Thermal Enhancement of Spiral Radiator with different Configuration of Circumferential Fin

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Abstract — In a Computational Fluid Dynamics (CFD), the trial has been conducted on the heat transfer coefficient, effectiveness and temperature, for a spiral radiator with circumferential fins. In the CFD investigation it was assumed that, the circumferential fins with different configuration are proposed. This investigation was carried out on a Reynolds Number ranging in between 2000-3500.

Keywords— Spiral radiator, Circumferential fin, Reynolds Number, Heat transfer coefficient.

I INTRODUCTION

The suggested study focuses on a better heat exchanger (Radiator) design that may be used to either heat or cool a fluid. Additionally, it discusses the study specifically related to an enhanced fan assisted air-cooled heat exchanger utilised in automobiles and internal combustion engines (IC) power plants, engines, and refrigeration systems. Everybody is competing for manufacturing in the working diligently to improve the quality, effectiveness, and performance of their equipment as well as to enhance parts, such as heat exchangers.

There are several types of heat exchangers that use air as the heat transfer medium since it is readily and abundantly accessible and poses no disposal problems. Air flow is either spontaneously produced or helped by the use of one or more fans in recognised heat exchangers. Utilizing a fan lowers it is more compact because of the equipment's size and price. Consequently, fan-assisted air more people choose cooled heat exchangers than others.

TYPE HEAT EXCHANGERS IN AUTOMOBILES

Various heat exchangers employed in modern automobiles are,

- Radiator
- Transmission Oil Cooler
- Engine Oil Cooler
- Evaporator
- Condenser
- Engine water Jackets
- Exhaust Gas Cooler
- Brake Drums
- Turbo intercooler

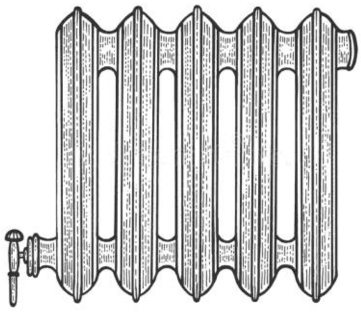

Figure 1: Radiator

According to the configuration of heat sink, it is classified as follows

- Rectangular channel heat sink
- Circular fin heat sink
- Stamped heat sink
- Annular fin shaped heat sink
- Zigzag shaped heat sink

II OBJECTIVES

- The main objective of our proposed work is validation of the spiral radiator models by comparing the shows simulated outcome.

- To predict temperature distribution of circumferential fin with different annular fin geometry in spiral radiator tube.
- To compare the numerical analysis with experimental result present in literature.

III PREPARATION OF THE CAD MODEL

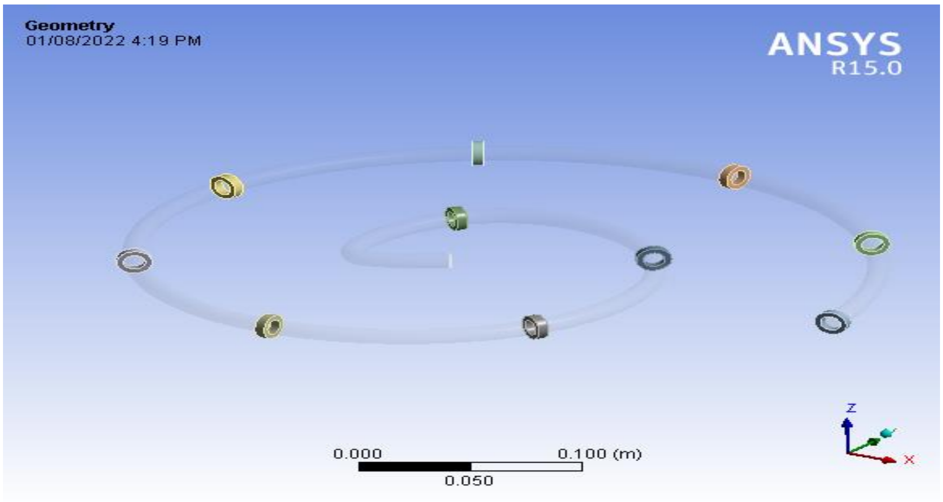

Fig.1 showing the geometric dimension of the spiral radiator with circular circumferential fins.

