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A Rapid Synthetic Method for Inderite

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1 Introduction

There are many different magnesium borates synthesized from various conditions or acquired naturally with different compositions, which can be used in a wide range of fields. Their applications involve ceramic industry, detergent industry, fire-retardants, lens solutions, super-conducting materials production, hydrocarbon catalysts, additive, or oils for friction reduction agents, due to their superior properties such as high elastic coefficient, resistance to dust, and high resistance to heat. In addition, some hydrous magnesium borate minerals can also be used as neutron and gamma radiation shield materials, owing to the high content of boron and high quantity of crystal waters present inside.

The inderite ($2\text{MgO} \cdot 3\text{B}_2\text{O}_3 \cdot 15\text{H}_2\text{O}$), associated with hydroboracite, was earliest found in the Yingjier Boron Deposit in the Former Soviet Union (Кешана, 1965). In China, the salt lake brines in the Qinghai-Xizang (Tibet) Plateau are famous for its high concentrations of magnesium and borate. The salt lake brine located in the Qaidam Basin, China, belongs to a new-style of borate salt lake. So far, nine kinds of borate minerals including six hydrated magnesium borates of, $2\text{MgO} \cdot 3\text{B}_2\text{O}_3 \cdot 15\text{H}_2\text{O}$ (inderite), $2\text{MgO} \cdot 3\text{B}_2\text{O}_3 \cdot 15\text{H}_2\text{O}$ (kurnakovite), $\text{MgO} \cdot 2\text{B}_2\text{O}_3 \cdot 9\text{H}_2\text{O}$ (hungchaoite), $\text{MgO} \cdot 3\text{B}_2\text{O}_3 \cdot 7.5\text{H}_2\text{O}$ (mcallisterite), $\text{MgO} \cdot \text{B}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$ (pinnoite), $2\text{MgO} \cdot 2\text{B}_2\text{O}_3 \cdot \text{MgCl}_2 \cdot 14\text{H}_2\text{O}$ (chloropinnoite) have been found in the Qaidam Basin (Gao et al., 2007; Qu et al., 1979). Therefore, it is essential to research the magnesium borates for availably exploiting and utilizing the valuable salt lake resources.

Although some borates were synthesised in the literature (Meng et al., 2011; Kipcak et al., 2013; Liu et al., 1994; Qian et al., 1979), a rapid synthetic method for inderite was successfully established in the first time.

In this paper, a certain proportion of $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ and $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$ were used to synthesize the inderite

($2\text{MgO} \cdot 3(\text{B}_2\text{O}_3) \cdot 15\text{H}_2\text{O}$) at $T=313.15\text{ K}$ by using a new method for the very first time. During the reaction, both of the pH value and the concentration of boron in aqueous solution were determined. The pH value and the concentration of boron changed regularly with the reaction time, which were shown in Figures 1 and 2, respectively. After two hours reaction, the pH value and the concentration of boron are declined to a constant value which means the reaction come to the end.

The synthesized products were also characterized combined with chemical analysis, X-ray Powder Diffraction analysis (XRD), Fourier Transform Infrared Spectroscopy analysis (FT-IR) and simultaneous thermo-analysis (TG-DSC), which were shown in Figures 3 to 5. The XRD result showed that the peak position and peak intensity agreed well with the standard spectra. The matching rate between the result and the standard FT-IR spectra was the same as in the literature. The weight loss of the synthesized magnesium borate during raising temperature calculated from the thermo-analysis was 48.31%, which is very close to the theoretical value of 48.28%. In addition, the analytical result showed in Table 1 also indicated the content of MgO and B_2O_3 in the synthesized product were in accordance with the theoretical values according to the standard analytical method (Institute of Qinghai Salt Lakes, 1988).

All the results of analysis indicated that the purity of synthesized products was high enough to be used for other studies of the physicochemical properties.

2 Conclusions

In this presentation, a rapid synthetic method for inderite was successfully established. The synthetic product of $2\text{MgO} \cdot 3\text{B}_2\text{O}_3 \cdot 15\text{H}_2\text{O}$ was characterized combined TG-DSC, XRD and chemical analysis.

