BLAST FURNACE PHENOMENA AND MODELLING

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Preface

As ironmakers are well aware, it was only a few decades ago that the blast furnace was viewed as a strange 'black box'. Recently, however, various in-furnace phenomena have become the subject of serious scientific study, largely as the result of the 'dissection' of dead furnaces, together with the development of advanced monitoring and control techniques. In this way, a new frontier has been opened within the venerable domain of metallurgy. In the light of these new developments, the Committee on Reaction within Blast Furnaces was set up in March 1977 by the Joint Society of Iron and Steel Basic Research — a cooperative research organization of the Iron and Steel Institute of Japan (ISIJ), the Japan Institute of Metals (JIM) and the Japan Society for the Promotion of Science (JSPS). Consisting of twenty-six members and advisors drawn from the fields of academia and industry, this committee collected, discussed, and evaluated numerous papers during its five-year commission. Particular attention was paid to the interpretation of findings drawn from the autopsy of dead furnaces, in the context of the live furnace state, and the correlation of data regarding cohesive zone configuration, level, and furnace performance. The results of this intense research activity are presented here in the hope that they will serve not only as a source of enrichment to the professional knowledge of researchers and operators, but also as textual material for graduate students in the field of metallurgy. The thirty-one papers are included within eight chapters as outlined in the following.

Chapter 1 is devoted to the detailed survey of dissected blast furnaces, focusing on their spatial analysis: namely, their cohesive zone and its

function, changes in properties of burden materials, burden distribution, and a number of intriguing metallurgical phenomena including the recirculation behavior of certain chemical components.

Chapter 2 deals with the progress made in measuring and control techniques, while Chapter 3 discusses the progress made in constructing mathematical models of the in-furnace state. Such models include the most up-to-date two dimensional steady-state and one-dimensional non-steady-state models, derived from the findings of furnace dissections.

Chapter 4 deals with quantification of the flows of gas, liquid and solid materials in the upper and lower parts of the furnace, and related phenomena such as flooding, fluidization in the dropping zone, coke movement, raceway behavior, the dead coke zone, and the flow of hot metal and slag at tapping. Simulation test data are also presented.

In Chapter 5 the in-furnace high temperature properties of agglomerated iron ores are discussed. Such properties constitute important parameters for the construction of mathematical models and for the prediction of cohesive zone position and level.

Chapter 6 takes up the subject of raceway phenomena and tuyere combustion zone models, while Chapter 7 examines slag-metal-gas reactions, with particular emphasis on silicon transfer in the lower part of the furnace. Such reactions are also related to the process of forming mathematical models.

Finally, Chapter 8 presents a number of views regarding future blast furnace technology.

The Chairman would like to express his sincere thanks to all members and advisors for their indefatigable efforts during their five years of research, and to the ISIJ secretariat for their efforts in documenting and editing the work. His special appreciation goes to Dr. G. Belton, Dr. Peter Scarfe, and Dr. John Burgess of the Broken Hill Proprietary Company who kindly carried out critical reading of the manuscript.

YASUO OMORI
COMMITTEE CHAIRMAN

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