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A literature review of titanium metallurgical processes

Wensheng Zhang ... Chu Yong Cheng

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Abstract

Various titanium metallurgical processes have been reviewed and compared for titanium dioxide and titanium metal, mainly focusing on the future development of hydrometallurgical processes. It is recognised that ilmenite is becoming increasingly important due to the rapid depletion of natural rutile. Many processes are commercially used or proposed to upgrade ilmenite to synthetic rutile. Most of these processes involve a combination of pyrometallurgy and hydrometallurgy and are generally expensive.

The commercialised thermo-chemical chloride processes such as Kroll and Hunter processes are batch operations and need higher grade natural rutile or upgraded synthetic rutile and slag as the feed and the involvement of cost sensitive chlorination and thermo steps. Many improvements for the thermo-chemical processes have been made, but they hold little potential for significant cost reductions beyond current technology. The development of the electro-chemical processes for direct reduction of

TiO_2 and electro-slag as feed material and *in-situ* electrolysis has achieved some success. However, some challenging issues such as redox cycling, feeding, kinetics, control heat balance have to be resolved before scaling-up to commercial applications.

Direct hydrometallurgical leach processes are advantageous in processing abundant ilmenite ores, low energy consumption and produce sufficiently high quality of pigment grade TiO_2 products for a wide range of applications and major demand. Novel BHP Billiton sulphate processes have been developed to improve leaching strategies, separation of metals by solvent extraction, reduced wastes and recycling acids, and very promising for commercial applications in future. Direct chloride leaching processes have been investigated intensively, featuring purification by solvent extraction and reclaiming HCl by hydrolysis or pyrohydrolysis. Caustic leach with high selectivity and titanium dioxide nano-technology has also been developed. Further development of direct leaching ilmenite coupled with solvent extraction for titanium pigment and metal production, is recommended.

Research highlights

â–º Various titanium metallurgical processes for the production of titanium dioxide and titanium metal have been reviewed and compared including: â–º Processes to upgrade ilmenite to synthetic rutile. â–º Thermo-chemical Kroll and Hunter processes. â–º Electro-chemical processes for direct reduction of TiO_2 and electro-slag and *in-situ* electrolysis. â–º Direct hydrometallurgical leach processes.

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Keywords

Titanium; Titanium dioxide; Titanium pigment

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