Effects of Using Hydrogen in Metallurgical Tests for Blast Furnace Iron Ores




Most standard tests for blast furnace (BF) iron ores consider only CO as the reductant gas. Nevertheless, all BFs have different ranges of hydrogen in the reducing gases, which vary according to the auxiliary fuels used. A fundamental step in laboratory characterization is to reduce the gap between lab results and industrial data. This article shows the development of nonstandard metallurgical tests applied to pellets, lumps and sinter, considering H_2 content as the reducing gas of a blast furnace with high natural gas injection rates. In addition, the nonstandard tests results are compared with industrial data of a real blast furnace.

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Introduction

Nowadays, there is a growing interest in the injection of natural gas (NG) and other H_2-carrying injections to achieve the CO_2 emission reduction goals that each steel company is projecting for the coming years. This implies that the reducing gases used in blast furnaces (BFs) tend to have a higher content of H_2, whose properties as a reducing gas are different from CO. In Ternium Argentina's blast furnaces, as well as in others, natural gas is used as an auxiliary reducing agent. However, the ISO 7215 standard test[1] historically used to evaluate reducibility, which uses a CO/N_2 mixture as the reducing gas, provides results that may differ from the behavior of a ferrous raw material in the operation of the industrial plant.

The H_2 content in the reducing gas of a BF can vary in a range of 4–15%, depending mainly on the auxiliary reducing agent used.

Characterization tests on a new pellet for BF consumption showed that it had low reducibility evaluated according to ISO 7215 compared to the pellets normally used. However, when the industrial test was carried out, no effect related to this characteristic was found; on the contrary, good performance was observed in the BF. As a result, it was decided to study the possible reason; for that an alternative laboratory test was developed to evaluate reducibility using a reducing gas composition similar to the one in the BF.

There are numerous authors who studied the reduction kinetics with increasing amounts of H_2 in the reducing gases, such as Abdelrahim et al.,[2] who performed experiments with different temperatures and gas compositions, finding that the temperature and the increase in H_2 improved the reduction rate in all the cases studied. However, this study does not aim to study kinetics itself, but to establish a simple test that is representative of the real conditions to which the raw material is exposed as a fundamental advance in laboratory characterization with results closer to the behavior in industrial use.

Results

Methodology

Two methodologies were used to assess the reducibility:

- Methodology according to ISO 7215: Iron ores for blast furnace feedstocks — Determination of the reducibility by the final degree of reduction index.