PERFORMANCE OF A FINNED-TUBE EVAPORATOR OPTIMIZED FOR DIFFERENT REFRIGERANTS AND ITS EFFECT ON SYSTEM EFFICIENCY

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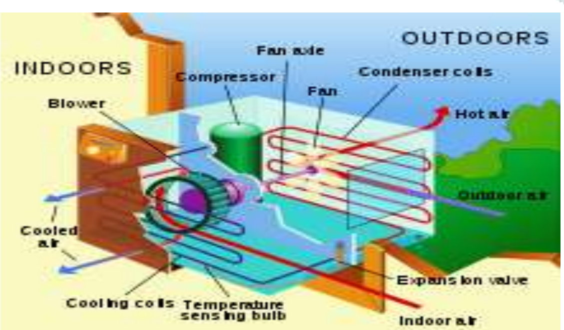
ABSTRACT: An evaporator is find in an air-conditioning machine or refrigeration device to allow a compressed cooling chemical, including Freon or R-134A, to evaporate from liquid to gas at the same time as enthralling warmth inside the procedure. It is also use to cast off water or other drinks from combos. The manner of evaporation is extensively used to concentrate meals and chemical compounds as well as salvage solvents. In the concentration process, the purpose of evaporation is to vaporize most of the water from an answer which contains the desired product.

In this thesis, diverse shapes of fins in fin tube evaporator are modeled in 3D modeling software program Pro/Engineer. The fins taken into consideration are rectangular fin, round fin a inner finned. The mass waft rate and warmth transfer charge are analyzed by means of CFD analysis completed in ANSYS.

CFD analysis is completed by way of varying fluids R407C, R404A and R22A on all the models. The inputs of CFD analysis are pace and stress and the results decided are Pressure, Velocity, Mass Flow Rate, Heat Transfer Rate and Heat Transfer Coefficient.

1INTRODUCTION TO AIR CONDITIONER

An air conditioner (often called AC) is a domestic equipment, machine, or mechanism designed to dehumidify and extract warmth from an area. The cooling is achieved using a easy refrigeration cycle. In creation, a entire machine of heating, ventilation and aircon is known as "HVAC". Its purpose, in a building or an automobile, is to provide consolation all through both hot or cold climate.



A typical home air conditioning unit.

INTRODUCTION TO EVAPORATORIt is in the evaporators in which the actual cooling effect takes region inside the refrigeration and the air con systems. For many human beings the evaporator is the primary a part of the refrigeration gadget and they bear in mind other parts as less useful. The evaporators are heat exchanger surfaces that transfer the warmth from the substance to be cooled to the refrigerant, accordingly disposing of the heat from the substance. The evaporators are used for wide type of various applications in refrigeration and aircon methods and as a result they're available in huge form of shapes, sizes and designs. They also are categorised in different way relying on the approach of feeding the refrigerant, production of the evaporator, direction of air circulate around the evaporator, utility and additionally the refrigerant manipulate.

In the domestic fridges the evaporators are commonly referred to as the freezers for the reason that ice is made in those booths. In case of the window and split air conditioners and other aircon structures in which the evaporator is directly used for cooling the room air, it is referred to as as the cooling coil. In case of massive refrigeration vegetation and important aircon plants the evaporator is likewise known as the chiller due to the fact that these structures are first used to chill the water, which then produces the cooling effect.

In the evaporator the refrigerant enters at very low stress and temperature after passing thru the growth valve. This refrigerant absorbs the warmth from the substance this is to be cooled so the refrigerant receives heated while the substance receives cooled. Even after cooling the substance the temperature of the refrigerant leaving the evaporator is less the than the substance. The refrigerant leaves the evaporator in vapor kingdom, ordinarily superheated and is absorbed by way of the compressor.

