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Salt Manufacturing Technology Using Rotating Cylindrical Heat Exchanger by Preventing Solid-Phase Adhesion on the Heat Transfer Surface

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Summary

Heat supply is necessary to evaporate water during the salt manufacturing process's concentration, crystallization, and drying processes. However, in heat exchange involving solid-phase deposition such as crystallization, efficient heat exchange is difficult because the solid phase adheres to the heat transfer surface and exhibits strong heat transfer resistance. The problem is that the excess high-temperature heat is supplied to ensure the production rate, but the heat cannot be adequately exchanged, so the high-temperature gas is released as waste heat, resulting in inefficient operation. The authors have been developing the acceleration of heat exchange in latent heat storage systems and in hot springs by using a "rotating cylindrical heat exchanger by preventing solid-phase adhesion on the heat transfer surface" This heat exchanger is that in which the rotating cylinder is used as the heat-transfer wall and the surface is constantly renewed by the fixed blades attached to heat transfer wall, and has high heat-transfer performance. It is expected to effectively improve the heat transfer rate and evaporation rate in systems with crystallization, such as salt manufacturing processes. In this study, we proposed a system in which a rotating cylindrical heat exchanger by preventing solid-phase adhesion on the heat transfer surface is immersed in a vessel containing a solution and dry gas is injected from the bottom of the vessel to evaporate the solution.

In this experiment, we designed and lab-scale "rotating cylindrical salt manufacturing device" equipped with a rotating heat exchanger with an outer diameter of 60 mmφ and three fixed blades immersed in a transparent acrylic cylindrical water tank with an inner diameter of 96 mmφ. Water was filled into the tank, and nitrogen gas was introduced from the bottom to measure the evaporation rate of water and observe the dispersion behavior of the injected gas when the tank was heated by approximately 70°C heating medium. The results showed that the evaporation rate of water increased as the rotation rate of the heat transfer tube, and the rate of rising bubbles decreased and the residence time increased. In addition, at high rotation rates, the phenomenon of bubble split and the vertical vortices were observed. The dependence of the evaporation rate on the rotation rate was limited in the low rotation range, but it was found to increase in the high rotation range. We will continue to elucidate the controlling factors for improving the evaporation rate and to design and fabricate the structure. This research has revealed the possibility of salt production using a low-temperature heat source of less than 100°C. Decarbonized salt production without fossil fuels such as geothermal and unused heat can be expected.