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Determination of Thermal Performance on Combined Air-conditioning and Refrigeration Unit

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ABSTRACT:

In recent years, the escalating cost of energy has drawn much more attention on improving the energy efficiency of super market operations. In a supermarket refrigeration system consume a large amount of energy in maintaining chilled and frozen food. Meanwhile a HVAC (heating, ventilating and air conditioning) system is used to assure thermal comfort for occupants and suitable climatic conditions for refrigerated cases.

In this thesis, the thermal performance of combined air conditioning and refrigeration unit will be analyzed by CFD. 3D model and assembly of the combined air conditioning and refrigeration unit will be done in Pro/Engineer.

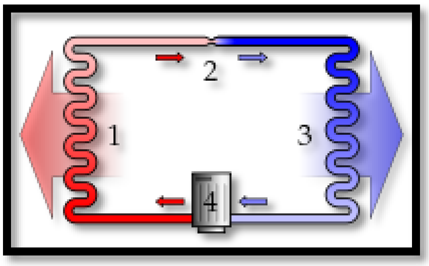
CFD and thermal analysis will be on the unit to determine the thermal performance by varying the refrigerants and materials. Analysis will be done in Ansys.

INTRODUCTION
INTRODUCTION TO 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.
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.

AIR CONDITIONING SYSTEM BASICS AND THEORIES
REFRIGERATION CYCLE



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

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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.

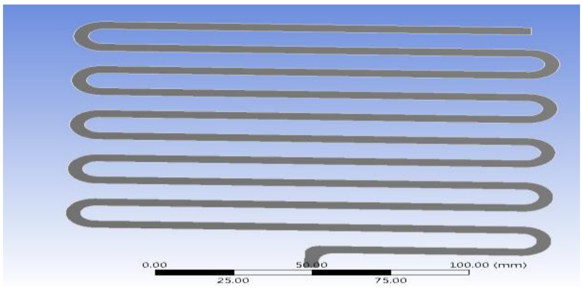
By placing the condenser (where the heat is rejected) inside a compartment, and the evaporator (which absorbs heat) in the ambient environment (such as outside), or merely running a normal air conditioners refrigerant in the opposite direction, the overall effect is the opposite, and the compartment 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 un loaders 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 un loaders which remove a portion of the load from the compressor so that it can run better when full cooling is not needed. Un loaders can be electrical or mechanical.

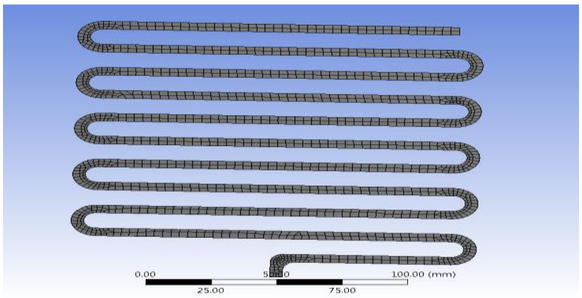
CFD ANALYSIS OF BI PROPELLENT EVAPORATOR

