INTISARI

Baterai litium-ion menjadi bagian penting dalam kehidupan saat ini, karena tingginya permintaan akan kebutuhan terhadap perangkat elektronik dan industri kendaraan listrik. Baterai NCA digunakan sebagai penyimpanan energi pada kendaraan mobil listrik karena memiliki daya yang tinggi. Akan tetapi, baterai akan menjadi limbah setelah periode penggunaan tertentu dan limbahnya dapat menyebabkan permasalahan lingkungan dimasa mendatang. Unit *recovery* limbah baterai penting untuk menyelamatkan lingkungan dari bahaya limbah logam berat pada baterai dan perolehan kembali *valuable metal* didalamnya. Penelitian ini berfokus pada pemisahan presipitat *nickel* dan *cobalt* dari endapan pasca pengambilan litium dari katoda baterai NCA melalui proses pelindian menggunakan asam oksalat. Selain itu, pada penelitian ini juga dilakukan studi kinetika proses pemisahan logam *nickel* dari *cobalt* dengan membandingkan model matematis yang diajukan.

Tahapan penelitian ini diawali dengan proses persiapan bahan baku dan merangkai alat penelitian. Persiapan bahan baku meliputi proses pemisahan komponen baterai NCA, pemungutan litium dari katoda baterai, dan tahapan presipitasi bertingkat. Presipitat campuran *nickel* hidroksida dan *cobalt* hidroksida kemudian dilakukan proses pemisahan melalui proses *leaching* menggunakan asam oksalat. Variasi penelitian berupa waktu pelindian, suhu operasi, pH larutan, dan rasio *solid/liquid*. Pelindian dijalankan pada labu leher tiga yang dilengkapi dengan pemanas, termometer, motor pengaduk, dan pendingin *reflux*. Selama proses *leaching* dilakukan pengambilan sampel untuk mengetahui *recovery* logam didapatkan.

Hasil penelitian menunjukkan bahwa semakin rendah pH dan semakin kecil S/L ratio maka akan meningkatkan perolehan *nickel* dalam larutan. *Dissolved nickel* dalam larutan tertinggi terdapat pada suhu 50-65°C. Semakin lama waktu pelindian maka perolehan *nickel* dalam larutan meningkat kemudian menurun karena terjadinya pengendapan produk. Selektivitas *nickel* terhadap *cobalt* bernilai tinggi pada pelindian dengan kondisi pH rendah dan S/L rendah. Difusi massa pada *inert layer* yang diikuti dengan laju pengendapan produk menjadi mekanisme yang mengontrol dengan tahanan difusi di *inert layer* didapatkan sebesar 96,35% dengan laju difusivitas *nickel* (De) sebesar 7,1826 dm^2/menit dan laju pengendapan *nickel oxalate* sebesar k_p = 0,0467 men^{-1}. Sementara itu, energi aktivasi untuk kinetika laju pelindian sebesar 0,52 kJ/mol dan kinetika laju pengendapan sebesar 0,49 kJ/mol.

Kata kunci: baterai NCA, *nickel*, pelindian, selektivitas, kinetika

ABSTRACT

Lithium-ion batteries (LIB) have currently become an important aspect of modern life, specifically due to demands from electronic devices and e-vehicle industries. NCA batteries are used as energy storage in electric car vehicles because they have high energy density. However, the battery will come to an end after a certain period of usage and the waste might cause environmental problems in the future. Due to its valuable metal content, a recovery unit is needed in order to save the environment and recycle the metals including nickel. The present work focused on the recovery of nickel from the remaining precipitates through a leaching process in oxalic acid following lithium recovery from the NCA battery cathode. The research aimed to investigate the effect of temperature, S/L ratio, pH, and reaction time on nickel recovery. In addition, this research also conducted a kinetics study of the separation process of nickel from cobalt by comparing the proposed mathematical models.

This research phase begins with the process of preparing raw materials and assembling research tools. Preparation of raw materials includes the process of separation of NCA battery components, lithium recovery from the battery cathode, and the multistage of precipitation. A precipitation mixture of nickel hydroxide and cobalt hydroxide is then carried out through the separation process through a leaching process using oxalic acid. The research variations are leaching time, temperature, pH of the acid solution, and solid to liquid ratio. The leaching process runs on a three-neck flask equipped with a heater, thermometer, mixing motor, and reflux cooler. During the leaching process, sampling is performed to determine the recovery of the metal obtained.

The results showed that the lower of pH solution and the smaller the S/L ratio, the higher the nickel gain in the solution. The highest dissolved nickel in the solution was found at a temperature of 50-65 °C. The increase in dissolved nickel in the solution was higher over time and then decreasing due to the deposition of the product. Nickel to cobalt selectivity on high value in seams with low pH and low S/L conditions. Mass diffusion in the inert layer, followed by the deposition rate of the product becomes a controlling mechanism with diffusion resistance in the inert layer obtained by 96.35% with the rate of nickel diffusion (De) of 7,1826 dm^2/min and the deposition rate of nickel oxalate of k_p = 0,0467 min^{-1}. Meanwhile, the activation energy for the kinetics of the draw rate is 0.52 kJ/mol and the precipitation rate kinetics is 0.49 kJ/mol.

Keyword: NCA battery, nickel, leaching, selectivity, kinetic