UTILIZATION OF SEAWATER BITTERN FOR OBTAINING REFRACTORY MAGNESIUM OXIDE

ISKORIŠTAVANJE GORKE MORSKE VODE ZA DOBIVANJE VATROSTALNOG MgO

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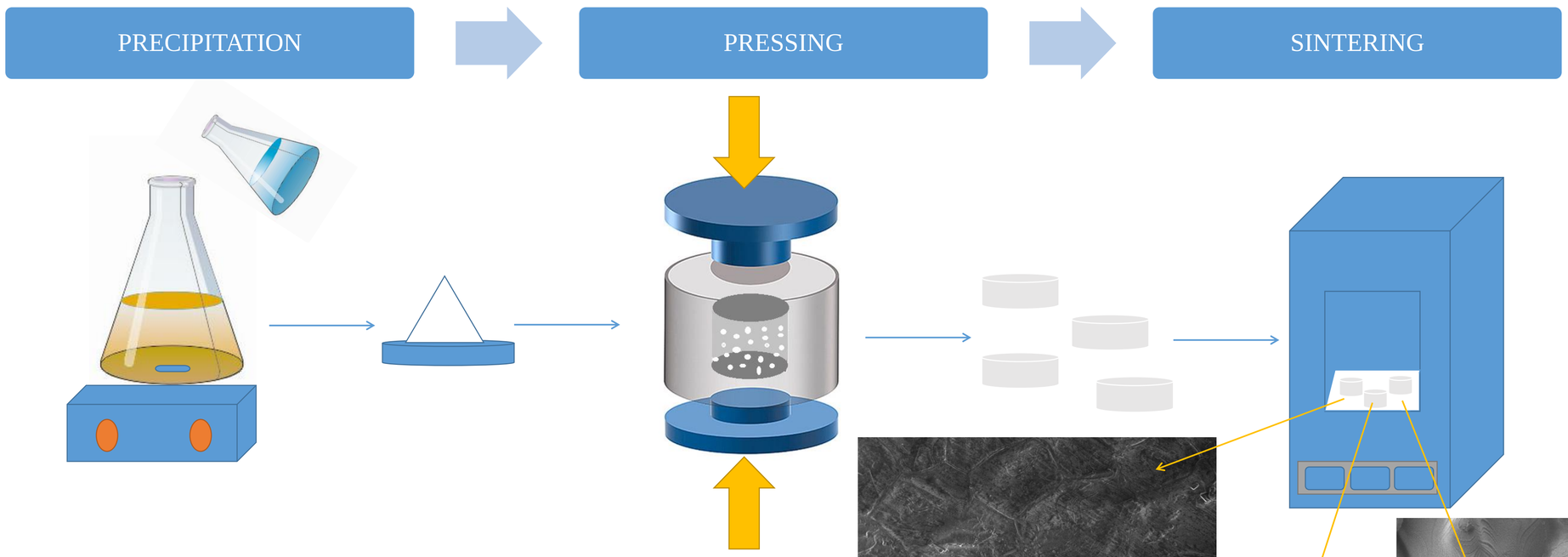
Introduction:

The seawater bittern produced in large quantities during the extraction of sea salt is a source for the extraction of valuable minerals. The magnesium concentration can reach values of up to 30-40 kg m^{-3} of seawater bittern, which is 20-30 times that of typical seawater. In this study, saturated limestone water was added to a seawater bittern solution to obtain a magnesium hydroxide precipitate. In the synthesis of magnesium oxide, poly(vinyl-alcohol) was added as a surfactant to prevent agglomeration and to influence particle size during synthesis. Magnesium oxide was produced by calcination at 950 °C/5 h. The aim of this research is to investigate the properties of the obtained refractory magnesium oxide sintered at different temperatures.

Experimental part:

The synthesis was carried out by a stoichiometric precipitation process using saturated limestone water (γ = 1.54 g L^{-1}) as precipitation reagent. The surfactant poly(vinyl alcohol) (PVA, Mw: 70000, Merck, partially hydrolyzed) was used during precipitation to affect the formation of magnesium hydroxide particles. The experiment was carried out at 50 °C/2h with constant stirring. The mixture was cooled to room temperature, decanted and rinsed. Distilled water (pH = 5.88) was used as the rinsing medium. Rinsing by filtration through multiple funnels by repeated rinsing (5 times) with hot distilled water was performed. The rinsed precipitate was dried in an oven at 105 °C and then calcined in a muffle furnace at 900 °C for 5 h to form caustic magnesia. The obtained caustic magnesium was sintered at different temperatures of 1400, 1500 and 1600 °C for 2 hours. The chemical composition, density, porosity and surface morphology of the refractory magnesium oxide were determined.



