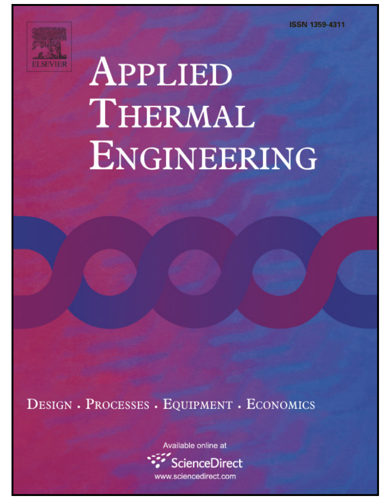
Accepted Manuscript



Numerical investigation on effects of using segmented and helical tube fins on thermal performance and efficiency of a shell and tube heat exchanger

Mohsen Amini, Reza Amini, Alireza Jafarinia, Mehdi Kashfi

PII: S1359-4311(18)30652-5
DOI: https://doi.org/10.1016/j.applthermaleng.2018.03.004
Reference: ATE 11892

To appear in: *Applied Thermal Engineering*

Received Date: 29 January 2018
Accepted Date: 1 March 2018

Numerical investigation on effects of using segmented and helical tube fins on thermal performance and efficiency of a shell and tube heat exchanger

Authors:
Mohsen Amini; (corresponding Author) Department of Mechanical Engineering, K. N. Toosi University of Technology, Tehran, Iran; amini.mohsen@sina.kntu.ac.ir
Reza Amini; University of Tabriz
Alireza Jafarinia; University of Yazd
Mehdi Kashfi: University of Tabriz

Abstract: Thermal performance of a shell-and-tube heat exchanger is investigated numerically using ANSYS FLUENT software under various conditions. Before proceeding with simulations, sensitivity analysis is performed for both mesh grid and turbulence model and the results are compared and validated with results obtained from Bell-Delaware method. The numerical study is consisted of three parts: First the effect of tubes wall relative roughness and Reynolds number on total heat transfer and pressure drop is investigated. In the second part, effect of simple segmented tube fins on heat transfer is studied under two independent adjustable parameters, namely fin pitch and fin height while surface roughness is fixed. Finally, a novel design of fins (helical fin) is proposed and its influence on thermal performance of the heat exchanger is investigated and results are compared to no-fin and segmented fin configurations. It is found that tube fins in general enhance overall efficiency of the heat exchanger. The efficiency is increased by 9.5% and 6% when the proposed helical fins and segmented fins are used respectively. CFD results purpose the efficiency is increased by increasing fin height, but decreased by increasing fin pitch. Helical fins increase effectiveness of heat exchanger by 17% compared to plain tubes. Although increasing surface roughness increases the efficiency, it leads to faster corrosion which means higher maintenance costs and is not desirable. The efficiency of the heat exchanger therefore can be prominently increased when combination of low surface roughness and helical fins with smaller pitch and larger height are used.

Nomenclature

B	Central baffle spacing (mm)	S	Scalar measure of the deformation tensor
B_c	Baffle cut (%)	S_ε	User defined source terms of transport equation
D_s	Shell size (mm)	T	Temperature (K)
d	Distance from the wall for near wall Treatment (m)	u, v, w	Velocity components (m/s)
d_o	Tube outer diameter (mm)	$\vec{V}$	Velocity Vector
g	Gravitational acceleration (m/s^2)	x, y, z	Position coordinates
T_h	Hot fluid temperature (K)	U	Heat transfer coefficient (W/m^2)
T_c	Cold fluid temperature (K)		
Gb	Generation of turbulence due to buoyancy		**Greek symbols**
Gk	Production of turbulence kinetic energy due to mean velocity gradients	ε	Viscous dissipation rate (m^2/s^3)
k	Kinetic energy of turbulent fluctuations per unit mass (m^2/s^2)	Φ	Dissipation function
K	Thermal conductivity (W/mK)	ν	Dynamic viscosity (Pa s)
A	Heat exchanger total tube area (m^2)	ξ	Heat exchanger effectiveness
L	Heat exchanger length (mm)	ν_t	Turbulent viscosity (Pa s)
N_b	Number of baffles	μ	Molecular viscosity (m^2/s)