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# EXPERIMENTAL INVESTIGATION OF HEAT TRANSFER, FRICTION FACTOR, AND OPTIMAL FIN GEOMETRIES FOR THE INTERNALLY MICROFIN TUBES IN THE TRANSITION AND TURBULENT REGIONS

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*For internally microfin tubes, most of the heat transfer and friction factor studies were focused on the turbulent region. However, there is a lack of information about the heat transfer and friction factor behavior of microfin tubes in the entire flow regime that covers laminar, transition, and turbulent regions. Furthermore, the effects of fin geometries and inlet configurations on microfin tube heat transfer and friction factor were seldom discussed. Therefore, an experimental study for friction factor and heat transfer on three microfin tubes with different inlet configurations (squared-edge and re-entrant) was conducted and the measured data were compared with the data of a plain tube. From the friction factor and heat transfer results, the transition from laminar to turbulent was clearly established and shown to be inlet- and spiral-angle dependent. For all the microfin tubes with two inlet types, it was observed that the efficiency index was larger than 1 when the Reynolds number was larger than 5000. The current microfin tubes data were also compared with the existing heat transfer and friction factor correlations in the turbulent region. Finally, the genetic algorithms and the algorithms of changes were applied to the existing turbulent correlations to find the optimal fin geometry. The efficiency index computed by both numerical methods outperformed the index computed by the fin geometries used in the past studies. This proved that both algorithms were capable of finding the optimal fin geometry of the microfin tubes*

**KEY WORDS:** *transition and turbulent regions, internally microfin tubes fin geometries optimization, algorithms of changes, genetic algorithms*

## 1. INTRODUCTION

Single-phase liquid flow in internally enhanced tubes is becoming more important in commercial heating, ventilating, and air conditioning (HVAC) applications, where enhanced tube bundles are used in flooded evaporators and shell-side condensers to increase heat transfer. This enables water chillers to reach high efficiency, which helps mitigate global warming concerns of HVAC systems. One kind of internally enhanced tube is the spiral microfin tube. For the laminar flow, several researchers (Brognaux et al., 1997; Esen et al., 1994; Shome and Jensen, 1996; Al-Fahed et al., 1999) concluded that the heat transfer and pressure drop were not greatly affected by microfins. Khanpara et al. (1986) reported that the turbulent heat transfer in microfin tubes had an increase of 30% to 100% with Reynolds numbers between 5000 and 11,000. Brognaux et al. (1997) indicated that there was a 65% to 95% increase in heat transfer for the microfin tube over the smooth tube. However, there was also a 35% to

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