Integrated Research on the Lithium Chain Value

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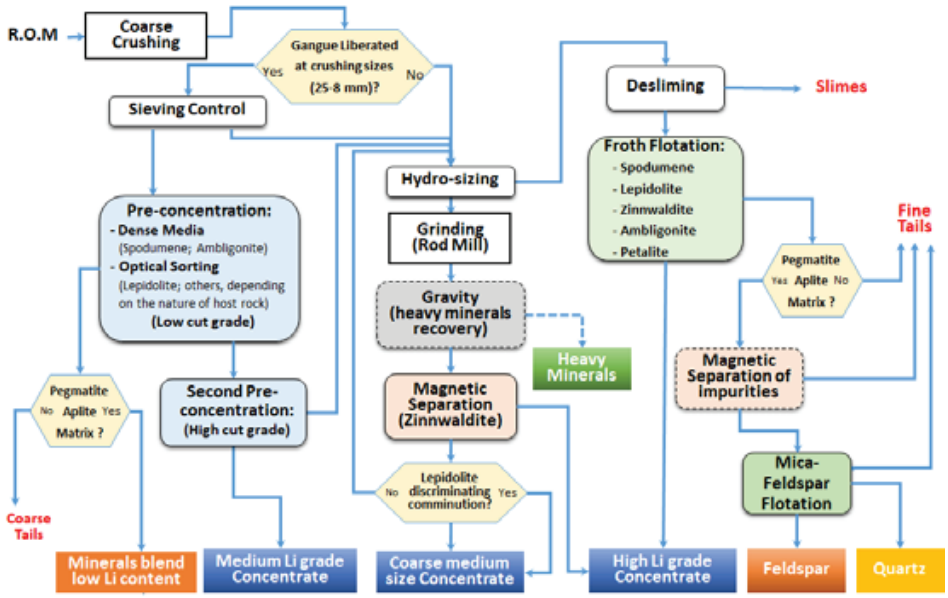
Introduction

The project "Lithium Chain Value" (CAVALI) focuses on various stages of the production chain of lithium batteries for the automotive industry. The overall project aims for several objectives, ranging from exploration where intending the development of a new system of lithium analysis by *laser-induced breakdown spectroscopy* (LIBS) allowing for the discrimination of lithium contained in different minerals to the development of a new solid-state battery architecture, with higher capacity, cheaper, compact, lighter and safer. In the field of ore processing, the main objective is the conceptualization of a process in which the generation of tailings is null or almost null. In the metallurgy stage, the project aims to develop a process that allows simultaneously the processing of spodumene and lepidolite concentrates, having as many unit operations as possible in common. Conceptual approaches to estimating *capital expenditure* (CapEx) and *operating expenditures* (OpEx) in mining, ore processing and metallurgy constitute an autonomous specific activity. In relation to the batteries, it is intended to develop a new and different type of architecture, "ferroelectric electrolyte batteries" (FEB) and respective control systems. Mining extraction, ore processing, and hydrometallurgy will be the subject of an integrated *Life Cycle Assessment* (LCA). This article focuses on developing the following research activities: ore processing, metallurgy, CapEx and OpEx and life cycle assessment.

Methodology

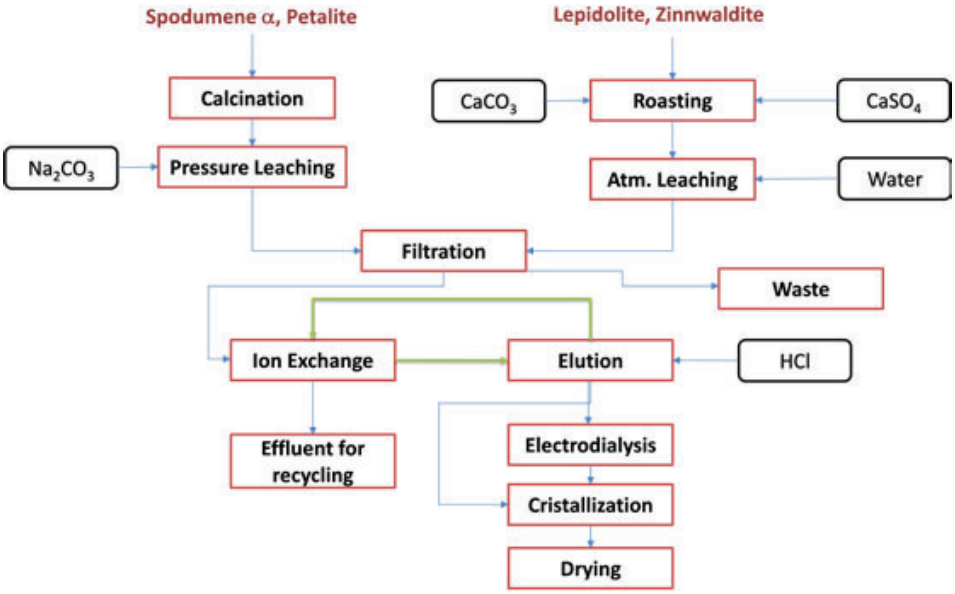
A generic approach to processing lithium minerals ores (spodumene, lepidolite, zinnwaldite, amblygonite and petalite) was conceived in the project avoiding (or alternatively minimizing) the production of solid waste. The conceptual flowsheet was developed based on laboratory and pilot-scale experiments with different ores from Portugal and Central Europe.

Figure 1
Processing of Li from Hard Rock Minerals – Generic Approach



In the metallurgical field, the research aimed to develop an alkaline process to treat spodumene and lepidolite concentrates having in common as many unit operations as possible. The process is schematized in the figure.

Figure 2
Flowsheet for simultaneous processing of spodumene and lepidolite



Another activity was process simulation, pre-dimensioning, CapEx and Opex from mining to metallurgy. To attain these objectives the following tasks were performed: mass and energy balances, simulation, pre-dimensioning, consumptions and cost estimate.

For the life cycle assessment, two main objectives were established:

- To characterize and evaluate the potential environmental impacts resulting from the production cycle of monohydrated lithium hydroxide.
- To include all stages of the production cycle ranging from mining extraction to ore processing and metallurgy.

Results and Conclusions

A conceptual approach to processing lithium minerals from different types of ores was established, as well as an integrated alkaline process for treating spodumene and lepidolite concentrates. Methodologies for estimating CapEx and OpEx for ore processing and metallurgy were implemented. The corresponding LCA uses a sequential approach 'cradle-to-gate',

'gate-to-gate' and 'gate-to-grave', meaning that each operation or step will lead to the next in the succession of the production cycle, thus allowing an independent view of each stage of the product life cycle and its relative and absolute relevance