R22

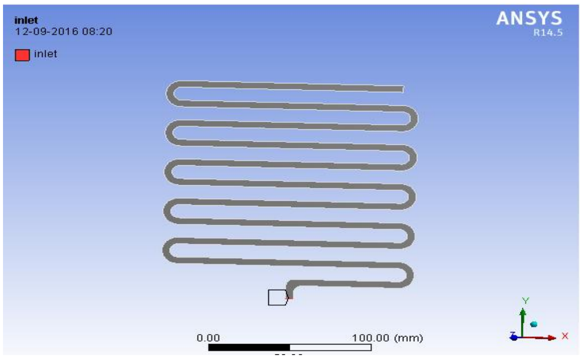
IMPORTED MODEL



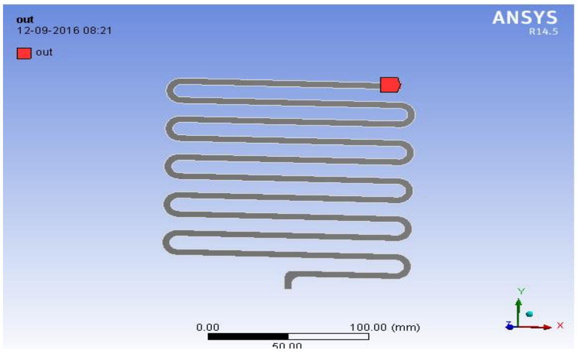
MESHED MODEL



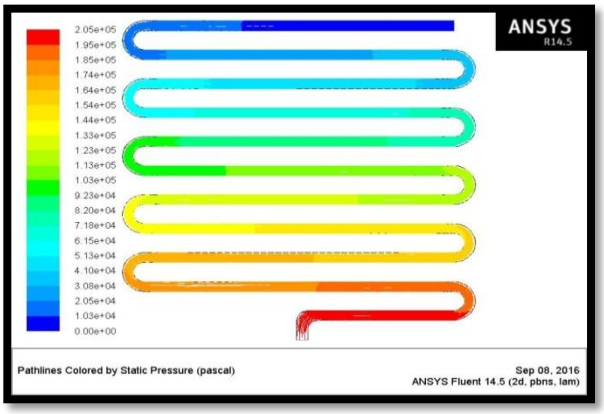
INLET



OUTLET



PRESSURE (PA)



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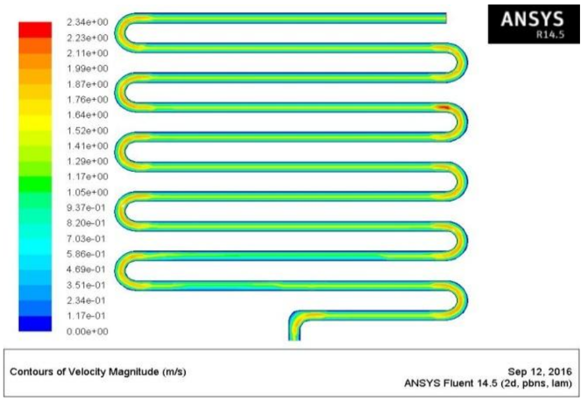
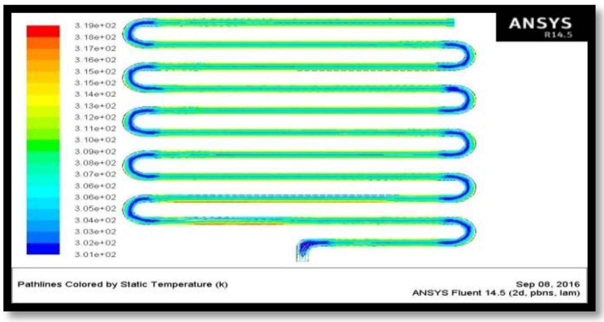
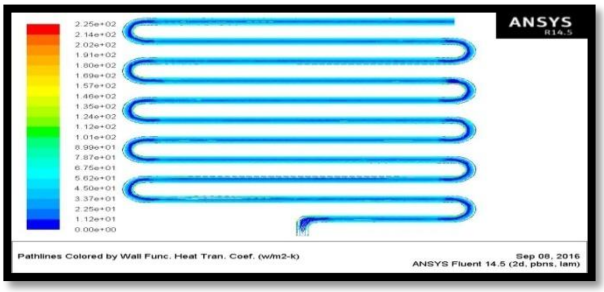
VELOCITY (M/SEC)



TEMPERATURE (K)

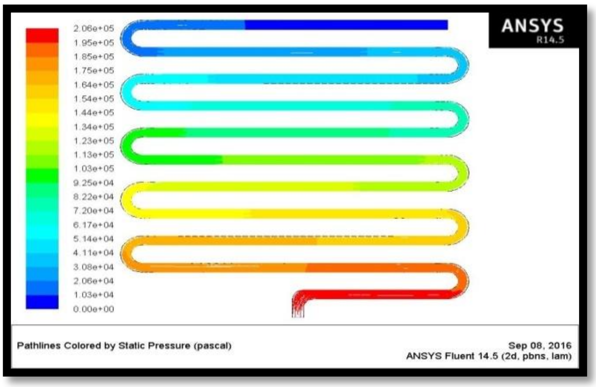


WALL FUNCTION HEAT TRANSFER COEFFICIENT (W/M2-K)



FLUID - R134A

PRESSURE (PA)



