Design and Analysis of Different Material to Increase the Performance of Ac Condenser

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ABSTRACT

In systems involving heat transfer, a condenser is a device or unit used to condense a substance from its gaseous to its liquid state, typically by cooling it. In so doing, the latent heat is given up by the substance, and will transfer to the condenser coolant. Condensers are typically heat exchangers which have various designs and come in many sizes ranging from rather small to very large industrial-scale units used in plant processes. Air cooled condensers are used in small units like household refrigerators, deep freezers, water coolers, window air-conditioners, split air-conditioners, small packaged air-conditioners etc. These are used in plants where the cooling load is small and the total quantity of the refrigerant in the refrigeration cycle is small. Air cooled condensers are also called coil condensers as they are usually made of copper or aluminum coil. Air cooled condensers occupy a comparatively larger space than water cooled condensers.

In this thesis a design optimization technique that can be useful in assessing the best configuration of a finned-tube condenser. Heat transfer by convection in air cooled condensers is studied and improved in this work. The assessment has been carried out on an air-cooled finned-tube condenser of a vapour compression cycle for air conditioning system. Heat transfer analysis and CFD analysis is done on the condenser to evaluate the better design and material. The materials considered for tube is copper and for fins are Aluminum alloys 1100, 6063 and Magnesium alloy for different refrigerants HCFC and 404R. 3D modeling is done in Pro/Engineer and analysis is done in Ansys. CFD analysis is done at different velocities. Theoretical calculations are done to determine heat transfer rate.

INTRODUCTION

Air Conditioner:

An **air conditioner** (often referred to as **AC**) is a home appliance, system, or mechanism designed to dehumidify and extract heat from an area. The cooling is done using a simple refrigeration cycle. In construction, a complete system of heating, ventilation and air conditioning is referred to as "HVAC". Its purpose, in a building or an automobile, is to provide comfort during either hot or cold weather.
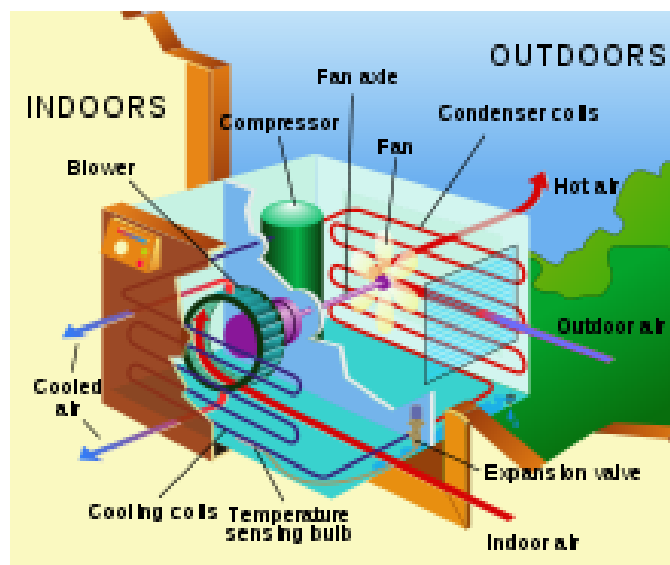

Figure 1: A typical home air conditioning unit
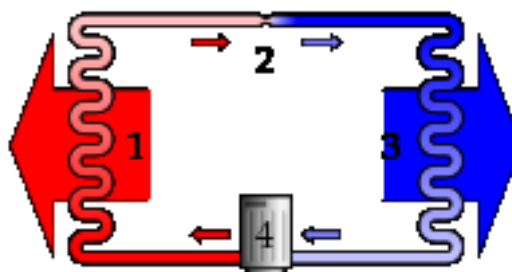
AIR CONDITIONING SYSTEM BASICS AND THEORIES

Figure 2: Refrigeration cycle

A simple stylized diagram of the refrigeration cycle: 1) condensing coil, 2) expansion valve, 3) evaporator coil, 4) compressor.

In the refrigeration cycle, a heat pump transfers heat from a lower-temperature heat source into a higher-temperature heat sink. Heat would naturally flow in the opposite direction. This is the most common type of air conditioning. A refrigerator works in much the same way, as it pumps the heat out of the interior and into the room in which it stands. This cycle takes advantage of the way phase changes work, where latent heat is released at a constant temperature during a liquid/gas phase change, and where varying the pressure of a pure substance also varies its condensation/boiling point. The most common refrigeration cycle uses an electric motor to drive a compressor. In an automobile, the compressor is driven by a belt over a pulley, the belt being driven by the engine's crankshaft (similar to the driving of the pulleys for the alternator, power steering, etc.). Whether in a car or building, both use electric fan motors for air circulation. Since evaporation occurs when heat is absorbed, and condensation occurs when heat is released, air conditioners use a compressor to cause pressure changes between two compartments, and actively condense and pump a refrigerant around. A refrigerant is pumped into the evaporator coil, located in the compartment to be cooled, where the low pressure causes the refrigerant to evaporate into a vapor, taking heat with it. At the opposite side of the cycle is the condenser, which is located outside of the cooled compartment, where the refrigerant vapor is compressed and forced through another heat exchange coil, condensing the refrigerant into a liquid, thus rejecting the heat previously absorbed from the cooled space.

By placing the condenser (where the heat is rejected) inside a compartment, and the evaporator (which absorbs heat) in the ambient environment (such as outside), or merely running a normal air conditioner's refrigerant in the opposite direction, the overall effect is the opposite, and the compartment is heated. This is usually called a heat pump, and is capable of heating a home to comfortable temperatures (25 °C; 70 °F), even when the outside air is below the freezing point of water (0 °C; 32 °F). Cylinder unloaders are a method of load control used mainly in commercial air conditioning systems. On a semi-hermetic (or open) compressor, the heads can be fitted with unloaders which remove a portion of the load from the compressor so that it can run better when full cooling is not needed. Unloaders can be electrical or mechanical.

Refrigerants

"Freon" is a trade name for a family of haloalkane refrigerants manufactured by DuPont and other companies. These refrigerants were commonly used due to their superior stability and safety properties. However, these chlorine-bearing refrigerants reach the upper atmosphere when they escape.[6] Once the refrigerant reaches the stratosphere, UV radiation from the Sun cleaves the chlorine-carbon bond, yielding a chlorine radical. These chlorine atoms catalyze the breakdown of ozone into diatomic oxygen, depleting the ozone layer that shields the Earth's surface from strong UV radiation. Each chlorine radical remains active as a

catalyst unless it binds with another chlorine radical, forming a stable molecule and breaking the chain reaction. The use of CFC as a refrigerant was once common, being used in the refrigerants R-11 and R-12. In most countries the manufacture and use of CFCs has been banned or severely restricted due to concerns about ozone depletion. In light of these environmental concerns, beginning on November 14, 1994, the Environmental Protection Agency has restricted the sale, possession and use of refrigerant to only licensed technicians, per Rules 608 and 609 of the EPA rules and regulations; failure to comply may result in criminal and civil sanctions. Newer and more environmentally-safe refrigerants such as HCFCs (R-22, used in most homes today) and HFCs (R-134a, used in most cars) have replaced most CFC use. HCFCs in turn are being phased out under the Montreal Protocol and replaced by hydro fluorocarbons (HFCs) such as R-410A, which lack chlorine. Carbon dioxide (R-744) is being rapidly adopted as a refrigerant in Europe and Japan. R-744 is an effective refrigerant with a global warming potential of 1. It must use higher compression to produce an equivalent cooling effect.

Types of air conditioner equipment

The external section of a typical single-room air conditioning unit. For ease of installation, these are frequently placed in a window. This one was installed through a hole cut in the wall. The internal section of the above unit. The front panel swings down to reveal the controls.

Window and through-wall units

Room air conditioners come in two forms: unitary and packaged terminal PTAC systems. Unitary systems, the common one room air conditioners, sit in a window or wall opening, with interior controls. Interior air is cooled as a fan blows it over the evaporator. On the exterior the air is heated as a second fan blows it over the condenser. In this process, heat is drawn from the room and discharged to the environment. A large house or building may have several such units, permitting each room be cooled separately. PTAC systems are also known as wall split air conditioning systems or ductless systems. These PTAC systems which are frequently used in hotels have two separate units (terminal packages), the evaporative unit on the interior and the condensing unit on the exterior, with tubing passing through the wall and connecting them. This minimizes the interior system footprint and allows each room to be adjusted independently. PTAC systems may be adapted to provide heating in cold weather, either directly by using an electric strip, gas or other heater, or by reversing the refrigerant flow to heat the interior and draw heat from the exterior air, converting the air conditioner into a heat pump. While room air conditioning provides maximum flexibility, when cooling many rooms it is generally more expensive than central air conditioning.

Evaporative coolers

In very dry climates, evaporative coolers, sometimes referred to as swamp coolers or desert coolers, are popular for improving

comfort during hot weather. This type of cooler is the dominant cooler used in Iran, which has the largest number of these units of any country in the world, causing some to refer to these units as "Persian coolers." An evaporative cooler is a device that draws outside air through a wet pad, such as a large sponge soaked with water. The sensible heat of the incoming air, as measured by a dry bulb thermometer, is reduced. The total heat (sensible heat plus latent heat) of the entering air is unchanged. Some of the sensible heat of the entering air is converted to latent heat by the evaporation of water in the wet cooler pads. If the entering air is dry enough, the results can be quite comfortable; evaporative coolers tend to feel as if they are not working during times of high humidity, when there is not much dry air with which the coolers can work to make the air as cool as possible for dwelling occupants. Unlike air conditioners, evaporative coolers rely on the outside air to be channeled through cooler pads that cool the air before it reaches the inside of a house through its air duct system; this cooled outside air must be allowed to push the warmer air within the house out through an exhaust opening such as an open door or window.

These coolers cost less and are mechanically simple to understand and maintain.

An early type of cooler, using ice for a further effect, was patented by John Gorrie of Apalachicola, Florida in 1842. He used the device to cool the patients in his malariahospital.

