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Two strategies for freeze desalination of seawater by progressive and block techniques

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ABSTRACT

This work is focused on the study of desalination of salt solutions (as a simulation of seawater fluid) through progressive stirred freeze concentration (PSFC) and block freeze concentration (BFC). The first strategy studies the effect of the initial concentration (C_0), agitation speed (ω) and refrigerant temperature (T) on the parameters of the PSFC process: ice concentration (C_i), impurity ratio ($\bar{K}$), and removal efficiency (RE). The results show that all the studied factors affect the final result of the solids concentration on ice, being the concentration of solids in the initial fluid the most relevant. Considering that the concentration 3.5% w/w is the same as seawater in Mediterranean Sea, based on the regression equation for C_i, and taking the parameters ω (rpm) and T (°C) at its optimum value, there could be a scheme of progressive freezing in three stages. At the end of the three stages, ice with an electrical conductivity below the limits set by Directive 98/83/EC (2.5 mS/cm), to be considered safe water for human consumption can be obtained. Likewise, the use of vacuum-assisted BFC is analysed by combining different pressures and vacuum times on samples of salt solutions to simulate seawater. The absolute pressure of 10 kPa and an extraction time of 45 min allows obtaining ice with conductivity <2.5 mS/cm in three stages. Finally, the results obtained suggest that it is possible to combine the two techniques (PSFC + vacuum assisted BFC) in the same equipment.

Keywords: Seawater; Progressive freezing; Block freezing; Electrical conductivity; Ice

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