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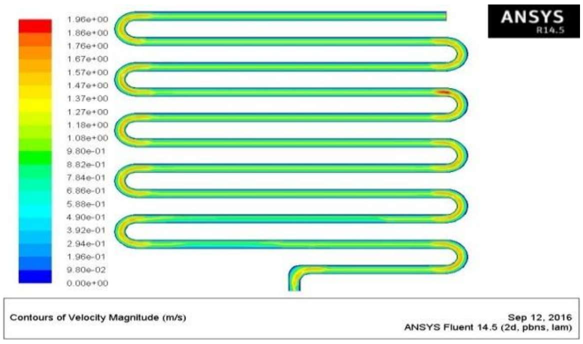

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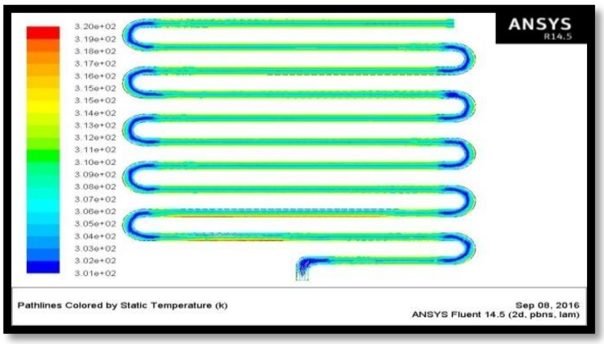
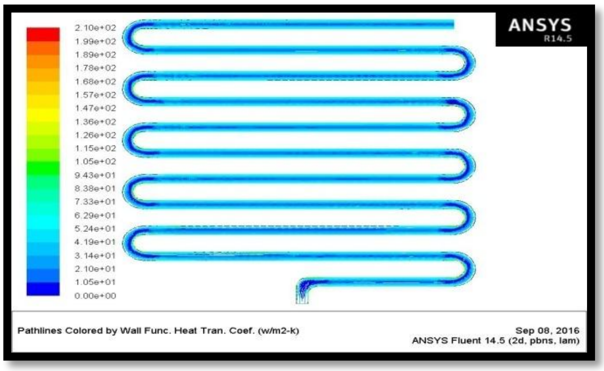
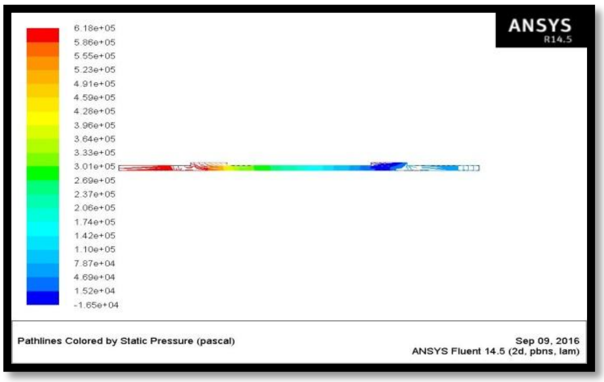


WALL FUNCTION HEAT TRANSFER COEFFICIENT (W/M2-K)



LOW PRESSURE COMPRESSOR

PRESSURE (PA)



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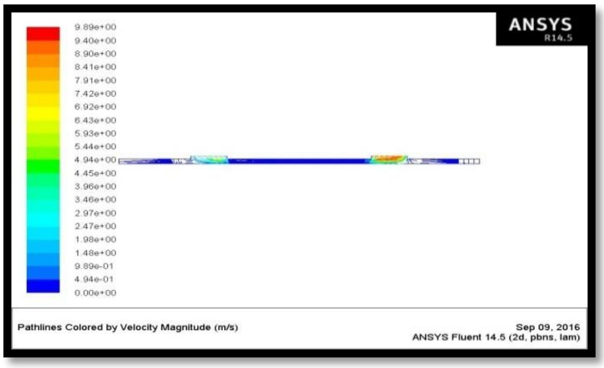
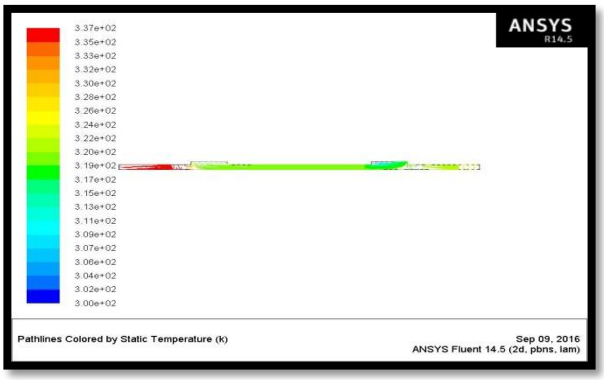


