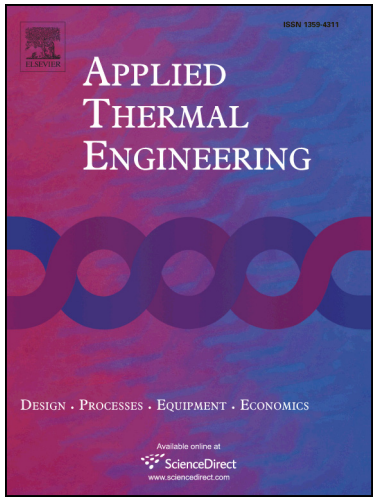

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PII: S1359-4311(16)34243-0
DOI: http://dx.doi.org/10.1016/j.applthermaleng.2016.12.082
Reference: ATE 9702

To appear in: *Applied Thermal Engineering*

Received Date: 24 August 2016
Revised Date: 21 November 2016
Accepted Date: 19 December 2016

Please cite this article as: S. Skullong, P. Promvonge, C. Thianpong, N. Jayranaiwachira, Thermal behaviors in a round tube equipped with quadruple perforated-delta-winglet pairs, *Applied Thermal Engineering* (2016), doi: http://dx.doi.org/10.1016/j.applthermaleng.2016.12.082

Thermal behaviors in a round tube equipped with quadruple perforated-delta-winglet pairs

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Abstract

The article deals with an experimental investigation of enhancing convective heat transfer in a heated circular tube with pairs of perforated-delta-winglets placed repeatedly on a perforated-cross-tape (PW-XT). The perforated-delta-winglets are placed in inline array and a triangular-hole is punched on each winglet to reduce the friction loss. The aim at using the PW-XT insert is to produce streamwise-vortex flows in the tube to reduce the thickness of thermal boundary layer and to increase fluid mixing of the flow. The involved winglet parameters are composed of relative winglet height or blockage ratio, (B_R=b/D= 0.1, 0.15, 0.2 and 0.25) and relative winglet pitch or pitch ratio, (P_R=P/D= 0.5, 1.0, 1.5 and 2.0) and those are performed at a single delta-winglet inclination/attack angle, α = 30° and a winglet porosity ratio, A_p/A_w=0.359 for Reynolds number from 4180 to 26,000. The present results of heat transfer and pressure loss displayed in terms of respective Nusselt number (Nu) and friction factor (f) show that Nu increases with increasing B_R but with decreasing P_R. Nu for the PW-XT insert is in a range of 1.96–5.06 times while f increases around 2.06–35.68 times above the plain tube alone. To estimate the real merits of the PW-XT, the thermal enhancement factor (TEF) is evaluated and found to be a maximum around 1.902 at B_R = 0.15, P_R = 1.0. In comparison, the PW-XT gives considerably higher TEF than the typical four delta-winglet pairs placed on the cross-tape (TW-XT) having the highest TEF around 1.72.

Keywords: Heat exchanger; Vortex generator; Delta-winglet; Cross-tape; Thermal performance