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A New Technology Study on the Production of Snow Salt

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1 Introduction

Snow salt is one of the multi-salt with highly added value, in named for its snowflakes structure appearance. In the present situation, the stacking density gap between different commercial snow salt is big, mainly ranged from 700 kg/m³ to 800 kg/m³. The competition in the market reflected that the snow salt with better snowflakes structure and less stacking density can obtain a higher added value, a higher sales in short supply, have a more promising market and a higher economic value. How to improve the crystallization process of snow salt to obtain the better snowflakes structure and less stacking density becomes an effective way to improve its added value.

In this paper, according to the analysis of several snow salt products in China, we developed a new technology of producing snow salt and analyzed the crystallization mechanism of salt formation process.

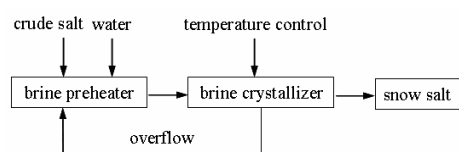
2 Materials and methods

2.1 Crude salt was purchased from Tianjin tanggu salt field, tap water.

D-8401 multi-functional digital temperature controller, electronic mixer, brine crystallizer, silk screen (diameter 2 mm), the salt net lifter, measuring cylinder and balance.

2.2 Process flow

2.2.1 Process flow diagram



2.2.2 Experimental apparatus figure.

The production experimental apparatus of snow salt is

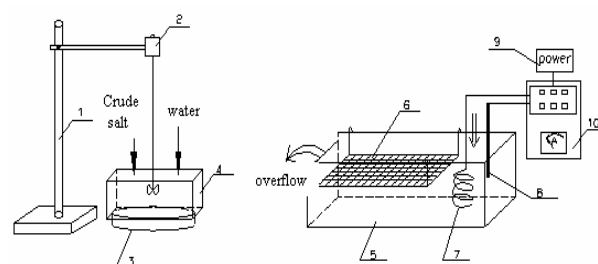


Fig. 1. The production experimental apparatus of snow salt. 1. retort stand, 2. mixer, 3. electric stove, 4. brine preheater, 5. stainless steel screen mesh, 6. brine crystallizer, 7. filaments, 8. thermocouple, 9. power, 10. temperature controller

shown in Figure.1.

3 Results

3.1 Products appearance

The appearance of products is lamellar structure looks like snow.

3.2 Influence of crystallization conditions on stacking density.

3.2.1 Influence of crystal saturation brine temperature on stacking density.

Under the following conditions: the temperature of crystal saturation brine that was replenished to the

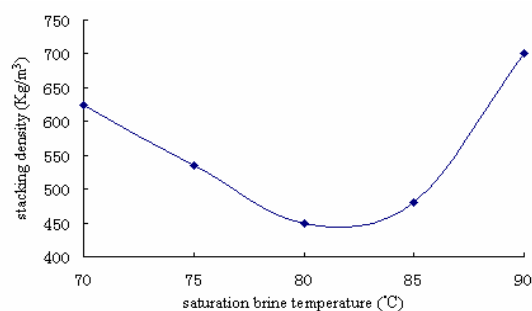


Fig. 2. Influence of crystal saturation brine temperature on stacking density.

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crystallizer was 60°C, the overflow flux was $2.5 \times 10^{-3} \text{ m}^3/\text{h}$, and the production of snow salt was dried under room temperature for 48 hours, controlled the products crystallization temperature to 70°C, 75°C, 80°C, 85°C, 90°C, respectively, the obtained stacking density of snow salt products was shown in Figure.2. The results showed that when the brine crystallization temperature reached 80°C, the stacking density of snow salt products was the least.

3.2.2 Influence of feed brine temperature on stacking density.

When the temperature of crystal saturation brine was 82°C, the overflow flux was $2.5 \times 10^{-3} \text{ m}^3/\text{h}$ and the production of snow salt was dried under room temperature for 48 hours, the temperature of crystal saturation brine that was replenished to the crystallizer controlled to 50°C, 55°C, 60°C, 65°C, 70°C, respectively, the obtained stacking density of snow salt products was shown in Figure3. The results indicated that the least stacking density of snow salt products was obtained when the temperature of crystal saturation brine that was replenished to the crystallizer was 60°C.

3.2.3 Influence of overflow flux on stacking density

When the temperature of crystal saturation brine was 82°C, the temperature of crystal saturation brine that was replenished to the crystallizer was 60°C and the production of snow salt was dried under room temperature for 48 hours, controlled the overflow flux to $2 \times 10^{-3} \text{ m}^3/\text{h}$, $2.5 \times 10^{-3} \text{ m}^3/\text{h}$, $3 \times 10^{-3} \text{ m}^3/\text{h}$, $3.5 \times 10^{-3} \text{ m}^3/\text{h}$, respectively, Figure 4 shows the obtained stacking density of snow salt products. The results indicated that the least stacking density of snow salt products was obtained when the overflow flux was $2.5 \times 10^{-3} \text{ m}^3/\text{h}$.

