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Evaluation of Thermal Characteristics of Continuous Fin and Interrupted Fin Tube Evaporators using R717 and R774 in CFD Analysis

M.Indira[1], N.Gopal[2], P.Srinivasulu[3], P.Raju[4]
[1]*M.Tech (TE) Student, Dept of Mechanical Engg/ Vagdevi College of Engineering, Warangal, T.S India*
[2]*Professor, Dept of Mechanical Engg/ Vagdevi College of Engineering, Warangal, T.S India*
[3]*Professor, Dept of Mechanical Engg/ Vagdevi College of Engineering, Warangal, T.S India*
[4]*Assistant Professor, Dept of Mechanical Engg/ Vagdevi College of Engineering, Warangal, T.S India*

Abstract - In this research paper aims to evaluate the thermal characteristics of continuous fin tube evaporator and interrupted fin tube evaporator using R717 and R774 refrigerants in CFD analysis. The CFD Analysis will be done to obtain fluid pressure, velocity, heat transfer coefficient, Heat transfer rate and mass flow rate for both R717 and R774 refrigerants. Were we have considered that Aluminium alloy7075 is the evaporator material. The drawing evaporator models done in Pro/Engineer and CFD analysis is done in Ansys to obtain thermal characteristics of both configurations. Finally comparative analysis also done for both configurations of evaporators at different refrigerants.
Key words: Evaporator, Refrigerants, pressure, velocity, heat transfer coefficient, Heat transfer rate, mass flow rate, CFD analysis etc

I. INTRODUCTION

An evaporator is used in an air-conditioning system or refrigeration system to allow a compressed cooling chemical, such as Freon or R-22, to evaporate from liquid to gas while absorbing heat in the process. It can also be used to remove water or other liquids from mixtures. The process of evaporation is widely used to concentrate foods and chemicals as well as salvage solvents. In the concentration process, the goal of evaporation is to vaporize most of the water from a solution which contains the desired product.

II. LITERATURE SURVEY

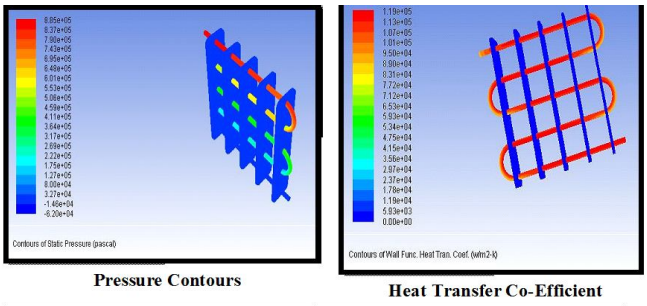
Jader R. Barbosa et all, have researched that Parametric Optimization of Fin-Tube Type Evaporator Using FEA-DOE Hybrid Modeling. An Evaporator is the Main component of Air-conditioning system. An evaporator is mainly used in different refrigeration and air-conditioning applications in food and beverage industry, in the pharmaceutical industry etc. Zine Aidoun et all, have worked on Thermal and CFD Analysis of Fin Tube Evaporator with Different Configurations, Materials and Fluids. In this thesis, different configurations of fin tube evaporator are modeled in 3D modeling software Pro/Engineer. The temperature distribution, heat transfer rate is analyzed by thermal and CFD analysis done in Ansys. Thermal analysis is done on four different configurations are continuous fin, continuous fins with zig-zag tubes, interrupted fin and interrupted fin with zigzag tubes with different materials for evaporator Aluminum, Aluminum alloy 7075 and Copper. CFD analysis is done by varying fluids R134a, R22a and R410a on all the configurations. Kiran B. Parikh et all, have worked on enhanced finned-tube condenser design and optimization. Finned-tube heat exchangers are widely used in space conditioning systems, as well as any other applications requiring heat exchange between liquids and gases. Their most widespread use is in residential air conditioning systems. Residential systems dictate peak demand on the U.S. national grid, which occurs on hot summer afternoons, and thereby sets the expensive infrastructure requirement of the nation's power plant and electrical distribution system. In addition to peak demand, residential air conditioners are major energy users that dominate residential electrical costs and environmental impact.

