TUESDAY, AUGUST 24, 2004, P.M.

SESSION 33: INTERNATIONAL SYMPOSIUM ON OXYGEN IN STEELMAKING: MILESTONES AND CHALLENGES

Sponsor: Iron and Steel Section, The Metallurgical Society of CIM
Room: 314
Chairmen: S. MILLMAN, Corus R.D. & T., Grangetown, Middlesbrough, United Kingdom and
D. MAZUMDAR, Indian Inst. of Technology, Kanpur, India

PAPER 33.1 — 14:00 (KEYNOTE)
EVOLUTION OF PROCESS CONTROL IN FIFTY YEARS OF OXYGEN STEELMAKING: THE LJMUIDEN EXPERIENCE
R. BOOM, Corus Research, Development & Technology, Ijmuiden, The Netherlands

Corus IJmuiden, formerly Hoogovens, was the first steel plant in Europe after Voest to introduce oxygen steelmaking. In the decision-making process contacts with Dofasco in Canada about the production of formability steel grades were crucial. In developing oxygen (LD-) steelmaking high liquid steel output rates had to be combined with accurate process control. For ingot casting static models with input control and sampling during interrupted blowing were sufficient to deliver liquid steel within the required carbon, phosphorus, sulphur and temperature windows. Computers were introduced to perform the complicated charge calculations. Continuous casting called for strict control of composition and temperature at process end point and made predictable timing crucial. Dynamic control was introduced based upon sublance measurements and waste gas analysis. Reliable disposable measurement sensors were developed in a concerted international action. Dissolved oxygen at blow end deteriorated the quality of low carbon aluminium killed steel grades. Blowing gases through the converter bottom improved process kinetics, resulting in lower carbon-oxygen products, yield increase and better phosphorus removal and generated new families of hybrid blowing processes. Introduction of secondary metallurgy facilities such as argon stirring stations, vacuum degassers and ladle furnaces relieved the demands for strict BOF end point control. Desulphurisation of hot metal became standard practice. In regions with scrap shortage hot metal desiliconisation followed by dephosphorisation, was introduced in the blast furnace cast house and hot metal transfer ladles. Later redundant converter vessels were used for pre-treatment, resulting in a two-stage process. The fundamentals of oxygen steelmaking are described and a vision on the future is presented.

PAPER 33.2 — 14:45
IMPORTANT FACTORS IN EFFECTIVE SLAG SPLASHING
K. PEASLEE, University of Missouri-Rolla, Rolla, Missouri, USA, and
W. CHEN, University of Science and Technology Beijing, Beijing, China

Slag splashing is an important development that has dramatically improved BOF vessel campaign life and reduced operating costs. This paper highlights research from physical modeling work using a 1/8-scale room temperature model BOF and slag characterization studies from several plants in North America and China. In the model studies, gas flow rate during blow and viscosity of the liquid were found to be two of the most important factors to changing the overall rate of liquid splashed onto the vessel sidewalls. When the flow rate was increased or viscosity decreased, the lower regions of the walls were splashed at a much greater rate. It was also shown that by changing the lance height, more liquid was deposited in the upper regions of the vessel at the expense of lower regions. Reducing the number of nozzles was found to be the most effective method of selectively coating a particular vertical section of the wall. Studies of BOF's using slag splashing in North America and China showed a difference in the melting characteristics of the final slag. Generally, slag splashing is successful when the melting point of the slag is 220-270^{o}C below the tap temperature to maintain a balance between fluidity and refractoriness.

COFFEE BREAK — 15:15 – 15:30

PAPER 33.3 — 15:30
ROLE OF OXYGEN IN INTERFACIAL PHENOMENA DURING HIGH TEMPERATURE REACTIONS
M.A. RHAMDHANI, K.S. COLEY, McMaster University, Hamilton, Ontario, Canada and
G.A. BROOKS, CSIRO Minerals, Melbourne, Australia

Interfacial phenomena in high temperature reactions such as between iron alloy and slag is well documented but not fully understood. It is believed that a gradient of oxygen concentration plays an important role to the occurrence of such phenomena. This article describes the results from the continuation of the study of interfacial phenomena between Fe-Al alloy droplets and CaO-SiO_2-Al_2O_3 slag. Materials characterization techniques involving microscopic

observations, depth profiling, bulk, point analysis and were carried out. The roles of oxygen as well as other factors that contribute to the interfacial phenomena were evaluated. The results and their implications to steelmaking will be discussed.

PAPER 33.4 — 16:00

A STUDY OF A GAS JET IMPINGING ON A LIQUID SURFACE

H.Y. HWANG and G.A. IRONS, McMaster University, Hamilton, Ontario, Canada

An impinging gas jet on a water surface was studied to understand momentum transfer in oxygen steelmaking. Depth, width and oscillation frequency of the jet cavity were measured and the splashes interpreted with Kelvin-Helmholtz instability and combined Rayleigh-Taylor and Kelvin-Helmholtz instability theory. A model to calculate separate gas and liquid velocities, applying the exact momentum boundary condition, is proposed.

PAPER 33.5— 16:30

NEW HEAT TRANSFER TECHNOLOGY (THERMOPUMP) FOR APPLICATIONS IN STEELMAKING AND REFINING

Z. YUAN and F. MUCCIARDI, McGill University, Montreal, Quebec, Canada

A new heat transfer technology --- termed Thermopump technology has been developed. This technology originates from conventional heat pipe configurations but has now evolved into its own class of heat transfer units, which we refer to as 'Thermopumps (TP)'. A key feature is that Thermopump technology can be applied to high temperature/high heat flux environments where conventional heat pipe technology fails. Moreover, when implemented in less demanding applications where heat pipes appear to operate, Thermopump units have been found to function more smoothly and reliably. This paper will introduce Thermopump technology and several applications of this technology in steelmaking and refining will also be discussed. In addition, this paper will focus on three classes of applications: 1) waterless, non-consumable, high efficiency Thermopump oxygen lance and/or burner for EAF's, 2) Thermopump ladle lance for the desulfurization process, and 3) Thermopump cooling panels for furnace walls and roofs. Facilities equipped with Thermopump technology are expected to be better than the current corresponding ones in terms of increasing productivity and energy efficiency while at the same time lowering operating costs.