Key words: Borates, Inderite, Synthesis, Characterize

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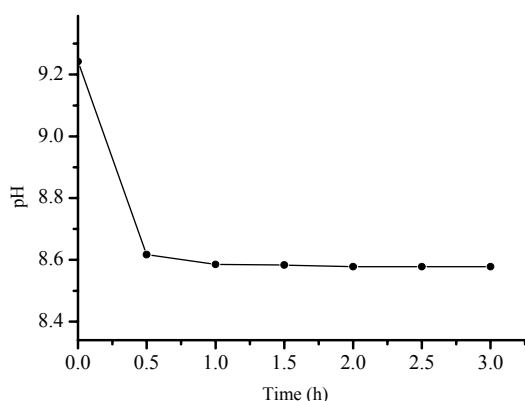


Fig. 1. The pH value in solution versus time.

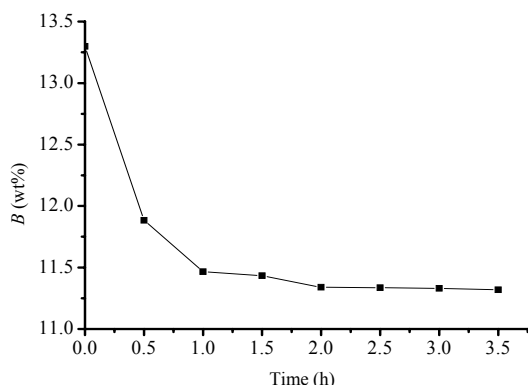


Fig. 2. The concentration of boron in solution versus time.

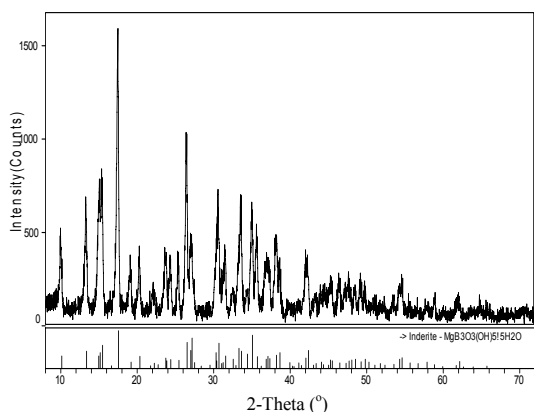


Fig. 3. X-ray diffraction diagram of $2\text{MgO} \cdot 3\text{B}_2\text{O}_3 \cdot 15\text{H}_2\text{O}$.

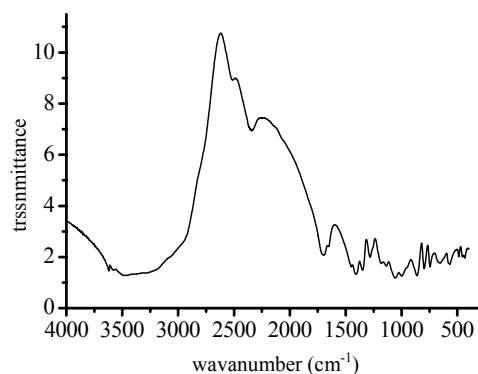


Fig. 4. Infrared spectra diagram of $2\text{MgO} \cdot 3\text{B}_2\text{O}_3 \cdot 15\text{H}_2\text{O}$.

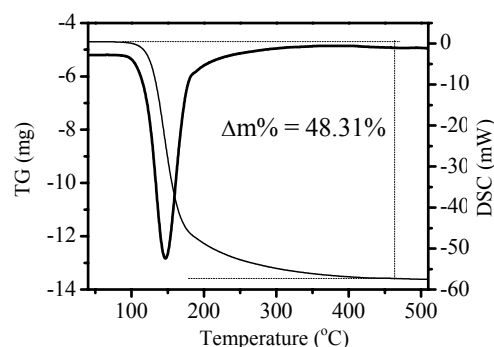


Fig. 5. The thermo-analysis diagram of $2\text{MgO} \cdot 3\text{B}_2\text{O}_3 \cdot 15\text{H}_2\text{O}$.

Table 1 Analytical results of $2\text{MgO} \cdot 3\text{B}_2\text{O}_3 \cdot 15\text{H}_2\text{O}$

	MgO (wt%)	B ₂ O ₃ (wt%)	H ₂ O (wt%)	n (MgO:B ₂ O ₃ :H ₂ O)
Exp.	14.29	37.28	48.43	2 : 3.02 : 15.16
Cal.	14.40	37.32	48.28	2 : 3.00 : 15.00

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