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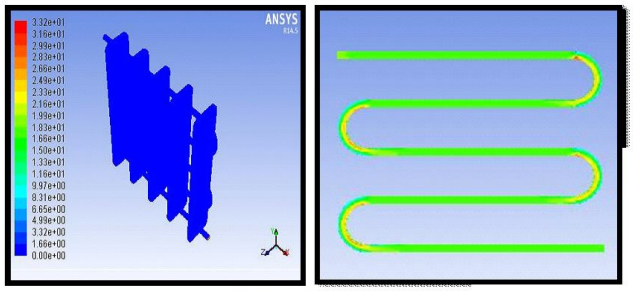
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III. CFD ANALYSIS OF FIN TUBE EVAPORATOR

A. Evaporator- Continuous Fin with Fluid- R717

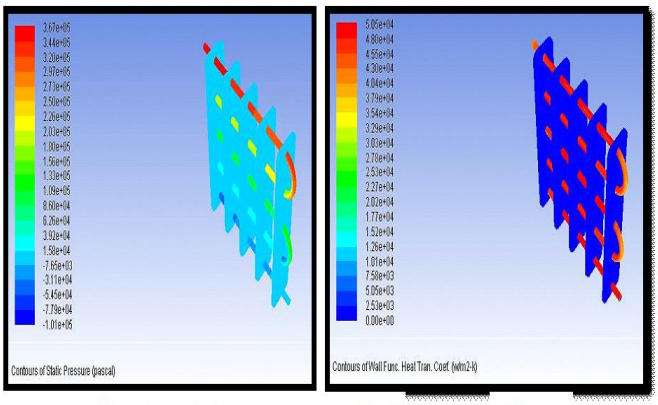


Pressure Contours Heat Transfer Co-Efficient

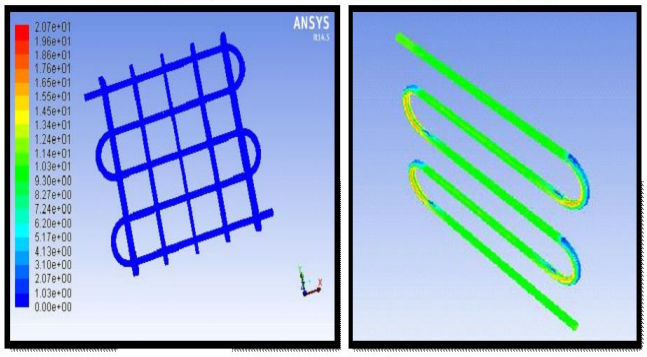


Velocity Magnitude

B. Evaporator- Continuous Fin with Fluid- R744



Pressure contours Heat Transfer Co-Efficient

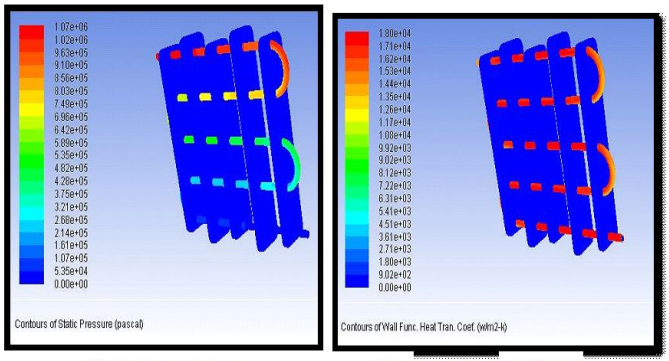


Velocity Magnitude

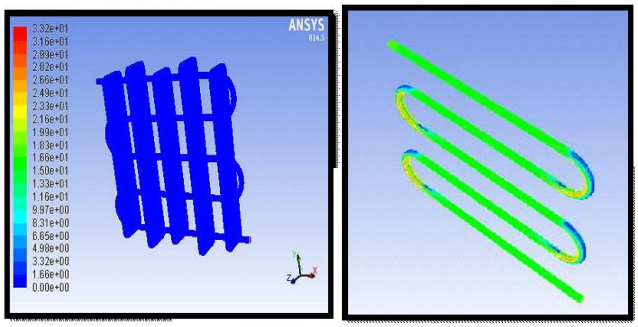
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C. Evaporator- Interrupted Fin with Fluid- R717

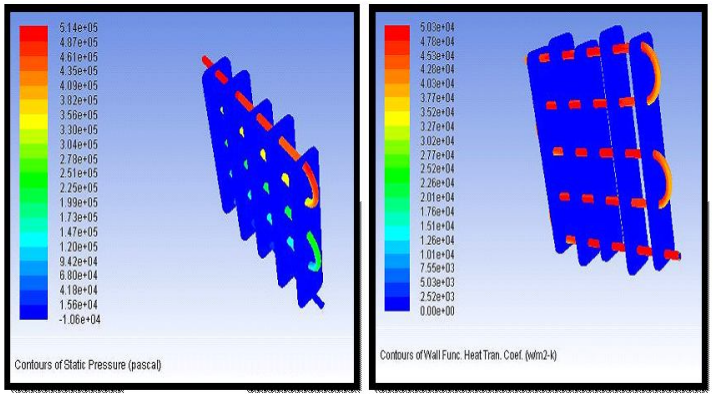


