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Freezing desalination of seawater in a static layer crystallizer

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ABSTRACT

This work aims in developing a static layer crystallizer for freezing desalination of seawater. The experiments were performed with a simple system of H_2O–NaCl and with samples of sea water from Rabat. The pilot crystallizer consists in a tube cooled by means of a thermostatic bath. The tube is immerged in a cylindrical double jacketed tank cooled by means of a second thermostatic bath. The brine is poured into the tank and the crystallization takes place on the external surface of the tube. The global process is divided into 4 steps: (i) crystallization of the ice layer by controlling the cooling rate in the tube (ii) draining off the concentrated brine (iii) purification of the layer by sweating and (iv) melting of the ice to recover the fresh water. A parametric study of the effect of the operating parameters has allowed us to quantify the role of the different key parameters of the crystallization step. Within the studied domain, the purity of the crystalline layer was mainly affected by the initial salinity of the brine. The growth rate of the layer, controlled by the cooling rate in the tube, had also a significant effect. Experiments performed with Rabat sea water showed that a fresh water of salinity close to the drinking water standards could be obtained in one stage within 31 h. Desalination operated in two consecutive stages (10 h + 11 h) gave salinity below the standards with a comfortable safety margin. If sufficiently severe operating conditions are applied, sweating is able to purify the interior of the ice layer and to reach the drinking water standards, provided the impurity concentration of the ice produced in the crystallization step is low enough. The mass loss induced by sweating is also high when the impurity concentration is high. These first results are promising and show the feasibility of the process which still requires to be optimized.

Keywords: Freezing desalination; Melt crystallization; Sea water; Crystal layer growth; Sweating

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