

## Valorization of Waste Reverse Osmosis Desalination Brine and Crystallization Sequence Approach for Kainite Recovery

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**Abstract :** Brine waste generated from reverse osmosis (RO) desalination plants contains various valuable compounds, mainly salts, trace elements, and organic matter. These wastes are up to two times saltier than standard seawater. Therefore, there is a strong economic interest in recovering these salts. The current practice in desalination plants is to reject the brine back to the sea, which affects the marine ecosystem and the environment. Our study aims to bring forth a reliable management solution for the valorisation of waste brines. Natural evaporation, isothermal evaporation at 25°C and 50°C, and evaporation using continuous heating were used to crystallize valuable salts from a reverse osmosis desalination plant brine located on the Moroccan Atlantic coast. The crystallization sequence of the brine was studied in comparison with standard seawater. The X-Ray Diffraction (XRD) of the precipitated solid phases showed similar results, where halite was the main solid phase precipitated from both the brine and seawater. However, Jänecke diagram prediction, along with FREZCHEM simulations, showed that Kainite should crystallize before Epsomite and Carnallite. As the absence of kainite formation in many experiments in the literature has been related to the metastability of kainite and the critical relative humidity conditions, and the precipitation of K-Mg salts is very sensitive to climatic conditions. An evaporation process is proposed as a solution to achieve the predicted crystallization path and to affirm the recovery of Kainite.

**Keywords :** salts crystallization, reverse osmosis, solar evaporation, frezchem, ZLD

**Conference Title :** ICW 2023 : International Conference on Wastewater

**Conference Location :** Tokyo, Japan

**Conference Dates :** May 22-23, 2023