Investigation into the effect of cooling conditions on the particle size distribution of titania slag

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Abstract

Titania slag is a feedstock to the pigment industry, which in turn provides titania pigment to producers of everyday products like paper, cosmetics and toothpaste. Titania slag is the primary product of the pyrometallurgical process of ilmenite smelting – the other products being iron and CO gas. Titania slag is typically tapped from the furnace into blocks of approximately 20 tons. After cooling these blocks are crushed and milled to size fractions suitable for the processes of the pigment producers. These processes are broadly grouped into two types of technology: the chloride route (during which titania slag is reacted with chlorine and subsequently re-oxidised thereby removing the impurities) and the sulphate route (in this process the titania slag is purified after dissolving the slag in sulphuric acid). Due to the nature of these two processes, several specifications are imposed on the quality of the titania slags.

The fluidised-bed technology used in the chloride process limits the size distribution of the slag to between 106 µm and 850 µm. Ilmenite smelting industries consequently crush and mill the titania slag to below 850 µm. The fraction below 106 µm is then sold to the sulphate market. Since the coarser chloride grade product is the more valuable product, slag producers continuously strive to improve the ratio between the coarser and finer fractions.

This study reports on parameters which influence the particle size distribution of titania slags and therefore the split between the coarser (more valuable) and finer (less valuable) products. Pilot-scale slag ingots were used to identify chemical and process variables which influence the yield of coarser material. The microstructure of as-cast and milled slag was examined, and indicated a role of silicate phases in the crushing behaviour. Industrial-scale slag ingots were used to test whether the roles of tapping rate and water cooling (as identified from the pilot-scale ingots) also applied under industrial conditions. A numerical method was applied to estimate the thermal conductivity of the solidified slag (from measurements on pilot-scale ingots), and to predict the cooling and solidification behaviour of industrial-scale ingots.

The study concludes that the chemical composition and cooling conditions of the slag block play central roles in the final particle size distribution of the slag.

Key words: titania slag; pseudobrookite; solidification; ilmenite smelting

Table of Contents

List of Figures

List of Tables