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THERMAL PERFORMANCE ANALYSIS OF RADIATOR WITH COATED MATERIAL

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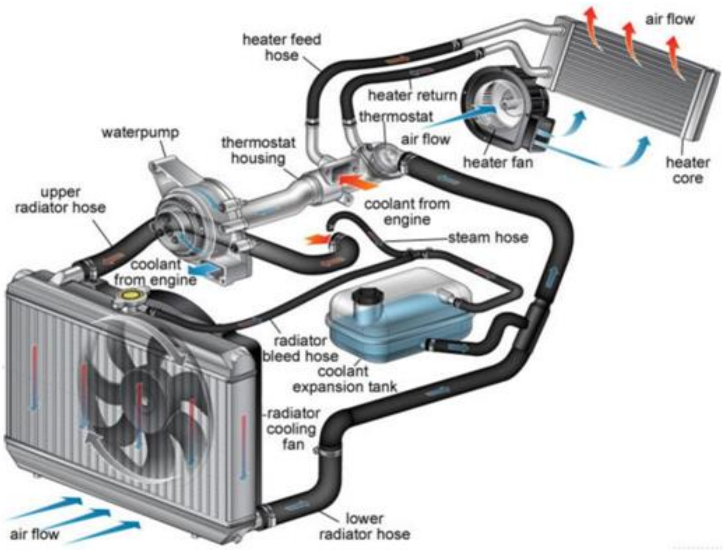
Abstract

Radiators are a type of heat exchangers used to transfer thermal energy from one medium to another for the purpose of cooling and heating. The heat dissipation efficiency of the radiator is of great significance to the reliability of the power transformer system. However, traditional coatings on the radiator are designed to improve the corrosion resistance of radiators, which usually have a lower thermal conductivity. In this project, the thermal properties of copper coating have been studied with 100micron coating thickness. The main objective of the work is about 15% improvement in the thermal conductivity compared to the traditional anti-corrosive coatings. It provides a simple and effective way to accelerate the heat spread of radiators and thus lower the system temperature. In this project, the coolant fluid will be transmitted at 0.04 kg/s mass flow rates, at 100 micron coating thicknesses, and coated on the top surface of the radiator tubes and fins. Flow analysis will be performed for 100c temperature as heat input conditioning for CFD. The optimal values of the parameters are obtained with the help of the graphs.

KEYWORDS : RADIATOR,COMPUTATIONAL FLUID, DYNAMICS, ALUMINIUM, COPPER, TEMPERAUTURE,COATING.

1. Introduction

Radiators are used to convert thermal energy from one mode to another for the purpose of cooling and heating. Radiators function in automobiles, buildings as well as in electronics. The radiator acts as a source of heat to the surrounding but might be the purpose of heating the environment, it acts as a coolant source for automotive engine cooling Radiators transfer most of their heat via convection rather than thermal radiation. If there are large temperature differences, it can cause distortion of the engine components. The radiator will do the cooling purposes because the temperature of the burning gases in the engine cylinder reaches up to 1500 to 2000°C Radiators transfer most of their heat via convection rather than thermal radiation. If there are large temperature differences, it can cause distortion of the engine components. The radiator will do the cooling purposes because the temperature of the burning gases in the engine cylinder reaches up to 1500 to 2000°C.The radiator has a wide range of application in automobile industries there are mainly used to cool the internal combustion engine in the automobile. They also used in piston-engined aircraft, Railway, locomotives, motorcycles, stationary generating plants and other places where such engines are used.



1.1 Types of Radiator

There are two basic types of radiator

1. Tubular type

2. Cellular type

Tubular Type Core

In tubular type core, the upper and lower tanks are connected by a series of tubes through which water passes. Fins are placed around the tubes to improve heat transfer. Air passes around the

outside of the tubes, between the fins, absorbing heat from the water in passing. In a tubular radiator, because the water passes through all the tubes, if one tube becomes clogged,

the cooling effect of the entire tube is lost.

Cellular Type Core

In cellular type core, air passes through the tubes and the water flows in the spaces between them.The core is composed of a large number of individual air cells which are surrounded by water. Because of its appearance, the cellular type usually is known as a honeycomb radiator, especially when the cells in front are hexagonal in form. In a cellular radiator, the clogging of any passage results in a loss but of a small part of the total cooling surface.