1.22 TYPES OF EVAPORATORS OR CLASSIFICATION OF THE EVAPORATORS

In the large refrigeration and aircon vegetation the evaporator is used for chilling the water. In such instances shell and tube type of heat exchangers are used because the evaporators. In such plant life the evaporators or the chillers are categorized as:

1) Dry growth form of evaporators
2) Flooded form of the evaporators

In case of the dry enlargement sort of chillers or evaporators the drift of the refrigerant to the evaporators is controlled by means of the growth valve. The enlargement valve allows the go with the flow of the refrigerant depending on the refrigeration load. In case of the shell and tube kind of evaporators the refrigerant flows alongside the tube facet, while the substance to be chilled (commonly water or brine) flows long the shell side. In case of the flooded the evaporator is filled with the refrigerant and consistent degree of the refrigerant is maintained internal it. In these evaporators or the chillers the refrigerant is alongside shell side even as the substance to be chilled or freezer flows alongside the tube aspect of the warmth exchanger.

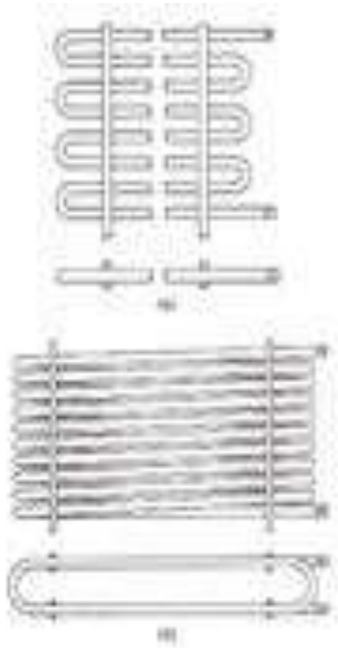


Plate Type of Evaporators

II. LITERATURE SURVEY

In the paper via Jader R. Barbosa, etal[1], the purpose is to evaluate a few elements of the design of evaporators for household refrigeration home equipment using Computational Fluid Dynamics (CFD). The evaporators below observe are tube-fin 'no-frost' warmth exchangers with compelled convection at the air-aspect and a staggered tube configuration. The calculation method become demonstrated against experimental records for the heat switch rate, thermal conductance and strain drop obtained for two evaporators with different geometries. The common errors of the warmth transfer rate, thermal conductance and pressure drop had been 10%, 3% and 11%, respectively. The CFD model become then used to assess the affect of geometric parameters which include the presence and role of the electric heater coil relative to the tubes, the fin configuration and the width of the by way of-skip clearance among the outer fringe of the fins and the tube bank for conditions standard of the layout of household refrigeration home equipment.

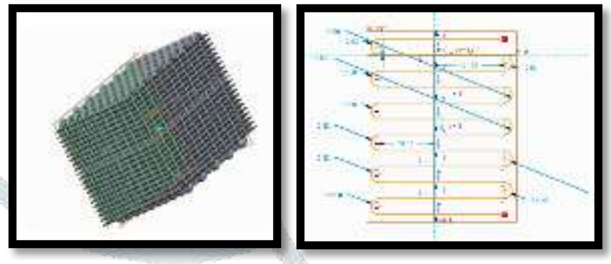
IV.INTRODUCTION TO CAD

Computer-aided layout (CAD), also known as pc-aided layout and drafting (CADD), is the use of pc era for the system of layout and layout-documentation. Computer Aided Drafting describes the manner of drafting with a pc. CADD software program, or environments, offer the user with input-gear for the purpose of streamlining layout tactics; drafting, documentation, and manufacturing strategies. CADD output is often inside the form of digital documents for print or machining operations. The development of CADD-based software program is in direct correlation with the procedures it seeks to save cash; enterprise-based totally software (production, production, and so on.) commonly makes use of vector-based totally (linear) environments whereas picture-primarily based software program utilizes raster-based (pixelated) environments.

INTRODUCTION TO CREO

PTC CREO, previously referred to as Pro/ENGINEER, is 3-D modeling software utilized in mechanical engineering, design, production, and in CAD drafting service corporations. It become one of the first three-D CAD modeling applications that used a rule-based totally parametric system. Using parameters, dimensions and capabilities to capture the conduct of the product, it could optimize the development product in addition to the design itself.

