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Heat Transfer of Single and Binary Systems in Pool Boiling

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Abstract

The present research focuses on the study of the effect of mass transfer resistance on the rate of heat transfer in pool boiling. The nucleate pool boiling heat transfer coefficients for binary mixtures (ethanol-n-butanol, acetone-n-butanol, acetone-ethanol, hexane-benzene, hexane-heptane, and methanol-water) were measured at different concentrations of the more volatile components. The systems chosen covered a wide range of mixture behaviors.

The experimental set up for the present investigation includes electric heating element submerged in the test liquid mounted vertically. Thermocouple and a digital indictor measured the temperature of the heater surface. The actual heat transfer rate being obtained by multiplying the voltmeter and ammeter readings. A water cooled coil condenses the vapor produced by the heat input and the liquid formed returns to the cylinder for re-evaporation.

The boiling results show that the nucleate pool boiling heat transfer coefficients of binary mixtures were always lower than the pure components nucleate pool boiling heat transfer coefficients. This confirmed that the mass transfer resistance to the movement of the more volatile component was responsible for decrease in heat transfer and that the maximum deterioration that was observed at a point was the absolute concentration differences between vapor and liquid phases at their maximum. All the data points were tested with the most widely known correlations namely those of Calus-Leonidopoulos, Fujita and Thome. It was found that Thome's correlation is the more representative form, for it gave the least mean and standard deviations.

Keywords : *pool , boiling , binary , systems.*

1. Introduction

Boiling heat transfer is defined as a mode of heat transfer, which occurs with a change in phase from liquid to vapor.

There are two basic types of boiling:

1. Pool boiling: Where a heated surface is submerged below a free surface of liquid.
2. Flow boiling: Where the liquid is flowing on heated surface.

Pool and Flow boiling are important in power industries and process industries. The present research focuses on pool boiling. [1]

Boiling of binary and multicomponent mixtures constitutes an important process in chemical process, air separation, refrigeration and many other industrial applications. Reboilers feeding the vapors to distillation columns and flooded evaporators generally employ pool boiling, while the tube evaporation process involves flow boiling. Although the multicomponent boiling is of greater interest from a process standpoint, fundamental understanding of the mechanism can be obtained first with binary mixtures.[2].

The objectives of the present study are to experimentally determine the nucleate pool boiling heat transfer coefficients of binary mixtures at different concentration of the more volatile components, and then the experimental results will be compared with famous correlations in pool boiling to examine the agreement with the experimental results and try to conclude a more representative correlation.