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A Kinetic Study of Molten Iron Desulphurisation
by Magnesium Vapour Bubbles

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1. INTRODUCTION : Industrially, magnesium is used for the desulfurisation of iron from the blast furnace and extensive tests on various techniques for efficient injection have been investigated (1~3). However, the kinetic mechanisms by which these desulphurisation reactions proceed have never been identified.
2. INVESTIGATION PROCEDURE : In order to circumvent the explosive reactions occurring when solid or liquid magnesium is introduced into iron at 1250°C, a magnesium vapouriser was built so that vapour bubbles of magnesium could be injected at a known frequency and size into the melt. This allowed the specific rate of bubble dissolution to be monitored simultaneously with the rate of desulphurisation of iron contained in 60kg induction heated baths. In order to establish bubble characteristics in liquid iron, a preliminary study was conducted in which argon bubbles were injected through graphite nozzles of various inside and outside diameters and geometry. Supplementary information from cineradiographic observations in a low temperature alloy (indium-gallium), enabled the mechanisms of bubble formation in liquid metals to be identified.
3. RESULTS AND DISCUSSIONS : It was shown that bubbles forming in liquid metals tend to be much larger than those in equivalent aqueous systems on account of their much higher interfacial tensions, and their tendency to spread away from the inner nozzle diameter as a result of non-wetting phenomena and inertial effects resulting from the high density of iron. The volume of the ante-chamber was shown to be of great importance in increasing bubble volumes at low flowrates ($10\text{--}500\text{ cm}^3\cdot\text{s}^{-1}$).

The desulphurisation study showed that magnesium vapour bubbles of at least 10 cm^3 initially, dissolved in molten iron with a mass transfer coefficient of $(4.6\pm 3.4)\times 10^{-3}\text{ cm}\cdot\text{s}^{-1}$. However, the rate of desulphurisation proceeded at a much greater rate than that expected on the basis of sulphur transport to the bubble interfaces. It was found that the majority of the desulfurisation occurred away from the bubble interfaces, in the bulk of the molten iron, at a rate proportional to the product of the dissolved magnesium and sulphur concentrations.

It is proposed that the primary desulphurisation occurring at the interfaces of rising bubbles, seeds the melt with particles of MgS. These enable a secondary (and far more significant) desulphurisation reaction to proceed in the bulk of the metal bath.

4. REFERENCES :

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