Hydrothermal Preparation of Nano-TiO_2 Pigments from Sri Lankan Natural Ilmenite

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Mineral sand deposits represent a most promising and profitable future resource for the country. The crude heavy minerals at Pulmudai-Sri Lanka contain about 60% to 70% of heavy minerals having composition of 70% to 75% ilmenite ($FeTiO_3$), 10% rutile (TiO_2) and 8 to 10% zircon ($ZrSiO_4$). Titanium dioxide is an important inorganic chemical material, especially the best-quality white pigment. Decomposition of ilmenite ($FeTiO_3$) structure into TiO_2 is normally done at 850 °C using 70% H_2SO_4. In this study, the above conversion has been carried out at a relatively low temperature with saturated vapor pressure under hydrothermal conditions. Ilmenite was collected from beach sands in Pulmudai and finely powdered. The powdered material was then treated with Concentrated HCl under hydrothermal conditions at different temperatures and pressures. Ilmenite was decomposed completely and nano-particles of anatse phase of rutile TiO_2 were obtained directly from the autoclave with further hydrothermal treatment under basic media, the anatse phase was converted into the rutile phase of TiO_2. The effect of pH on the size and morphology of particles in nano-powders were also investigated. Results showed that after the hydrothermal treatment of ilmenite, black-colored granules changed into swelled yellowish-white powder. The X-ray powder diffraction pattern confirmed that the products were well crystalline pure phases of rutile (TiO_2) depending on the experimental conditions. The SEM-EDX and XRF analysis confirmed the product contained 100% TiO_2. The particles sizes of nano TiO_2 produced were between 85 nm to 100 nm. ICPS chemical analysis of the final product indicated 17.50 ppb of Fe which is within the range of acceptable levels when pure TiO_2 is concerned. The leachate solution was also colored yellowish, indicating the Fe leaching from the natural source. This phenomenon implies that the hydrothermal treatment for natural rutile can be used not only as a reaction step but also as a semi-purification step. The results demonstrated that the process is inexpensive, environment friendly and promising in preparing high-purity TiO_2 from ilmenite with a high content of gangues.

Keywords- hydrothermal conditions, ilmenite, titanium dioxide