Blast Furnace Technology

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(A review of papers presented at the Iron & Steel Division's sessions on Blast Furnace Technology during the 1961 AIME Annual Meeting in St. Louis, Mo.)

Thermal Balance For a Ferromanganese Blast Furnace by W. H. Burr and J. H. Bergmark, Duquesne Works, U. S. Steel Corp.

This paper presented by W. H. Burr compares heat balances for the production of basic pig iron by the conventional blast-furnace process with those for the production of ferromanganese both with a conventional air blast and with a blast enriched to 28.8 pct O_2 . This comparison shows that the heat requirement for the ferromanganese blast furnace is much greater than that for a basic iron furnace and also that a greater portion of the total heat required must be in the high-temperature range above 2500°F. By enriching the blast with oxygen a larger percentage of the total heat can be produced in this range. The use of a blast containing 28.8 pct O_2 increased the production rate of the ferromanganese furnace 54 pct and decreased the coke requirement 13 pct.

The use of blast-moisture additions which promote indirect reduction is beneficial for a basic iron furnace when high hot-blast temperatures are used; however, moisture has only an undesirable effect on the ferromanganese blast furnace where almost all of the reduction of MnO must be done as direct reduction at very high temperatures. Sintering the ores prior to charging has shown practically no benefit in the ferromanganese blast furnace although a sinter burden promotes indirect reduction and lowers the coke rate in a basic iron furnace.

In the ferromanganese blast furnace, the production rate is limited only by the rate at which high-temperature heat can be supplied to the

hearth; consequently, this process is greatly accelerated by the use of oxygen enrichment and high hot-blast temperature.

Kinetics of Reduction of FeO and MnO From Silicate and Aluminate Slags by S. K. Tarby, Lehigh University and W. O. Philbrook, Carnegie Institute of Technology. The following summary was prepared by W. O. Philbrook:

The reduction of MnO and FeO from $CaO-Al_2O_3$ and $CaO-SiO_2-Al_2O_3$ slags to carbon saturated iron in stationary graphite crucibles was found to proceed in two stages. It is proposed that this process is controlled by the rate of transport of Mn^{2+} or Fe^{2+} ions to the slag-metal interface in both stages. In the first part of the process, the stirring caused by carbon monoxide evolution results in turbulent flow in the slag, with the result that the mass transfer coefficient is a function of the reaction rate. As the boil subsides, the slag reverts to streamline flow conditions where the boundary layer becomes independent of further changes in reaction rate, and the process behaves as one with simple diffusion control. This change occurs well before the reduction rate becomes limited by simultaneous slow reduction of SiO_2 . The latter limitation has prevented attainment of the true equilibrium distribution ratio for manganese in previously published studies.

Reduction Kinetics of Hematite in Hydrogen-Water Vapor-Nitrogen Mixtures by W. M. McKewan, Fundamental Research Laboratory, U.S. Steel Corp.

Dense hematite pellets were reduced in hydrogen-water vapor-nitrogen mixtures in the temperature range of 700° to 1000°C and at a total pressure of 0.97 atm. The rate of reduction per unit area was directly proportional to the partial

pressure of hydrogen when the ratio of hydrogen to water vapor was constant. As the ratio of hydrogen to water vapor decreased, the reduction rate decreased and approached zero at the wüstite-iron equilibrium point. The enthalpy of activation for this reaction was shown to be 15,400 cal per mole.

In addition, an equation was derived from entirely theoretical considerations that was shown to fit the experimental data.

W. E. Marshall of Armco Steel Corp., presented a paper on **Taconite Pellets in the Blast Furnace**, which was published in the April issue of JOURNAL OF METALS.

Fuel-Oil Injection Tests in a Blast Furnace at the Cockerill-Ougree Works in Liege, Belgium by E. Noel, Ougree Works; J. Molderez, Seraing Works; and A. Poos, Centre National de Recherches Metallurgiques, Belgium.

This paper, presented by Mr. Poos, describes tests in which fuel oil was injected through the tuyeres of a 12.5 ft hearth-diameter furnace. While fuel oil was injected, the operation of the furnace became smoother and the sulfur content of the metal was controlled more easily. Indirect reduction increased and the coke rate decreased. Every lb of fuel oil replaced about 1.8 lb of coke when a 40 pct sinter burden was used and 1.6 lb of coke when a 90 pct sinter burden was used. For a constant driving rate (that is, for the same quantity of bosh gas per hr), the injection of 120 lb of fuel oil per net ton of hot metal gave an increase in production of about 3 pct.

During the tests, temperature and chemical composition of the furnace gas were determined by the means of vertical and horizontal probes; however, additional data will be necessary before the full meaning of these results can be calculated.