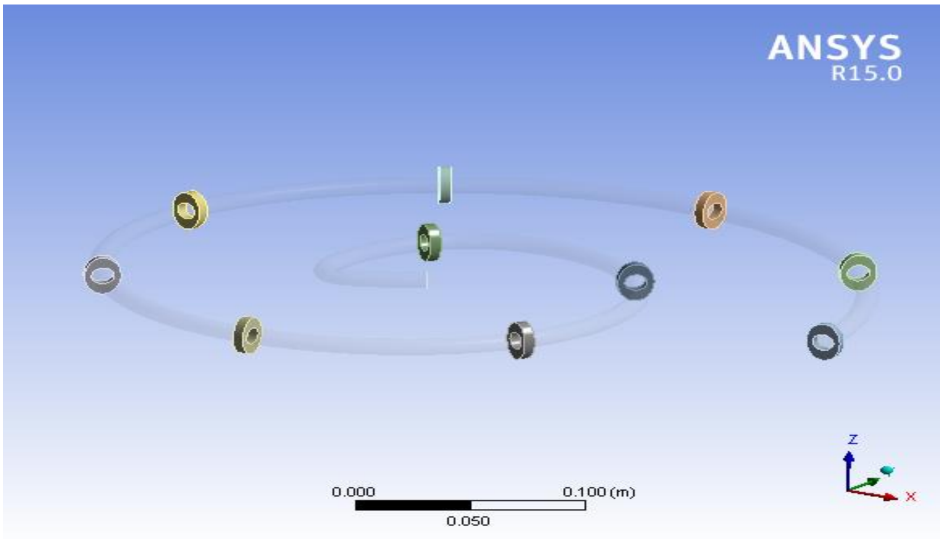

Fig. 2 showing the geometric dimension of the spiral radiator with elliptical circumferential fins.

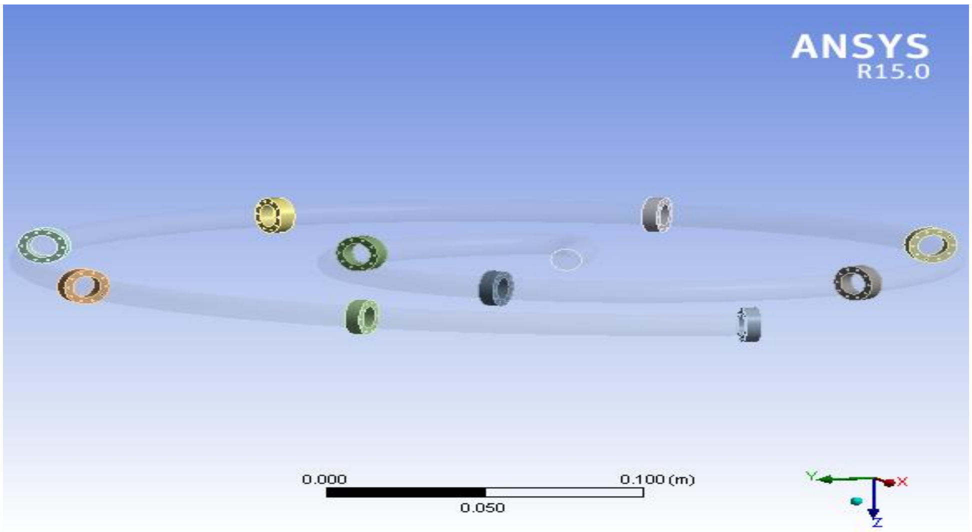

Fig. 3 showing the geometric dimension of the spiral radiator with circular perforated circumferential fin

