Reactive crystallization of magnesium hydroxide from brines

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Reactive crystallization

Concept

In recent years, the increase of the global population has been accompanied by a growing demand for raw materials. Conventional resources are not able to fully accomplish such considerable demand anymore. As a solution to this problem, a novel concept has been established, i.e. from the classical linear economy to a **circular one**. The main objective is to valorise wastes making them resources, thus ensuring the eco-sustainability of economic systems. However, the recovery of wastes presents many difficulties.

- How can **exhausted wastes** be valorised?
- What might be the way to proceed?

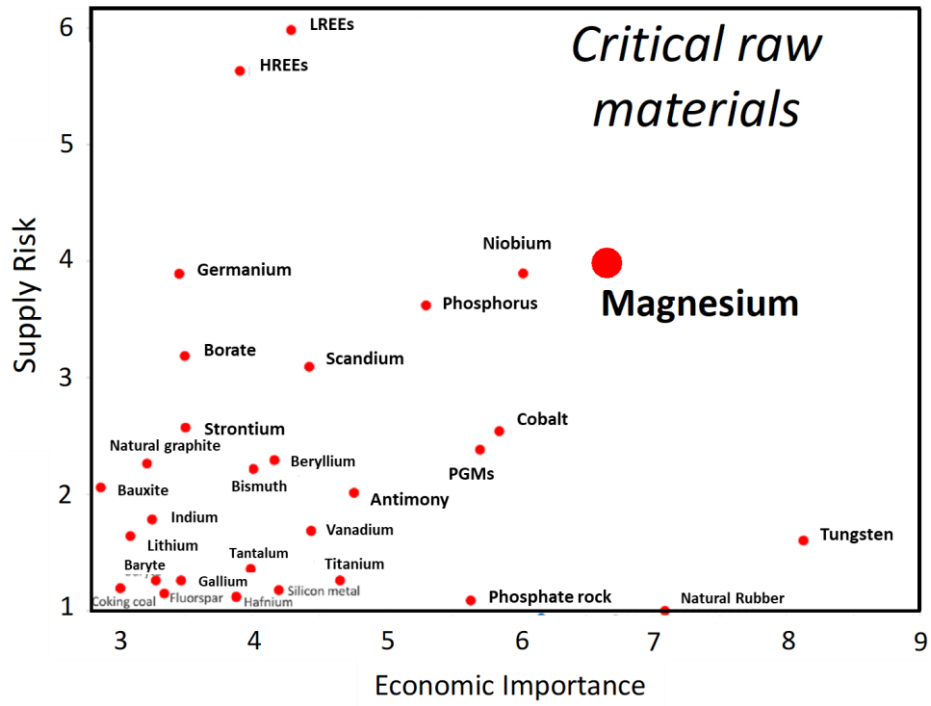
This research project will focus primarily on the valorisation of waste bittern from the ancient salt-works. Bitterns are solutions highly concentrated in high-added value products. In this project, attention is mainly focused on the **recovery** of **magnesium**. This chemical element is one of the **30** critical raw materials listed by the European Union, which has marked its high economic importance with high supply risk.

Scientific approach

One of the cheapest routes to recover magnesium is through a precipitation process. The latter is affected by **mixing.** Precipitation processes are often characterized by low reaction times. For this reason, it is necessary to guarantee mixing times comparable with reaction times. This can be accomplished by employing **T-mixers.**
A novel digital colorimetric technique will be developed to investigate mixing and precipitation phenomena, using a pH indicator to detect the evolution of the phenomena.
Several experimental techniques will be used to characterise the produced particles, such as Static and Dynamic Light Scattering (SLS and DLS), Scanning Electron Microscope (SEM) and X-Ray Diffraction (XRD).
Mathematical modelling tools will be developed in order to optimize the magnesium hydroxide precipitation process.

Research objectives

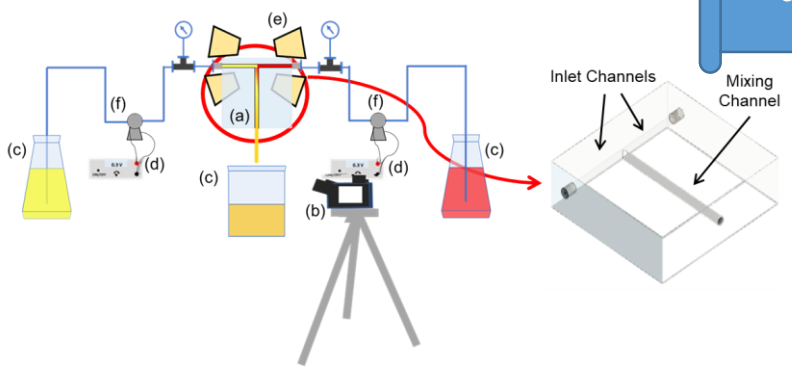
- Development of a pilot-scale process for the recovery of magnesium from real and artificial brines.
- Investigation on the mixing quality impact on the precipitation performance.
- Extensive experimental magnesium hydroxide precipitation characterization.
- Development of mathematical modelling tools for the prediction of the precipitation process of magnesium hydroxide.
- Achievement of final products with controlled particles size and morphology, complying with market requirements.



The Magnesium Hydroxide precipitation process

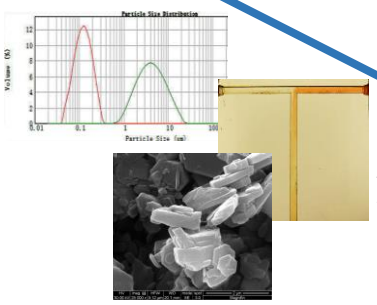
Investigation on the mixing quality in a T-shaped mixer for the precipitation of sparingly soluble compounds **(magnesium hydroxide)**

Novel digital image colorimetric technique



Experimental set-up: (a) circular cross-sectional T-shaped mixer; (b) high frame rate digital camera; (c) flasks; (d) power supply; (e) halogen bulbs; (f) gear pumps.

Experimental results + **Mathematical modelling**



$$\frac{dm_k}{dt} = (0)^k + \int_0^\infty kL^{k-1}G(L)n(L;t)dL + B_k(t) - D_k(t)$$

Crystallization kinetic parameters

Controlled **Magnesium Hydroxide** particles size and morphology

In line with product market requirements