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Effect of flame spray coating on falling film evaporation for multi effect distillation system

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ABSTRACT

Horizontal tubefalling film evaporators find various applications like multi effect distillation for sea water desalination, power and process applications, refrigeration applications, etc. In this system, latent heat released inside the tube due to condensation is transferred to the falling film on the tube surface resulting in convective evaporation. Among many heat transfer enhancement techniques, thermal spray coatings enjoy diverse applications with economic advantage for commercial applications. This paper focuses on Computational Fluid Dynamic (CFD) analysis of falling film evaporation of water on horizontal tubes under the influence of gravity at vacuum. ANSYS Fluent with VOF two-phase model is used for the falling film studies on the horizontal tube. Half section of the tube is modeled with gravitational flow of sea water from the top. This model is used to predict the enhancement in convective evaporation on thermal spray coated tube surface with varying roughness. These CFD results are validated with published experimental data available in the literature. From this study, it is observed that heat transfer coefficient is increased by 10–15% due to increased roughness for laminar convective film boiling under vacuum. The film coefficient enhancement is higher for the larger diameter tubes. The tubes in the tube bank located beneath the top tube exhibit reduction in performance, which may be due to partial drying out of film on tube surface or due to evaporation and maldistribution of flow. At high heat flux and low feed rate, the decrease in film coefficient is more predominant. The effect of feed rate, tube diameter, wall temperature, heat flux, tube arrays, etc. on the heat transfer characteristics is studied and presented in this paper.

Keywords: Multi effect distillation; Falling film evaporation; Thermal spray coating; Surface roughness

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