IV. Validation of CFD model

Water velocity (m/s)	Temperature (K)
0.25	345.2
0.3	334.5
0.4	323.7
0.7	309.7
1	304.1

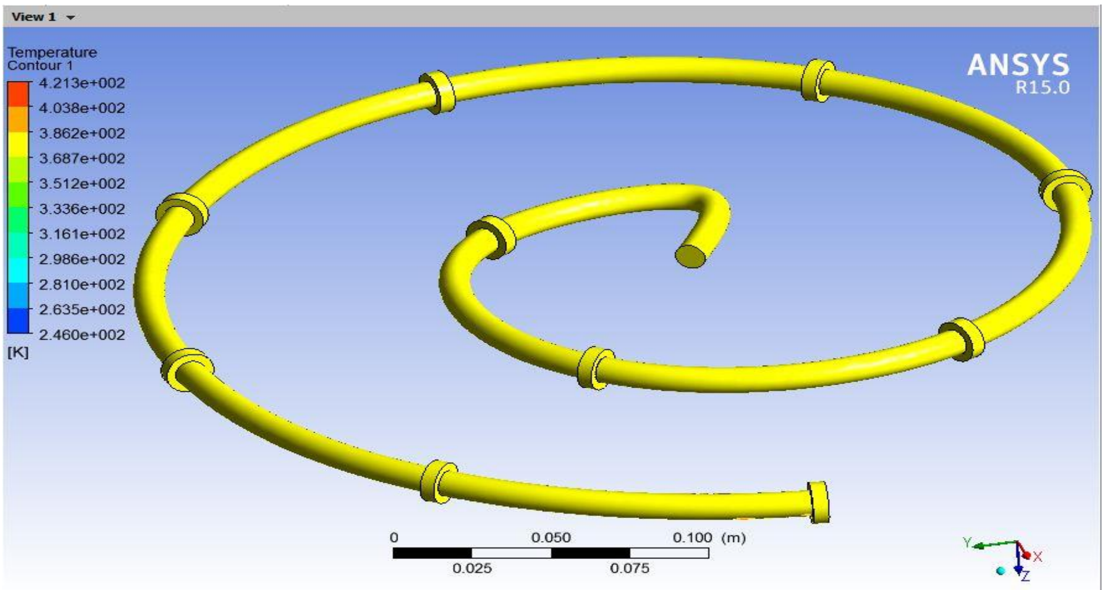

Fig 4: Temperature distribution of spiral tube radiator with circular shaped circumferential fin.