3D MODEL OF EVAPORATOR



INTRODUCTION TO FEA

Finite detail analysis is a method of fixing, generally about, sure problems in engineering and science. It is used mainly for problems for which no exact solution, expressible in a few mathematical shape, is available. As such, it's far a numerical in preference to an analytical method. Methods of this kind are wished due to the fact analytical techniques can not address the actual, complex troubles which can be met with in engineering. For example, engineering power of substances or the mathematical theory of elasticity may be used to calculate analytically the stresses and strains in a dishonest beam, however neither might be very a success in finding out what's occurring in a part of a car suspension gadget for the duration of cornering.

INTRODUCTION TO CFD

Computational fluid dynamics, commonly abbreviated as CFD, is a branch of fluid mechanics that uses numerical strategies and algorithms to remedy and examine problems that involve fluid flows. Computers are used to carry out the calculations required to simulate the interplay of drinks and gases with surfaces described through boundary situations. With high-pace supercomputers, better solutions may be achieved. Ongoing studies yields software that improves the accuracy and velocity of complex simulation eventualities such as transonic or turbulent flows. Initial experimental validation of such software program is completed using a wind tunnel with the final validation coming in full-scale testing, e.G. Flight checks.

METHODOLOGY

In all of these methods the equal fundamental method is observed.

• During preprocessing

• The geometry (bodily bounds) of the problem is defined.

• The volume occupied by means of the fluid is divided into discrete cells (the mesh). The mesh can be uniform or non-uniform.

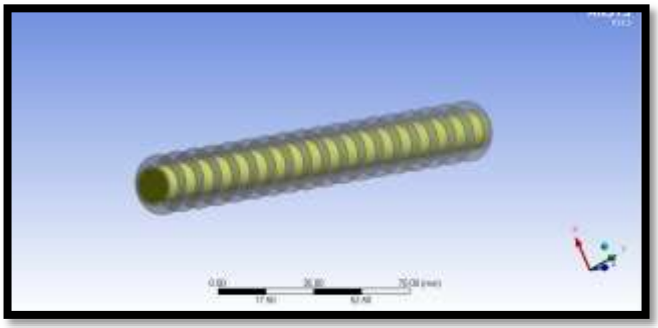
• The physical modeling is described – for instance, the equations of motion + enthalpy + radiation + species conservation

• Boundary conditions are described. This entails specifying the fluid behaviour and homes at the limitations of the problem. For transient issues, the initial conditions are also described.

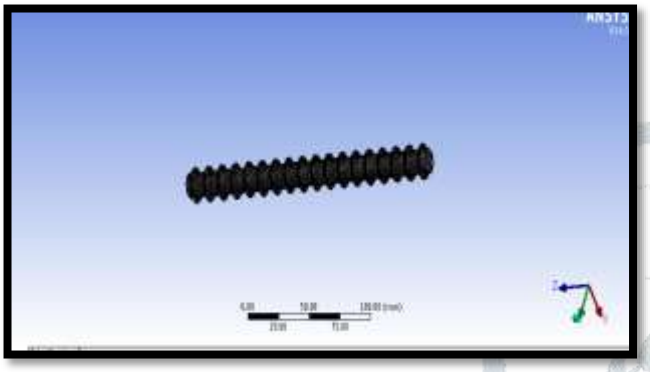
• The simulation is commenced and the equations are solved iteratively as a regular-kingdom or transient.

• Finally a postprocessor is used for the evaluation and visualization of the ensuing solution.