Thermostats

Thermostats control the operation of HVAC systems, turning on the heating or cooling systems to bring the building to the set temperature. Typically the heating and cooling systems have separate control systems (even though they may share a thermostat) so that the temperature is only controlled "one-way." That is, in cold weather, a building that is too hot will not be cooled by the thermostat. Thermostats may also be incorporated into facility energy management systems in which the power utility customer may control the overall energy expenditure. In addition, a growing number of power utilities have made available a device which, when professionally installed, will control or limit the power to an HVAC system during peak use times in order to avoid necessitating the use of rolling blackouts. The customer is given a credit of some sort in exchange, so it is often to the advantage of the consumer to buy the most efficient thermostat possible.

Equipment capacity

Air conditioner equipment power in the U.S. is often described in terms of "tons of refrigeration". A "ton of refrigeration" is approximately equal to the cooling power of one short ton (2000 pounds or 907 kilograms) of ice melting in a 24-hour period. The value is defined as 12,000 BTU per hour, or 3517 watts. Residential central air systems are usually from 1 to 5 tons (3 to 20 kilowatts (kW)) in capacity.

The use of electric/compressive air conditioning puts a major demand on the

electrical power grid in hot weather, when most units are operating under heavy load. In the aftermath of the 2003 North America blackout locals were asked to keep their air conditioning off. During peak demand, additional power plants must often be brought online, usually expensive peaker plants. A 1995 meta-analysis of various utility studies concluded that the average air conditioner wasted 40% of the input energy. This energy is lost in the form of heat, which must be pumped out.

In an automobile, the A/C system will use around 5 horsepower (4 kW) of the engine's power.

unit size, BTU/h × hours per year, h × power cost, $/kW·h ÷ (SEER, BTU/W·h × 1000 W/kW)

(72,000 BTU/h) × (1000 h) × ($0.08/kW·h) ÷ [(10 BTU/W·h) × (1000 W/kW)] = $576.00 annual cost

A common misconception is that the SEER rating system also applies to heating systems. However, SEER ratings only apply to air conditioning.

Air conditioners (for cooling) and heat pumps (for heating) both work similarly in that heat is transferred or "pumped" from a cooler heat source to a warmer "heat sink". Air conditioners and heat pumps usually operate most effectively at temperatures around 10 to 13 degrees Celsius (°C) (50 to 55 degrees Fahrenheit (°F)). A balance point is reached when the heat source temperature falls below about 4 °C (40 °F), and the system is not able to pull any more heat from the heat source

(this point varies from heat pump to heat pump). Similarly, when the heat sink temperature rises to about 49 °C (120 °F), the system will operate less effectively, and will not be able to "push" out any more heat. Geothermal heat pumps do not have this problem of reaching a balance point because they use the ground as a heat source/heat sink and the ground's thermal inertia prevents it from becoming too cold or too warm when moving heat from or to it. The ground's temperature does not vary nearly as much over a year as that of the air above it.

SPECIFICATIONS OF CONDENSOR

The length and size of air conditioner condensers and evaporators have to be sized such that,

- the refrigerant is completely condensed before the condenser's exit, and
- the refrigerant is completely boiled before the evaporator's exit

Those two, depends mainly on the size of the compressor and refrigerant used. Air conditioner manufacturers has to understand how conduction, as well as convection works, to design an **effective**, yet compact air conditioner condenser and evaporator, per unit heat transferred. Normally, the condenser and evaporator will be designed to 110% of the intended heat transfer requirement, to cater for any performance drop during the service life.

It's good that we know the basics now.

Types of Condensers:

1) Evaporative Condenser

2) Air cooled condenser

3) Water cooled condenser

EVAPORATIVE CONDENSER:

Whereas a condenser/cooling tower arrangement requires a system of water distribution piping, this is almost entirely absent in the evaporative condenser. Only enough water need be circulated to ensure that the outside surface of the condenser coils is completely wet. The heat exchange is solely latent, and less water is required in circulation than is necessary with a condenser/cooling tower, where a sensible heat exchange occurs in the shell-and tube condenser. The evaporative condenser is thus more compact and is cheaper. It suffers from lack of flexibility, and oil return and other problems demand that the condenser should not be too far from the compressor. A cooling tower, on the other hand, may be a considerable distance away, the condenser then being adjacent to the compressor. Scaling on the tubes of an evaporative condenser may be something of a problem, particularly if a high condensing temperature is used. Cleaning difficulties, caused by the presence of scale, dirt and corrosion, and by the close nesting necessary for the tubes (the use of finning being impossible), have considerably reduced the popularity of the evaporative condenser in recent years.

AIR COOLED CONDENSER:

Unlike evaporative condensers, air-cooled condensers have a capacity which is related to the dry-bulb temperature of the ambient air, rather than to its wet-bulb temperature. If working condenser pressures are not to become excessively high, making the plant expensive to run, large condenser surface areas must be used. This has set a limit on the practical upper size of air-cooled condensers. Their use in air conditioning has been commonly confined to plants having a capacity of less than 70 kW of refrigeration, although they have been used for duties as high as 2000 kW, in temperate climates. The hot gas discharged from the compressor is de superheated over approximately the first 5 per cent of the heat transfer surface, followed by condensation over the succeeding85 per cent, with a small drop in the condensing temperature, related to the frictional pressure loss. A certain amount of sub-cooling of the liquid can then occur. Additional heat transfer surface may be provided to assist the sub-cooling, achieving an increase of about0.9 per cent in the cooling capacity for each degree of liquid temperature drop, according to ASHRAE (1996).Propeller fans, direct-coupled to split-capacitor driving motors, are most commonly used to promote airflow, although axial flow or centrifugal fans are also sometimes adopted. Fan powers are about 20 to 40 W for each kW of refrigeration capacity. Noise is often a problem and this is made worse if there are obstructions in the inlet or outlet airflow paths. Although vertical fan arrangements are possible, with horizontal cooling airflow paths, these are susceptible to wind pressures and it is recommended that the

condenser coils should be horizontal with vertical cooling airflow paths.

Propeller fans will not deliver airflow against any significant external resistance. It follows that ducting connections are then not possible if these fans are used. A 20-degree difference between the entering dry-bulb temperature and the condensing temperature is often consistent with the avoidance of excessively large condenser surface areas. Air-cooled condensers are increasing in popularity because of the absence of water piping, the consequent simplicity of operation and the freedom from any health risk associated with the use of spray water.

One objection to their use is that the capacity of the refrigeration plant does not gradually reduce as the ambient dry-bulb rises but ceases suddenly when the high pressure cut-out operates. A partial solution is to arrange for some of the compressor to be unloaded when the condensing pressure rises, before it reaches the cut-out point. Continued operation at a reduced capacity is then possible beyond the design ambient dry-bulb. It is a good plan to select air-cooled condensers to operate in an ambient temperature two or three degree higher than the design value chosen for the rest of the air conditioning system.
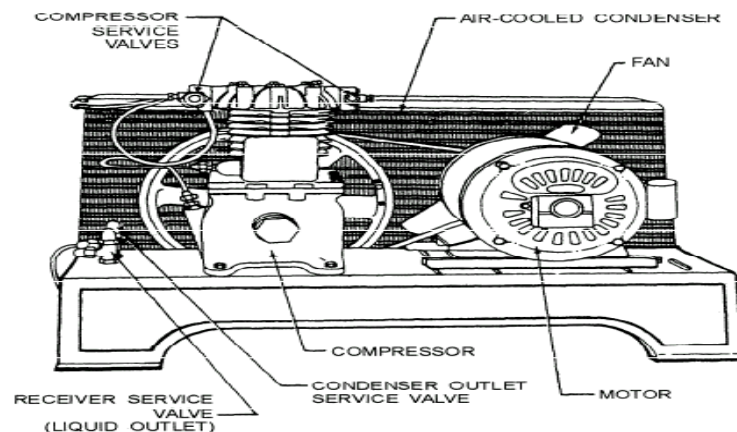
WATER COOLED CONDENSER:

Water is used to cool condensers. One method is to cool condensers with water from the city water supply and then exhaust the water into the sewer after it has been used to cool the refrigerant. This method can be expensive and, in some instances, is not allowed by law. When there is a sewer problem, a limited sewer treatment plant capacity, or drought, it is impractical to use this cooling method. The use of recirculation to cool the water for reuse is more practical. However, in recirculation, the power required to pump the water to the cooling location is part of the expense of operating the unit. There are three types of water-cooled condensers.
They are:
• The double tube
• The shell and coil
• The shell and tube types

The double-tube type consists of two tubes, one inside the other. Water is piped through the inner tube. Refrigerant is piped through the tube that encloses the inner tube. The refrigerant flows in the opposite direction than the water.

METHODOLOGY

In this thesis a design optimization technique that can be useful in assessing the best configuration of a finned-tube condenser. Heat transfer by convection in air cooled condensers is studied and improved in this work. The assessment has been carried out on an air-cooled finned-tube condenser of a vapour compression cycle for air conditioning system.

- The materials used for tube is copper and for fins are Aluminum Alloy 1100, Aluminum alloy 6063 and Magnesium. The refrigerants are HCFC, 404R.
- Cooling load calculations are done to determine the capacity of air conditioner required to cool the required room.
- Thermal flux calculations are done theoretically to compare the results with analytical results.
- 3D modeling is done in Pro/Engineer. The dimensions of the condenser are taken from the component itself using reverse engineering process.
- Heat transfer analysis is done on the condenser to evaluate the better design and material. Analysis is done in Ansys. The analysis is done to verify the heat transfer rate, temperature distribution.
- The better material for fin and better refrigerant are analyzed using heat transfer analysis.