Results and Discussion:

Table 1. Chemical composition of the MgO samples obtained from seawater bittern after calcination and after sintering at different temperatures (in mass.%).

MgO (100 % precipitation)		CaO	MgO	B_2O_3
		mass. %		
Calcination / 5h	950 °C	2.44	96.46	0.72
Sintering / 2h	1400 °C			0.66
	1500 °C			0.56
	1600 °C			0.54

The samples of refractory magnesium oxide obtained from seawater bittern contain 2.44% CaO, 96.46% MgO and 0.72 - 0.54% B_2O_3.

The comparison of the results before and after sintering shows that the B_2O_3 content in the magnesium oxide decreases with increasing temperature, but is still very high, because according to N. Hesman, sintered quality magnesium oxide used in the refractory industry contains $\leq$ 0.05% B_2O_3 by mass.

The changes in the microstructure are caused by the increase in sintering temperatures, which have a favorable effect on the increase in relative density (85.07%, 87.78% and 89.65%), the reduction in porosity and the better B_2O_3 evaporation from the MgO samples.

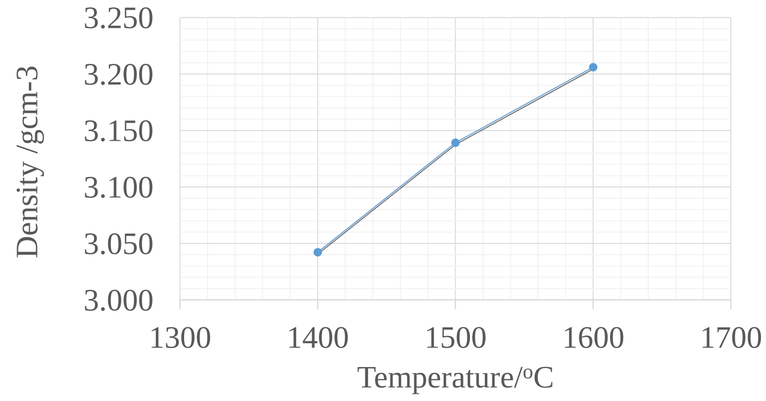


Fig. 2. Bulk density of sintered MgO samples at 1400, 1500 and 1600 °C .

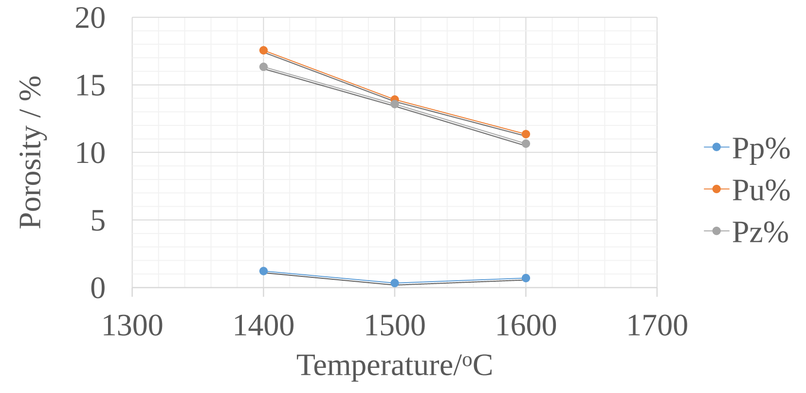


Fig. 3. Apparent porosity (Pp), total (Pu) and closed (Pz) porosity of sintered MgO samples at 1400, 1500 and 1600 °C.

Conclusions:

- Seawater bittern can be used to recover magnesium in the form of magnesium hydroxide/oxide by a precipitation method.
- The obtained refractory magnesium oxide contains 96.46% MgO and 2.44% CaO. The B_2O_3 content is between 0.72% and 0.54%, which indicates that the requirements for the B_2O_3 content in high-quality refractory material are not achieved.
- The relative density of refractory magnesium oxide at 1600°C/2h reaches a value of 89.65%, while the total porosity is 11.37%.
- According to the relative density and porosity of the samples obtained, the sintering temperature has a favorable effect on the properties and microstructure of the refractory materials.

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