Hydrogen Reduction of New Zealand Titanohematite Pellets

A. Zhang[1], R. J. Longbottom[2], M. Nusheh[3], C. W. Bumby[4] and B. J. Monaghan[5]

1.
PhD candidate, Robinson Research Institute, Victoria University of Wellington, Lower Hutt 5046, New Zealand. Email: ao.zhang@vuw.ac.nz

2.
Research fellow, University of Wollongong, NSW 2522, Australia. Email: rayl@uow.edu.au

3.
Research fellow, Robinson Research Institute, Victoria University of Wellington, Lower Hutt 5046, New Zealand. Email: Mohammad.Nusheh@callaghaninnovation.govt.nz

4.
Senior scientist, Robinson Research Institute, Victoria University of Wellington, Lower Hutt 5046, New Zealand. Email: chris.bumby@vuw.ac.nz

5.
Professor, University of Wollongong, NSW 2522, Australia. Email: monaghan@uow.edu.au

ABSTRACT

New Zealand ironsand is a titanomagnetite (TTM) ore and a potential cheap source of iron units. Direct reduction of the ore using hydrogen gas is attractive as there are extant technologies/processes that are capable of utilizing the feed and reductant gas. Further, the use of hydrogen gas as a reductant offers potential environmental benefits. Common direct reduction technologies utilise pellets. During pelletisation, the TTM is oxidised to titanohematite (TTH), which has the added possible benefit of increasing the rate of reduction.

In this study the reduction of TTH pellets by hydrogen gas has been studied to understand the pellet reduction mechanism and to establish a kinetic reaction model for the direct reduction of the TTM ore.

TTH pellets were made by pelletising a mixture of wet milled TTM ironsand, 1 wt% bentonite and water. The green pellets were then sintered in air to form TTH. Thermogravimetric analysis was used to measure the reaction progress at temperatures between 770°C to 1170°C at a hydrogen gas flow rate of 520ml/min. Ex-situ x-ray diffraction was used to trace the evolution of key critical phases at different temperatures. Scanning electron microscopy was used to characterise the phase and morphology changes on reduction at different temperatures.

It was found that the reduction rate of the TTH pellets increased with increasing temperature up to 1170°C. Metallic iron and ilmenite were found in the reduced pellets at all temperatures. At temperatures higher than 870°C, the second Ti bearing phase was pseudobrookite, while at and below 870°C, rutile was present. A single interface shrinking core model was found to give a good representation of the bulk kinetics for reduction degrees up to 90%.