THERMAL FLUX CALCULATIONS

Inside temperature = 50^0C+273 = 323K

Atmospheric temperature = 40^0C+273 = 313K

Total area = 39807.7

Contact area = 47.12

Discharge of heat flow = x = 21mm

Tube thickness = 1

Calculating heat flux for 3 different materials:

1. Copper : Thermal conductivity = K =390W/mk
2. Aluminum(1100): K = 220 W/mk
3. Aluminum(6063): K = 193W/mk
4. Mg   : K = 160 W/mk
   For HCFC Heat Transfer Coefficient = 243

Heat flux for Aluminum 1100 and R404 as refrigerant

Heat flow is given by = q = U

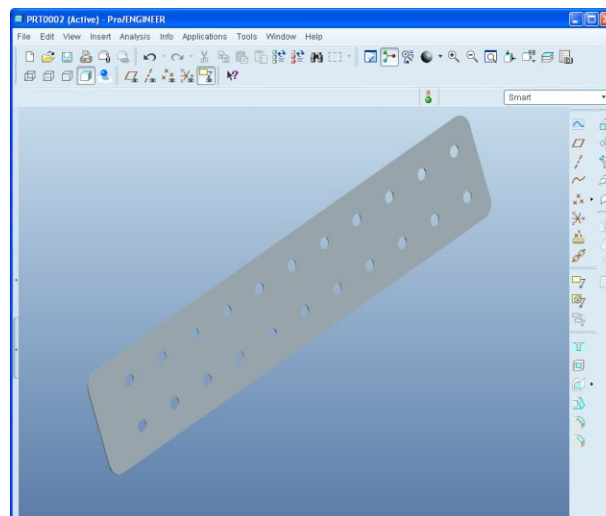Where U = overall heat transfer coefficient

A = contact area = $0.002073m^2$
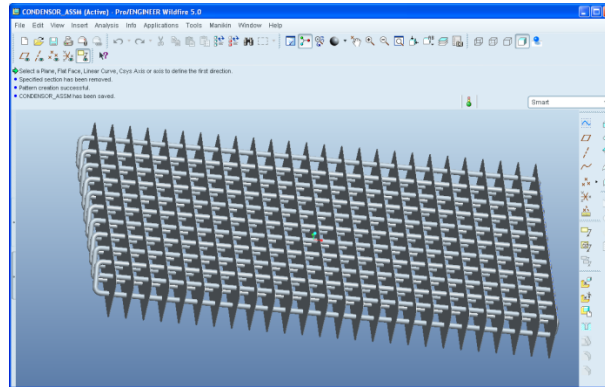
MODEL OF CONDENSER
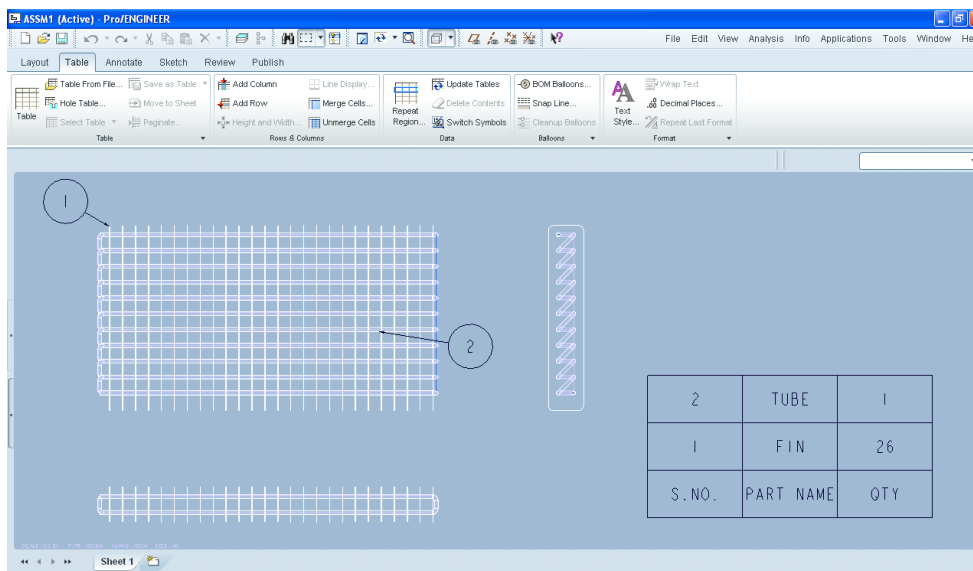
TUBE
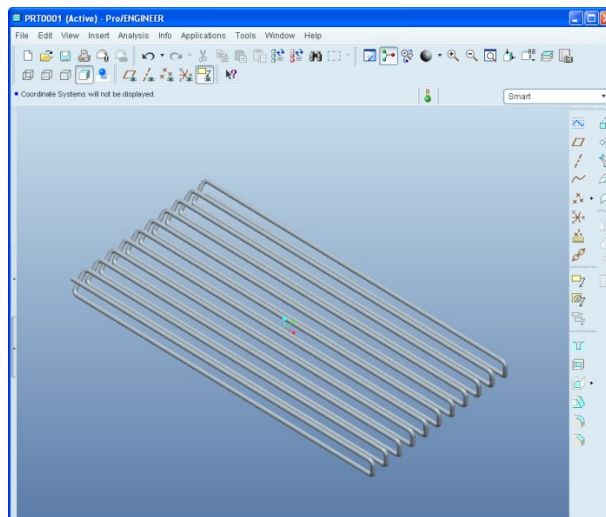
PLATE

ASSEMBLY

ASSEMBLY

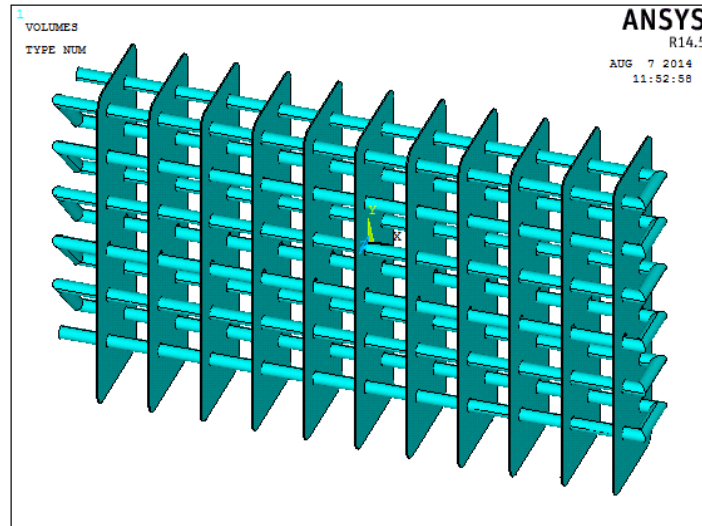## THERMAL ANALYSIS OF CONDENSER

Aluminum1100, Aluminum6063, Magnesium, Copper

Thermal analysis of condenser for HCFC refrigerant: Al 1100 for tubes

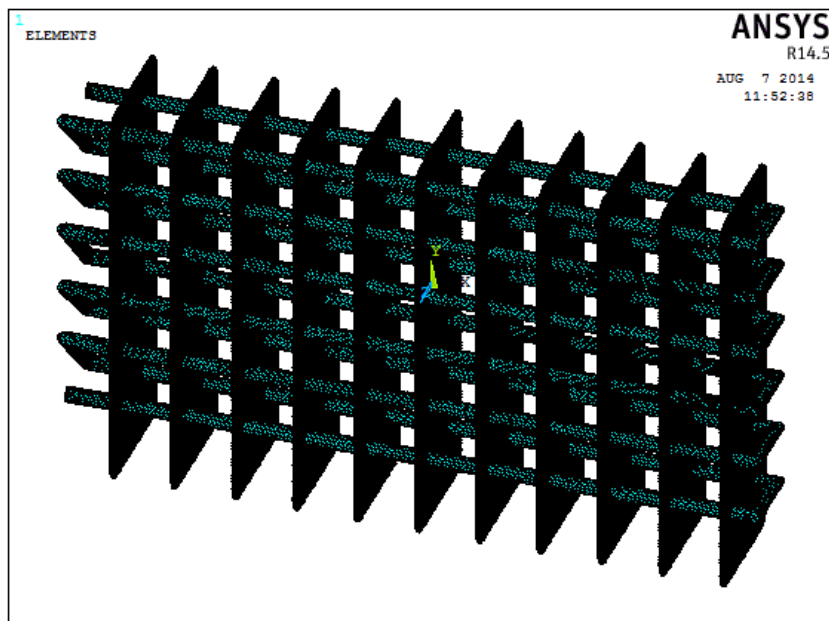Thermal conductivity=230w/mk, Specific heat=900J/Kg.k, Density=2705Kg/m^3

Copper for fins, Thermal conductivity=390w/mk, Specific heat=390J/Kg.k, Density=8900Kg/m^3

Imported model

Meshing>mesh tool>smart sizes on> mesh>ok

Meshed model

Boundary conditions

The temperature is applied inside the tube of the condensor

The convection is applied on the fins

Solution>solve>current Ls>ok

General post processor>plot results>counter plot>nodal solution>dof solution>nodal temperature>ok

Nodal temperature
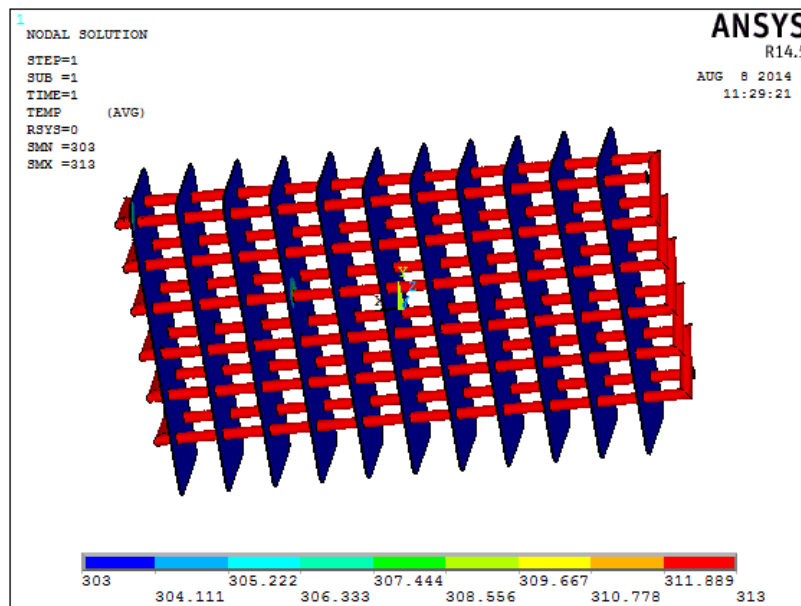
The above figure indicates that the maximum temperature (311.889K to 313K) is in the tubes and is reducing on the fins (303K to 304.111K).