TEMPERATURE (K)



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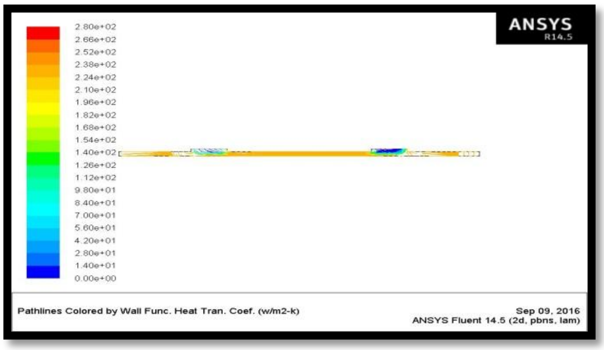
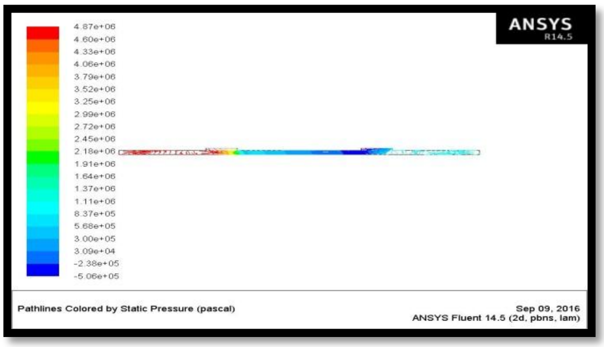


HIGH PRESSURE COMPRESSOR

PRESSURE (PA)



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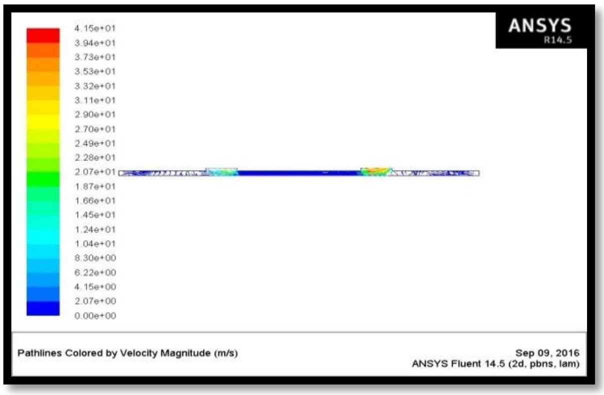
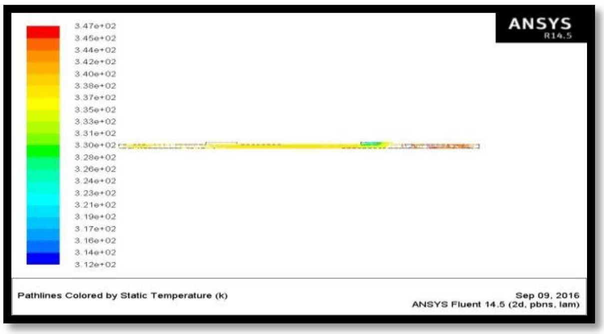


TEMPERATURE (K)



