A CRITICAL REVIEW ON PERFORMANCE ANALYSIS OF HELICAL TUBES IN CAR RADIATOR

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Abstract— *Radiator plays vital role in engine cooling. It is used to cool the engine. Car radiator is a heat exchanger which is used for cooling of car engines. Now a days Straight tubes heat exchangers are used in car radiator but helical tube heat exchanger has better advantages than straight tube or shell and type heat exchangers like it can accommodate a large heat transfer area in a small space, with high heat and mass transfer coefficients, also it has compact structure. In this paper, a comprehensive literature on the thermal behaviour of helical tubes in car radiator have been compiled and reviewed. Latest up to date literatures in terms of PhD and master thesis, Journal articles, conference proceedings have been reviewed. This paper aims to review some of these researches and compare the results obtained in previous studies.*

Keywords— Helical Tubes; Car Radiator; Heat Transfer Enhancement

1. INTRODUCTION

Nomenclature
H Heat transfer coefficient
K Thermal conductivity
Nu Nusselt number
Re Reynolds number
De Dean Number

Radiator is an important equipment for car engine. Radiators are one type of heat exchangers used to cool the engine. Cooling system is one of the most important factors in engine as it is responsible to take large amount of waste heat yo surrounding for best working of an engine. Conventionally, straight tubes were used in car radiator. Helical tubes have better advantages than straight tubes.

The technology of automobile industry has been increasing continuously and it requires a high efficiency engines which can be obtained by better heat transfer in radiator.it can be achieve by helical tubes which gives more heat transfer in small area. The heat flow of process Q is directly proportional to h, A and T, where Q is the heat flow, h is the heat transfer coefficient, A is the heat transfer area and ΔT is the temperature difference that results in a heat flow. Increased heat transfer can be achieved by increasing ΔT, increasing A, increasing h.

Maximizing the heat transfer area A is a common strategy to improve heat transfer, increasing the heat transfer area can only be achieved by increasing the size of the heat exchangers which can lead to unwanted increase in weight. So by using of helical tubes which gives more surface area in same volume. And it can give more heat transfer in same volume.

2. L I T E RATU RE REVIEW

<table>
<tr><th>Research Paper Title</th><th>Content</th></tr>
<tr><td>Parametric study of heat transfer enhancement on cross-flow heat exchangers</td><td>Author Name – X.J.Luo Year-2017
Material-Copper-brass
Research findings –The effects of internal and external recycle on cross flow heat exchangers were investigated. The heat transfer rate of heat exchangers can be effectively enhanced by recycles in most cases. The enhancement of heat transfer rate increase with the increase of recycle ratio, heat capacity ratio or the decrease of heat transfer area. Heat transfer rate of cross-flow heat exchanger can reach up to 121% to 128% with internal and external recycles, respectively</td></tr>
<tr><td>Experimental study of forced convection from helical coiled tubes with different parameters</td><td>Author Name – M.Moawed
Year-2010 Material- brass
Research findings –For the same P/ I, the higher values of nusselt
number(N n) can be obtained with a high value of D/ I, while the small value N n of can be obtain with the small value of D/ I. Pitch ratio of coiled tube is affecting on nusselt number and higher value of nusselt number can be achieved with the small value of pitch ratio P/ I,
N n=0.0345 1 I.nn ( )I.n1n ( )I.nn1</td></tr>
<tr><td>Thermal analysis of a helical coil heat exchanger</td><td>Author Name – Amol Andhare, V.Mkriplani, J.p.modak
Year-2014
Material- copper-brass
Research findings –
<table>
<tr><th>Coil</th><th>di (mm)</th><th>do(mm)</th><th>Dc(mm)</th><th>L(mm)</th><th>b (mm)</th><th>δ</th><th>N</th></tr>
<tr><td>1</td><td>11.7</td><td>12.7</td><td>90</td><td>5715</td><td>18</td><td>0.13</td><td>18</td></tr>
<tr><td>2</td><td>11.7</td><td>12.7</td><td>105</td><td>6000</td><td>15</td><td>0.111</td><td>17</td></tr>
<tr><td>3</td><td>11.7</td><td>12.7</td><td>115</td><td>6000</td><td>24</td><td>0.101</td><td>15</td></tr>
</table>
Characteristic Shell length=0.5m
Shell diameter=15.24m
di-inner diameter do-outer diameter
Rc-Curvature radius
L-stretched of coiled tube b-coil pitch
δ-curvature ratio=d/2Rc N-number of data points
An experimental analysis was carried out to study heat transfer coefficients considering pitch ratio and curvature</td></tr>
</table>

