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CFD ANALYSIS OF HEAT EXCHANGER FROM DIFFERENT CONFIGURATION OF FIN

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ABSTRACT
Several fin types geometries have been developed seeking improvements on the thermal and hydraulic characteristics of compact heat exchangers. The geometry selection is generally based on the comparison of performance data. Information is only existing for few geometries types and the performance analysis is assessed in several ways. Furthermore, the parameters used as means of comparison might be derived from different reference values, making the geometry selection not a straight forward task. In this study, the thermal and hydraulic characteristics of plain fin, annular fin and pin fin attached to circular tubes are obtained using 3D CFD simulation using ANSYS software.

INTRODUCTION
Heat transfer is a discipline of thermal engineering that deals with the generation, consumption, conversion and exchange of Thermal energy between physical systems. Thermal energy is Transferred from one system to another by various mechanisms, namely conduction, convection and thermal radiation. Each heat transfer mechanism has a unique phenomenon so is Expressed by characteristic rate equations among the popular Topics that are extensively studied all over the world, heat Transfer from extended surfaces(fins) stands out with its wide Concept and rapidly developing applications equations a fin is a type of heat exchanger that transfers the Heat generated by an electronic or a mechanical Device to a fluid medium, often air or a liquid coolant, where it is dissipated away from the device, thereby Allowing regulation of the device's temperature at Optimal levels. The problem arises when the heat Transferred by these fins are not sufficient enough to Cool the heat generating devices and causes damage to the components of the device. The basic solution Available is that the shape of fins can be optimized Such that the heat transfer density is maximum when the space and the materials used for the finned Surfaces are constraints.

FINS
The fins are designed and manufactured in many shapes and forms. They manufactured in different geometries, depending upon the practical applications. The ribs attached along the length of a tubes are called longitudinal fins. The concentric annular disc around a tube are termed as circular or annular fins Pin fins or spines are rods protruding from a surface.

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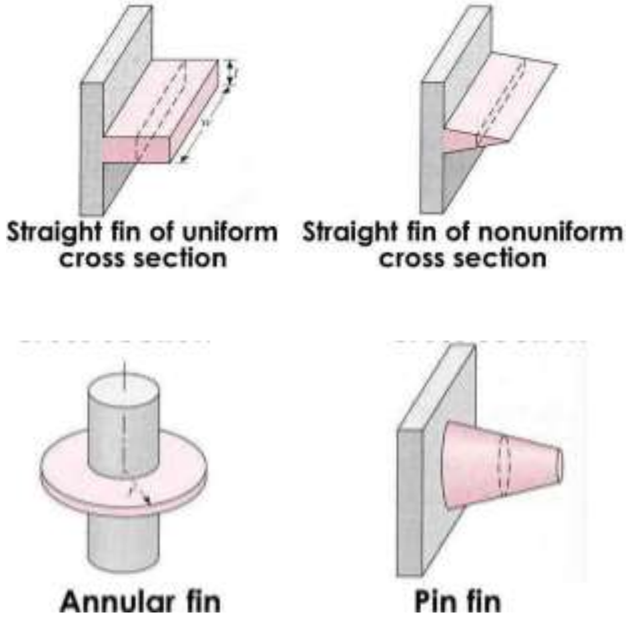
Types of FINS



Natural convection heat transfer from vertical rectangular fin arrays with and without notch and fins with triangular notch have been investigated experimentally and theoretically. It was observed that heat transfer coefficient and in turn the rate of heat transfer can further be increased by increasing the surrounding fluid velocity i.e., by forced convection. It is also observed that heat transfer coefficient is highest for the set of fins with triangular notch. Results has been shown by the CFD as well as experimental analysis.

MATERIAL SELECTION

ALUMINIUM ALLOY 6061

COMPONENT	Al	Cr	Cu	Fe	Mg	Mn	Si	Ti	Zn
WEIGHT %	98.6	0.35	0.4	0.7	1.2	0.15	0.8	0.15	0.25

The standard values mechanical and thermal properties of Aluminum Alloy 6061 are taken from International Alloy Designations and Chemical Composition Limits for Wrought Aluminum and Wrought Aluminum Alloys. The values of various properties are found to be:

1. Melting Point: 582 - 652 °C
2. Thermal Conductivity: 167 W/m-°C
3. Specific Heat Capacity: 0.896 J/g-°C
4. Modulus of Elasticity: 68.9 GPa

COMPUTATIONAL FLUID DYNAMICS

CFD (Computational fluid dynamics) is a branch of fluid mechanics that uses numerical analysis and algorithms to solve fluid flows situations. High-performing computers are used to conduct the calculations required to simulate the interaction of liquids and gases with surfaces defined by boundary conditions.

