

## Falling film flow characteristics on horizontal tubes and their effects on scale formation in seawater evaporators

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### ABSTRACT

Horizontal tube falling film evaporators are the main components of multiple-effect distillation plants for seawater desalination. Seawater is distributed onto a horizontal tube bundle and forms a thin film on the outside of the evaporator tubes, which are internally heated by steam. The thickness and the wave motion of the seawater film crucially determine heat and mass transfer rates in the film and, therefore, scale formation on the tube surfaces. Falling film flow on horizontal tubes was studied with a high-resolution optical micrometer in a unique test rig. The liquid film thickness was measured at a high sampling frequency along and around a tube providing information on wave structure and wave frequency at different wetting rates. Moreover, experiments were performed in a horizontal tube falling film evaporator test rig at pilot plant scale with artificial seawater in order to study the formation of calcium- and magnesium-containing salts at different wetting rates. The mean film thickness on the tube surface increases with increasing wetting rate and it highly depends on the position on the tube surface. The wave motion of the film is predominantly governed by liquid impingement at the tube top and liquid detachment at the tube bottom. Scale mass and scale layer thickness are closely connected to falling film characteristics.

*Keywords:* Falling film; Scale formation; Multiple-effect distillation

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