3.2.4 Influence of drying-time on stacking density

When the temperature of crystal saturation brine was 82°C, the temperature of crystal saturation brine that was replenished to the crystallizer was 60°C, the flux of overflow brine was $2.5 \times 10^{-3} \text{ m}^3/\text{h}$, controlled the drying-time to 24 h, 48 h, 72 h, 96 h, respectively, the obtained

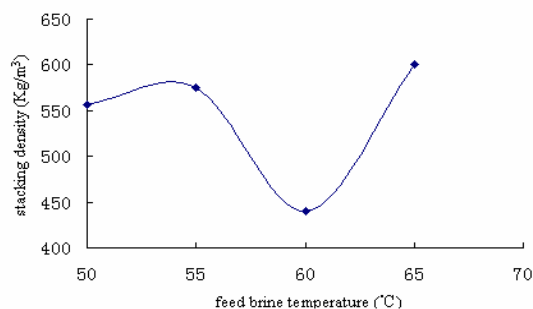


Fig. 3. Influence of feed brine temperature on stacking density.

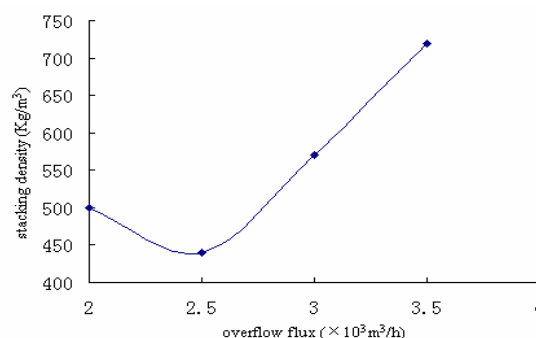


Fig. 4. Influence of overflow flux on stacking density.

stacking density of snow salt products was shown in Figure 5. The results showed when the drying-time higher than 48 h, there was little impact on stacking density; when the drying-time was 48 h, the least stacking density of snow salt products was obtained.

4 Crystallization mechanism analysis of snow salt

The crystallization process of snow salt is the recrystallization process of sodium chloride solution. Same to other solution crystallization process, the precipitation of sodium chloride from solution can be obtained in two steps: nucleation and growth. The driving force of the two steps is the degree of solution super-saturation or super-cooling degree, namely, the solution system is in a state of non-equilibrium where the solution solubility is not stable. The key to this process is to control the crystallization conditions, and then to control the nucleation and growth process of sodium chloride crystal.

According to the theory of diffusion (Jiang et al., 2013), crystal growth process is composed of three steps: (1) to be crystallized solute go through a stationary liquid layer near the surface of the crystal by diffusion, transferred from solution onto the crystal surface; (2) the solute on the crystal surface grew till the crystal surface, made the crystal grew up and released crystallization heat; (3) there leased crystallization heat conducted back to the solution. The formation of crystals acquisition is controlled by its

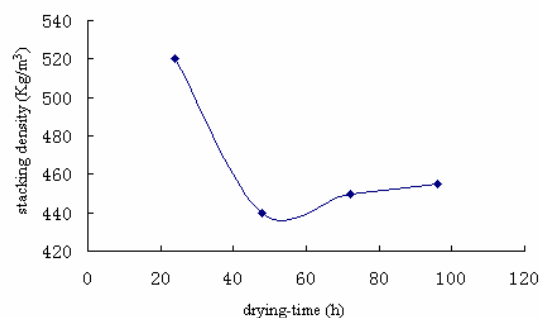


Fig. 5. Influence of drying-time on stacking density.

growth mechanism. The environment of crystal growth is complicated, so in addition to the internal structure factors, external physical and chemical conditions, such as solution crystallization temperature, super-saturation degree, the impurity in crystal mother liquor, pH and viscosity, flow rate and additives, would exert an influence on crystals acquisition (Yan et al., 2012). To some salt, the addition of additives can significantly change the crystals acquisition and then obtains lamellar products, but do not have an significant influence on obtaining sodium chloride lamella (Jiang et al., 2013). In addition, the position of crystal particles in the solution also directly affects the crystals acquisition.

In the process of producing snow salt, the brine used in this process was obtained by dissolving crude salt and filtered. So the formation of crystal nucleus in the crystallizer, after the brine reaching a certain degree of super-saturation, is spontaneous nucleation. By controlling the main factors influencing the nucleation and growth of sodium chloride, namely: the solution crystallization temperature, the over flow flux, the liquid flow caused by density difference of solution heat position, sodium chloride crystal is given priority to spontaneous nucleation, and crystal growth rate in the x-y direction is quicker, changed the sodium chloride crystals acquisition which, in general, is hexahedral crystal; obtained snow salt products with better snow flakes structure and less stacking density.

5 Conclusions

By controlling different crystallization conditions, lower stacking density snow salt with highly added value was obtained. Under the following crystallization conditions: the temperature of crystal saturation brine was 82°C, feed brine was 60°C, the over flow flux was $2.5 \times 10^{-3} \text{ m}^3/\text{h}$ and snow salt was dried under the room temperature for 48 hours, obtained snow salt products with a stacking density reached 440 kg/ m^3 .

Key words: snow salt, new technology, theory of crystal

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