CFD is based on the Navier-Stokes Equation. Arising from applying Newton's second law to fluid motion, together with the assumption that the stress in the fluid is the sum of a diffusing viscous term and a pressure term, these equations describe how the velocity, pressure, temperature, and density of a moving fluid are correlated.

Fins work on the principle that heat transfer rate increase with increase in surface area across which convection occurs. There are lots of engineering application, large quantities of heat have to be dissipated from small areas. The fins increase the effective area of the surface thereby increasing the heat transfer by convection. In other words, the shape of fins must be optimized such that the heat transfer density is maximized when the space and the materials used for the finned surfaces are Constraints.
The convective heat transfer is calculated by

$Q = h*As*(Ts-T\infty)$

Where,

Q-convective heat transfer rate(W/mK), h - heat transfer coefficient in W/m

Ts - surface temperature in °C, $T\infty$- ambient temperature °C

The optimum fin spacing for maximum heat transfer varies between 5 to 6mm roughly for Rayleigh number. The overall fin efficiency depends on the operating condition of the fin surface. The heat transfer rate increases with increase in length of the fin at a particular point after it decreases. By varying the pitch.

FIN PERFORMANCE PARAMETER

Fin Performance can be described in two different ways

1. 1.Effectiveness
2. 2.Efficiency

EFFECTIVENESS (€)

It is defined as the ratio of actual heat transfer that takes place from fin to the heat that would be dissipated from the same surface without fin. By above definition € for infinite length is given by

€=h.P.K.Ac(ts-ta)/h.Ac(ts-ta)

Factors Affecting Fin Effectiveness

1. P.Kh.Ac should be greater than unity if the rate of heat transfer from the primary surface is to be improved.
2. If the ratio of P and Ac is increased, the effectiveness of fin is improved.

EFFICIENCY

The efficiency of a fin is defined as the ratio of the actual heat transfer from the fin to that of the heat that would be dissipated if whole surface of the fin is maintained at base temperature.

ηfin= Actual heat transferred by the fin (Qfin)/Maximum heat that would be transferred if whole surface of the fin is maintained at the base temperature (Qmax).

METHODOLOGY AND IMPLEMENTATION

This is the first step of the CFD simulation process which helps in describing the geometry in the best possible manner. One needs to identify the fluid domain of interest. The domain of interest is then further divided into smaller segments known as mesh generation step Which is done using ANSYS.

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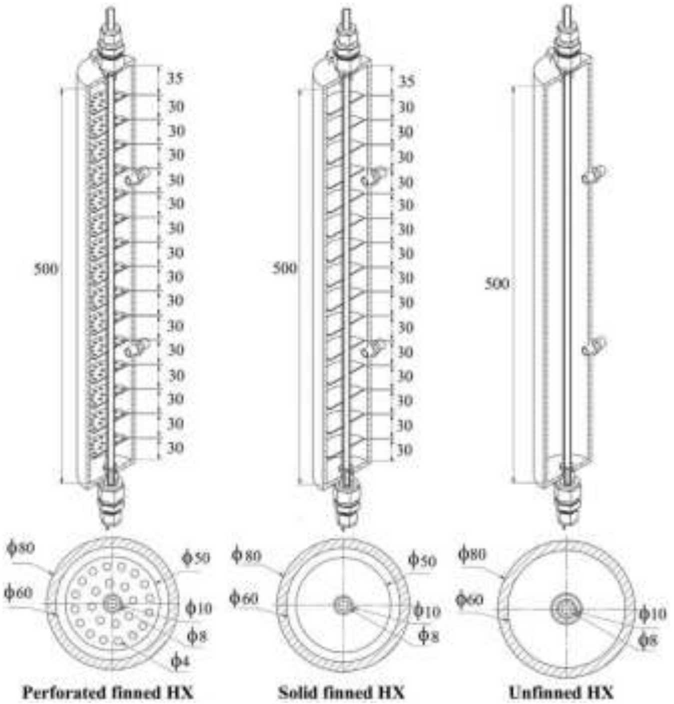
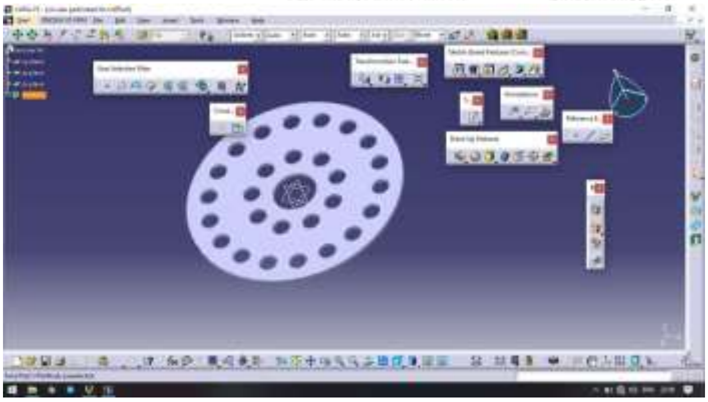
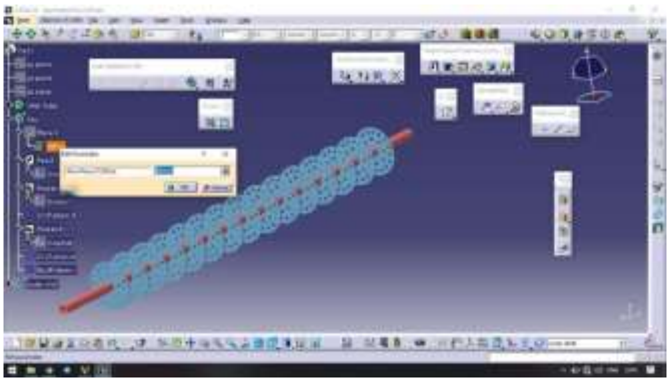
Geometric Modelling