2. Materials and Methods

2.1 CFD

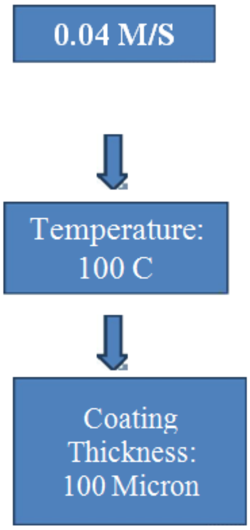
Computational Fluid Dynamics (CFD) is one of the branches of fluid mechanics that uses numerical methods and algorithms to analyze and solve the problems that involve fluid flows.

CFD has become an integral part of the engineering design cycle. CFD analysis reduces the development time and increases the reliability of the designs. It makes it possible to evaluate and predict the working parameters such as velocity, pressure and temperature throughout the solving process. The fundamental basis of any CFD problem is the Navier Stokes equations, which define any single phase fluid flow. It works by solving the equations of the fluid flow over a region of interest, with the specified known conditions on the boundary of that region. Conservation of matter, momentum and energy must be satisfied throughout the region of interest.

2.2 Flow simulation

Flow Simulation is capable of calculating flow of fluids of different types in the same analysis, but fluids of different types must be separated by walls. A mixing of fluids may be considered, only if the fluids are of the same type. Flow Simulation has an integrated database containing properties of several liquids, gases and solids. Solids are used in conjugate heat conduction analysis. For each analysis maximum of ten liquids or gases can be chosen. It can analyse various types of flows namely turbulent flows, Laminar flows and Laminar or Turbulent flows. The turbulent equations can be disregarded, only if the flow is entirely laminar. It will analyse and simulate the effects of fluid flow, heat transfer, and related forces on immersed or surrounding components.

