High Decarburization Rates During the Refining of Fe-Cr-Ni-C Alloys in EAF.

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1. Introduction

The economical crisis in Mexico has made very expensive to refine heat resistant steels (HRS), (0.4%C, 25%Cr, 25-35%Ni) for the oil and chemical industries since the low carbon ferrochromium (LCF) and the alloyed scrap are imported. A research was launched to design a process in EAF which might employ high carbon ferrochromium (HCF) and low carbon steel scrap available in mexican market. Nickel sinter (87%Ni) was melted instead of electrolitic nickel, since the former, although is an imported raw material too, is around 40% cheaper than the latter.

2. Experimental Methods and Results.

From literature data (1) a statistical relationship between the angle of expansion of submerged gaseous jets in liquids and the ratio of the densities of these phases for various systems was established. From that Eq. and the momentum balance reported somewhere else (2), it was found that the hydrodynamical behavior of the He-H_2O system is similar to that of liquid steel-O_2 and/or Ar gases system. The physical model tests were carried out in a 64 l plexiglass vessel with water containing 3% of H_2O_2. A gas mixture of He-2%SO_2 was injected through stainless steels lances into the liquid to form sulfuric acid similar to a technique already reported (3).

In Fig.1 we can see the results for the bulk mass transfer coefficient $k_g\alpha$ where k_g is the mass transfer coefficient of SO_2 and α is the superficial area between the gaseous jet and the liquid phase. The main findings at this stage are: a) The deeper is the position of the lance into the liquid, the higher is the mass transfer coefficient (MTC) , b) the MTC increases as the modified Froude number (Ff) increases too, c) at the same injection Froude number the MTC is higher for lances with big diameters than for small diameters and d) the MTC is higher for an angle between the lance axis and the liquid surface of 30° than for an angle of 45°. Making use of these previous results, industrial trials in a 2 T EAF were performed. The Fig. 2 shows a kinetic behavior of carbon and the corresponding Cr losses during the refining stage. Decarburization rates as high as 0.13%C/min were obtained with practically low Cr losses. The deep injection controlled well the metal splashing and the efficiency of the sinter was almost 98%.

3. Discussion.

High momentums give high residence times of the gaseous bubbles in the molten metal, so that Cr immediately oxidized at the exit of the lance has longer times to be reduced by the carbon contained in the metal. Conventional practices employ low momentum injections which give shorter residence times and the Cr is fastly oxidized increasing its content in the slag. This is in agreement with some EAF operators who have observed (4) that there is a critical flow rate of oxygen from which higher flows diminish strongly Fe, Cr, Mn and Si losses to the slag during stainless steels refining.

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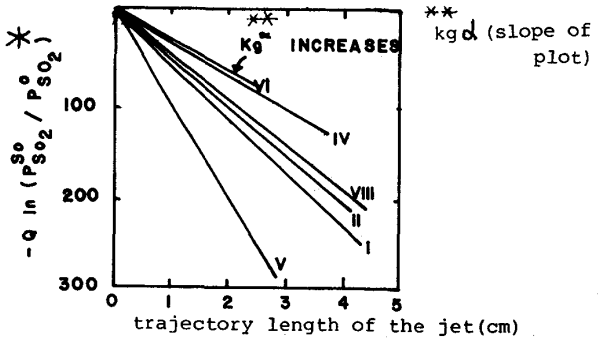

Fig. 1 Physical model results
(Lance deepness: 21cm)

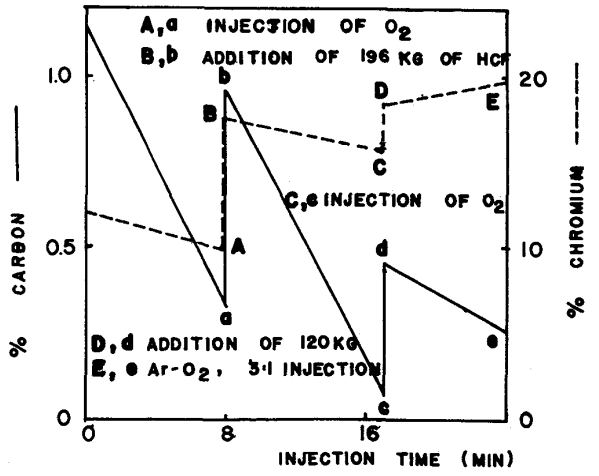

Fig. 2 Decarburization rate and Cr losses

* Q: volume flow rate of gas in the jet

$P^{o}_{SO_2}, P^{Se}_{SO_2}$: partial pressure of SO_2 in the gas, at the lance and at the surface of the bath, respectively