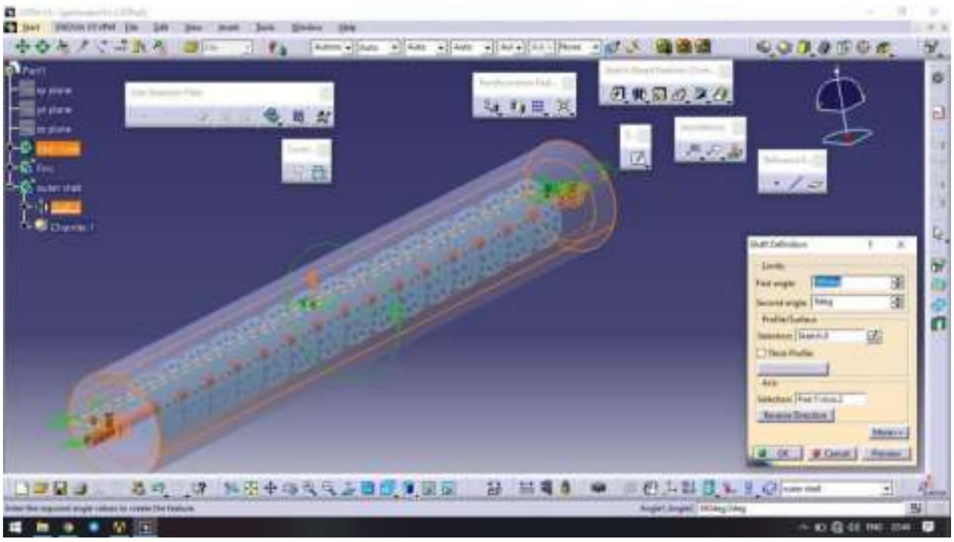




Modelling of Annular Perforated Disc in CATIA



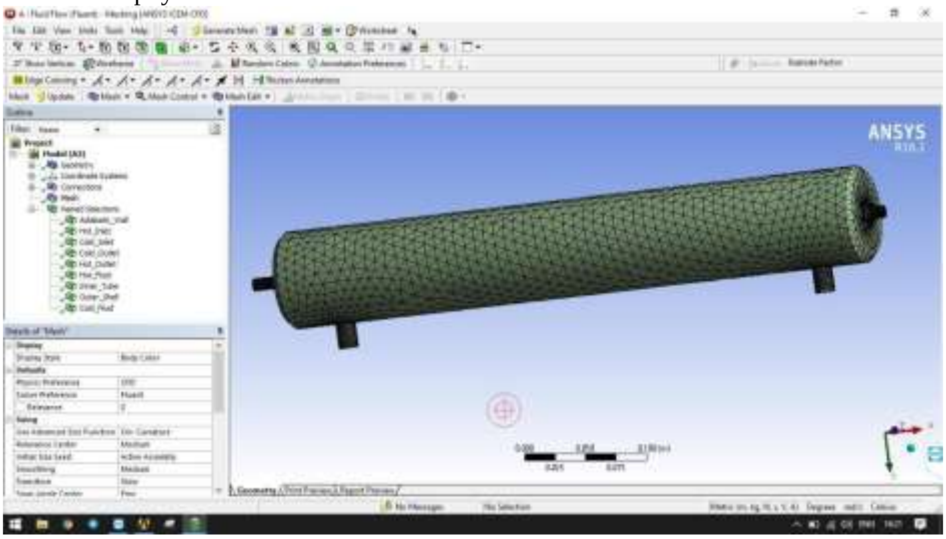
Perforated Discs Mounted Over Heat Source