Thermal gradient>vector sum thermal gradient>ok

Thermal gradient
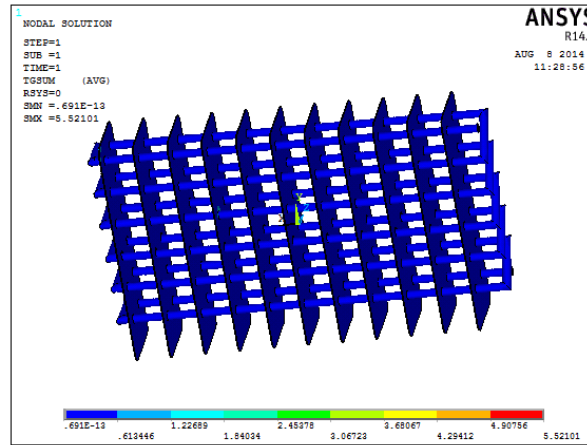
The maximum change in temperature is 5.52101K/mm and minium is $0.691e^{-13}$

Heat flux>vector sum heat flux>ok Heat flux
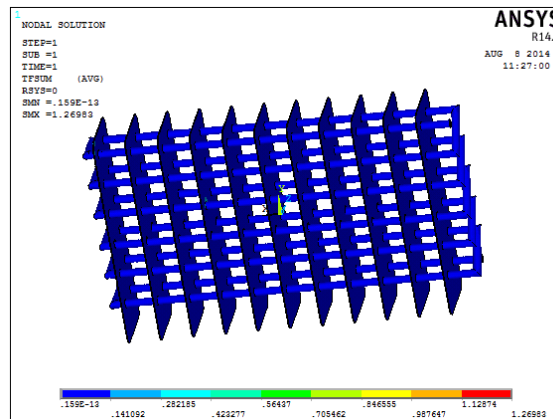
The maximum heat transfer rate is $1.26983W/mm^2$ and the minimum value is $0.159e^{-13}$

Thermal analysis of condenser for HCFC refrigerant

Al6063 for tubes

Thermal conductivity=193w/mk, Specific heat=900J/Kg.k, Density=27000Kg/m³

Copper for fins

Thermal conductivity=390w/mk, Specific heat=390J/Kg.k, Density=8900Kg/m³

RESULTS AND DISCUSSION

REFRIGERANTS	MATERIALS	RESULTS		
		Nodal Temperature (K)	Thermal Gradient (K/mm)	Heat flux (W/mm²)
HCFC	Aluminum 1100	313	5.52101	1.26983
	Aluminum 6063	313	5.82506	1.12424
	Magnesium	313	6.16722	0.986754
404R	Aluminum 1100	313	6.43696	1.4805
	Aluminum 6063	313	6.07077	1.28162
	Magnesium	313	6.94673	1.11148

In the above table, the nodal temperature, thermal gradient and thermal flux values are presented from thermal analysis results. From the results, thermal flux is more when Aluminum alloy 1100 is used for fin and refrigerant used is 404. That is the heat transfer rate is more. Thermal gradient is also more that is the change in temperature over a distance is more.

THEORETICAL THERMAL FLUX RESULTS

	Al ALLOY 1100	Al ALLOY 6063	MAGNESIUM
HCFC	2.64	2.44	2.21
R404	2.69	2.488	2.24

In the above table, thermal flux values are presented from theoretical calculations. From the results, thermal flux is more when Aluminum alloy 1100 is used for fin and refrigerant used is 404. That is the heat transfer rate is more.

COMPARISON GRAPHS

THERMAL GRADIENT COMPARISON GRAPH
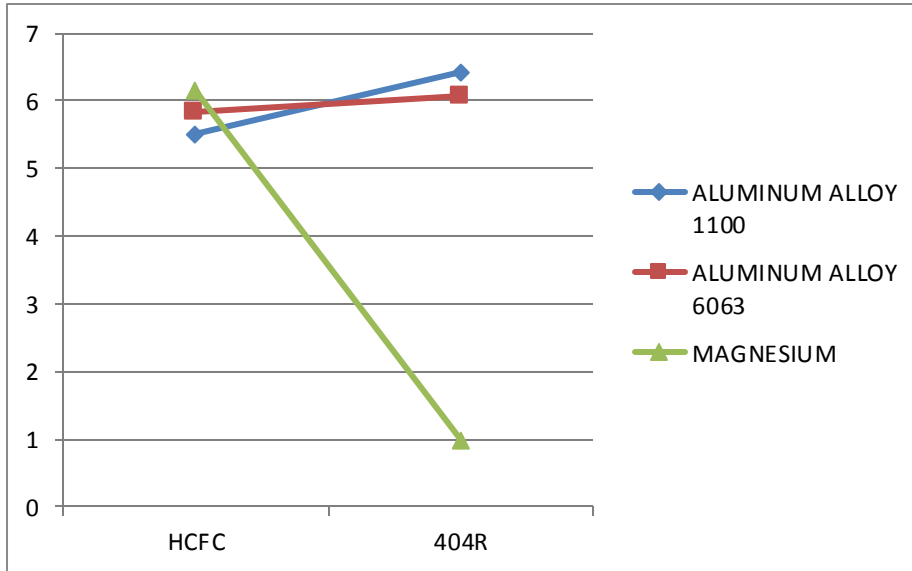
The above graph represents the comparison of thermal gradient values for all the 3 materials and two refrigerants. It shows that refrigerant 404R and aluminum alloy 1100 has more thermal gradient value.
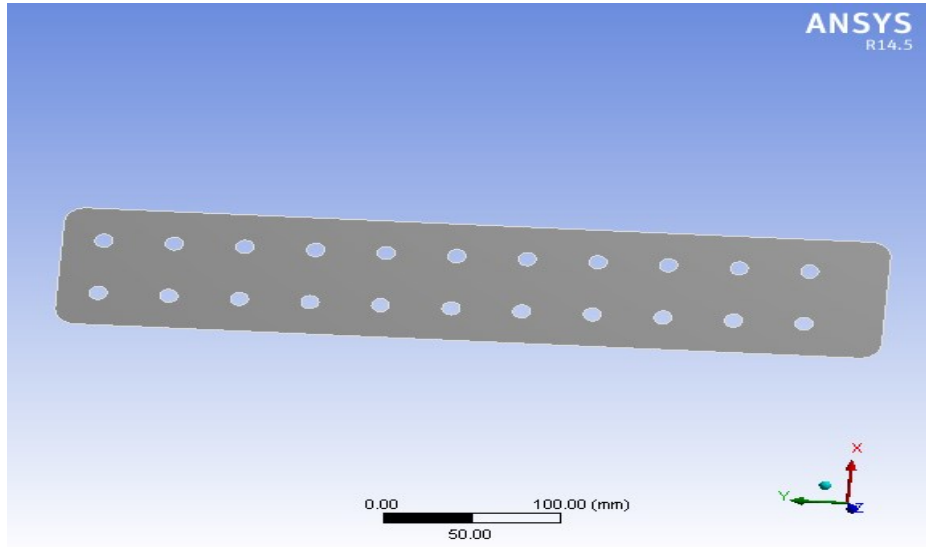
THERMAL FLUX COMPARISON GRAPH
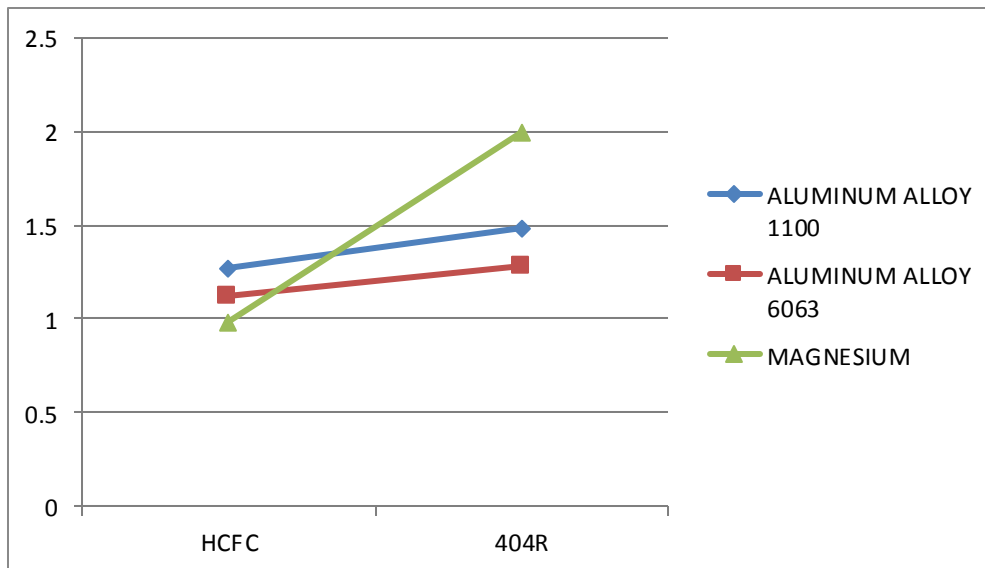
The above graph represents the comparison of thermal flux values for all the 3 materials and two refrigerants. It shows that refrigerant 404R and aluminum alloy 1100 has more thermal flux value.