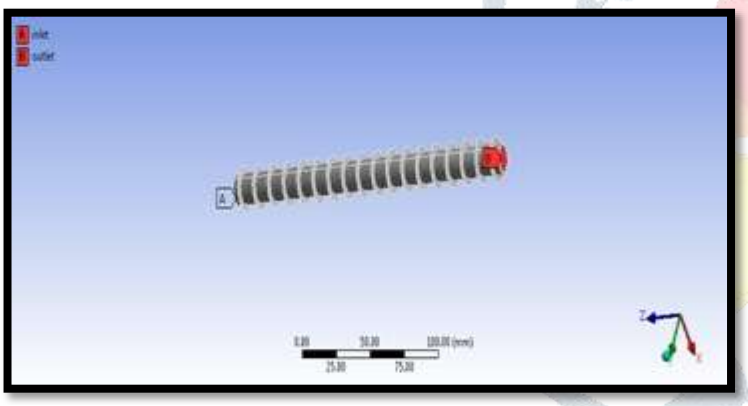
CFD ANALYSIS OF FINNED TUBE EVAPORATOR CONDITION -CIRCULAR FINS
FLUID -R407C



Geometry model

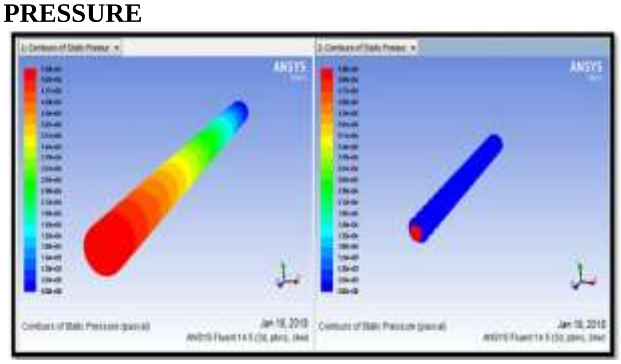


Meshed model

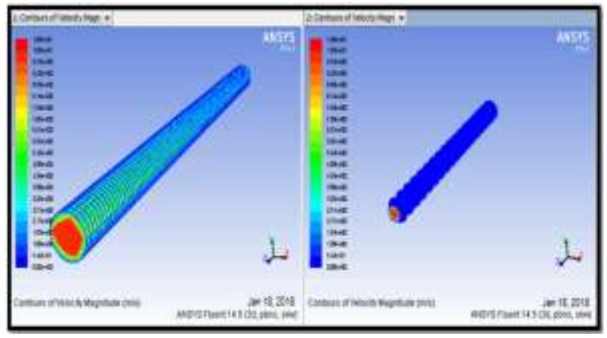


Inlet and outlet conditions

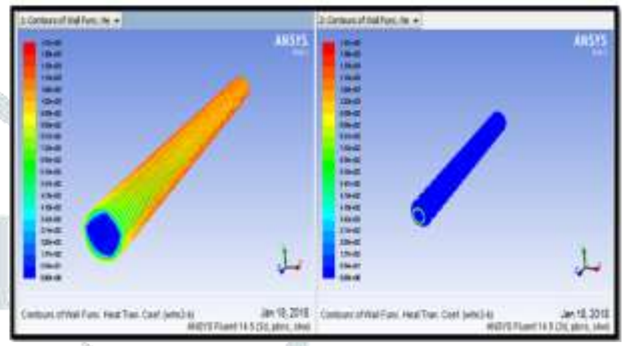
PRESSURE



VELOCITY



HEAT TRANSFER COEFFICIENT



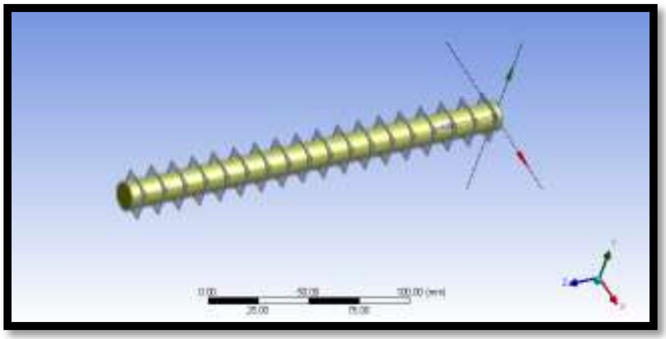
MASS FLOW RATE

contact_region-src	0
contact_region-trg	0
inlet	1.4757769
interior-____msbr	0
interior-solid	150.58551
outlet	-1.4759138
wall-12	0
wall-13	0
wall-7	0
wall-7-shadow	0
wall-____msbr	0
Net	-0.00013685226

