

## INTISARI

Salah satu perkembangan teknologi dalam mengatasi menipisnya cadangan bahan bakar tak terbarukan adalah transisi menuju tenaga listrik, salah satunya adalah inovasi mobil listrik. Berdasarkan data dari PT PLN, diestimasikan pada tahun 2037 terdapat kendaraan listrik berjenis BEV/PHEV sebanyak 223.391 unit sehingga diperkirakan akan dihasilkan limbah baterai litium berjenis LFP sebanyak 52.000 ton/tahun. Oleh karena itu, diperlukan industri pengolahan limbah baterai sehingga dapat menekan dampak negatifnya terhadap lingkungan.

Proses yang digunakan dalam pengolahan limbah baterai LFP adalah hidrometalurgi dengan proses *leaching* kimia. Proses *leaching* dilakukan menggunakan Asam Fosfat ( $\text{H}_3\text{PO}_4$ ) 0,5 M dan  $\text{H}_2\text{O}_2$  2,5% vol pada suhu  $60^\circ\text{C}$  dan tekanan 1 atm, menghasilkan endapan besi fosfat dengan *recovery* hingga 99,5%. Logam litium diambil menggunakan proses presipitasi dalam kondisi pH 13,5 suhu  $30^\circ\text{C}$ , dan tekanan 1 atm dengan cara menambahkan NaOH 5 M. Logam natrium kemudian diambil dengan proses evaporasi larutan dan kristalisasi.

Pabrik daur ulang limbah baterai LFP direncanakan beroperasi pada tahun 2037 dengan kapasitas pengolahan limbah baterai sebanyak 52.000 ton/tahun dan beroperasi 24 jam sehari dengan 330 hari operasional per tahun. Bahan baku yang dibutuhkan adalah  $\text{H}_3\text{PO}_4$  85% sebanyak 21.787,6037 MT/tahun,  $\text{H}_2\text{O}_2$  30% sebanyak 18.321,8984 MT/tahun, NaCl 99% sebanyak 104,3666 MT/tahun, dan NaOH 99% sebanyak 20.074,4734 MT/tahun. Sedangkan bahan penunjang yang dibutuhkan seperti air laut sebanyak 476,1202 ton/jam dengan sistem *once-through*, *steam* sebanyak 29.711,25 kg/jam, dan listrik sebesar 13,3260 MW.

Pabrik ini direncanakan dibangun di Kawasan Industri Cilegon, Banten di atas tanah seluas 3,99 ha dengan luas bangunan sebesar 1,80 ha. Proses produksi membutuhkan modal tetap sebesar \$ 47.918.832,83 dan Rp 473.640.620.937,61 dan modal kerja sebesar \$ 34.067.459,18 dan Rp 411.960.289.842,40. Berdasarkan analisis kelayakan yang dilakukan, pabrik ini tergolong dalam kategori *high risk* dan memperoleh pendapatan bebas pajak sebesar \$ 4.887.270,19 / tahun. Nilai ROI dan POT sebelum pajak adalah 8,03% dan 5,87 tahun. Selain itu, didapatkan nilai BEP sebesar 80,41%, SDP sebesar 53,57%, dan nilai DCFRR sebesar 12,84%. Berdasarkan parameter kelayakan ekonomi, pabrik daur ulang limbah baterai LFP kurang menarik untuk dikaji lebih lanjut karena mahalnnya harga bahan baku limbah baterai LFP.

**Kata kunci:** baterai LFP, *leaching*, presipitasi

## ABSTRACT

*One of the technological developments in overcoming the depletion of non-renewable fuel reserves is the transition to electric power, one of which is the innovation of electric cars. Based on data from PT PLN, it is estimated that in 2037 there will be 116,030 units of BEV/PHEV type electric vehicles so that it is estimated that 52,000 tons/year of LFP type lithium battery waste will be generated. Therefore, a battery waste processing industry is needed so that it can reduce its negative impact on the environment.*

*The process used in processing LFP battery waste is hydrometallurgy with a chemical leaching process. The leaching process is carried out using 0.5 M Phosphoric Acid ( $H_3PO_4$ ) and 2.5%vol  $H_2O_2$  at 60°C and 1 atm pressure, producing iron phosphate precipitates with a recovery of up to 99.5%. Lithium metal was recovered using a precipitation process under conditions of pH 13.5, temperature 30°C, and pressure 1 atm by adding 5 M NaOH. Sodium metal is then recovered by solution evaporation and crystallization.*

*The LFP waste battery recycling plant is planned to operate in 2037 with a waste battery processing capacity of 52,000 tons/year and operates 24 hours a day with 330 operational days per year. The raw materials required are  $H_3PO_4$  85% as much as 21,787.6037 MT/year,  $H_2O_2$  30% as much as 18,321.8984 MT/year, NaCl 99% as much as 104.3666 MT/year, and NaOH 99% as much as 20,074.4734 MT/year. While the supporting materials needed are seawater as much as 476.1202 tons / hour with a once-through system, steam as much as 29,711.25 kg / hour, and electricity of 13.3260 MW.*

*The plant is planned to be built in Cilegon Industrial Estate, Banten on a land area of 3.99 ha with a building area of 1.80 ha. The production process requires fixed capital of \$47,918.832,83 and IDR 473.640.620.937,61 and working capital of \$34.067.459,18 and IDR 411.960.289.842,40. Based on the feasibility analysis conducted, this plant belongs to the high risk category and earns a profit before tax of \$4.887.270,19/year. The ROI and POT before tax values are 8,03% and 5,87 years. In addition, the BEP value of 80,41%, SDP of 53,57%, and DCFRR value of 12,84% were obtained. Based on the economic feasibility parameters, the LFP waste battery recycling plant is less attractive for further study due to the high price of LFP waste battery raw materials.*

**Keywords:** LFP Battery, leaching, precipitation