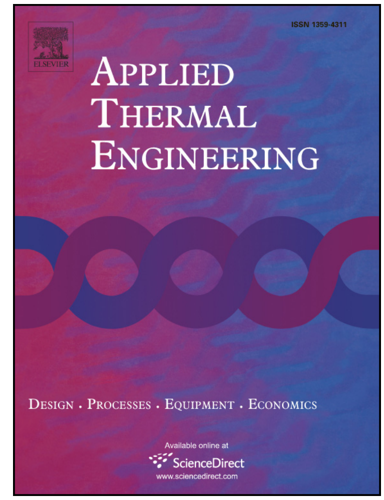
Accepted Manuscript



Thermal and Fluid Flow First-Principles Numerical Design of an Enhanced Double Pipe Heat Exchanger

John M. Gorman, Kevin R. Krautbauer, Ephraim M. Sparrow

PII: S1359-4311(16)31050-X
DOI: http://dx.doi.org/10.1016/j.applthermaleng.2016.06.134
Reference: ATE 8545

To appear in: *Applied Thermal Engineering*

Received Date: 16 November 2015
Revised Date: 7 June 2016
Accepted Date: 21 June 2016

Please cite this article as: J.M. Gorman, K.R. Krautbauer, E.M. Sparrow, Thermal and Fluid Flow First-Principles Numerical Design of an Enhanced Double Pipe Heat Exchanger, *Applied Thermal Engineering* (2016), doi: http://dx.doi.org/10.1016/j.applthermaleng.2016.06.134

Thermal and Fluid Flow First-Principles Numerical Design of an Enhanced Double Pipe Heat Exchanger

John M. Gorman *, Kevin R. Krautbauer, Ephraim M. Sparrow
Department of Mechanical Engineering, University of Minnesota, Minneapolis, MN 55455, USA.

Abstract
This investigation is concerned with the thermal and fluid flow design of a double-pipe heat exchanger in which the wall of the inner pipe is helically corrugated. In this an arrangement, the inner tube is geometrically unique since it is comprised of alternating ridges and grooves. By means of the continuous helical twist, the pipe wall creates a swirl flow component superimposed on an axial flow within both fluid streams. Steady numerical simulations were used as the design tool. Results were obtained for both parallel and counter flow, and for both constant- and variable-fluid property models. Two thermal-hydraulic models were employed. In one, the heat exchanger was analyzed as a single end-to-end entity. In the other, a spatially periodic model was created to obtain generally applicable thermal resistance results. Comparisons with simple smooth-walled double-pipe exchangers showed roughly a factor of three increases in heat transfer for the helically corrugated double-pipe heat exchangers. The corresponding comparison of the pressure drops revealed the corrugated double-pipe heat exchangers had anywhere from a factor of two to four larger pressure drop. These comparisons correspond to the two compared cases having the same perimeters of the participating pipes. Counter-flow operation yielded higher rates of heat transfer, but to an extent that depends on whether the fluid properties are temperature-dependent or constant. Reynolds numbers for the investigated cases ranged from 420 to 2000.

Keywords: Pipe-in-pipe heat exchanger, Fluid warmer, Helical pipe, Twisted pipe, Corrugated pipe, Numerical simulation

Corresponding author. Tel.: +1 612 625 5502.
E-mail address: gorma157@umn.edu (J.M. Gorman).