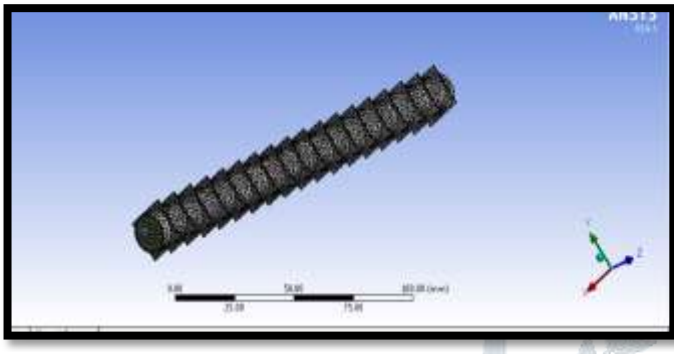
HEAT TRANSFER RATE

Total Heat Transfer Rate	(w)
contact_region-src	0
contact_region-trg	0
inlet	4053.6031
outlet	-4043.708
wall-12	0
wall-13	0
wall-7	10.456677
wall-7-shadow	-10.458258
wall-____msbr	-10.526047
Net	-0.55252934

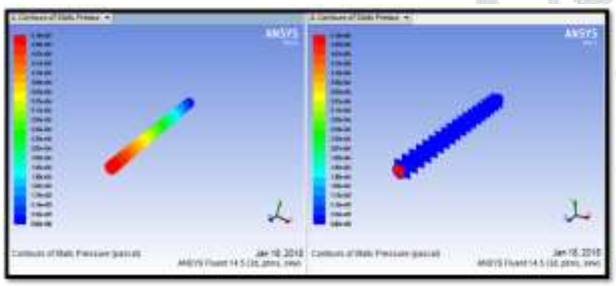
CONDITION
-RECTANGULAR FINS
FLUID -R407C
IMPORTED MODEL

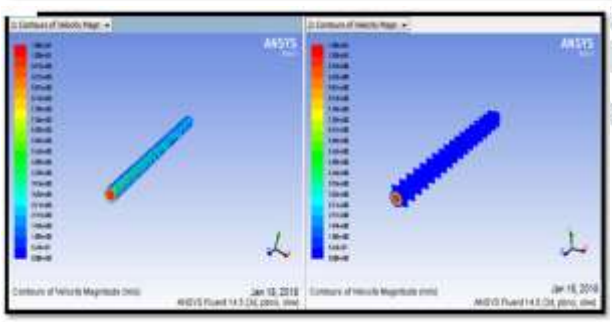


MESHED MODEL

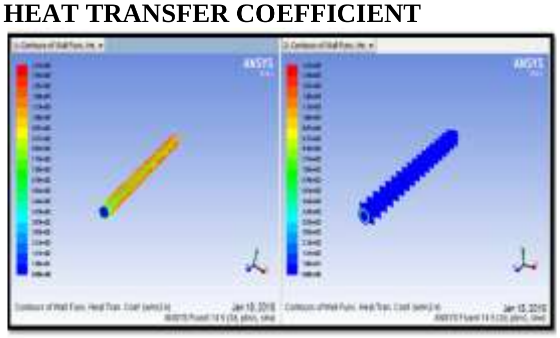


PRESSURE





VELOCITY
HEAT TRANSFER COEFFICIENT



MASS FLOW RATE

```
 contact_region-src               0
 contact_region-trg               0
              inlet       1.4527532
   interior-____msbr              0
     interior-solid      -149.54221
             outlet      -1.4523633
            wall-12               0
            wall-13               0
             wall-7               0
      wall-7-shadow               0
       wall-____msbr              0
  ---------------- ----------------
                Net  0.00038993359
```

