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ACCEPTED MANUSCRIPT

Introducing ultrasonic falling film evaporator for moderate temperature evaporation enhancement

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Abstract

In the present study, Ultrasonic Falling Film (USFF), as a novel technique has been proposed to increase the evaporation rate of moderate temperature liquid film. It is a proper method for some applications which cannot be performed at high temperature, such as foodstuff industry, due to their sensitivity to high temperatures. Evaporation rate of sodium chloride solution from an USFF on an inclined flat plate compared to that for Falling Film without ultrasonic irradiation (FF) at various temperatures was investigated. The results revealed that produced cavitation bubbles have different effects on evaporation rate at different temperatures. At lower temperatures, size fluctuation and collapse of bubbles and in consequence induced physical effects of cavitation bubbles resulted in more turbulency and evaporation rate enhancement. At higher temperatures, the behavior was different. Numerous created bubbles joined together and cover the plate surface, so not only decreased the ultrasound vibrations but also reduced the evaporation rate in comparison with FF. The highest evaporation rate enhancement of 353% was obtained at 40℃at the lowest Reynolds number of 250. In addition, the results reveal that at temperature of 40℃, USFF has the highest efficiency compared to FF.

Keywords: ultrasonic waves; falling film; moderate temperature evaporation; enhancement

1. Introduction

Investigation on behavior of falling films has been always important for researchers due to their different industrial applications such as evaporation which is the most significant one. Some effects, which surface renewal and local mixing are the most important ones, create the waves at the interface. The created waves at the interface lead to enhance heat and mass transfer from falling films [1].These waves including continuous and solitary waves near the film surface is the most important factor to increase the heat and mass transfer rate [2, 3]

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