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Correlating Isothermal Friction Factor Data for Micro-Fin Tubes Using Logistic Dose-Response Curve Fitting Method

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Simultaneous heat transfer and friction factor experiments for plain and micro-fin tubes were conducted in our previous study. The results showed that the heat transfer characteristics of the micro-fin tubes were the same as for the plain tube. However, the friction factor characteristics of the micro-fin tubes in the transition region were different compared to the plain tube. This type of friction factor data cannot be easily correlated by the traditional regression method. Therefore, a logistic dose-response curve-fitting method is proposed in this study. This particular method has recently been used by other researchers in correlating the friction factor data in plain tubes. In this study, three sets of micro-fin tubes friction factor data with different inlets from our previous study were correlated by the logistic dose-response curve-fitting method. All the fully developed friction factor data for the entire flow regime were predicted by a composite logistic dose-response function within ±11% deviation. The majority of the data (over 85%) was predicted with less than ±5% deviation.

INTRODUCTION

Single-phase liquid flow in internally micro-finned tubes is important in commercial heating, ventilation, and air conditioning (HVAC) applications. It has been observed that heat transfer can be increased when using the micro-fin tubes inside the flooded evaporators as well as shell-side condensers. This enables water chillers to reach high efficiency, which helps mitigate global warming concerns of HVAC systems. It is commonly understood that the micro-fin enhances heat transfer but at the same time increases the pressure drop as well. However, our understanding of the friction factor and heat transfer characteristics in the entire flow regime, especially in the transition region, is insufficient. Furthermore, in the open literature, the friction factor and heat transfer correlations for single-phase flow in micro-fin tubes are mainly focused on the turbulent region. The correlations for the transition region are not available in the open literature. Following our plain tube studies, the micro-fin tube correlations can be developed based on the particular characteristics of friction factor and heat transfer.

Referring to Tam et al. [1], it was observed that the heat transfer characteristics of the micro-fin tubes behaved the same way as the plain tube. However, the friction factor characteristics of the micro-fin tube in the transition region were different than the plain tube. Owing to the different characteristics, the plain tube correlations are not applicable to the micro-fin tube data. However, the correlating methods for the transition region data in the plain tube may be applicable to the micro-fin tube data in the transition region.

For the plain tube transition region friction factors, several empirical correlations [2–5] have been developed. In the study of Ghajar and Madon [2], those correlations were compared with the fully developed friction factor data with different inlet configurations. Based on the plain tube parabolic data trend in the transition region, Ghajar and Madon [2] and Hrycak and

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