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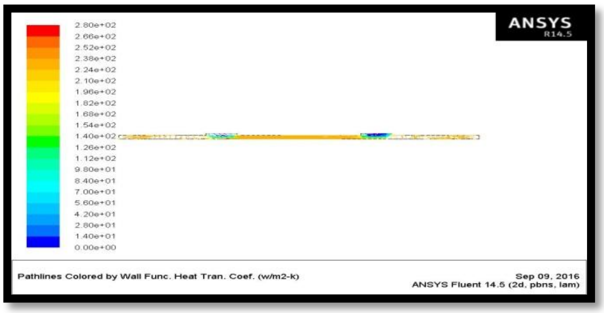
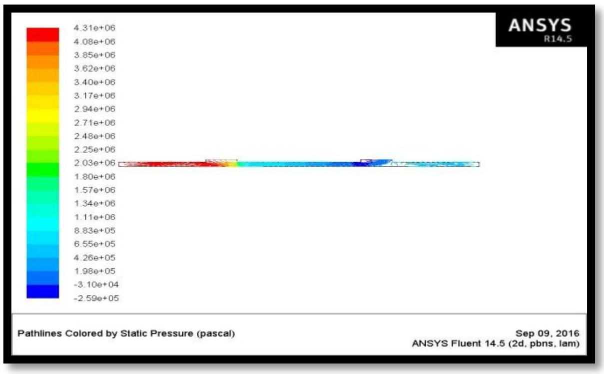


R134A

INLET BOUNDARY CONDITIONS

PRESSURE (PA)



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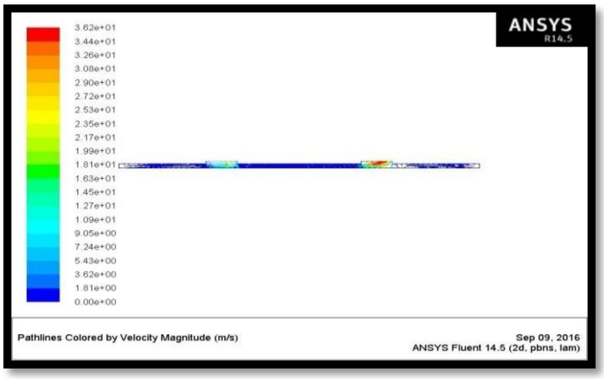

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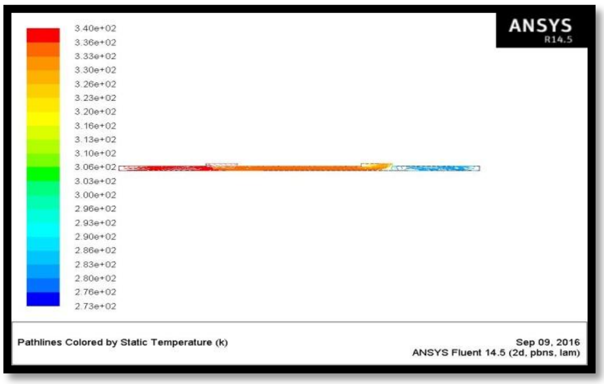

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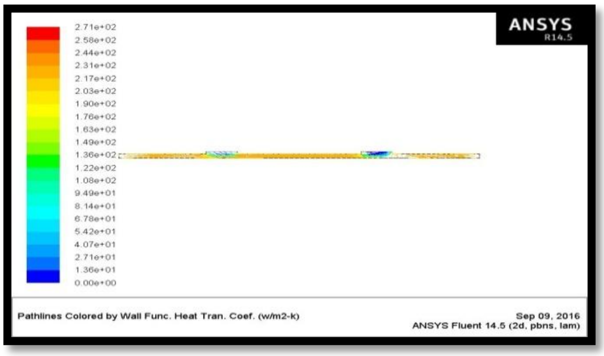
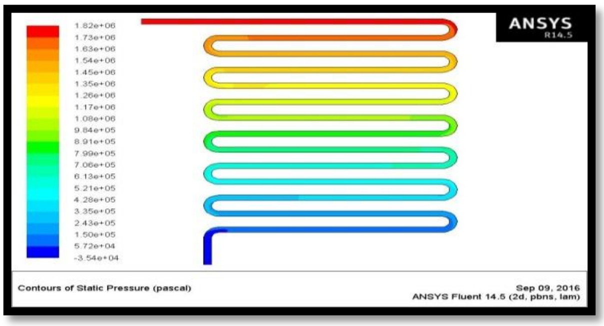


LP CONDENSER

PRESSURE (PA)



