

PRODUCTION OF BISCHOFITE FROM DOLOMITE

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Abstract

This study investigates the production of magnesium chloride (bischofite) from locally available dolomite by decomposition with a mixture of sulfuric and hydrochloric acids. Dolomite from the Dehkanabad and Navbahor deposits was examined using standard chemical analysis methods. The composition of the resulting solutions and magnesium chloride recovery were evaluated under different liquid-to-solid ratios. The obtained solutions contained 15.9–16.7 g/dm³ of magnesium ions and 45.0–48.8 g/dm³ of chloride ions, with magnesium chloride yields ranging from 69.0% to 77.1% of the stoichiometric value. The developed process was implemented at the Electrochemical Plant joint-stock enterprise, where 42 tonnes of product were manufactured. The approach provides a technological basis for producing magnesium chloride from domestic mineral resources.

Keywords: Bischofite, magnesium chloride, dolomite, sulfuric acid, hydrochloric acid, mineral processing, acid decomposition, magnesium salts.

Introduction

Bischofite is a naturally occurring magnesium chloride mineral that is not widespread in Uzbekistan. In international practice, it is used as a source of magnesium compounds, including in the production of magnesium-chlorate defoliants, as well as in construction, medicine, power engineering,

transport, and mining. It is also used in refrigerant compositions, antifreeze and de-icing mixtures, and as a coating component for mine wagons to prevent wet ore from freezing to their inner surfaces during winter.

Industrial production of magnesium chloride relies on natural carnallite, synthetic carnallite crystallized from magnesium chloride liquors together with potassium sulfate, magnesium oxide, seawater, and salt-lake brines. Decomposition of synthetic carnallite obtained by crystallization during evaporation yields magnesium chloride hexahydrate, which may undergo further dehydration. The MgCl_2 content of such liquors can reach 28–31% [1].

Magnesium chloride can also be produced by reacting magnesium oxide with chlorine: $\text{MgO} + \text{Cl}_2 \rightarrow \text{MgCl}_2 + \frac{1}{2}\text{O}_2$. At low temperatures, chlorine-containing gas is supplied to the reaction zone at relatively low concentration, whereas operation at 500–700°C requires a higher chlorine concentration [2]. Industrial processes may also involve chlorination of magnesium oxide in molten KCl-MgCl_2 salts in the presence of a solid reducing agent [3].

Other research has investigated the brines of Lakes Karaumbet and Barsakelmes as raw materials for magnesium chloride production, together with a process for obtaining sodium sulfate [4, 5]. However, the above approaches can be energy-intensive, and residual Ca^{2+} impurities may prevent the product from meeting applicable quality requirements. Consequently, identifying an efficient method for processing locally available dolomite-bearing materials into magnesium chloride remains important. Bischofite is also imported as a raw material for magnesium-chlorate defoliant manufacture in quantities exceeding 6,000 tonnes annually, according to the cited source [6].

Research Aim and Methods

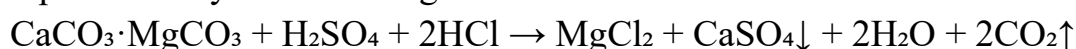
The aim of this work was to determine suitable laboratory conditions for obtaining magnesium chloride from dolomite by treatment with a mixture of sulfuric acid (H_2SO_4) and hydrochloric acid (HCl).

The study examined dolomite from the Dehkanabad and Navbahor deposits. Its reported composition was as follows (wt.%): CaO , 30.5; MgO , 19.7; Fe_2O_3 , 0.1; and SiO_2 , 0.3. Standard laboratory chemical and analytical

methods were used to characterize the feedstock and optimize the technological conditions. Pilot-industrial approaches to process development were also applied, followed by preparation of technological specifications for magnesium compound production.

Results and Discussion

The overall decomposition of dolomite by the mineral acid mixture may be represented by the following balanced reaction:



Laboratory experiments were carried out using an apparatus comprising a chemical beaker, an electric stirrer, and a dropping funnel. Table 1 presents the cationic and anionic compositions of the solutions obtained after decomposition of dolomite in the H_2SO_4 – HCl acid mixture, as well as magnesium chloride recovery and the calcium and magnesium contents of the washing water.

Table 1. Cationic and anionic composition of dolomite decomposition products in an H_2SO_4 – HCl acid mixture

Experiment	Liquid:solid ratio	Ca^{2+} (g/dm ³)	Mg^{2+} (g/dm ³)	SO_4^{2-} (g/dm ³)	Cl^- (g/dm ³)	MgCl_2 yield (%)	Wash water Ca^{2+} (g/dm ³)	Wash water Mg^{2+} (g/dm ³)
1	2:1	3.5	16.1	5.5	48.8	69.7	1.0	3.0
2	2:1	2.1	15.9	7.2	45.0	77.1	1.0	3.3
3	4:1	2.2	16.2	9.7	47.5	74.0	1.0	3.2
4	4:1	2.2	16.4	7.2	47.5	69.0	0.78	3.3
5	4:1	2.1	16.7	6.0	48.8	72.0	0.78	3.6

Source: Authors' experimental results as reported in the original thesis.

The dolomite slurry decomposition process produced magnesium chloride solutions with volumes of 0.250–0.295 dm³ and densities of 1.063–1.067 g/cm³. The solution composition was 15.9–16.7 g/dm³ Mg^{2+} , 45.0–48.8 g/dm³ Cl^- , 2.1–3.5 g/dm³ Ca^{2+} , and 5.5–9.7 g/dm³ SO_4^{2-} . The solutions initially remained turbid following separation of the solid residue but clarified after several days as residual calcium sulfate precipitated.

Across the five experiments, magnesium chloride yield was 69.0–77.1% of the stoichiometric amount. The highest reported yield, 77.1%, was observed

in Experiment 2 at a liquid-to-solid ratio of 2:1. These findings indicate the feasibility of recovering magnesium chloride from dolomite using an acid decomposition route; however, further control of residual calcium and sulfate impurities is relevant to product purification.

Conclusion

A process for obtaining magnesium chloride solution by decomposing dolomite with a mixture of sulfuric and hydrochloric acids was developed. A material balance was calculated, and suitable process conditions were identified. According to the original study, the technology was implemented at the Electrochemical Plant joint-stock enterprise, where 42 tonnes of product were manufactured. These results support the potential for processing domestic dolomite resources into magnesium chloride products.

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