Pressure contours **Heat transfer co-efficient**

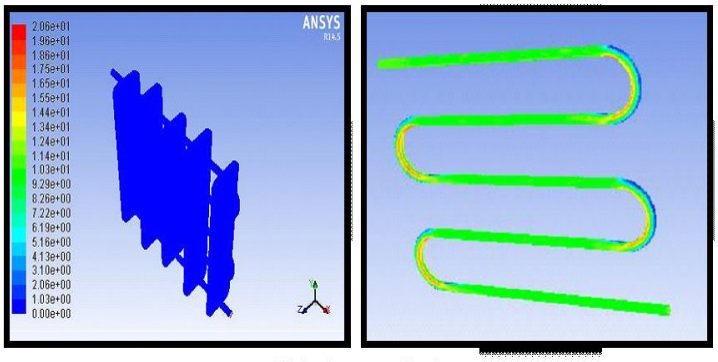


Velocity magnitude

D. Evaporator- Interrupted Fin with Fluid- R744



Pressure contours **Heat transfer co-efficient**



Velocity magnitude

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IV. RESULTS AND DISCUSSIONS

Table: CFD Analysis Results

Evaporator type	Continuous Fin		Interrupted Fin	
Refrigerant type	R717	R744	R717	R744
Pressure (Pa)	8.85E+05	3.67E+05	1.07E+06	5.14E+05
Velocity (m/s)	3.32E+01	2.07E+01	3.32E+01	2.06E+01
Heat transfer coefficient (W/m^2-K)	1.19E+05	5.05E+04	1.80E+04	5.03E+04
Mass flow rate (Kg/s)	0.00418	0.00374162	0.0001006	0.007844
Heat transfer rate (W)	793.500	330.1645	1.8354	691.68