	ratio of a helical coil heat exchanger. Helical coil heat exchangers with three different coil pitch and three different curvature ratio were done for counter flow. And then found that shell side heat transfer coefficient is larger than tube side heat transfer coefficient. And heat transfer of coil 1 was more compared to other two coil.
Parametric studies on automotive radiators	Author Name – C.oliet, A.oliva , j.castro Year-2007 Parameter tested – temperature, pressure Material- copper brass Research findings - the overall heat transfer coefficient Reveals almost independent of the air inlet temperature. The overall heat transfer coefficient essentially depends on the coolant flow regime (Re number) when coolant fluid or coolant flow arrangement are varied. The I-flow coolant arrangement is generally better than U- flow, if the achieved flow regime is considered acceptable. Nozzles pressure drop can overshadow the impact of a parameter on the core coolant pressure drop
Flow analysis of automobile radiator	Author Name – G.vinod reddy Year-2013 Parameter tested – temperature, mass flow rate Material- aluminum, copper Research findings – A comparison between Aluminium and Copper alloy radiator models. It is found that Copper radiator is more efficient when compared with the Aluminium radiator due to higher temperature drop (3.56 %.). However, The Aluminium radiator is less costly. In copper radiator The length of radiator gets decreased by 204mm from its original dimensions. Height also gets decreased to 30mm from its original dimensions. A new design of the radiator has been proposed. The radiator dimensions were changed by increasing the width from 20 mm to 40 mm. And this change has reduced in reducing the maximum temperature by 3.9 %.
Heat transfer and pressure drop for low Reynolds turbulent flow in helically dimpled tubes	Author Name – Pedro G. Vincete, alberto Garcia, Antonio viedema Year-2011 Parameter tested – pressure, mass flow Material- aluminum Research findings – higher pressure dropped and heat transfer found in all dimpled tubes than smooth tube at the same flow condition.150% to 350% increase in friction factor and up to 250% increase in nusselt number.
Developing turbulent convective heat transfer in helical pipes	Author Name - c. X. Lin, m. A. Ebadian Year-2014 Parameter tested – temperature, mass flow rate, pressure Material- aluminum Research findings – Experiment was done on the fabricated spiral radiator, with circumference aluminium fins. Numerical studies also performed on the radiator. Heat exchangers namely heat transfer rate, non-dimensional numbers such as Reynolds number, Nusselt number, effectiveness, overall heat transfer coefficient, log mean temperature difference were studied. After comparison of experimental value and numerical value, it was found that, they are almost same with each other. Deviation 3.38% found in outlet temperature. It was found that outlet temperature increased with the increase of volume flow rate of water. Observed that nusselt number is increase rapidly with Reynolds number at starting, but then increase of Reynold number, nusselt number is found to be constant.
Experiment investigation of heat transfer and pressure drop characteristics of flow through spirally fluted tubes	Author Name – Richard N. Christensen Year Parameter tested – mass flow rate, pressure Material- aluminum Research findings – laminar and transition flow has best nl Ratio. n=heat transfer enhancement =friction factor enhancement Friction factor increase over smooth tube value were typically between 1.1 and 2.0 for laminar flow and up to 10 for turbulent flow. Friction factor increase with an increase in flute depth, decrease in flute pitch and an increase in flute helix angle.
Comparison of heat transfer between a helical and straight tube heat exchanger	Author Name-Bibin Prasad, saju haneef Year-2013 Parameter tested – mass flow rate, temperature, pressure Material- aluminum Research findings- comparison of heat transfer characteristics in helical tube heat exchanger and straight tube heat exchanger is carried out numerically. It was found that helical tube heat exchanger is much better than straight tube heat exchanger with increase in the heat transfer coefficient. For particular mass flow rate ,helical tube heat exchanger provides an increase in heat transfer coefficient by 10% Heat transfer coefficient is increase with mass flow rate. Results are interpreted by predicting correlation between nusselt number and dean number as I = 0.0271 (inner helical tube) I.nnnn 1 I = 0.1407 11.IInn (outer helical tube)

3. CONCLUSION

From the above review we can concluded that as we are using helical tubes in car radiator will gives much better advantages like compact structure. Helical tubes radiator has better heat transfer coefficient so good heat transfer rate can be achieve. Also various configuration is possible by set different pitches of helical tubes. Another advantages is that pressure drop is low. It gives more surface area in less volume, which gives more heat transfer in same volume because surface area is increased. So efficiency of radiator increase if we use helical tube radiator

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