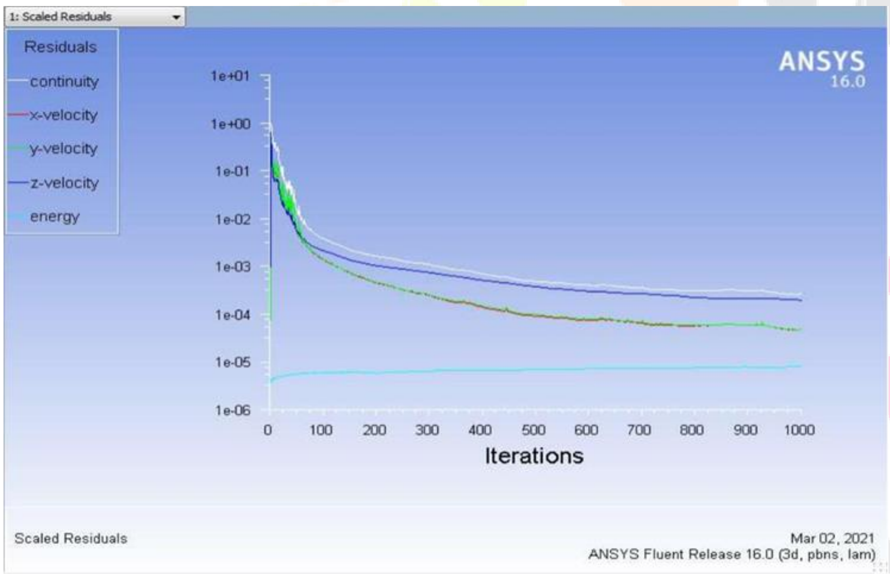
2.3 Input parameters for Simulation



3. Results and Discussion

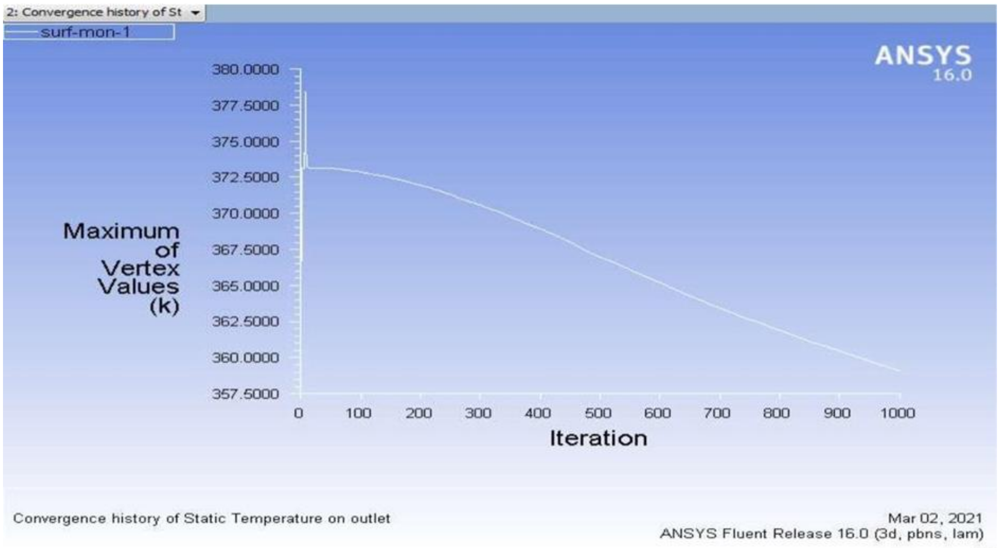
3.1 Perforamnce analysis

a. WITHOUT COATING – CONVERGENCE HISTORY



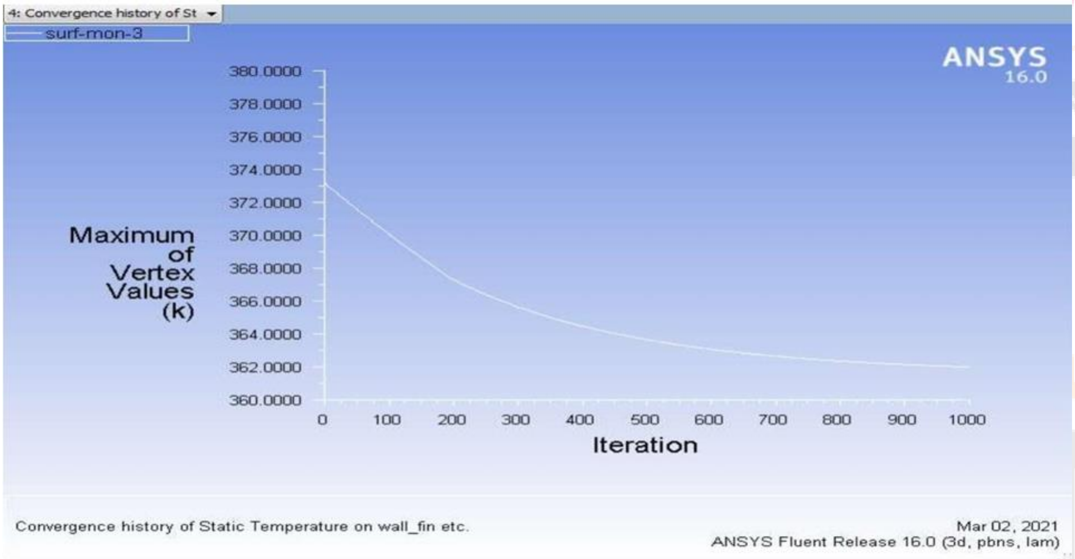
The Above Graph represents all the x,y& z velocity are come to linear condition while reaching 1000.

