Investigation of heat transfer in concentric annuli with perforated inserts

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Abstract

The increasing necessity for saving energy and material imposed by the diminishing world resources and environmental concerns have prompted the development of more effective heat-transfer equipment with improved heat-transfer rates. The hydrodynamic boundary layer acts as main resistance for the transfer of heat from tube surface to fluid or vice-versa and many researchers are trying to improve the convective heat transfer rate with inserts in tubes to break the boundary layer and produce turbulence. In line with the aim, this paper presents results of an experimental investigation carried out to study the effect of relative roughness pitch and perforation of the spring roughness on heat transfer and friction factor for turbulent flow in an asymmetrically heated annular duct (radius ratio =0.39) with heated tube having spirally wound helical spring. The relative roughness pitch ranges from 4 to 8, while the relative coil pitch is 2.66–4.5. Thermal performance assessment at equal pumping power for the roughened and smooth annuli shows performance advantage of 32–83% for the Spring 2, while the lowest enhancement of 54–81% is seen for the Spring 12 in the flow Reynolds number range of about 4000–14000; the Nusselt number ratio, Nu/Nus, has been found to first increase with increase in the Reynolds number up to about 10000 and then decrease. The matching augmentation in the friction factor values is found over the bare pipe. Nusselt number and friction factor correlations have been developed for the most preferred type of perforated insert.

Keywords: Disproportionately heated annuli, spirally wound perforated insert, heat transfer enhancement, thermo hydraulic performance