CFD ANALYSIS OF FIN USING REFRIGERANTS HCFC AND 404R

REFRIGERANT - HCFC

INLET VELOCITY – 2.5m/s
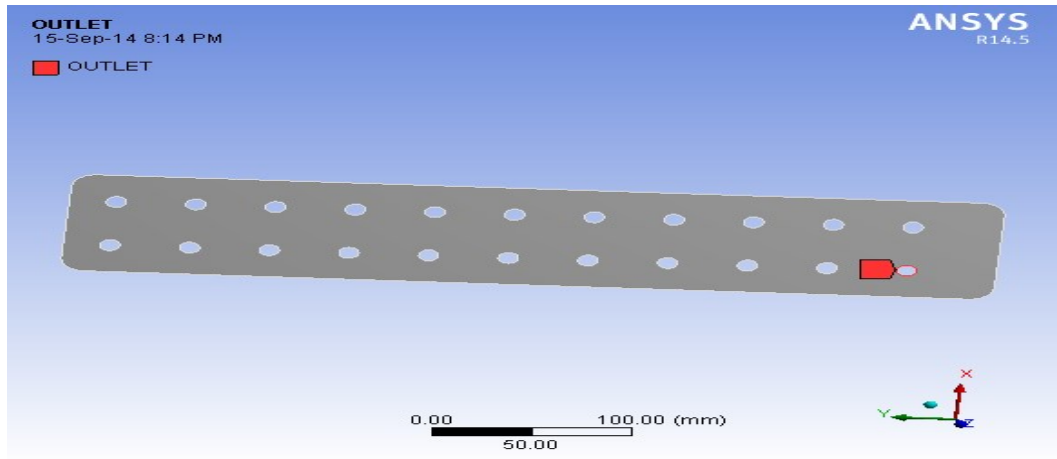
Imported model from Pro/Engineer

Meshed model
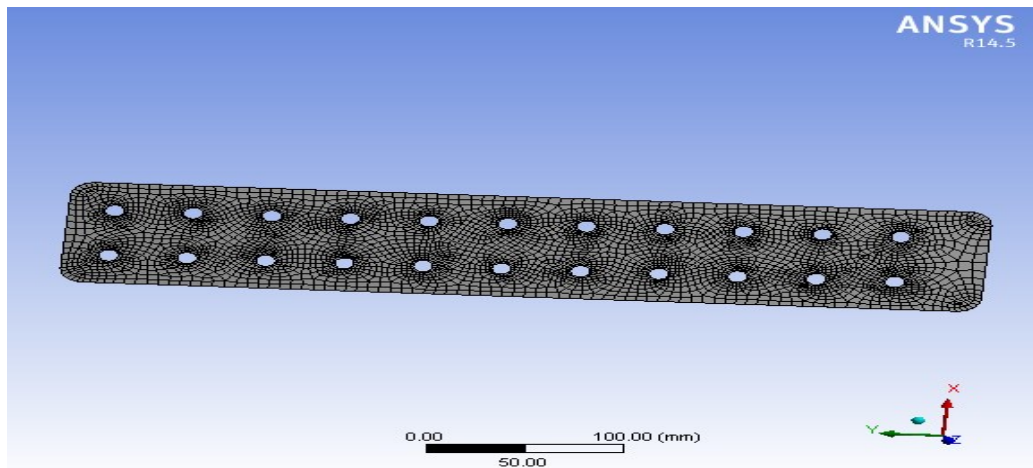
Inlet
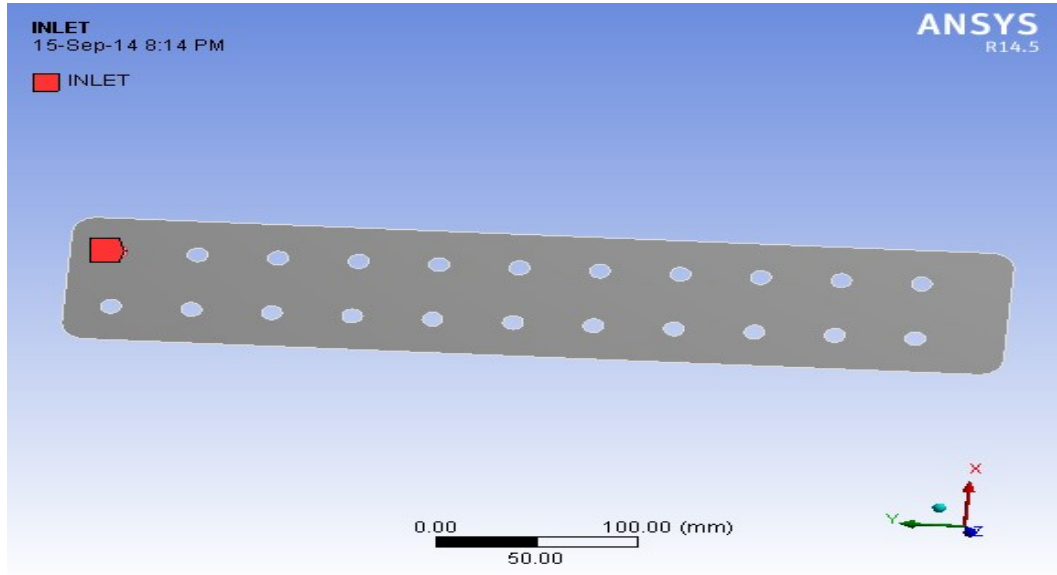
Outlet

SPECIFYING BOUNDARIES FOR INLET AND OUTLET

Velocity magnitude

Contours of Velocity Magnitude (m/s)
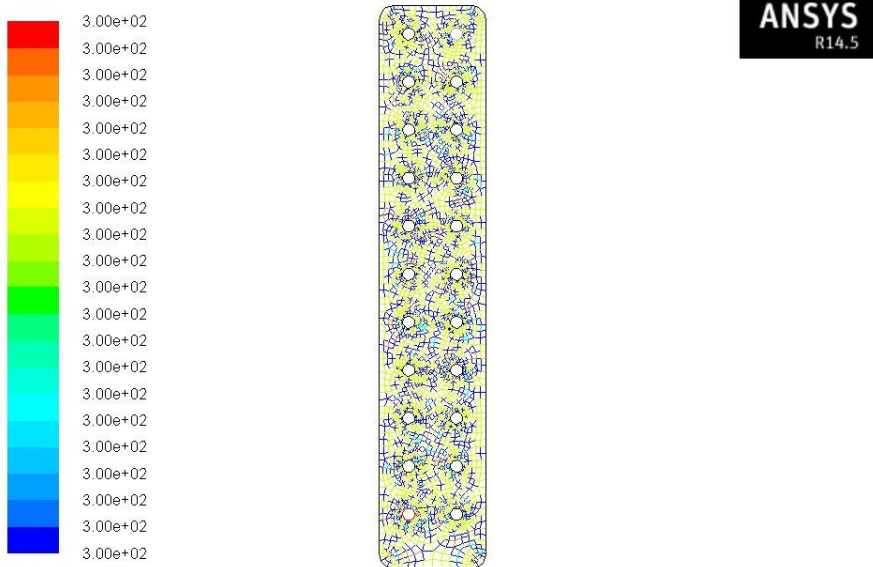
Sep 15, 2014
ANSYS Fluent 14.5 (2d, dp, pbns, ske)
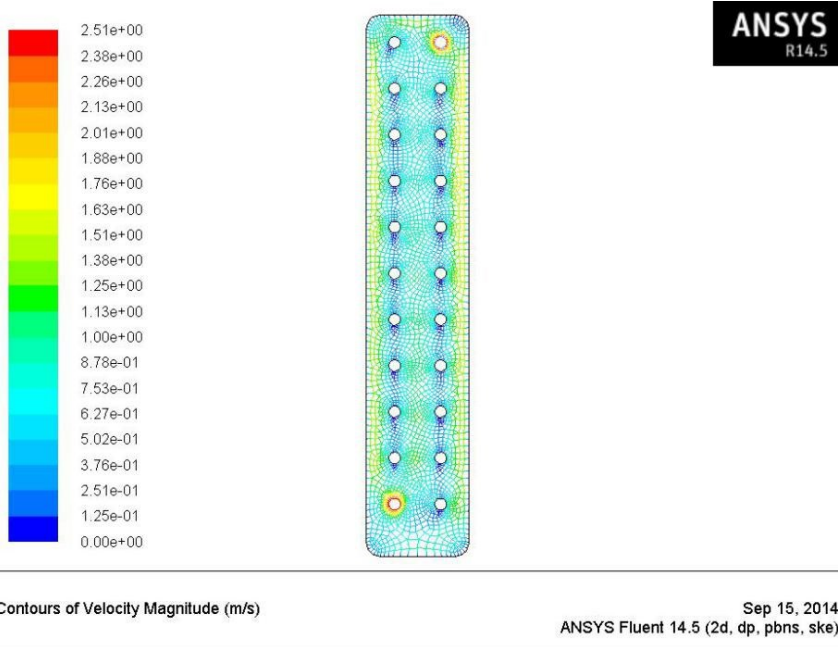
According to the contour plot, the maximum velocity at inlet and outlet holes is 2.51e+00 m/s and the minimum at in between inlet and outlet holes is 1.25e-01 m/s

Static Pressure
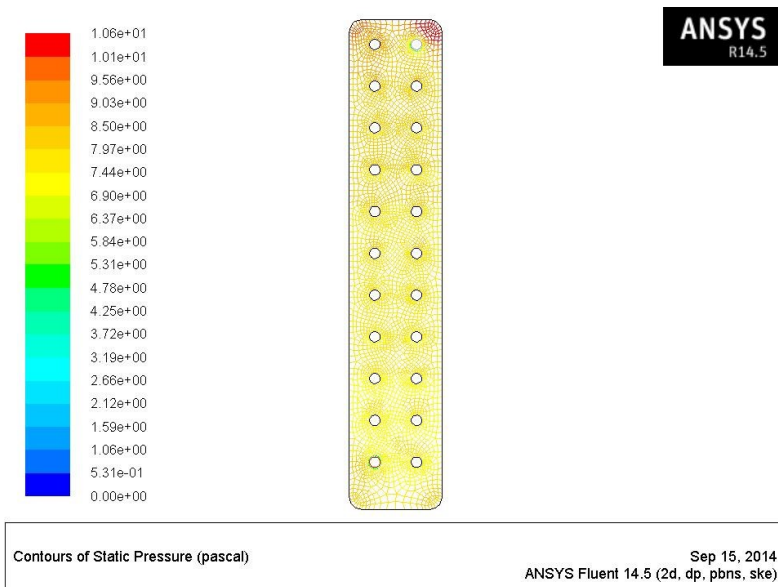
Contours of Static Pressure (pascal)