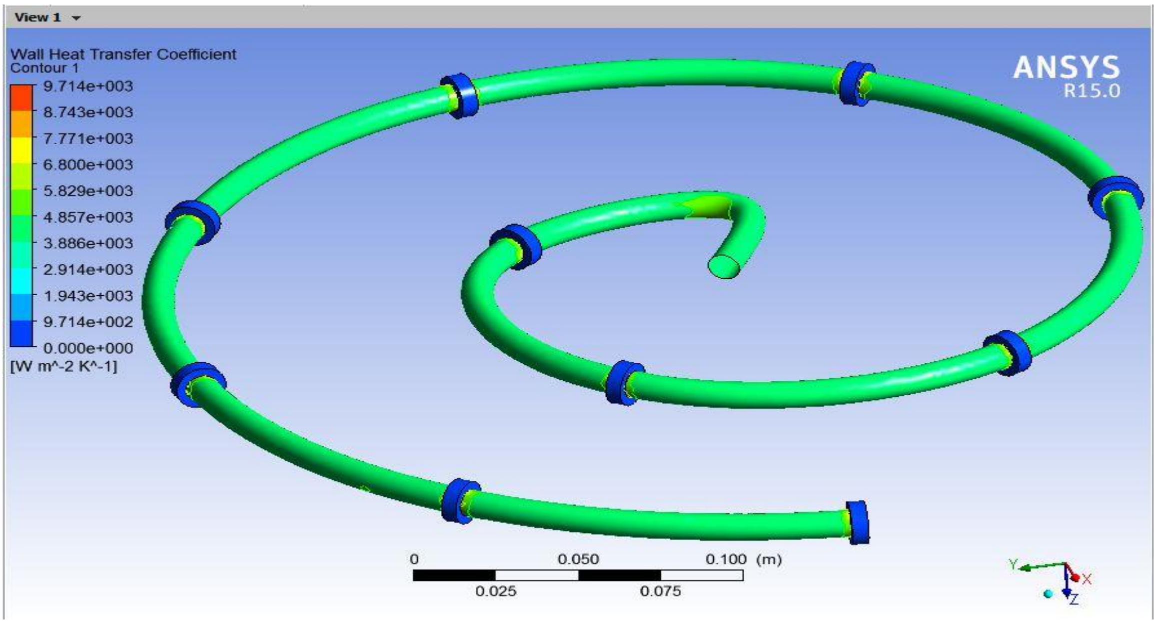

Fig 5: Heat transfer coefficient of spiral tube radiator with circular shaped circumferential fin.

V. Optimization result for radiator spiral tube with elliptical circumferential fin

Table.1: The values of temperature calculated through CFD for different water velocity in elliptical circumferential fin.

Velocity (m/s)	Temperature (K)
0.25	367
0.3	357
0.4	339
0.7	318
1	311

Table: 2: The comparison of temperature values of heat sink top surface calculated

S No.	Velocity (m/s)	Temperature (K) measured in previous research work	Temperature (K) measured through CFD	% Error
1	0.25	345.2	367	6.31
2	0.3	334.5	357	6.726
3	0.4	323.7	339	4.72
4	0.7	309.7	329	6.24
5	1	303	322	6.27

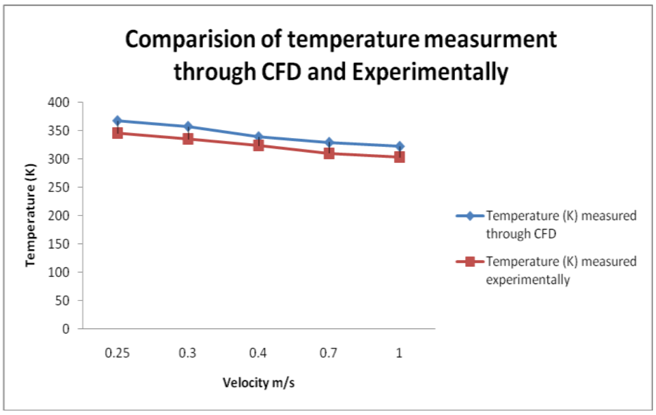

Fig.6: Showing the comparison of temperature measure at the circumferential fin through CFD and experimentally (Base paper result)

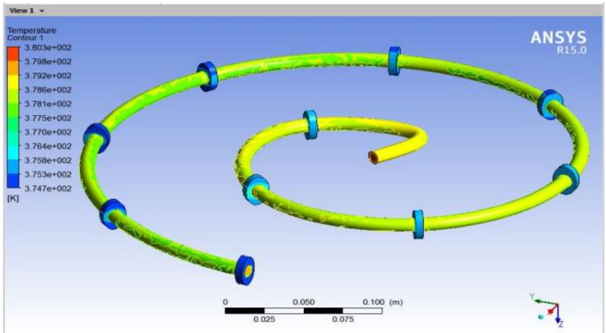

Fig 7: temperature distribution of spiral tube radiator with circular shaped circumferential fin.

