator. This result shows that intergranular corrosion was caused by preferential corrosion of Cr carbide that had developed along the grain boundaries.

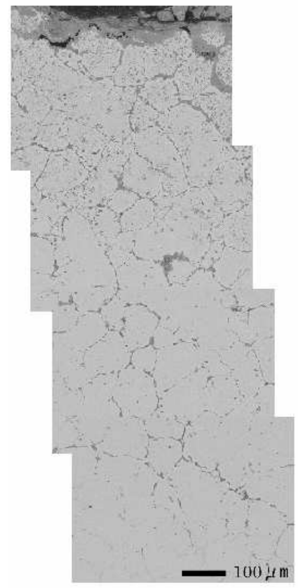

Fig.1 Cross-sectional microstructure of SCH2 steel exposed in waste incinerator for about 16,000 hours.

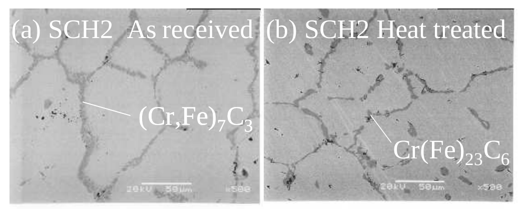

Fig [illegible] er heat treatment at 1373K for 86.4ks of SCH2 alloy.

3-3 Effect of additional Nb on SCH2 cast steel

To improve the intergranular corrosion resistance, Nb was added to SCH2 cast steel. Fig.3 shows the microstructure of the SCH2-1.0wt% Nb steel. Development of Cr carbide along grain boundaries was inhibited by precipitates of Nb carbide. Exposure tests of the SCH2-1.0Nb alloy showed good intergranular corrosion resistance in the waste incinerator.

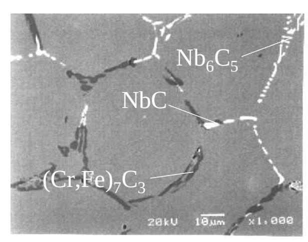

Fig.3 Microstructure of the SCH2-1.0Nb alloy.

4. Conclusions

The intergranular corrosion behavior and corrosion mechanism of SCH2 heat resistant cast steel in waste incineration environments were investigated. The results may be summarized as follows:

1. A network of intergranular corrosion within the alloy and beneath the outer scale was identified. Intergranular corrosion was caused by preferential corrosion of Cr carbide that developed on grain boundaries.

2. The addition of Nb to the cast steel resulted in good intergranular corrosion resistance, as Nb carbide precipitated at the grain boundaries and inhibited the formation of a Cr carbide network.