Sep 15, 2014
ANSYS Fluent 14.5 (2d, dp, pbns, ske)

According to the contour plot, the maximum static pressure at outlet hole beside corners is

1.06e+01pa and the minimum at inlet hole 5.31e-01pa

Temperature

Contours of Static Temperature (k)   Sep 15, 2014
ANSYS Fluent 14.5 (2d, dp, pbns, ske)

According to the contour plot, the maximum temperature at fin body is 3.00e+02 k

Mass flow report
"Flux Report"
        Mass Flow Rate   (kg/s)
------------------------------ --------------------
          inlet   0.09587553
  interior-_trm_srf   -1.0707636
       outlet   -0.095938734
   wall-_trm_srf   0
     --------------- --------------------
      Net   -6.3204351e-05 kg/sec.
The net mass flow rate of fin body is -6.3204351e-05 kg/sec

"Flux Report"
Total Heat Transfer Rate   (w)
------------------------------ --------------------
       inlet   178.51022
      outlet   -178.6279
   wall-_trm_srf   3.5367242e-13
     --------------- --------------------

Net   -0.1176799 w

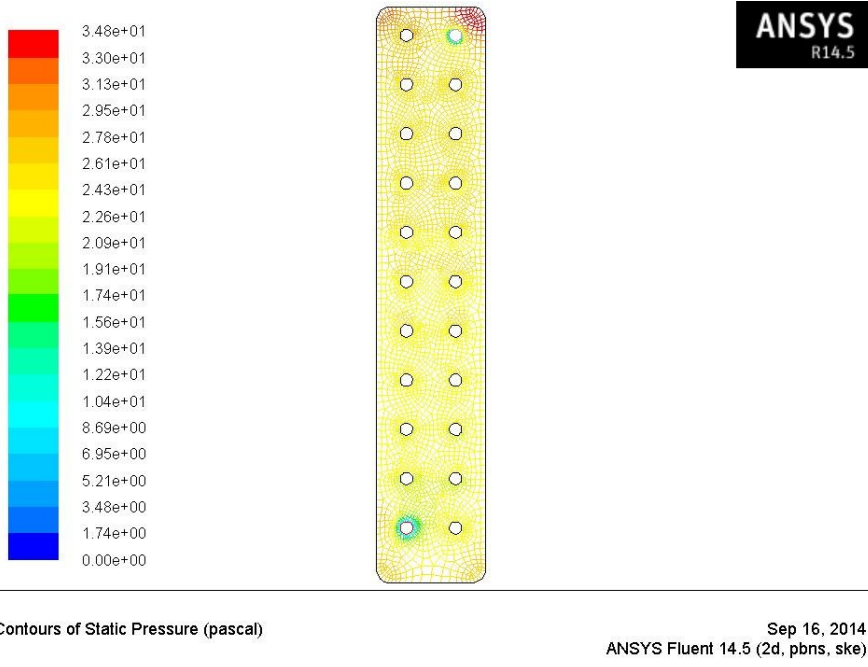The net Total heat transfer rate of fin body is -0.1176799 w.

HCFC velocity 5(m/s)
Velocity Magnitude
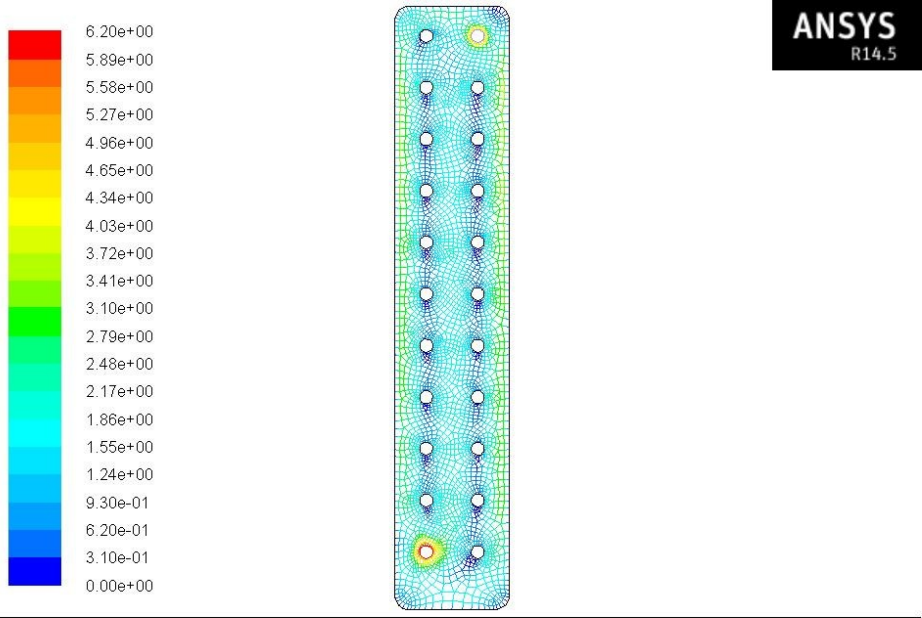
Contours of Velocity Magnitude (m/s)

Sep 16, 2014
ANSYS Fluent 14.5 (2d, pbns, ske)

According to the contour plot, the maximum velocity at inlet and outlet holes is 6.20e+00 m/s and the minimum at in between inlet and outlet holes is 3.10e-01m/s

Static pressure

Contours of Static Pressure (pascal)

Sep 16, 2014
ANSYS Fluent 14.5 (2d, pbns, ske)

According to the contour plot, the maximum static pressure at outlet hole beside corners is

3.48e+01pa and the minimum at inlet hole 1.74e+00pa

Temperature

Contours of Static Temperature (k)   Sep 16, 2014
                                    ANSYS Fluent 14.5 (2d, pbns, ske)
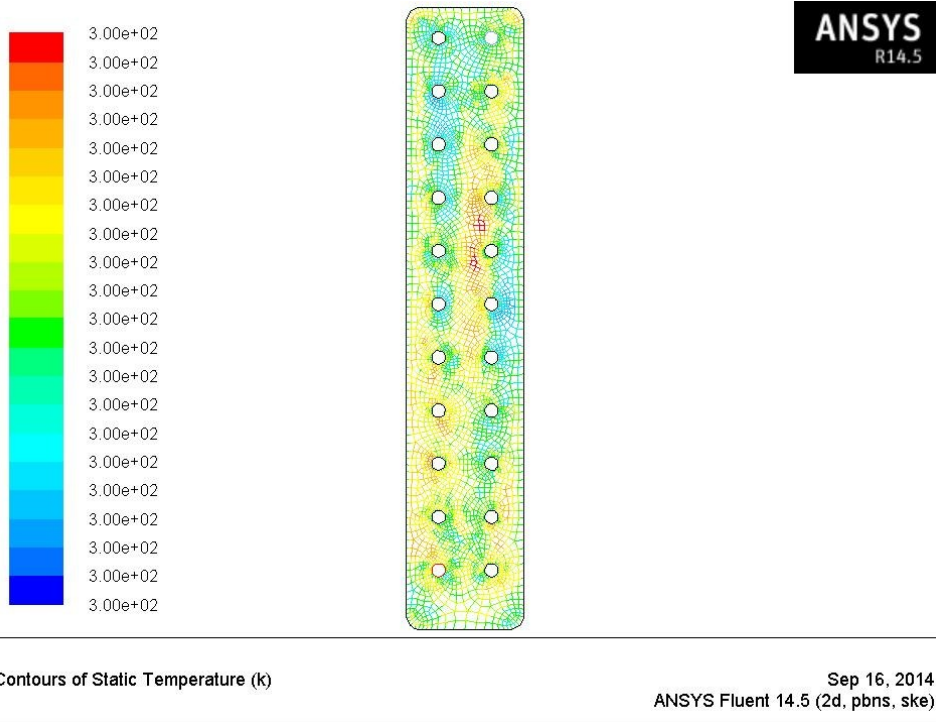
According to the contour plot, the maximum temperature at fin body is 3.00e+02 k

Mass flow rate
"Flux Report"

```
        Mass Flow Rate          (kg/s)
------------------------------- -------------------
        inlet        0.191751
    interior-_trm_srf       -1.537853
        outlet      -0.1914832
    wall-_trm_srf         0
    ---------------- -------------------
        Net     0.00026780367  kg/sec
```

