Circular economy perspective for critical raw materials valorization and hydrogen production from secondary resources

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Raw materials are essential to produce a wide range of goods and appliances used in the quotidian and by modern technologies, constituting a strong industrial base. However, the reliable and unrestricted access to certain raw materials is now raising awareness across the globe. The technological progress and the fast economic growth have resulted in risks of hindered access and raw materials price change, namely when dependence of supplies from outside EU countries is needed (Černý et al., 2021).

The European Commission (EC) has developed a list of critical raw materials (CRM), which is reviewed and updated every 3 years. This list combines raw material economically important and with high risk of supply. In 2023, the list included 34 raw materials, and 16 strategic raw materials (SRM) were also comprised, due to their important role on the clean energy transition (European Commission, 2023).

Moreover, this initiative promotes the development of recycling and recovery policy relating to CRM in the context of circular economy transition in a sustainable, low carbon, resource efficient and competitive way (European Commission, 2020) .

Lithium is an important alkali metal to produce electrical vehicles (EV) batteries. The EV market has boomed in recent years, and it is foreseen that EV account for around 60% of total vehicle sales in 2030 (International Energy Agency, 2022). Lithium demand have increased the extraction of primary resources, and is expected to increase 14 times by 2040, when compared to 2020 levels. Due to their prominent role, lithium is now considered a CRM and a SRM by the EC (European Commission, 2022).

Secondary resources that promote the recovery of lithium in a circular economy perspective during the production of innovative technologies is now a top priority. Electro-based technologies were applied to recover lithium selectively from lithium-ion batteries recycling wastewater and from an organic solvent from the pharmaceutical industry.

Electro-based technologies consist on the application of a low-level current density to mobilize species through transport mechanisms in an electrodialytic (ED) reactor, using ion exchange membranes to separate the samples and increase the selectivity of the species to be recovered (Almeida et al., 2020). Moreover, these treatments inherently produce electrolytic hydrogen at the cathode compartment. This could improve the overall sustainability of the ED process, in line with EU targets defined for renewable energy share in energy consumption (up to 32% by 2030). According to Magro et al. (2019), experimental self-generated energy can promote savings on electroremediation of approximately 7%.

The present work tested different set ups, current and operation time for the ED process to optimise the recovery of lithium from the two liquid effluents. Additionally, to tackle global energy demand from an increasing human population, hydrogen production during the treatment was also analysed, as a major concern for the planet sustainability.

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