Fins Assembled Inside Heat Exchanger

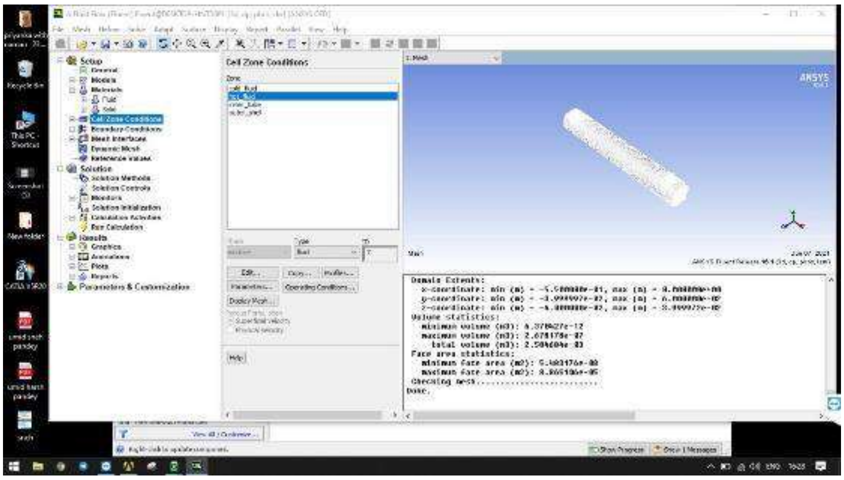
Meshing

Mesh generation is a crucial step in the CFD workflow. It divides the physical domain into a finite number of discrete regions called control volumes or cells.



Solver

Once the problem physics has been identified, fluid material properties, flow physics model, and boundary conditions are set to solve using a computer.



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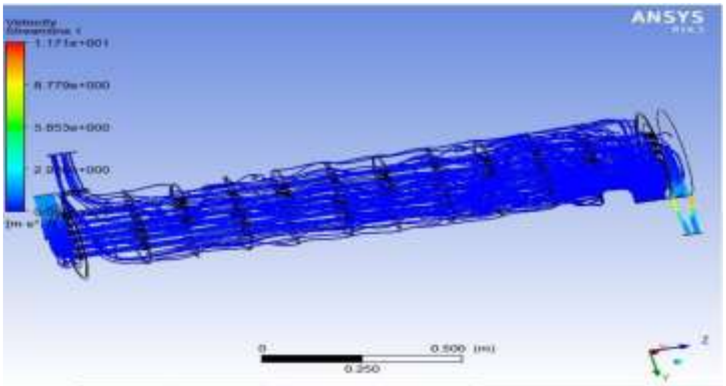
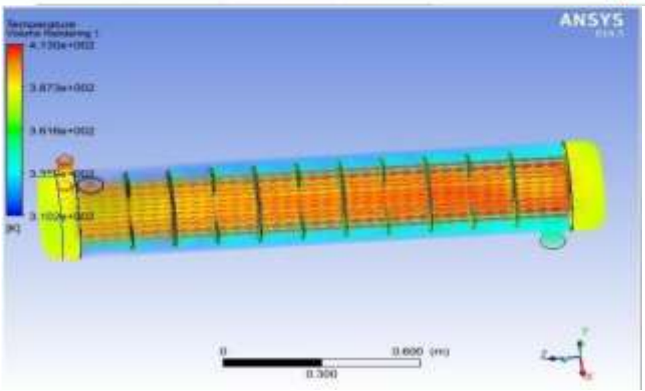
RESULT





CONCLUSION

It is clear that if we increase the shell side area so that mass flow rate of cold fluid increases enhancing heat transfer rate and apportioning*copper(cu) to the whole assemblage, hence for above discussed materials best possible value of heat transfer rate is obtained; nevertheless, that will also be a very pricey affair. It is concluded that temperature of cold fluid increased from 356 to 359 ºK. Hot fluid decreases 404 - 403 ºK. Accomplished value of heat transfer rate for hot fluid is 11475.76 KW and cold fluid is 64221.52 KW. Consequently, the comparisons of temperatures of experimental value to the attained CFD value are valid. It is clear, temperature of cold fluid increases because of 37.5% Perforated fins compared to 25. Which increases Heat transfer rate.

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