Available online at www.asric.org

ASRIC Journal on Engineering Sciences 1 (2021) 1-6

Performance Study of Fins and Tube Heat Exchanger with Different Fin Geometry

R. Jegede [a], J. E. Ogbezode[a,b,1], and C. J. Diji [a]

[a] *Department of Mechanical Engineering, University of Ibadan, Ibadan, Nigeria*
[b] *Department of Mechanical Engineering, Edo State University Uzairue, Edo State, Nigeria*

Received 31 August 2021; revised 13 November 2021; accepted 23 December 2021

Abstract

In various engineering devices, a considerable amount of thermal energy has to be dissipated through a small area using extended surfaces referred to as fins. The insufficient rate of thermal energy dissipation in heat exchangers has created a high demand for more powerful engines in smaller hood spaces. For this reason, a two-phased study was carried out to examine the relationship between varying fin shapes and their heat transfer performance, considering three selected geometric shapes namely, rectangular, triangular, and trapezoidal. The first phase (experimental) was used to analyze the performance of rectangular fins and Tube Heat Exchanger (HE) using car radiator while the second phase (numerical) was used to investigate all the selected fin geometries while an experimental test rig was developed with commercially available car radiator. A 1.5kW electrical heater was used to heat the water and circulated using 0.5 HP centrifugal pumps and gate valve with varying coolant of 0.1-0.3 Kg/s flow rate was used. The result indicates that experimental and numerical heat loss across the various fin geometries decreases as the mass flow rate decreases. Performance analysis of the fins and tube heat exchanger has shown that heat loss for trapezoidal fins and tube heat exchangers are higher when compared with the other fins geometry.

Keywords: Fins, Tube, Heat Exchanger, Thermal Energy, Computational Fluid Dynamics (CFD)

1. Introduction

1.1 Study Background

Devices that allow heat flow from one fluid medium to another fluid medium without both fluids having to mix or come directly in contact is known as the heat exchanger. The fluids may also be in direct contact in some peculiar cases. But the essential principle of a heat exchanger is that it transfers the heat without necessarily transferring the fluid that carries the heat [1]. In some instances, the fluids may also be in direct contact with heat transferred. Thus, the basic concept of a heat exchanger is its ability to transfer heat from one medium to another without necessarily transferring the fluid that carries the heat [2]. Thermal energy transfer generally occurs due to temperature at different modes of heat transfer (i.e. conduction, convection, and radiation) [3]. Fins are appendages or components of thin material attached to a larger structure. Based on the cross-sectional area type, straight fins are of different types such as rectangular fin, triangular fin, trapezoidal fin parabolic fin, or cylindrical fin. Fin performance can be measured by using the effectiveness of fin, thermal resistance, and efficiency [4].

1.2 Analysis of Heat Transfer

[1]Corresponding author: *Email addresses:* ogbezode.joseph@edouniverisity.edu.ng; jegerotimi@gmail.com (J. E. Ogbezode)

21. Shrikant V. B.; Sanjay, K. (2014): Investigation of Optimum Porous Pin Fin Parameter for Forced Convective Heat Transfer Through Rectangular Channel Part-I", International Journal of Emerging Technology and Advanced Engineering Issn 2250-2459, Iso 9001:2008 Certified Journal, Vol. 4, No. 8, pp. 1-12
22. Srinivasan, K.; Muthu, S.; Devadasan, S.R.; and Sugumaran, C. (2014): Enhancing effectiveness of Shell and Tube Heat Exchanger through Six Sigma DMAIC phases, Procedia Engineering, Vol. 97, pp. 2064 – 2071.
23. Sunil, C. (2015): A Taguchi Approach for Optimization of Flow And Geometrical Parameters In A Rectangular Channel Roughened with V-Down Perforated Baffles, Case Studies in Thermal Engineering, Vol. 5, pp. 59–69.
24. Tawat S.; Tanongkiat K.; and Atipoang N.; (2014): Enhancement of Fin Efficiency of A Solid Wire Fin by Oscillating Heat Pipe under Forced Convection, Case Studies in Thermal Engineering, Vol. 2, pp. 36–41.
25. Tonio Sant and Robert, N.F. (2015): Modeling the Energy Yield Enhancement from a Wind Turbine at a Deep Offshore Low Wind Site through Combined Power and Thermocline Energy Production, Journal of Solar Energy Engineering, Vol. 137, No. 11, pp. 1-8.
26. Vahabzadeh, A.; Ganji, D.D.; and Abbasi, M. (2015): Analytical investigation of porous pin fins with variable section in fully-wet conditions", Case Studies in Thermal Engineering, Vol. 5, pp. 1–12.
27. Valery, P.; Yitung, C.; James, C.; Merrill, W.; and Anthony, E. H. (2008): Calculation of Fluid Flow Distribution Inside a Compact Ceramic High-Temperature Heat Exchanger and Chemical Decomposer, Journal of Fluids Engineering, Vol. 130, No. 1, pp. 1-8.
28. Patil, S.; Chopade, D, and Pande, M. (2017): Experimental Analysis of Natural Convection of Heat Transfer of Different Types of Notches in Fins: A Review, International Journal for Scientific Research and Development, Vol. 5, No.1, pp. 781-785.
29. Weikla, M. C, Braunb, K. and Weiss, J. (2014): Coil Wound Heat Exchangers for Molten Salt Applications, Energy Procedia, Vol. 49, No. 4, pp. 1054 – 1060,
30. Yanhui, H.; Yan, L.; Ming, L.; and Jin H.; (2012): A Review of Development of Micro-Channel Heat Exchanger Applied in Air-Conditioning System", Energy Procedia, Vol. 14, No. 1, pp. 148 – 153.
31. Mansour, J. and Omid, D. (2020). Heat Transfer Correlation for Two-Phase Flow in a Mixing Tank, Journal of Heat and Mass Transfer Research, Vol. 7, No. 1, pp. 1-10. DOI: 10.22075/jhmtr.2020.17712.1232
32. Soheil, N.S. and Rahim, H. (2020). Heat Transfer Enhancement in a Spiral Plate Heat Exchanger Model Using Continuous Rods, Journal of Heat and Mass Transfer Research, Vol. 7, No. 1, pp. 39-53. DOI: 10.22075/JHMTR.2020.18783.1251
33. Narender, G.., Govardhan, V. and Sarma, S.G. (2019). Heat and Mass Transfer of Nanofluid Over a Linear Stretching Surface with Viscous Dissipation Effect, Journal of Heat and Mass Transfer Research, Vol. 6, No. 2, pp. 117-124. DOI: 10.22075/jhmtr.2019.15419.1214
34. Ananda, S., Sureshb, S. and Santhosh, K.D. (2019). Heat Transfer Studies of Supercritical Water Flows in an Upward Vertical Tube, Journal of Heat and Mass Transfer Research, Vol. 6, No. 2, pp. 155-167. DOI: 10.22075/jhmtr.2019.17488.1229
35. Rahmati, A. R. and Gheibi, A. Performance Investigation of Two Two-Stage Trans-Critical Carbon Dioxide Refrigeration Cycles Ejector and Internal Heat Exchanger, Journal of Heat and Mass Transfer Research, Vol. 6, No. 1, pp. 75-84. DOI: 10.22075/jhmtr.2018.1707.1152