HEAT TRANSFER RATE

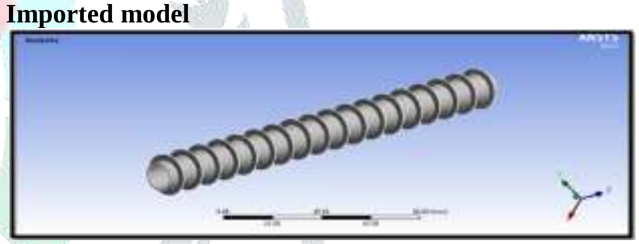
```
Total Heat Transfer Rate                  (w)
------------------------ --------------------
      contact_region-src                    0
      contact_region-trg                    0
                   inlet            6376.1357
                  outlet           -6363.9346
                 wall-12                    0
                 wall-13                    0
                  wall-7            10.591985
           wall-7-shadow           -10.587517
           wall-____msbr           -10.673385
         --------------- --------------------
                     Net            1.5822552
```

THERMAL ANALYSIS OF FINNED TUBE EVAPORATOR
MATERIAL – ALUMINIUM
CONDITON -CIRCULAR

FLUID -R407C

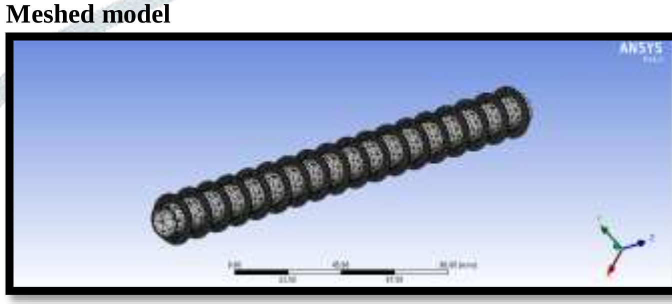
Open work bench 14.5>select **steady state thermal** in analysis systems>select geometry>right click on the geometry>import geometry>select **IGES** file>open

Imported model

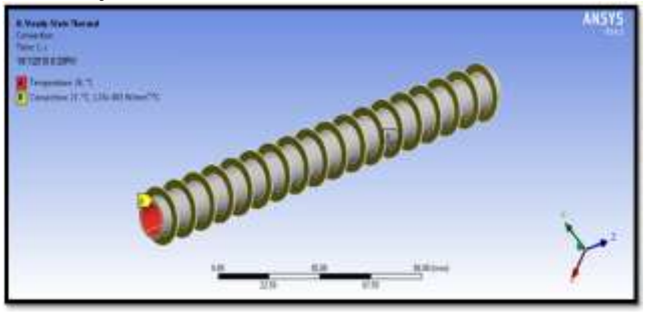


ALUMINIUM MATERIAL PROPERTIES
Thermal conductivity of aluminum = 15.1W/mk
Specific heat =356J/Kg K
Density = 0.00000412 Kg/mm^3

