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Influence of bicarbonate/carbonate removal on magnesium hydroxide slurry: A pilot study

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Nowadays, the continuous increase in raw materials demand is leading research to seek alternative and unconventional sources, such as waste industrial brine or seawater.
Indeed, seawater and seawater brines (e.g. produced by seawater reverse osmosis (RO) desalination plant) can be exploited in order to recover fresh water but also to produce many other valuable minerals such as magnesium.
The importance of the magnesium recovery stands for its high risk of supply and significant economic importance for key sectors in the European economy. Thus, magnesium has been defined as one of thirty-four Critical Raw Materials (CRMs) by the European Commission.
In the framework of the Horizion 2020 European Project Water Mining, a novel and unconventional selective reactive crystallizer designed by ResourSEAs was tested for the recovery of magnesium in form of hydroxide by means of direct mixing with an alkaline solution (i.e. sodium hydroxide solution). This crystallizer is called Multiple Feed Plug Flow Reactor (MF-PFR). The MF-PFR was installed within an integrated demonstration plant aiming at the production of magnesium hydroxide, chemicals (such as sodium hydroxide and hydrochloric acid), fresh water, sodium sulfate, and sodium chloride, combining together (i) nanofiltration, (ii) MF-PFR, (iii) Eutetic Freez Crystallizer (EFC), (iv) Electro-dialysis with bipolar membrane, and (v) Multiple Effect Distillation (MED).
A wide experimental campaign has been carried out aiming at investigating how the settling rate and purity are influenced by operative conditions, such brine feed or recycle flow-rates, and by the nature of the feed brine itself (i.e. NF retentate or RO retentate).
The results obtained show that decreasing feed brine flow-rate is consistent with an increase in the settling rate, while conversely decreasing recycle flow rate leads to a clear decrease. This behavior was observed for both feed brine solutions. Moreover, also the influence of the presence of carbonate and bicarbonates in the feed stream on product settling rate and purity was investigated by applying an acidification pretreatment step. After this step, a purity increase from 94% up to 98/99% along with an increase in sedimentation rate (up to two times) was obtained. These outcomes were observed for both feed brine solutions.

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