b. WITHOUT COATING OUTLET TEMP CONVERGENCE GRAPH



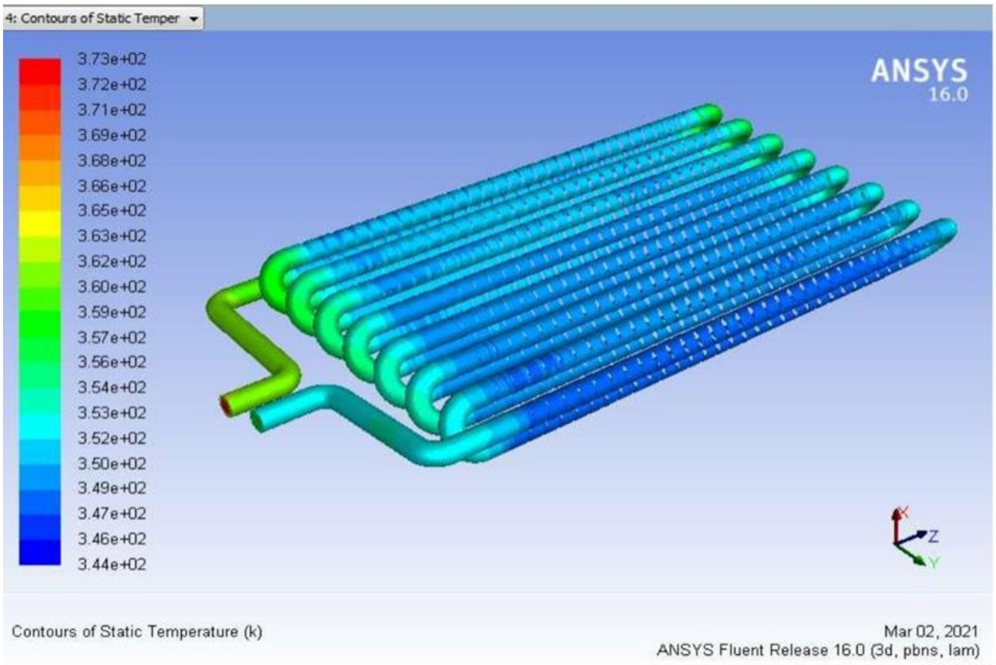
The Above Graph represents the convergence history of static temperature. The maximum of Temperature Values drops in iteration while reaching 1000.

c. WITHOUT COATING – FIN SURFACE TEMP CONVERGENCE GRAPH



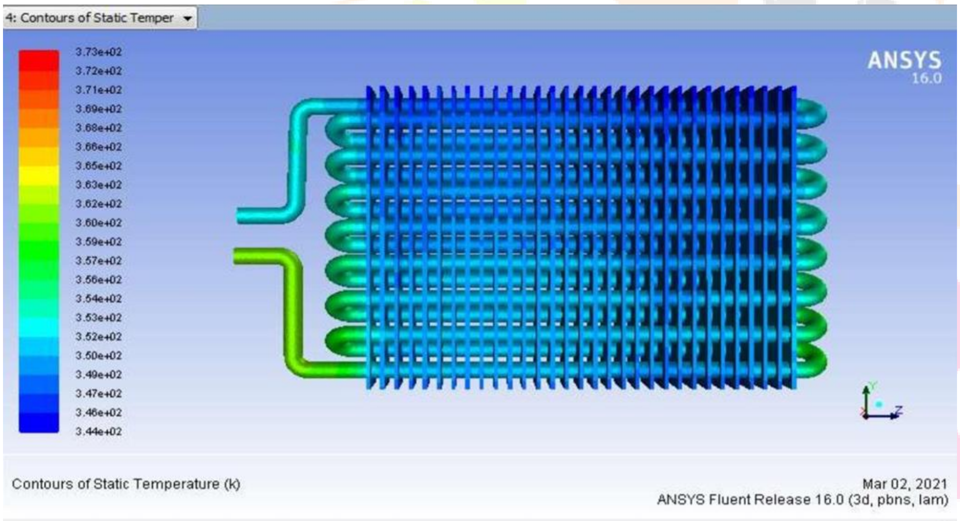
The Above Graph represents the convergence history of static temperature. The maximum of temperature Values drops in iteration while reaching 1000.

d. WITHOUT COATING – INLET, OUTLET, FIN, PIPE TEMP RESULTS



The Analysis is done without coating. According to input in all (inlet, outlet, fin & pipe), the static Temperature is 3.6 e +02 at inlet and 3.53 e +02 at outlet. The Static Temperature of radiator is maximum at inlet and minimum at outlet.

e. WITHOUT COATING – INLET, OUTLET, FIN, PIPE TEMP RESULTS



Area-Weighted Average Static Temperature	(k)
inlet	373.15001
outlet	358.9077
wall_fin	348.68731
wallout	350.9823
Net	349.24907

