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Development of High-Performance Multiple-Effect Diffusion Still Producing Highly Concentrated Seawater

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Summary

Multiple-effect diffusion stills producing concentrated seawater were examined to find their performance. The stills consist of a series of seawater-soaked wicks stuck on closely-spaced parallel plates with the first plate steam-heated at 100℃ and the last plate cooled by evaporation into the ambient air. Seawater evaporates from the wicks, and the vapor diffuses through the narrow spaces and then condenses on the other sides of plates. The first plate has a steam jacket for heating the first plate.

Two stills were constructed; all parallel plates were hung vertically for a still, and the second to the last plates were laid down on the first plate tilled at 9° from the horizon for another still. Wicks were stuck underneath the second to the last tilted plates to soak the condensate, and plastic meshes were sandwicked between the plates. Seawater was fed at the top ends of the seawater-soaked evaporating wicks, and concentrated seawater and condensate were collected at the bottom ends of wicks. The plates were spaced with 5mm gaps between them for both stills without any local contact between the concentrated seawater and the condensate.

Every plate has a small reservoir, and a wick soaks up seawater in the reservoir to feed it to the evaporating wick stuck on the plate. Seawater flows more uniformly in wicks on the vertical plates than those on the tilted plates. The wicks are capable to feed more amount of seawater to the evaporating wicks on the tilted pates than those on the vertical ones.

We tested the performance of the tilted still with 5 wicks of 1 m by 2 m evaporating area, feeding it tap water in place of seawater. The tap water fed to the fifth wick increases its temperature in around 1 m in the flow direction and then keeps it nearly constant downstream. The first wick showed the largest evaporation rate of 3.9 kg/hr, and the rate becomes smaller on the second, the third and the fourth wicks in order. The fifth wick in contact with the ambient air showed the second largest rate of 3.6kg/hr because of the evaporation enhanced by the natural convection.

The still showed a coefficient of performance (the ratio of total heat of evaporation from all wicks to the heat input into the first plate) of 3.6 and a 16.6 kg/hr production rate (total amount of evaporation from all wicks). These are respectively 88% and 74% of theoretical predictions by Nosoko et al. (*Bull. Soc. Seawater Sci., Jpn.* **58**, 102-109, 2004)..