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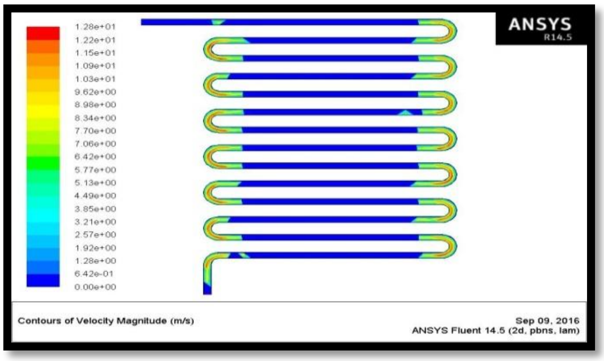
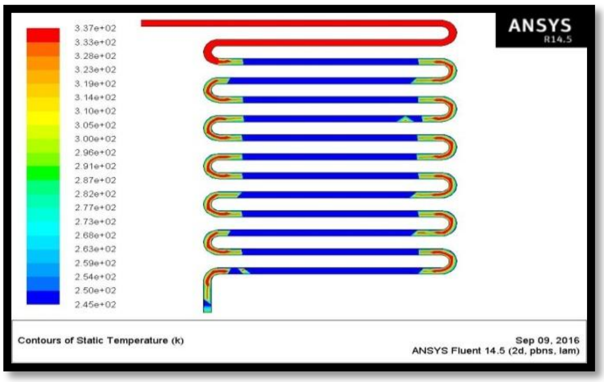
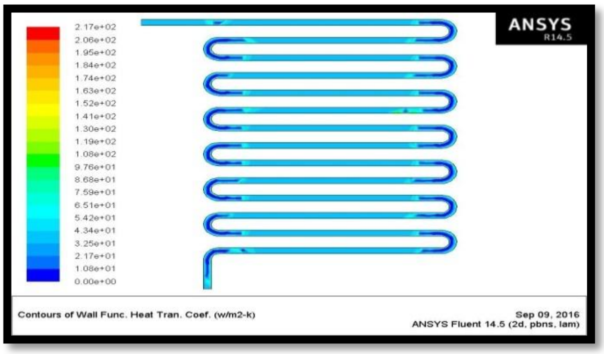


TEMPERATURE (K)

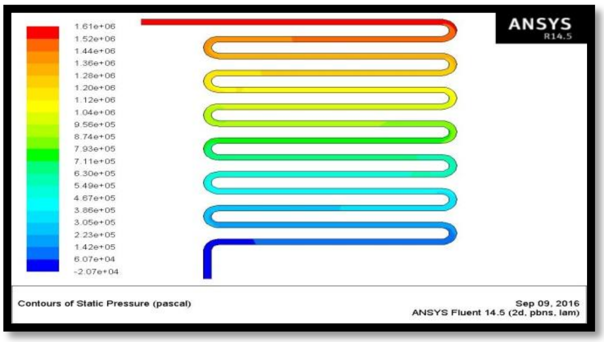


WALL FUNCTION HEAT TRANSFER COEFFICIENT (W/M2-K)



R134A

PRESSURE (PA)



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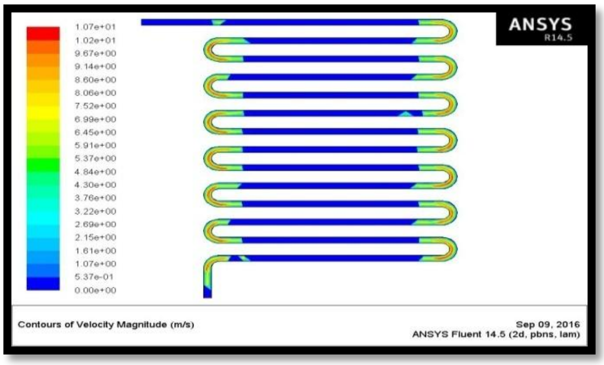
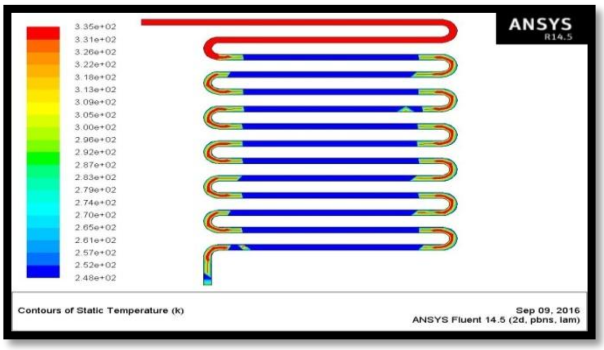
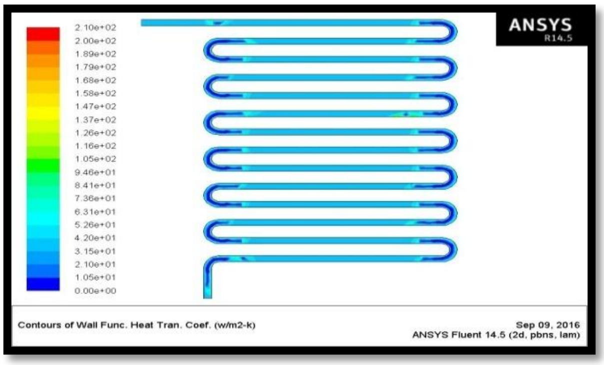
VELOCITY (M/SEC)



