ANALYSIS OF A SCAB DEFECT FROM A WCC CASTING

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ABSTRACT

The optical and SEM examination was conducted on a scab defect removed from a WCC steel casting. The scab was a result of slag attack of the mold during pouring. The matrix of the scab consisted of a mixture of calcium, aluminum, and manganese oxide. This matrix surrounded zircon sand grains which were being decomposed by the heat and the oxidizing environment. A sintering reaction resulting from the slag attack of the sand opened up pores in the sand.

The incidence of this type of scab defect can be reduced by minimizing slag carry-over from the melting furnace and reoxidation during pouring.

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STEEL PROCESSING

A sample of sand from the sand-metal interface of a WCC steel casting was removed during mold shakeout. The metal was WCC poured at a temperature of 2880°F. The mold was green silica sand that had been faced with green zircon sand. The scab defect was about 1.5 inches in diameter on the surface of the casting.

RESULTS AND DISCUSSION

The appearance of the scab defect is shown in Figure 1. Figure 1(A) illustrates the side adjacent to the casting, and Figure 1(B) illustrates the sand side of the defect.

The optical microstructure of a cross section through the scab is illustrated in Figure 2 at a magnification of 25x. The scab appeared to be composed principally of zircon sand, metal oxides, and relatively large pores formed during a sintering reaction between the metal oxides and the zircon.

Higher magnification micrographs of two areas of the scab are presented in Figure 3 at 200x. The gray granular material in both micrographs was zircon sand (ZrSiO₄). The very fine particulate material distributed around the zircon sand grains is zirconia (ZrO₂) formed by decomposition of zircon under the influence of the oxidizing slag and the high temperatures.

Several areas of the scab were analyzed in a scanning electron microscope using energy dispersive x-ray analysis (EDXR). The regions analyzed are indicated by the letters and arrows in Figure 4.

Region "A", a nearly continuous matrix phase of the scab, contained substantial amounts of alumina, silica, calcia, and manganese oxide, as illustrated by the spectrum in Figure 5. The high calcium concentration coupled with the presence of manganese, alumina, and silica suggests slag carry-over from the melting furnace or AOD furnace.

Region "B" consisted of a very finely divided particulate material distributed in the slag matrix. The spectrum from Region "B" is illustrated in Figure 6. The finely divided particulate material is zircon in the process of being decomposed into ZrO₂ and SiO₂. This particulate material lies in a matrix of alumina, calcia, and manganese oxides.

Region "C", one of the two phases of the matrix, was rich in silica and manganese oxides with small amounts of aluminum and magnesium oxide, as illustrated by the spectrum in Figure 7. The presence of magnesium oxide suggests some attack of the furnace lining by the slag.

The granular material indicated by the arrow "D" was found to be zircon, as shown by the spectrum in Figure 8.
SUMMARY

The optical and SEM examination conducted on the scab removed from a WCC casting indicated the scab to be a result of slag attack of the mold during pouring. The matrix of the scab consisted of a mixture of calcium, aluminum, and manganese oxide. The matrix surrounded zircon sand grains which were being decomposed by the heat and the oxidizing environment. A sintering reaction resulting from the slag attack on the sand opened up pores in the sand facing. This type of slag attack can be reduced by minimizing slag carry-over and reoxidation during pouring.

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Figure 1. Scab Defect Removed from WCC Casting. (A) Adjacent to Casting, (B) Opposite to Casting Surface.
Figure 2. Optical Microstructure of Scab. (25x)
Figure 3. Optical Microstructures of Scab. (200x)
Figure 4. SEM Micrograph of Scab. (200x)
Figure 5. EDXR Spectrum of Scab Region A.
Figure 6. EDXR Spectrum of Scab Region B.
Figure 7. EDXR Spectrum of Scab Region C.
Figure 8. EDXR Spectrum of Scab Region D.