ABSTRAK

OPTIMASI SINTESIS NANO-TiO_2 DARI PASIR ILMENIT BANTEN MELALUI FUSI KAUSTIK DAN DUA TAHAP PELINDIAN ASAM

Oleh
Hazim Haikal Labib
NIM: 116210005
(Program Studi Sarjana Teknik Metalurgi)

Indonesia memiliki potensi besar dalam sumber daya nano-TiO_2 yang diperoleh dari pasir ilmenit. Nano-TiO_2 digunakan sebagai pigmen, fotokatalisis, dan fotovoltaik. Meski Indonesia kaya akan cadangan ilmenit, dengan total mencapai 21.922.229 ton, produksi TiO_2 masih relatif kecil dibandingkan logam lain sedangkan impor produk terus meningkat. Proses pelindian HCl dipilih karena dapat mengektrasi bijih kadar rendah dan bersifat lebih ramah lingkungan karena jumlah limbah yang lebih sedikit. Penelitian ini mengeksplorasi optimasi proses pelindian HCl untuk mencapai kadar dan *recovery* yang optimal, Optimasi meliputi kombinasi parameter rasio S/L, konsentrasi asam klorida, waktu pelindian, dan temperatur.

Pada penelitian ini, metode yang digunakan meliputi konsentrasi magnetik, fusi kaustik pada 850°C rasio NaOH 1:2 selama 1 jam, pelindian air, kemudian pelindian asam tahap I menggunakan HCl 20% selama 240 menit pada 90°C. Pelindian tahap II divariasikan dari hasil desain eksperimen Taguchi dengan parameter rasio S/L (1:10, 1:15, 1:20), konsentrasi HCl (20%, 25%, 30%), waktu (2, 4, 6 jam), dan temperatur (60°C, 75°C, 90°C). Analisis produk dilakukan dengan XRD, XRF, FTIR, dan PSA. Sedangkan analisis statistika menggunakan Taguchi, ANOVA, dan Uji-T berpasangan.

Hasil penelitian menunjukkan bahwa parameter optimal pada pelindian II terhadap kadar diperoleh pada konsentrasi HCl 30%, rasio S/L 1:10, temperatur 90°C, dan waktu 4 jam, menghasilkan kadar TiO_2 sebesar 88,83%. Sedangkan parameter optimal terhadap *recovery* diperoleh pada konsentrasi HCl 30%, rasio S/L 1:15, temperatur 90°C, dan waktu 4 jam menghasilkan *recovery* 82,94%. Karakterisasi XRD mengonfirmasi dominasi fasa rutil, FTIR menunjukkan gugus fungsi Ti–O–Ti khas TiO_2, sedangkan PSA mengindikasikan ukuran partikel rata-rata 363,6 nm. Uji ANOVA menegaskan bahwa konsentrasi asam memberikan kontribusi terbesar terhadap kadar TiO_2. Sedangkan konsentrasi asam dan waktu pelindian berpengaruh besar pada *recovery*.

Kata kunci: pasir ilmenit, pelindian asam, fusi kaustik, nano-TiO_2, optimasi

ABSTRACT

OPTIMIZATION OF NANO-TiO_2 SYNTHESIS FROM BANTEN ILMENITE SAND THROUGH CAUSTIC FUSION AND TWO-STAGE ACID LEACHING

By
Hazim Haikal Labib
NIM: 116210005
(*Metallurgical Engineering Undergraduated Program*)

Indonesia has great potential in nano-TiO2 resources obtained from ilmenite sand. Nano-TiO2 is used as a pigment, photocatalyst, and photovoltaic. Although Indonesia is rich in ilmenite reserves, totalling 21,922,229 tonnes, TiO2 production is still relatively small compared to other metals, while product imports continue to increase. The HCl leaching process was chosen because it can extract low-grade ore and is more environmentally friendly because less waste is produced. This research explores the optimisation of the HCl leaching process to achieve optimal grade and recovery. The optimisation includes a combination of parameters such as S/L ratio, hydrochloric acid concentration, leaching time, and temperature.

In this study, the methods used include magnetic concentration, caustic fusion at 850°C with a NaOH ratio of 1:2 for 1 hour, water leaching, followed by Stage I acid leaching using 20% HCl for 240 minutes at 90°C. Stage II leaching was varied based on the Taguchi experimental design with parameters of S/L ratio (1:10, 1:15, 1:20), HCl concentration (20%, 25%, 30%), time (2, 4, 6 hours), and temperature (60°C, 75°C, 90°C). Product analysis was conducted using XRD, XRF, FTIR, and PSA. Meanwhile, statistical analysis employed Taguchi, ANOVA, and paired T-test.

The research results show that the optimal parameters of Stage II leaching for content were obtained at an HCl concentration of 30%, an S/L ratio of 1:10, a temperature of 90°C, and a time of 4 hours, resulting in a TiO_2 content of 88.83%. Meanwhile, the optimal parameters for recovery were obtained at an HCl concentration of 30%, an S/L ratio of 1:15, a temperature of 90°C, and a time of 4 hours, resulting in a recovery of 82.94%. XRD characterisation confirmed the dominance of the rutile phase, FTIR showed the Ti–O–Ti functional group typical of TiO_2, while PSA indicated an average particle size of 363.6 nm. ANOVA tests confirm that acid concentration has the largest contribution to TiO_2 content, while acid concentration and leaching time significantly affect recovery.

Keywords: ilmenite sand, acid leaching, caustic fusion, nano-TiO_2, optimisation