TEMPERATURE (K)



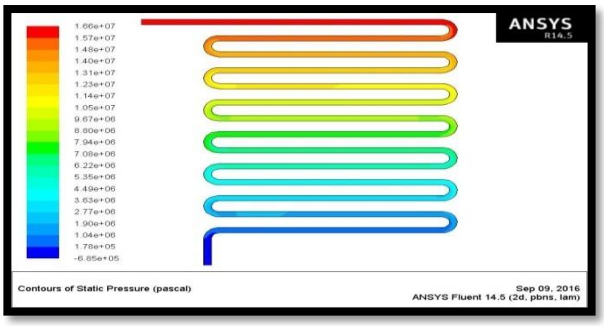
WALL FUNCTION HEAT TRANSFER COEFFICIENT (W/M2-K)



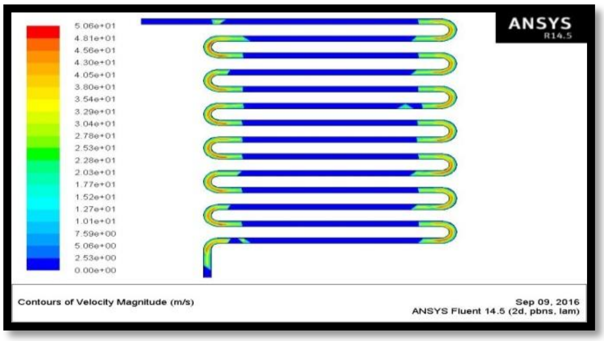
H.P. CONDENSER

R22

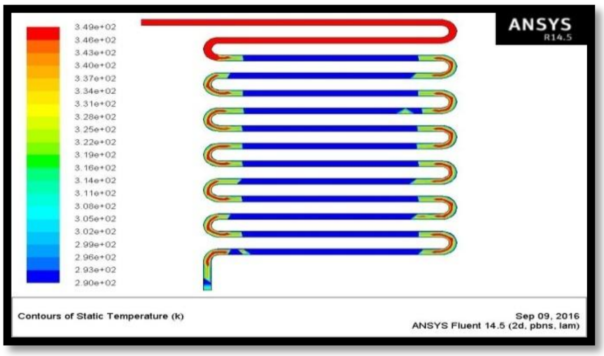
PRESSURE (PA)



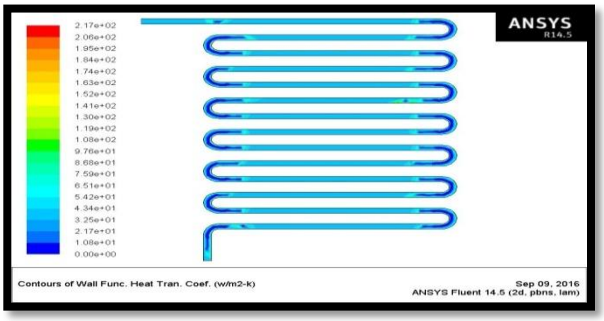
VELOCITY (M/SEC)



TEMPERATURE (K)