The net mass flow rate of fin body is 0.00026780367kg/sec

"Flux Report"
Total Heat Transfer Rate   (w)

```
------------------------------- -------------------
        inlet        357.02032
        outlet      -356.51999
    wall-_trm_srf      -0.0013494033
    ---------------- -------------------
        Net      0.49898629  w
```
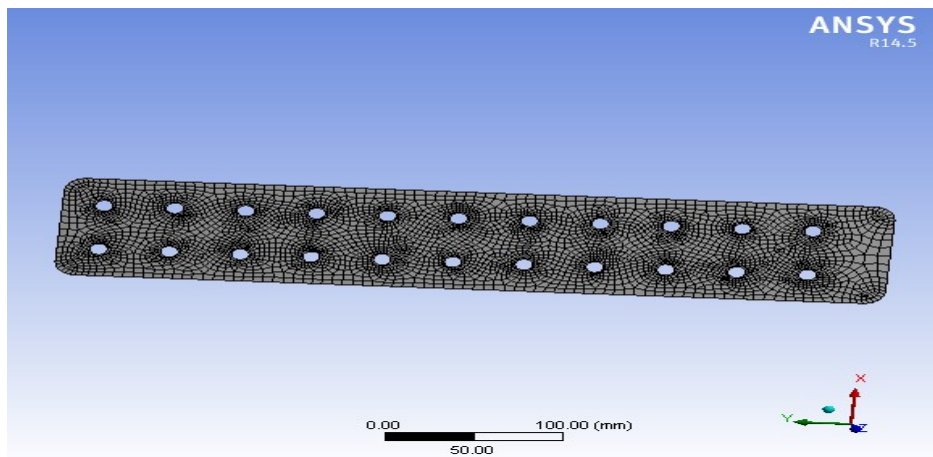
The net Total heat transfer rate of fin body is 0.49898629w
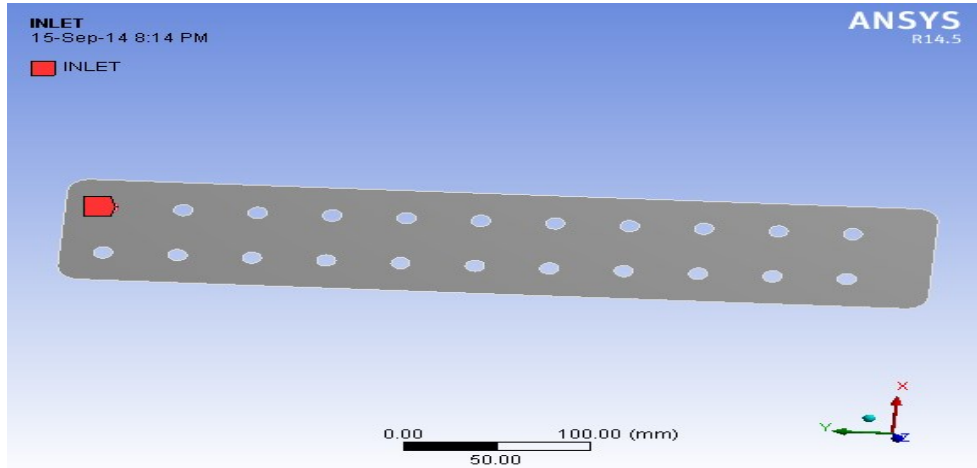
404R Velocity 2.5(m/s)
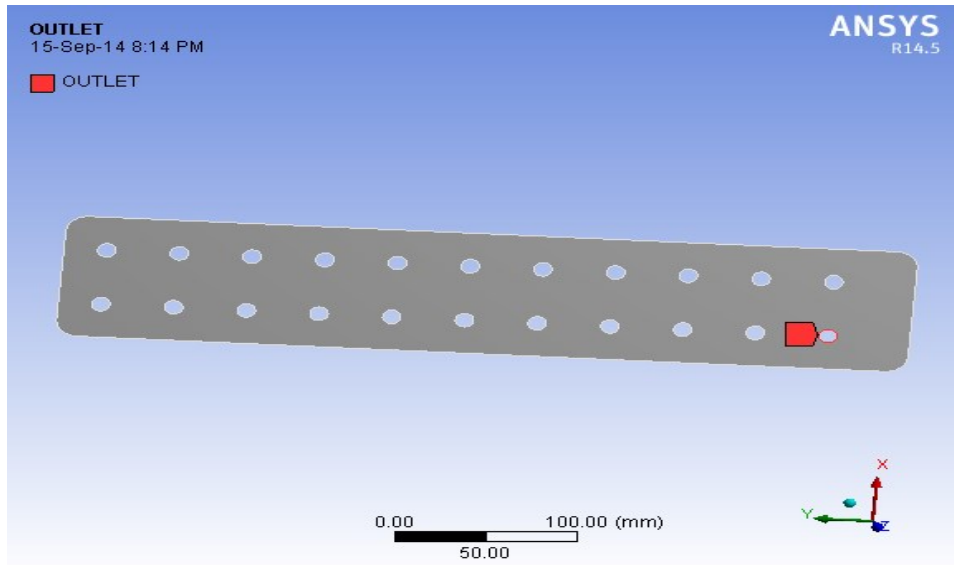
Import model
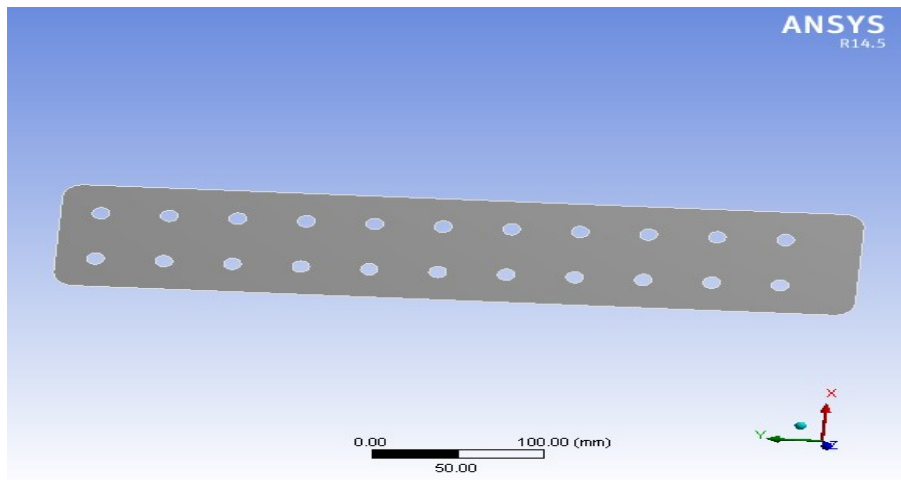
Meshed model

Inlet view

Outlet view

RESULTS TABLE

		Velocity Magnitude (m/s)	Static pressure (Pascal)	Temperature (k)	Mass Flow Rate (kg/s)	Heat Transfer Rate (w)
	2.5m/s	2.51e+00	1.06e+01	3.00e+02	6.3204351e-05	0.1176799
Hcfc	5 m/s	6.20e+00	3.48e+01	3.00e+02	0.00026780367	0.049898629

|		Velocity Magnitude (m/s)	Static pressure (Pascal)	Temperature (k)	Mass Flow Rate (kg/s)	Heat Transfer Rate (w)
	7.5 m/s	9.02e+00	7.21e+01	3.00e+02	0.00015335049	0.28552244
404R	2.5 m/s	3.58e+00	5.23e+01	3.00e+02	0.0052805282	9.8317916
	5 m/s	5.40e+00	2.96e+01	3.00e+02	7.5668995e-05	0.14088776
	7.5 m/s	7.51e+00	1.70e+02	3.00e+02	0.000562426693	1.0506061

GRAPHS

VELOCITY MAGNITUDE
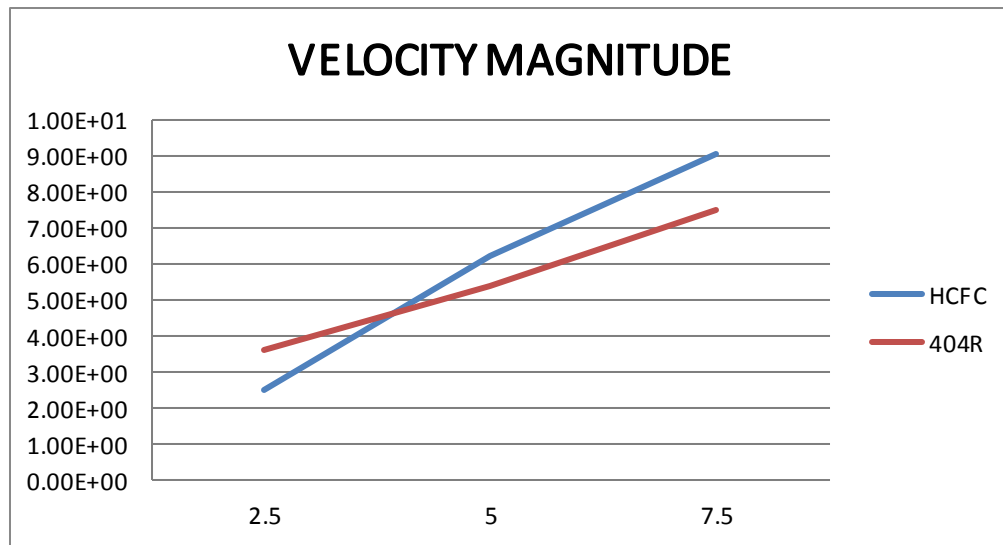
The above graph represents the comparison Between refrigerant and velocities for the 2 materials of HCFC and 404R refrigerant. It shows that the HCFC has more velocity magnitude than 404R.
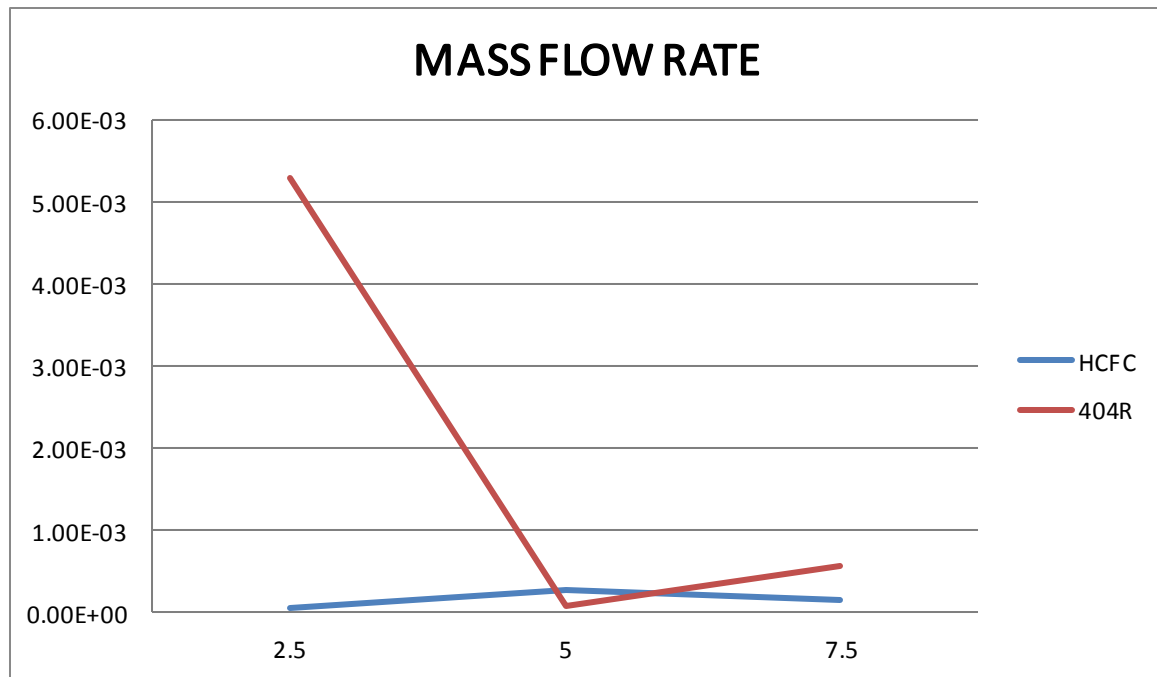
STATIC PRESSURE
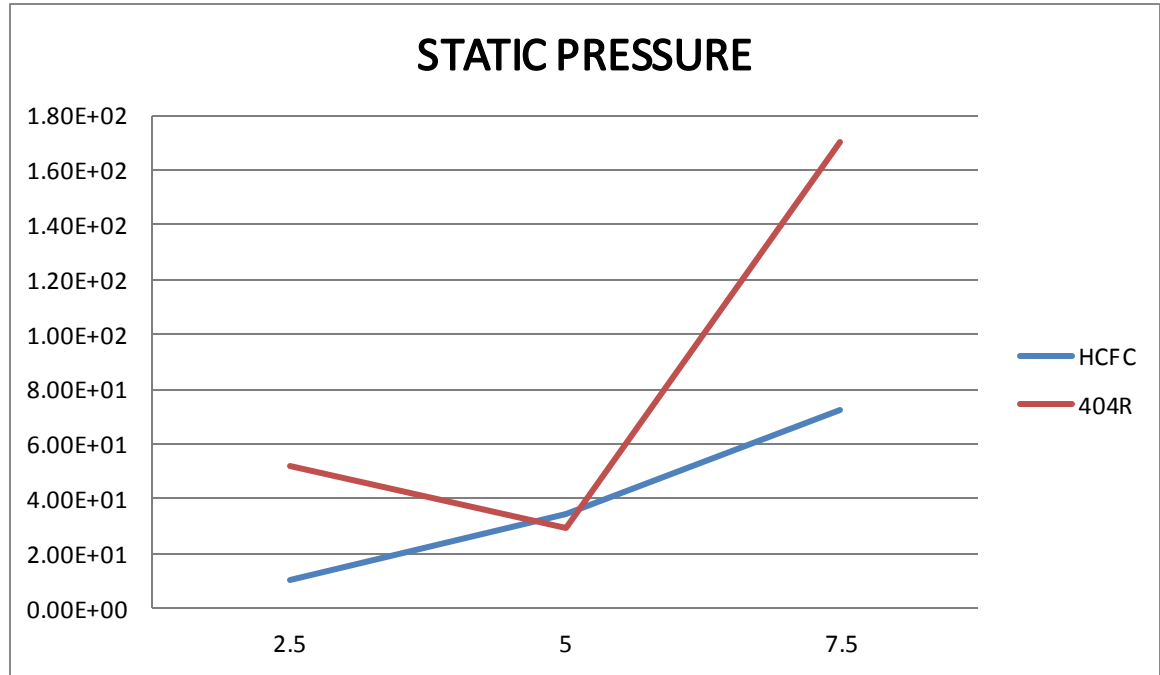
The above graph represents the comparison Between refrigerant and velocities for the 2 materials of HCFC and 404R refrigerant. It shows that the 404R has more static pressure than HCFC

