

INTRODUCTION

In steel making, as in any money-making venture, it is essential to produce the desired product as cheaply as possible. From a technical standpoint, the economics of steelmaking depend to a great extent upon the thermodynamics and kinetics of the system producing the steel. The thermodynamics of the system determine whether or not the desirable components are largely in a reduced state and the undesirable components are in an oxidized state as desired at the end of the process ; kinetics determine how fast the desired conditions can be obtained.

In making stainless steel, an oxidizing agent is first used to remove the undesirable components from iron, such as carbon. At the same time, however, valuable components, such as, chromium, will also be oxidized. The economics of the process can be greatly improved by creating a condition to retain these alloying elements in the alloy. Recently a major break-through has been made in the manufacturing process of stainless steel. Stainless steel now can be made almost without the addition of high cost low-carbon ferrochromium and stainless steel scrap. The process is known as argon-oxygen refining of stainless steel and practiced in various modifications in steel-industry, for example, AOD (Argon-Oxygen Decarburization) or AOR (Argon-Oxygen Refining), AVR (Alleghany Vacuum Refining), the BOF-RH combination and so on. Thermodynamics of the process have been studied quite extensively. But laboratory investigations and studies of plant data indicate that the system does not reach equilibrium. Chromium oxidation occurs at carbon levels higher than those expected with argon dilution of CO in the bath. Therefore, the actual reaction sequence and kinetics must be considered for clear understanding of the process. Little is known about the mechanism that controls the rate of decarburization. The purpose of this investigation is to study the rate of decarburization of Fe-Cr melts and to determine the rate-limiting step of the reaction. The effect of temperature, size of melt, blowing condition, flow rate and partial pressure of oxygen, composition of the melt etc. are investigated as a means of identifying the slowest step.

In our country the cost of argon is about 30 times more than that of nitrogen. Therefore, to adopt such a process, an effort has to be made to replace atleast some of the argon by nitrogen, if not completely. Therefore, the mechanism of decarburization of Fe-Cr melts was investigated in the present study mainly under N_2-O_2 mixture.

The experimental technique used was to melt the Fe-Cr alloy in a magnesite crucible and to oxidize carbon under a soft jet of N_2-O_2 mixture. The change of concentrations of carbon and chromium in the melt were determined by sampling the metal phase at regular intervals. In another set of experiments, N_2-O_2 gas mixture was bubbled through the metal with the help of an alumina tube which was immersed upto 1.0 cm above the bottom of the crucible.

Once the rate-determining mechanism of the reaction has been determined, steps could be taken to speed up the commercial process. For instance, if diffusion is found to be the rate controlling step in the process then the rate of reaction can be increased by increased stirring of the system. On the other hand, any temperature change would be relatively ineffective in changing the rate of the reaction. If an interfacial chemical reaction is the rate-controlling step, just opposite would be true.

The results would also suggest the extent of replacement of argon by nitrogen and hence the economy of the process. It is hoped that the results of this basic study on the preferen-

-tial decarburization of Fe-Cr melts will contribute to process development in the area of steelmaking kinetics.