No. 202415

Verification of a High-Efficiency Salt Manufacturing Process by Microwave Heating

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Summary

This study explored the potential of microwave heating technology to improve the energy efficiency of traditional salt production methods. In Japan, salt has long been produced from seawater by heating processes that require substantial energy to evaporate large volumes of water. Such methods, particularly for small-scale or local production, pose challenges in terms of environmental impact and sustainability.

To address these issues, this research focuses on the unique characteristics of microwave heating, including internal heat generation and high energy concentration. Experiments were conducted using seawater and saline solutions. The results showed that in saline solutions, the time to reach boiling increased with increasing salt concentration. However, seawater with the same concentration was heated more quickly. This is likely due to the dielectric properties of minerals, such as potassium and calcium, in seawater, which enhance uniform heating under microwave irradiation.

Further experiments were performed under reduced pressure to induce salt crystallization in seawater using microwave irradiation. Compared to a mantle heater, microwave heating achieved a significant reduction in heating time, even with similar energy consumption, owing to the output control. Electron microscopy and X-ray analysis revealed that the obtained crystals resembled those of commercial sea salt in both composition and shape. Notably, the magnesium (nigari) content was close to that of commercial products, suggesting potential advantages in terms of flavor.

These findings indicated that microwave heating is an energy-efficient and effective alternative for salt production. It holds promise for self-sufficient salt supply in energy-limited settings and sustainable small-scale salt operations. Future work will focus on optimizing the equipment, improving the process control, and integrating renewable energy sources to develop a sustainable salt production model.