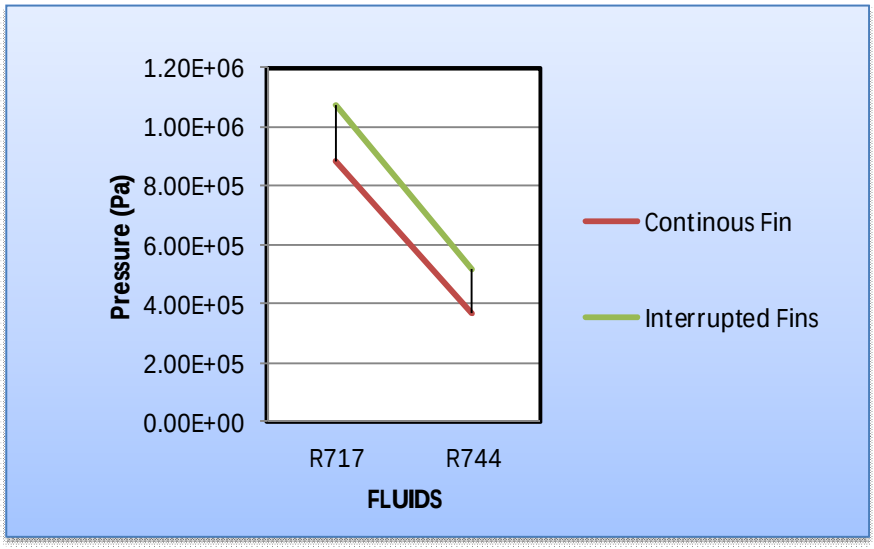


Fig: comparison of pressure values for different configurations and fluids

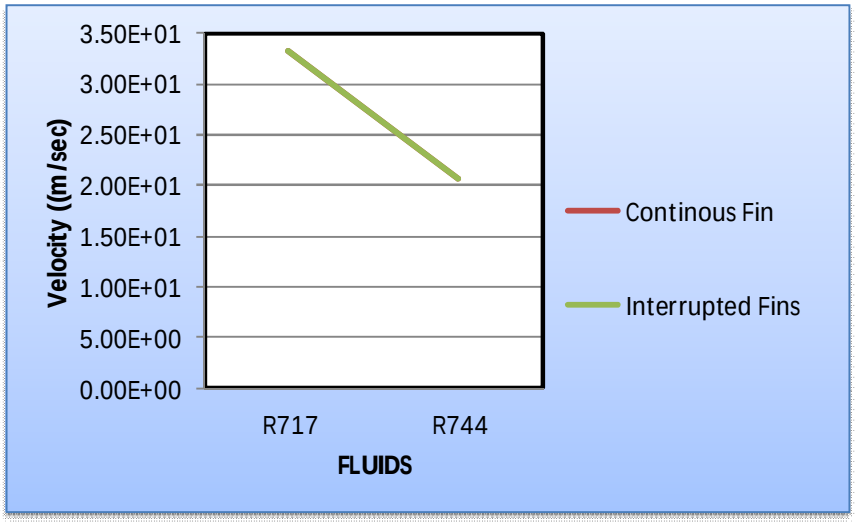


Fig: comparison of velocity values for different configurations and fluids

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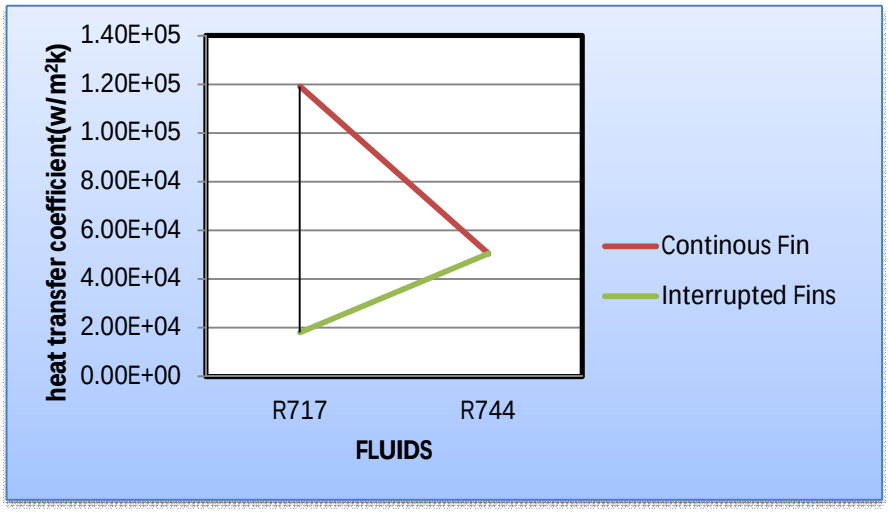


