

INTISARI

Kebutuhan manusia mendorong terjadinya perkembangan teknologi yang masif, termasuk dalam bidang otomotif. Perkembangan tersebut ditandai dengan adanya upaya peralihan kendaraan bermotor dengan bahan bakar minyak menjadi tenaga listrik. Berdasarkan analisis data dari PT. PLN terkait jumlah mobil listrik di Indonesia, diprediksi pada tahun 2030 terdapat 452.259 mobil listrik dengan jenis PHEV dan BEV. Diperkirakan akan terkumpul limbah baterai jenis NMC sebanyak 52.000 ton pertahun. Untuk mengatasi limbah tersebut maka perlu didirikan industri pengolahan limbah baterai agar limbah dapat diolah kembali menjadi bahan untuk membuat baterai. Metode yang cocok digunakan dalam pabrik pengolahan limbah baterai NMC adalah proses *leaching* kimia hidrometalurgi. Proses *leaching* katoda baterai membutuhkan Asam Sulfat (H_2SO_4) 0,8 M dan Hidrogen Peroksida (H_2O_2) 3% dengan kondisi operasi pada suhu 60 °C dan tekanan 1 atm. Proses *leaching* dapat mengambil kembali material baterai berupa Litium, Nikel, dan Kobalt hingga 80%. Pengambilan logam selanjutnya diambil dengan proses presipitasi. Pengambilan logam Nikel, Kobalt, dan Mangan dilakukan dengan presipitasi menggunakan Natrium Hidroksida (NaOH) pada pH 11 dengan suhu 35 °C dan tekanan 1 atm. Sementara logam Litium diambil dengan presipitasi menggunakan Natrium Karbonat (Na_2CO_3) pada pH 12 dengan suhu 65 °C dan tekanan 1 atm.

Pengolahan limbah baterai jenis NMC sebanyak 52.000 ton/tahun (330 hari, 24 jam) membutuhkan bahan baku H_2SO_4 98% sebanyak 18.109,0491 MT/tahun, H_2O_2 30% 11440,1050 MT/tahun, $Ca(OH)_2$ 95% 5052,2599 MT/tahun, NaOH 99% 14636,8015 MT/tahun, dan Na_2CO_3 99,2% 4044,9895 MT/tahun. Selain itu, dibutuhkan juga bahan-bahan penunjang seperti air sebanyak 68.382,70 kg/jam, 5.555,5216 kg/jam *steam*, bahan bakar sebanyak 17.000 ton/tahun, serta listrik sebesar 1.880,13 kW. Produk akhir dari pabrik ini berupa Nikel-Mangan-Kobalt Hidroksida dan Litium Karbonat. Selain itu dihasilkan juga produk samping berupa Kalsium Sulfat 1338,0888 kg/jam, lembaran tembaga 604,0404 kg/jam, lembaran aluminium 361,1111 kg/jam dan selongsong baterai 2442,4242 kg/jam.

Pabrik didesain dengan luas bangunan 1,5 ha di atas tanah seluas 6 ha. *Fixed cost* pabrik sebesar \$21.934.205,87 + Rp 542.872.762.989,33, dan modal beroperasinya pabrik (*working capital*) sebesar \$ 16.825.245,36+ Rp 149.991.830.281,26. Berdasarkan analisis ekonomi yang dilakukan, diperoleh penjualan sebesar \$ 145.461.211,06/tahun, dengan ROI dan POT sebelum pajak adalah sebesar 28,67 % dan 2,59 tahun. Nilai BEP dan SDP yang diperoleh adalah sebesar 51% dan 26%, dan nilai DCFRR sebesar 23,90%. Berdasarkan beberapa parameter kelayakan ekonomi, pabrik pengolahan limbah baterai jenis NMC yang dirancang ini cukup menarik untuk dikaji lebih lanjut.

Kata Kunci: baterai, *leaching*, presipitasi, Litium, Nikel, Kobalt, Mangan

ABSTRACT

Human needs drive massive technological development, including in the automotive sector. This is proven by the efforts to switch oil-fueled vehicles into electric vehicles. Based on the data from PT. PLN regarding the number of electric vehicles in Indonesia, it is predicted that in 2030 there will be 452.259 electric car with PHEV and BEV types. It is estimated that 52.000 tons of NMC battery waste will be collected per year. To overcome this waste, it is necessary to establish a battery waste treatment industry so that the waste can be reprocessed into materials for making batteries. A suitable method used in the NMC battery waste treatment plant is the hydrometallurgical chemical leaching process. The battery cathode leaching process requires 0.8 M Sulfuric Acid (H_2SO_4) and 3% Hydrogen Peroxide (H_2O_2) with operating conditions at a temperature of 60 and a pressure of 1 atm. The leaching process can recover up to 80% of battery material in the form of Lithium, Nickel, and Cobalt. Metal extraction is then taken by the precipitation process. Nickel, Cobalt, and Manganese were taken by precipitation using Sodium Hydroxide ($NaOH$) at pH 11 with the temperature of 35 °C and the pressure of 1 atm. Meanwhile, lithium metal is taken by precipitation using sodium carbonate (Na_2CO_3) at pH 12 with the temperature of 65 °C and the pressure of 1 atm.

The processing of 52.000 tons/year NMC waste battery (330 days, 24 hours) requires 98% H_2SO_4 as raw material as 18.109,0491 MT/year, H_2O_2 30% 11440,1050 MT/year, $Ca(OH)_2$ 95% 5052,2599 MT/year, $NaOH$ 99% 14636,8015 MT/year, and Na_2CO_3 99,2% 4044,9895 MT/year. In addition, supporting materials are also needed, such as water of 58.382,70 kg/hour, 5.555,5216 kg/hour of steam, coal of 17.000 ton/year, and electricity of 1.880,13 kW. The final products of this factory are Nickel-Manganese-Cobalt Hydroxide, and Lithium Carbonate. In addition, by-products such as Calcium Sulfate 1338,0888 kg/hour, copper sheet 604,0404 kg/hour, aluminum sheet 361,1111 kg/hour and battery sleeves 2442,4242 kg/hour are also produced.

The plant is designed with a building area of 1,5 ha on a land area of 6 ha. The fixed capital of this plant is \$21.934.205,87 + Rp 542.872.762.989,33, and the working capital is \$ 16.825.245,36 + Rp 149.991.830.281,26. Based on the economic analysis calculated, the sales is \$ 145.461.211,06/year, with ROI and POT before tax of 28,67 % and 2,59 years. The BEP and SDP values obtained are 51% and 26%, and the DCFRR value is 23,90%. Based on several parameters of economic feasibility, this designed NMC type battery waste treatment plant is interesting to study further.

Keywords: battery, leaching, precipitation, lithium, nickel, cobalt, manganese