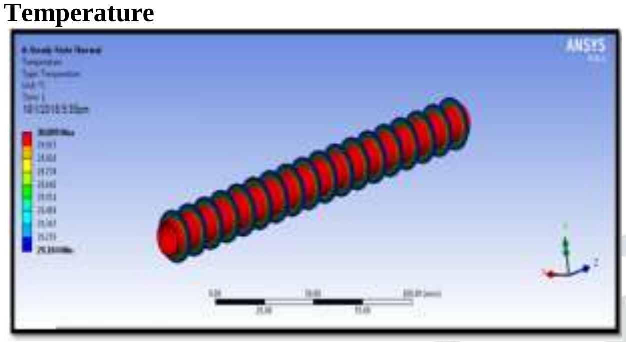
Meshed model



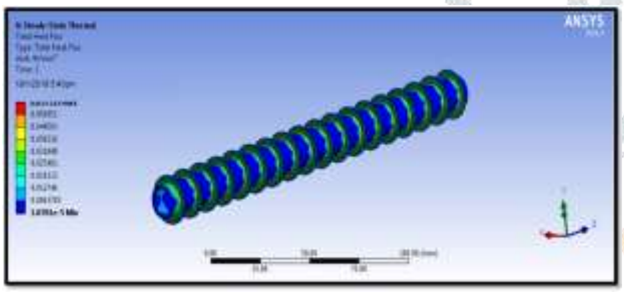
Boundary conditions



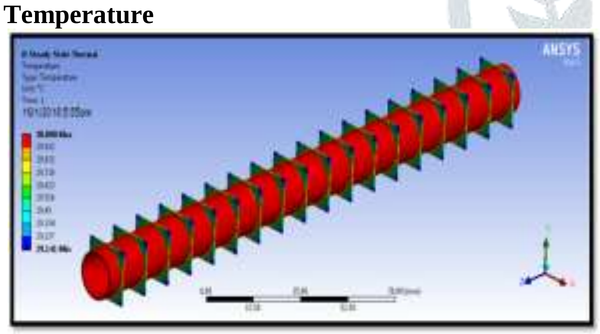
Temperature



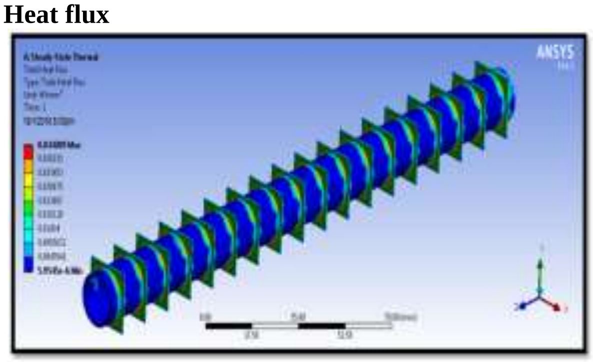
Heat flux



CONDITION -RECTANGULAR FINS
FLUID -R407C
Temperature



Heat flux



RESULT TABELS
CFD RESULTS

CONDITION	FLUID	PRESSURE (Pa)	VELOCITY (m/s)	HEAT TRANSFER COEFIECNT (W/m^2K)	Mass flow rate (kg/sec)	Heat transfer Rate (w)
CIRCULAR	R407C	5.30e+04	1.08e+01	1.37e+03	0.000136	0.5525
	R404A	4.82e+04	1.09e+01	1.67e+03	0.000363	1.9468
	R22A	3.88e+04	1.06e+01	2.15e+03	0.0008285	3.0523
RECTANGULAR	R407C	5.19e+04	1.083e+01	1.41e+03	0.0003899	1.5322
	R404A	4.81e+04	1.08e+01	1.61e+03	0.0003597	1.7594
	R22A	3.77e+04	1.07e+01	2.09e+03	0.0004937	1.6975

THERMAL ANALYSIS RESULTS
MATERIAL -ALUMINUM

CONDITION	FLUID	Temperature (K)	Heat flux (w/mm^2)
CIRCULAR	R407C	30.009	0.057319
	R404A	30.316	1.4958
	R22A	30.33	1.4963
RECTANGULAR	R407C	30.008	0.043009
	R404A	30.009	0.04787
	R22A	30.011	0.058602

MATERIAL -COPPER

CONDITION	FLUID	Temperature (K)	Heat flux (w/mm^2)
CIRCULAR	R407C	30.004	0.063727
	R404A	30.025	0.38331
	R22A	30.006	0.094924
RECTANGULAR	R407C	30.003	0.048092
	R404A	30.004	0.054321
	R22A	30.005	0.068739

CONCLUSION

In this thesis, different shapes of fins in fin tube evaporator are modeled in 3D modeling software Pro/Engineer. The fins considered are rectangular fin, circular fin. The mass flow rate and heat transfer rate are analyzed by CFD analysis done in ANSYS.

CFD analysis is done by varying fluids R407c, R404a and R22a on all the models.CFD analysis is done in ANSYS.

By observing the CFD analysis results, heat transfer coefficient, heat transfer rate, mass flow rate are more for circular fin. Heat transfer coefficient and pressure are more for circular fin. By comparing the fluids, heat transfer rate, mass flow rate are more for R22a, heat transfer coefficient is more for R22aand outlet pressure is more for 407c.

By observing the thermal analysis results, the heat flux is more for circular fin than rectangular fins. R22a has more heat flux than R407cand R404a. So using circular fins and R22a is better.

so we can conclude that aluminum is the better material for fin tube evaporator.

REFERENCES

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