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Numerical Analysis of Heat Transfer and Nanofluid Flow in a Triangular Duct with Vortex Generator: Two-Phase Model

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Laminar forced convection heat transfer and nanofluids flow in an equilateral triangular channel using a delta-winglet pair of vortex generators is numerically studied. Three nanofluids, namely; Al_2O_3, CuO, and SiO_2 nanoparticles suspended in an ethylene glycol base fluid are examined. A two-phase mixture model is considered to simulate the governing equations of mass, momentum and energy for both phases and solved using the finite volume method (FVM). Constant and temperature dependent properties methods are assumed. The single-phase model is considered here for comparison. The nanoparticle concentration is assumed to be 1% and 4% and Reynolds number is ranged from 100 to 800. The results show that the heat transfer enhancement by a using vortex generator and nanofluids is greater than the case of vortex generator and base fluid only, and the latest case provided higher enhancement of heat transfer compared to the case of a base fluid flowing in a plain duct. Considering the nanofluid as two separated phases is more reasonable than assuming the nanofluid as a homogeneous single phase. Temperature dependent properties model provided higher heat transfer and lower shear stress than the constant properties model. © 2014 Wiley Periodicals, Inc. Heat Trans Asian Res, 45(3): 264–284, 2016; Published online in Wiley Online Library (wileyonlinelibrary.com/journal/htj). DOI 10.1002/htj.21163

Key words: heat transfer, nanofluid, triangular duct, vortex generator, two-phase

1. Introduction

Equilateral triangular passages are preferred in heat exchangers because they provide high compactness and then increase the heat transfer surface area [1]. The circular tubes have to be replaced with a duct configuration which exhibits a greater heat transfer area such as a corrugated surface of plate consisting of a succession of V grooves [2] as shown in Fig. 1(a). Many researchers have concentrated their investigations to obtain more sufficient heat transfer surfaces for noncircular channels which are widely used in such fields as automobile industries, power systems, heating and air conditioning, chemical engineering, electronic chip cooling and aerospace, and so on. Improving