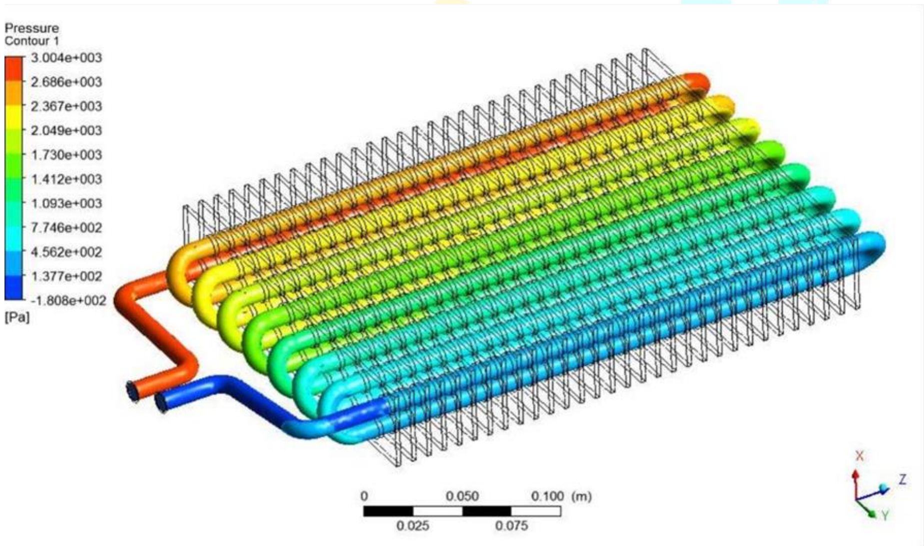
The Analysis is done without coating. According to input in all (inlet, outlet, fin & pipe), the static Temperature is 373k at inlet and 358k at outlet. Minimum Temperature 350k at pipe surfaces and 348k at radiator fin surface due to convection between solid and atmosphere.

f. WITHOUT COATING – INLET, OUTLET, FIN, PIPE WALL TEMP RESULTS

Area-Weighted Average Static Temperature	(k)
inlet	373.15001
outlet	358.9077
wall_fin	348.68731
wallout	350.9823
Net	349.24907

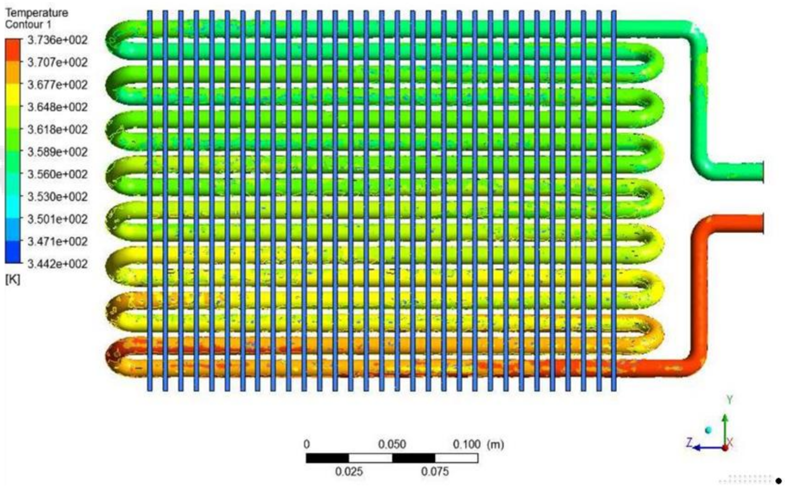
The above Figure shows Area Average values of temperature at different locations

