Inclusion Analysis to Predict Casting Behavior

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ABSTRACT

To identify potential problems associated with inclusions in the steelmaking process and final products, techniques are being developed to identify inclusions in steel rapidly. The goal is to take a sample, prepare it, perform a complete quantative analysis of the inclusions present, and report the results in a useful manner in less than one hour. In order to develop software and expert systems to analyze the results, a variety of steelmaking problems related to inclusions are being examined. In this work, casting-related issues at U. S. Steel Gary and Fairfield Works were examined. At Gary Works, inclusion analysis of samples from the liquid steel could be used as a predictor of casting behavior and helped in identifying the cause of clogging problems. The technique consisted of examining the inclusions on a CaO-Al_2O_3-S (Ca-Al-S) ternary diagram or the "modified Ca/Al ratio" of the inclusions. From the inclusion composition or the Ca/Al ratio, it was possible to predict stable, clogging, or eroding conditions. At Fairfield Works, the samples were from the solidified steel, and the Ca-Al-S diagrams alone could not predict the casting behavior. However, the amount of CaS or Ca-rich inclusions could predict the amount of erosion of the tundish slide gate.

INTRODUCTION

There is an increasing demand for cleaner steels with low inclusion contents, and the inclusions in the steel often must have defined properties. The composition, and hence the properties, of the inclusions can be controlled through the chemistries of the metal and slag. Despite the major advances in our knowledge of inclusion control, there is currently no rapid and accurate method for determining the type, size, and number of inclusions present. Usually, a post-mortem analysis is performed on samples using a scanning electron microscope (SEM) or conventional metallography long after the steel has been processed. Also, in any given sample there are inclusions of varying chemistry present, and an analysis of a single or even several inclusions may not truly reflect the cleanliness or the type of inclusions