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Synthesis and Characterization of Sodium Pentaborate Pentahydrate

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1 Introduction

Sodium borates as important raw materials are widely used in the field of glass industry, ceramic industry, medical industry, paper industry, agriculture and so on for their special properties (Liu et al., 2006). Borax can be used as additive in preservatives and herbicides and it also can be added to the grass for improving the thermal stability and strength (Zheng, 2005).

The sodium borates generally exist in the form of hydrates under natural environment. So far, a variety of sodium borates has been obtained in the Na_2O-B_2O_3-H_2O system, such as sodium metaborate tetrahydrate ($NaBO_2{\cdot}4H_2O$), borax ($Na_2B_4O_7{\cdot}10H_2O$) and sborgite ($NaB_5O_8{\cdot}5H_2O$). The borates of $NaBO_2{\cdot}4H_2O$ and $Na_2B_4O_7{\cdot}10H_2O$ have the commercial regents whereas there is no commercial product of $NaB_5O_8{\cdot}5H_2O$ at present (Li et al., 1993; Li et al., 1998; Li et al., 2007)

In this paper, a pure sodium pentaborate pentahydrate ($NaB_5O_8{\cdot}5H_2O$) was synthesized by using $Na_2B_4O_7{\cdot}10H_2O$ and H_3BO_3 with a mole proportion of 1: 6 under hydrothermal conditions at T = 323.15 ± 0.1 K. The $NaB_5O_8{\cdot}5H_2O$ was obtained by a series of operation including filtration, washing and drying, and then re-crystallized twice by deionized water free of CO_2. The synthetic product was characterized by X-ray powder diffraction (XRD), simultaneous thermal analysis (TG-DSC) and chemical analysis.

As shown in Figure 1, the synthetic sample of $NaB_5O_8{\cdot}5H_2O$ was belonged to A2/a(15) space group with lattice parameters of a = 13.535, b = 16.450, c = 11.110, z = 8. The positions of peaks were obvious hardly any impurity peaks, which are consistent with the standard pattern of $NaB_5O_8{\cdot}5H_2O$ in the X-ray diffraction analysis software.

Figure 2 shows the TG-DSC curves of the product under nitrogen atmosphere. The weight of the $NaB_5O_8{\cdot}5H_2O$ lost starting from T = 378 K due to the decomposition of crystal water. The DSC curve appears two obvious peaks which mean two stages of reaction may

Table 1 The analytical result of $NaB_5O_8{\cdot}5H_2O$ sample

	Na_2O /wt%	B_2O_3 /wt%	H_2O /wt%	$n(Na_2O: B_2O_3: H_2O)$
Exp. value	10.47	58.92	30.61	1: 5.01: 10.07
theoretical value	10.51	59.05	30.44	1: 5: 10

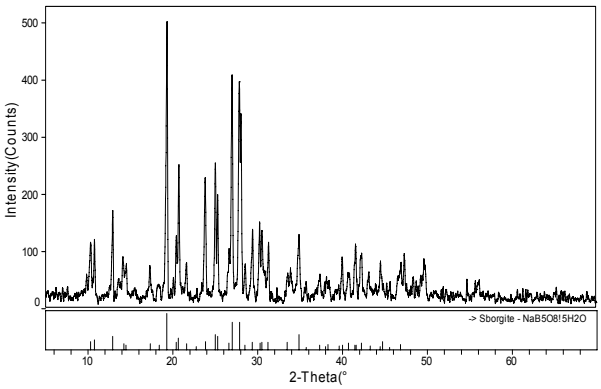

Fig. 1. The X-ray diffraction pattern of $NaB_5O_8{\cdot}5H_2O$ sample and standard substance.

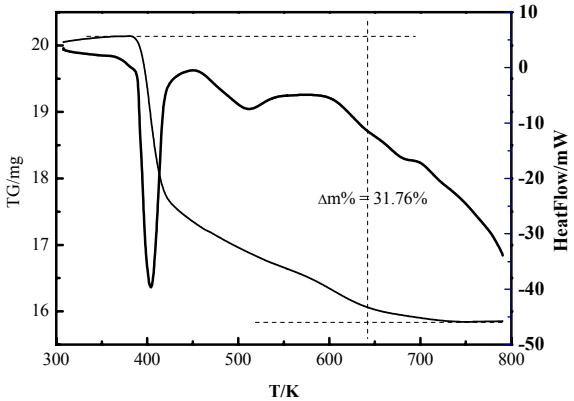

Fig. 2. TG-DSC curves of $NaB_5O_8{\cdot}5H_2O$ sample.

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occur during raising temperature. The whole weight loss ratio was calculated to be 31.76%, which might correspond to the loss of five water molecules compared with the theoretical value 31.57%. The TG-DSC result suggested that the synthesized product was quite pure.

Meanwhile, the analytical results showed in Table 1 also indicated the content of Na_2O and B_2O_3 in the sample agrees well with the theoretical value.

As characterized above, the synthetic $NaB_5O_8{\cdot}5H_2O$ was considered as pure and suitable sample for the further studies of the physicochemical properties.

2 Conclusions

In this presentation, a pure sodium pentaborate pentahydrate ($NaB_5O_8{\cdot}5H_2O$) was synthesized by using $Na_2B_4O_7{\cdot}10H_2O$ and H_3BO_3 with a mole proportion of 1: 6 under hydrothermal conditions at T = 323.15 ± 0.1 K. And then, the synthetic product was characterized combined with TG-DSC, XRD, and chemical analysis. More works such as thermodynamic properties of sodium pentaborate pentahydrate will be discussed in the next step.

Key words: Synthesis, Characterization, Sodium Pentaborate

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