PEA Level Engineering and Cost Estimation Study for a Lithium Converter

Final Report

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for

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28.02.2023

Executive summary

In September 2021 UKR Lithium Mining LLC ordered the present "PEA Level Engineering and Cost Estimation Study for a Lithium Converter". This report summarizes the results of the desktop study and class 5 cost estimate according to AACE classification.

The current study is evaluating two options, a 3.1 wt.-% Li_2O grade petalite concentrate and a 4.0 wt.-% Li_2O grade petalite concentrate as feed material for a downstream lithium converter. For each concentrate three different processing routes were investigated, resulting in in total six engineering cases. In the first processing route lithium carbonate (LC route) was produced from the petalite feed. In the second processing route lithium hydroxide monohydrate was generated via conversion of the intermediate product lithium carbonate (indirect LHM route). In the third processing route lithium hydroxide was directly produced from the petalite feed (direct LHM route).

For each case a flow sheet, mass balance, energy balance and mechanical equipment list were developed providing the basis for an estimation of capital and operational expenditures.

The petalite feed mass to the individual converter units was selected to result in an identical lithium mass flow to the converter. Based on the mass flow of 200,000 t/a of 4.0 wt.-% Li_2O grade petalite concentrate respectively 260,000 t/a of 3.1 wt.-% Li_2O grade petalite concentrate the mass balance was calculated. Due to higher recirculation streams and slightly higher leach recovery, the product recovery for the 4.0 wt.-% feed grade processing routes is slightly higher than their counterpart of the 3.1 wt.-% feed grade processing routes. For the LC route approximately 17,000 t/a lithium carbonate can be produced. The indirect LHM route is resulting in approximately 19,000 t/a of lithium hydroxide monohydrate

product. Recovery of the direct LHM route is slightly higher than for the indirect LHM route resulting in approximately 19,400 t/a of product.

Main equipment cost are estimated mainly based on budgetary quotes from vendors. Direct and indirect plant cost are estimated applying international cost factors, which are characteristic for the present type of processing plant. Where required factors were adjusted to the specifics based on ANZAPLAN's experience.

Due to higher feed mass, main equipment cost for the individual 3.1 wt.-% feed grade processing routes are higher than their counterpart of the 4.0 wt.-% feed grade processing route. Furthermore, the main equipment cost, within identical feed grade routes, are ascending in the order direct LHM route, LC route and indirect LHM route, with direct LHM route and LC route being almost identical. Main equipment costs are ranging between EUR 56.6 m and EUR 67.7 m.

Based on the main equipment cost the total plant cost are estimated. For the 4.0 wt.-% feed grade and direct LHM route the total plant cost are lowest accounting for EUR 308.4 m with EUR 192.3 m direct plant cost, EUR 54.4 m indirect plant cost and EUR 61.7 m contingencies.

For the 3.1 wt.-% feed grade indirect LHM route the total plant cost are highest accounting for EUR 403.0 m with EUR 251.3 m direct plant cost, EUR 71.1 m indirect plant cost and EUR 80.6 m contingencies. Other processing routes are ranging in between.

Summarized annual operational expenditures are lowest for the 4.0 wt.-% feed grade LC route, accounting for EUR 163.3 m and highest for the 3.1 wt.-% feed grade indirect LHM route accounting for EUR 198.4 m. Other processing routes are ranging in between. Operational expenditures include raw materials, chemicals and reagents, electrical and thermal energy, water, waste disposal, labor, quality control, maintenance and supplies and packaging material.

Operational expenditures for the 3.1 wt.-% feed grade processing routes are higher than their counterpart of the 4.0 wt.-% feed grade processing route, mainly due to larger petalite concentrate feed volumes involved. At same feed grade the operational expenditures for individual processing routes are ascending in the order LC route, direct LHM route and indirect LHM route.

Based on the results of the current study and depending on the forecast market development the optimal processing case and feed material scenario can be selected.

As a next step, the data presented in the current report can be fed into a financial model to optimize the economics of the project.

The current report provides the engineering portion which is substantial for completing the PEA study for the petalite converter.

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