Shaping $Mg(OH)_2$ crystals through hydrothermal treatment

Ferdinando Miciletta[a,b,*], Giuseppe Battaglia[a], Giuseppe Polillo[a], Fabrizio Vicari[b], Alessandro Tamburini[a,b], Andrea Cipollina[a], Giorgio Micale[a,*].

[a] *Dipartimento di Ingegneria, Università degli Studi di Palermo, Palermo, Viale delle Scienze, 90128, Italy*
[b] *ResourSEAs SrL, Via Notarbartolo n. 38, 90141 Palermo, Italy*

E-mail: ferdinandodomenico.miciletta@unipa.it - giorgiod.maria.micale@unipa.it

Magnesium hydroxide (MDH) is a compound widely employed in several industrial sectors, with increasing interest as halogen-free flame-retardant agent. Battaglia et al. [1] demonstrated a practical approach to recover MDH from waste brines via reactive crystallization, achieving high conversions and purities (about 100%). On the other hand, nanometric strongly aggregated crystals have been mainly obtained. These crystals do not comply with market requirements for flame-retardant applications: (i) a specific surface area (SSA) below 10 m^2/g, (ii) hexagonal plate-like morphology and (iii) a narrow particle size distribution without aggregation [2]. To enter the flame-retardant market, as part of the European project *LIFE23-ENV-IT-MareMag LIFE*, this work focuses on the hydrothermal modification of magnesium hydroxide powders obtained from waste bittern solutions. The hydrothermal treatment relies on a dissolution–recrystallization mechanism, promoting the rearrangement of the solid phase to minimize its surface energy and increase crystal size.

For the first time, a detailed comparative study was conducted exploring $Mg(OH)_2$ suspensions and particles (after filtration and drying) with controlled particle sizes and morphologies. The influence of key operating parameters, namely temperature, reaction time, feed suspension concentration, and the presence of a mineralizing agent such as sodium hydroxide, was also analyzed.

A specific surface area of 8 m^2/g and a hexagonal morphology were achieved at 200 °C for reaction times exceeding 30 hours (using dried solids). Notably, similar performances were obtained under milder operating conditions (180°C and 5h) using suspensions with controlled initial nanoparticles distributions, leading to routes for industrial applications. Results will be adopted for scale-up and energy optimization studies.

Keywords: *Hydrothermal recrystallization, Magnesium hydroxide, Crystal morphology.*

References

[1] G. Battaglia, M. A. Domina, S. Romano, A. Tamburini, A. Cipollina, and G. Micale, "Magnesium Hydroxide Nanoparticles Production from Natural Bitterns," *Chem Eng Trans*, vol. 96, pp. 43–48, 2022

[2] M. Ren, M. Yang, S. Li, G. Chen, and Q. Yuan, "High throughput preparation of magnesium hydroxide flame retardant: Via microreaction technology," *RSC Adv*, vol. 6, no. 95, pp. 92670–92681, 2016