TEMPERATURE
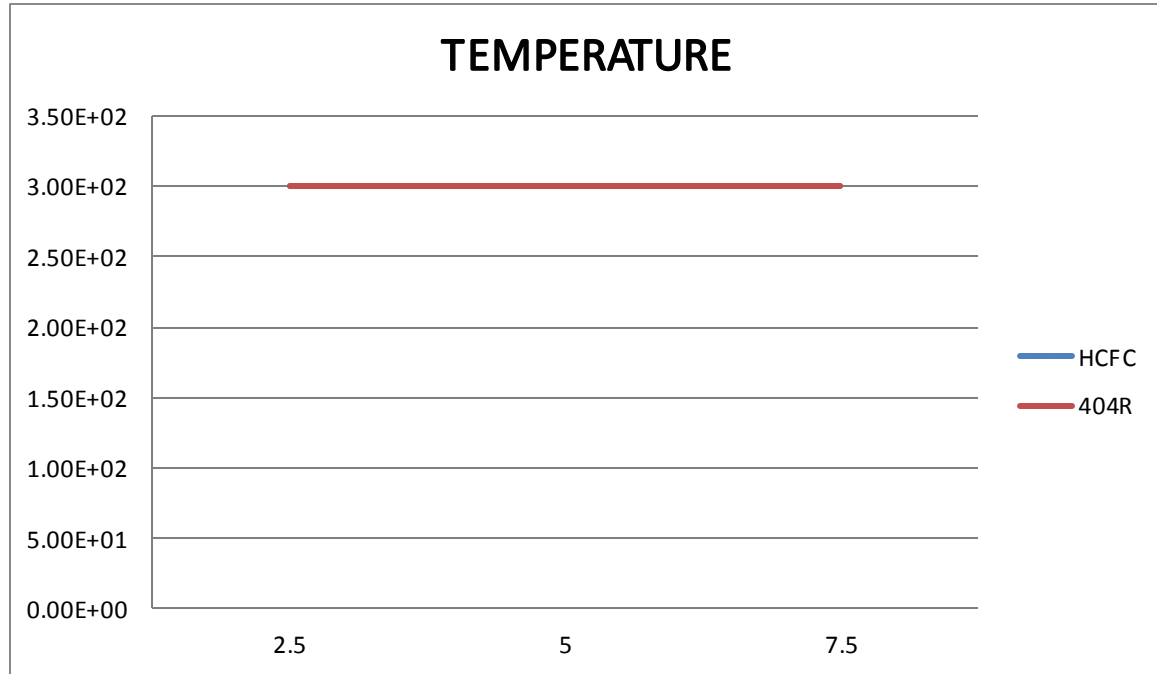
TEMPERATURE

The above graph represents the comparison Between refrigerant and velocities for the 2 materials of HCFC and 404R refrigerant. It shows that the HCFC and 404R are equal.

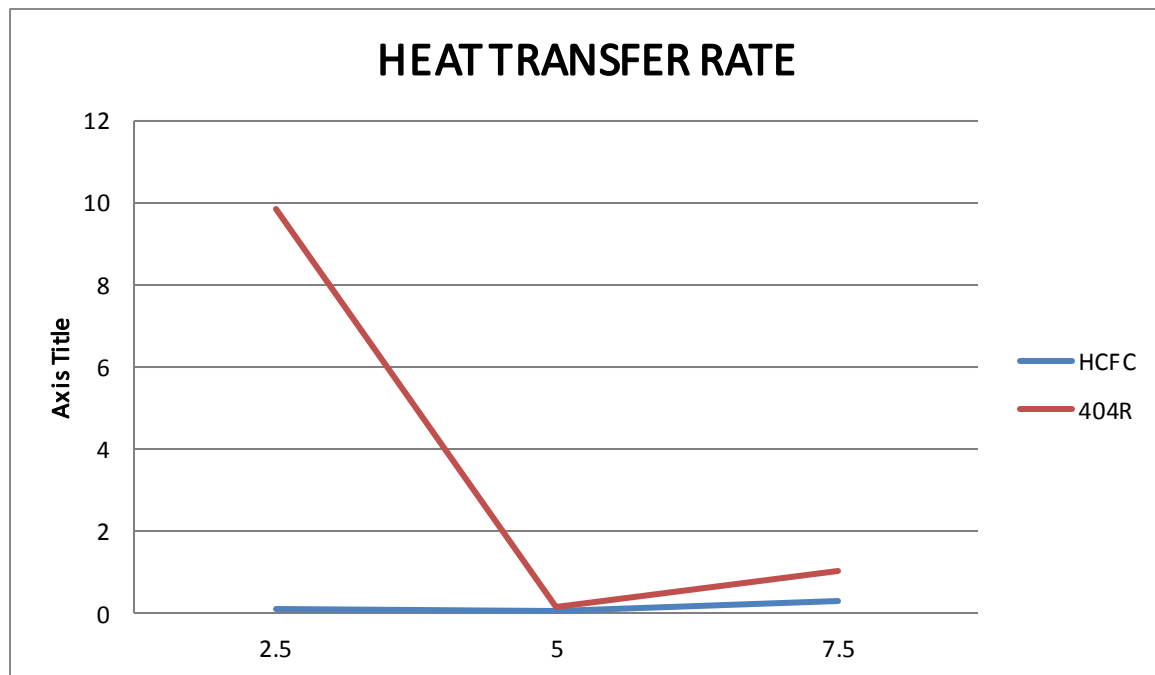## TOTAL MASS FLOW RATE

MASS FLOW RATE

The above graph represents the comparison Between refrigerant and velocities for the 2 materials of HCFC and 404R refrigerant. It shows that the HCFC has more mass flow rate than 404R.

TOTAL HEAT TRANSFER RATE

HEAT TRANSFER RATE

The above graph represents the comparison Between refrigerant and velocities for the 2 materials of HCFC and 404R refrigerant. It shows that the HCFC has more heat transfer rate than 404R.

CONCLUSION

In this thesis, an ac condenser is designed and optimized for better material, refrigerant and thickness to improve the heat transfer rate. Present used material for fin is Aluminum alloy 204 and cooling fluid is HCFC. Modeling is done in Pro/Engineer. To optimize the condenser for best result, thermal analysis is done on the condenser. Analysis is done using fin materials Aluminum Alloy 1100, Aluminum Alloy 6063 and Magnesium alloy. And also by changing the cooling fluid HCFC and R404.

By observing the thermal analysis results, by using fin material Aluminum alloy 1100, thermal flux is more than by using other two materials. So by using Aluminum alloy 1100, the heat transfer rate increases. And also by taking refrigerant R404 is better. Thermal flux is also calculated theoretically, by observing the results, using fin material Aluminum alloy 1100 and refrigerant R404 has more heat transfer rate.

FUTURE SCOPE

The use of material Aluminum alloy 1100 is better analytically. More experiments have to be done to check the feasibility of using the material depending on other factor like environment conditions and cost analysis. Refrigerant 404R is better. Experiments are to be done also for that.

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