f. WITHOUT COATING – PRESSURE CONTOUR



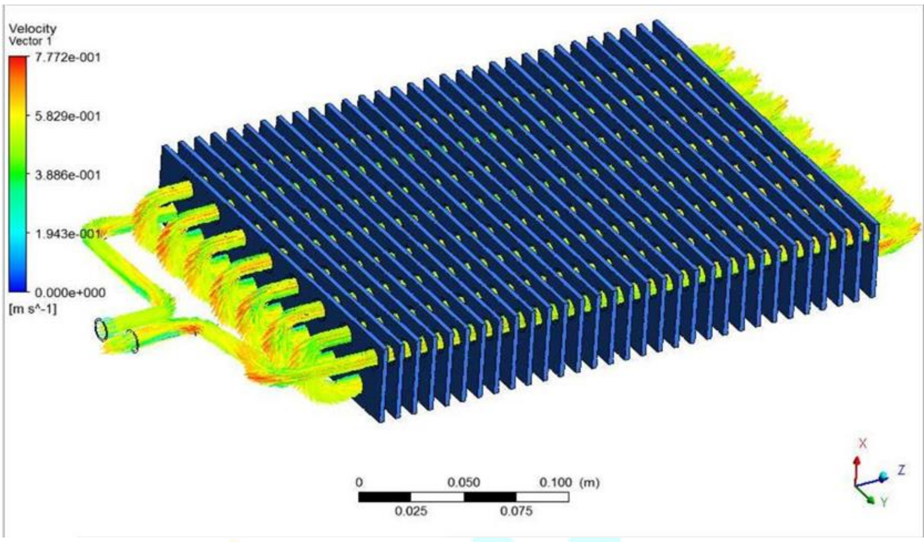
The figure shows the pressure contour in the radiator at mass flow rate of coolant is 0.04 m/s and inlet temperature is 1.80e+005 Pa. The Pressure of inlet and goes on increasing till the outlet.

g. FLUID – TEMPERATURE



The figure shows the Fluid Temperature in the radiator at mass flow rate of coolant is 0.04 m/s and inlet temperature is 3.5e+002 Pa. The Temperature of Inlet is high while comparing outlet.

h. VELOCITY VECTOR FLOW



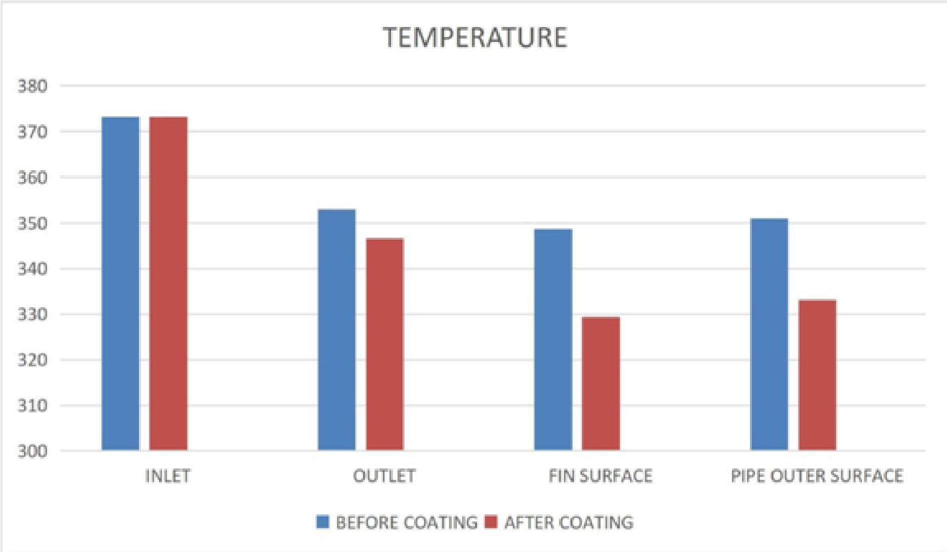


Fig.xxx Temperature Vs Coating (before and after)

TEMPERATURE (K)	BEFORE COATING (K)	PERCENTAGE OF TEMP LOSS	AFTER COATING(K)	PERCENTAGE OF TEMP LOSS
INLET	373.15	-	373.15	-
OUTLET	358.91	3.82%	346.61	7.11%
FIN SURFACE	348.68		329.32	
PIPE OUTER SURFACE	350.98		333.15	

4. Conclusion

CFD with and without coating on the pipe and pin surface of the radiator, analysis has been carried out. From the table it clearly shows that coating material has play the vital role in increasing heat transfer rate in radiators. In this analysis, using copper coating over the pipe and fin surface, 7.11 % heat has reduced in the radiator outlet.

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