No. 1614

# Development of Decentralized Simple Multiple-Effect Evaporator for Liquid Concentration and Distillation

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## Summary

The structure of vapor-diffusion multiple-effect evaporator is simple—flat plate with wicks on them are piled up with narrow gaps between them, and the first plate has a heating equipment such as a vapor jacket on its bottom. The evaporator has a great potential to be used to produce drinking water or to concentrate various solutions at many small factories. One of the requirements to develop the evaporator is to decrease the amount of heat carried out of the evaporator with condensate and concentrate. For this requirement, the present author suggested to extend the plates with wicks downstream from the heated area and insulate the bottom of the extended area of the first plate.

A steady-state two-dimensional theoretical model was constructed to predict temperature and vapor flux varying downstream, and applied to evaporation of seawater. The results of the theoretical analysis may be summarized as;

1. Evaporation occurs from seawater in the insulation area, and the temperature of the seawater and condensate decreases downstream. The total amount of evaporation increases with an increasing insulation area, and the rate of the increase of evaporation decreases.
2. The heat carried out with the seawater and condensate from the evaporator with 8 plates decreases to a half as the insulation area is lengthened to the same as the heated area.
3. The total amount of evaporation increases by 38% and the ratio of the total heat of evaporation to the heat supplied to the first plate increases from 3.5 to 5.0, as the insulation area is lengthened to the same as the heated area.

An evaporator with $1.0 \times 1.6\mathrm{m}^2$ heated area and $1.0 \times 0.51\mathrm{m}^2$ insulated area was constructed and its performance with 4 or 5 plates was explored. The experimental data of the total evaporation and the ratio of the total amount of heat of evaporation scattered widely. After 20 or more experimental runs, the evaporating wicks on lower plates were observed. Many air bubbles had grown between evaporating wicks and plates. Air dissolved in seawater fed to wicks might have come out and accumulated between evaporating wicks and plates. The more bubbles appeared in areas where temperature of seawater had rosen more rapidly on hotter plate. The bubbles had the large resistance to heat flux through the prates and wicks, and might cause the experimental data to scatter widely.