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Towards Sustainable Nickel Laterite Processing: Optimising Hydrothermal Iron Removal under Industrial Conditions

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ABSTRACT

The growing demand for nickel and cobalt for electrification and battery technologies, particularly lithium-ion batteries used in electric vehicles and energy storage systems, is driving the need for increased processing of nickel laterite ores. The most widely used method for processing laterite ores, high-pressure acid leaching (HPAL), is however energy-intensive and generates large amounts of toxic waste, motivating the development of alternative approaches. Nitric acid-based metallurgical flowsheets are gaining increasing attention as a viable alternative for nickel laterite processing due to their potential to reduce waste generation and improve resource efficiency. In these systems, efficient removal of iron as hematite ($\alpha\text{-Fe}_2\text{O}_3$) plays a critical role in determining process efficiency, product quality, and downstream waste management.

This study investigates the hydrothermal hydrolysis of iron(III) nitrate under industrially relevant conditions. . Experiments were conducted in a 1.2 L autoclave using concentrated reaction mixtures at 190–240 °C, combined with time-resolved kinetic sampling. Hydrolysis products were characterised using XRD, SEM, PSD, TGA, BET, XRF and XPS analysis

Iron hydrolysis was found to increase with increasing temperature in tests conducted over 80 minutes from ~65% at 190 °C to ~95% at 240 °C. Kinetic data that was obtained showed that rapid iron

hydrolysis occurred at elevated temperatures.

XRD analysis confirmed the formation of hematite across all conditions. SEM observations revealed systematic changes in particle morphology with increasing temperature, consistent with variations in particle growth behaviour. PSD analysis showed that median particle size (Dv50) decreased from ~21.6 µm at 190 °C to ~9 µm at 225 °C, followed by an increase at 240 °C, indicating changes in particle formation dynamics under intensified conditions. XPS analyses indicated a reduction in surface-associated species with increasing temperature, while TGA results supported the formation of thermally stable hematite with minimal other hydrolysis products being present.

KEY WORDS

Nickel laterite processing; Hydrothermal hydrolysis, Iron removal; Sustainable processing; Critical minerals; Reaction kinetics; Hematite; Nitric acid processing

BIOGRAPHY

(Include a short biographical of 100 words for the presenting author)

Malik Nausherwan Ali Saggu is a third-year PhD student at the Centre for Advanced Materials and Industrial Chemistry (CAMIC), School of Science, RMIT University, Australia. His research focuses on the sustainable processing of nickel laterite ores. In collaboration with QPM Energy, he investigates hydrothermal iron removal in nitric acid-based metallurgical flowsheets to improve process efficiency and reduce waste. His work integrates advanced materials characterisation with reaction engineering to generate process-relevant insights, supporting the development of sustainable and industrially viable processing technologies for critical minerals processing.

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