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HEAT TRANSFER AUGMENTATION IN PLATE FINNED TUBE HEAT EXCHANGERS WITH VORTEX GENERATORS: A COMPARISON OF ROUND AND FLAT TUBES*

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Abstract– Heat transfer augmentation and pressure loss penalty caused by vortex generators (*VGs*) are numerically studied for finned flat/round tube heat exchangers and compared with available experimental results. The simulations are performed with the steady three-dimensional incompressible conditions and a *RNG K-ε* turbulence model is used. The Reynolds numbers based on the bulk velocity and the height of channel are selected from 600 to 4050. To compare the effectiveness of *VGs* on the round and flat tubes for tube-fin heat exchangers, two different configurations are investigated with two and four delta winglet vortex generators for each tube. The streamlines, vorticity, the averaged Nusselt number, the friction factor and the performance factor (*JF*) are provided to evaluate the effectiveness of *VGs* for the heat exchangers employed. It is found that the flat tube with *VGs* provides better thermal performance than the round one, especially at the lower Reynolds numbers.

Keywords– Tube-fin heat exchanger, heat transfer enhancement, flat tube, round tube, vortex generator

1. INTRODUCTION

Tube-fin heat exchangers are mostly employed as gas-to-liquid exchangers. Nowadays, many applications such as chemical, petroleum industries, thermal processing systems in automotive, refrigeration and air conditioning are found for tube-fine exchangers. Depending on the fin type, these exchangers are referred to as finned tube exchangers (having normal fins on individual tube) and tube-fin exchangers (having flat continuous fins). In these exchangers, the fins can be plain, wavy, or interrupted, while round, flat and oval tubes may be used. A tube-fin exchanger with flat fins is referred to as a plate finned tube [1], (Fig. 1). Apart from the flow structure, geometrical parameters such as tube form (round or flat tube), arrangement (inline or staggered), and tube and fin spacing are effective in the performance of these exchangers. For example, with an inline arrangement, the horseshoe vortices may not be generated in front of the tubes of the second and the other rows, while in the staggered arrangement, the horseshoe vortices appear in front of each tube, which can influence the flow structure on the large area of the fin.

In recent years, vortex generators such as fins, ribs, wings etc. have been successfully used for heat transfer enhancement of the modern thermal systems. Vortex generators form secondary flow by swirl and destabilize the flow. They generate the longitudinal vortices and create rotating and secondary flow in the main flow which can raise turbulent intensity, mix the warm and cold fluid near and in the center of channel and increase the heat transfer in the heat exchangers. Different types of vortex generators such as

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