The Upgradability of Beach Ilmenite found in Sri Lanka by Mechanically Activated Carbothermic Reduction

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Abstract

A large amount of high-quality titanium ore minerals are required for future development of the titanium industry. Although ilmenite ($FeTO_3$) is a type of low-grade titanium ore, it has a significant utility value in the production of titanium dioxide (TiO_2). The existence of ilmenite percentage (70%-72%) is much higher than the rutile percentage (8%) in the northeastern coastal area of Sri Lanka. The results of a large number of chemical and physical investigations have been published regarding the reduction of ilmenite but the effective and improved reduction of ilmenite is relatively limited. The long reduction time, slower reduction rate are the major problems in the existing electric furnace process. In this study, the carbothermic reduction behavior and optimum temperature under specific conditions for milled ilmenite were investigated. Magnetically separated ilmenite sample was supplied by Lanka Mineral Sands, Pulmoddai. Activated carbon was used as a reducing agent. A mixture of ilmenite and activated carbon (4 to 1 ratio) was subjected to high energy ball milling for one to four hours separately. Subsequently, milled samples were heated for two hours at different temperature of 800°C, 900°C, 1000°C, 1100°C, and 1200°C. Phase identification and functional groups of the treated samples were determined using X-ray Diffractometer (XRD) and Furrier Transform Infrared (FTIR), respectively. The particle sizes of the initial and milled samples were determined using a dry sieving method. In contrast with initial ilmenite, relative peak heights, sharpness of peaks, the number of titanium dioxide (TiO_2), XRD peaks in treated samples, and metallization of the iron were increased with the time during the studied four hours. Many corresponding ilmenite peaks were disappeared after four hours milling and annaling at 1000°C, 1100°C and 1200°C. FTIR analysis indicates initial ilmenite contains Fe-O and OH stretching vibrations. The upgraded ilmenite sample contains Ti-O stretching vibrations with more broadness. The d_{50} particle size of initial ilmenite sample and four hours milled samples were 0.10 mm and 0.075 mm, respectively. Mechanical activation significantly improve effiency of carbothermic reduction due to particle size reduction and increasing of specific area. The annealing temperature can be reduced up to 1000°C during the studied four hours. Therefore, beach ilmenite found in Sri Lanka can be upgraded by mechanically activated carbothermic reduction.

Keywords: Annealing, Ball milling, Low grade, Reduced, Titanium dioxide

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