Fig: comparison of heat transfer coefficient values for different configurations and fluids

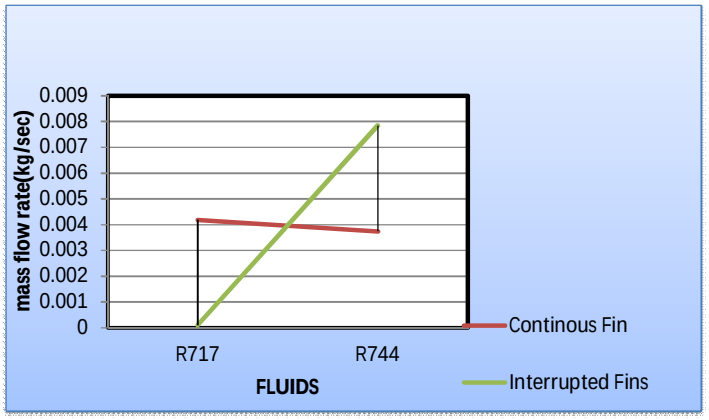


Fig: comparison of mass flow rate values for different configurations and fluids

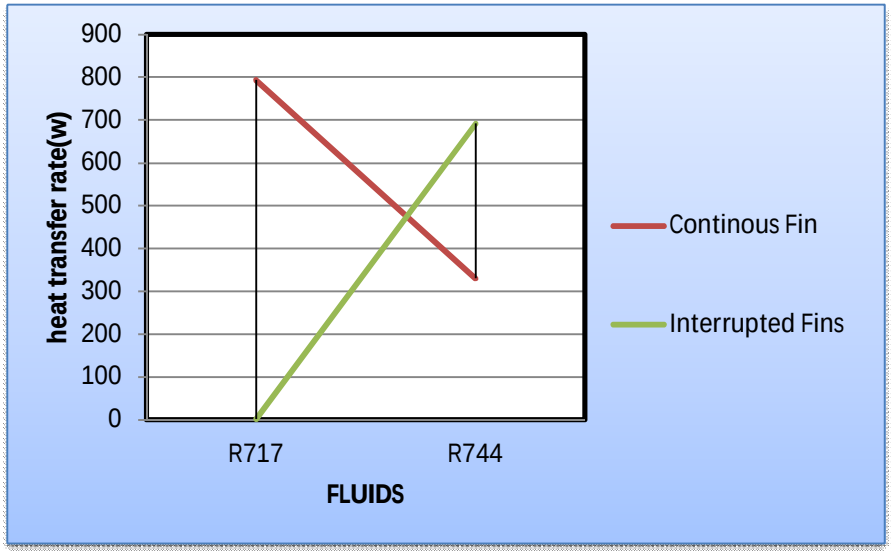


Fig: comparison of heat transfer rate values for different configurations and fluids