VI. Optimization of circumferential fin geometry circular perforated

Table: 3: The surface temperatures of heat sink having rectangular annular fins for different velocities

Velocity (m/s)	**Temperature (K) at the top of the heat sink calculated through CFD analysis**
0.25	367
0.3	357
0.4	339
0.7	318
1	311

Table: 4: Showing the temperature values of heat sink top surface at different velocities

S. No.	Velocity (m/s)	Temperature (K) of fin surface
1	0.25	362
2	0.3	350
3	0.4	335
4	0.7	316
5	1	309

S. No.	Velocity (m/s)	Temperature (K) measured for sink having Rectangular annular fins	Temperature (K) measured for sink having circular annular fins
1	0.25	367	362
2	0.3	357	350
3	0.4	339	335
4	0.7	318	316
5	1	311	309

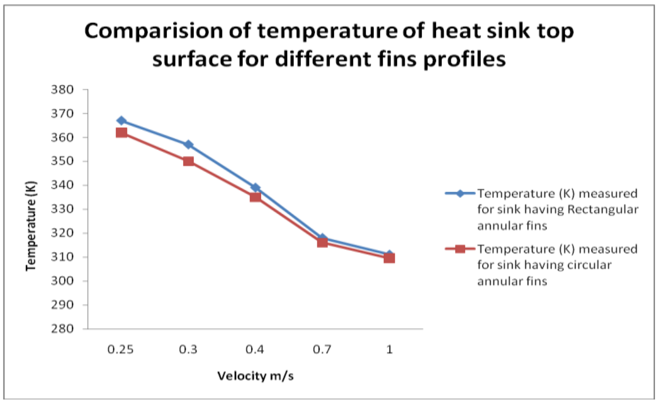

Fig.8: Shows the comparison of temperature at the top of the heat sink using PLA as a working material for heat sink having different fins profile.

Table: 5: Showing the temperature distribution of heat sink top surface having rectangular fins

Velocity (m/s)	**Temperature (K) at the top of the heat sink calculated through CFD analysis**
0.25	404
0.3	398
0.4	395
0.7	390
1	383

Table: 5 Showing the temperature of the heat sink top surface for different velocities

S. No.	Velocity (m/s)	Temperature (K) at the top of the heat sink
1	0.25	398
2	0.3	392
3	0.4	388
4	0.7	383
5	1	378

Table: 6 Comparison of temperature measured in circumferential fin top surface with different velocities

S. No.	Velocity (m/s)	Temperature (K) at the top of the heat sink having rectangular annular fins	Temperature (K) at the top of the heat sink having circular annular fins
1	0.25	404	398
2	0.3	398	392
3	0.4	395	388
4	0.7	390	383
5	1	383	378

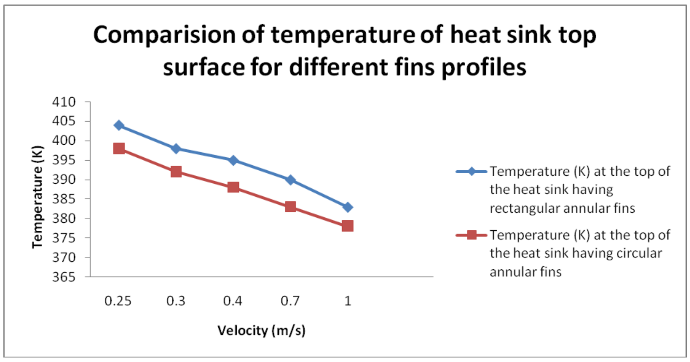

Fig.9: Showing the comparison of the temperature at the top of the heat sink for different configuration.

CONCLUSION

- Simulated the spiral radiator having circumferential fin of rectangular, circular and circular perforated annulus shaped fins for different velocity of (0.25-1.00m/s).
- From the above result we have least temperature distribution for circular perforated shaped annular profiled circumferential fin for different velocity of water circulating inside the spiral radiator tube.
- From the above result the best temperature distribution on perforated circular shaped annular fin of spiral tube radiator with different water velocities and in material of aluminium and copper as spiral tube material.
- So, from the above it was concluded that the perforated circular shaped heat sink on annular profile at different velocity having better heat transfer rate, due to increase in surface area of circumferential fin thus heat concentration decreases as increase in surface area of fin of spiral radiator tube.

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