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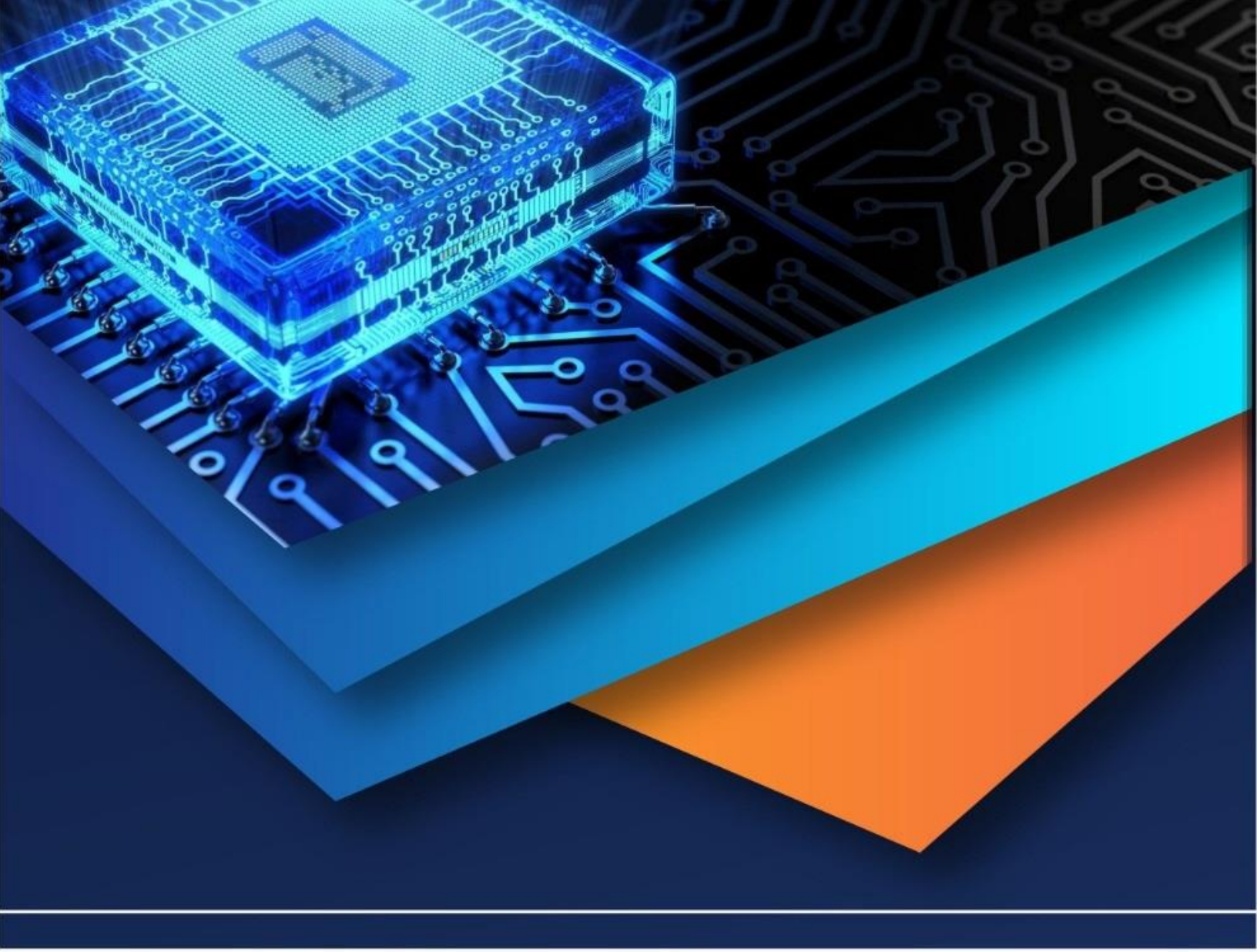
V. CONCLUSION

In this thesis, different configurations of fin tube evaporator are modeled in 3D modeling software Pro/Engineer. CFD analysis is done in Ansys with Different configurations are continuous fin and interrupted fin tubes and different fluids R717 and R744. By observing the CFD analysis results, Pressure and heat transfer rate is more in R717 compared to R744 in continuous fin and in interrupted fin has pressure is more in R744 compared to R717 but pressure is more in continuous fin compared to interrupted fin in both fluids. It is noticed that velocity is more in Continuous fin at R717 compared to R744 and same results are obtain in interrupted fin also. Heat transfer coefficient and Mass flow rate is more in R744 compared to R717 in both type of fin configurations.

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