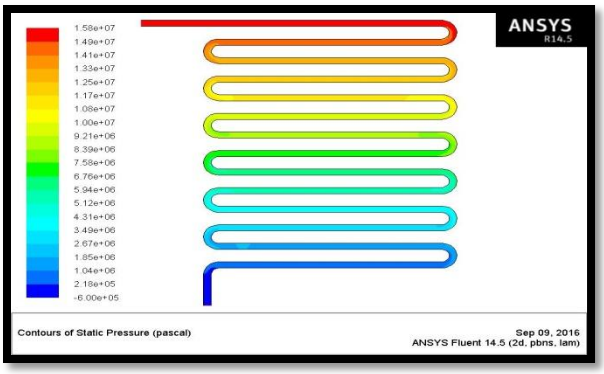
WALL FUNCTION HEAT TRANSFER COEFFICIENT (W/M2-K)



R134A

INLET BOUNDARY CONDITIONS

PRESSURE (PA)



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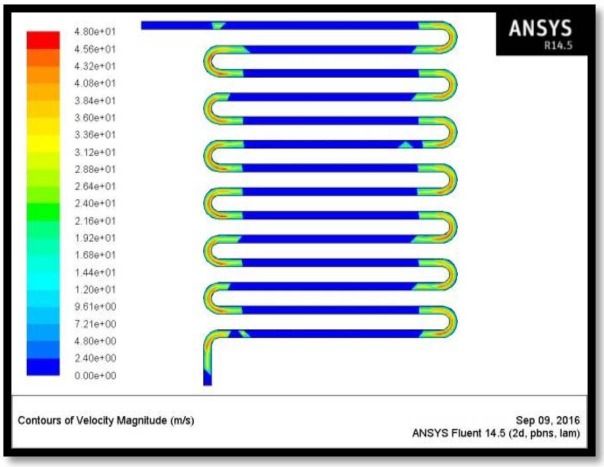
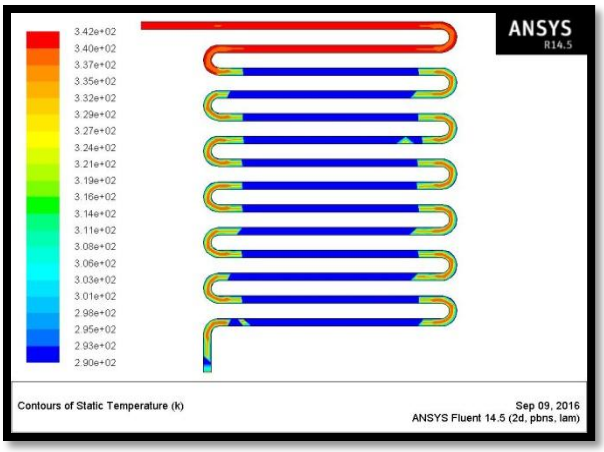
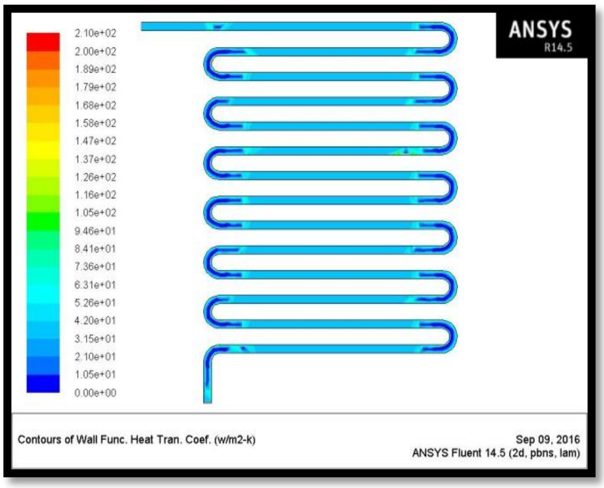
VELOCITY (M/SEC)



TEMPERATURE (K)



WALL FUNCTION HEAT TRANSFER COEFFICIENT (W/M2-K)



RESULTS AND DISCUSSIONS
EVAPORATOR

Fluids	Pressure (Pa)	Temperature (K)	Velocity (M/Sec)	Wall Function Heat Transfer Coefficient (W/M2-K)	Mass Flow Rate (Kg/Sec)	Total Heat Transfer Rate (W)
R22	205109.5	319.0063	2.343	224.8694	-0.002458	10.169
R134A	205586.7	320.3197	1.9590	209.5591	-0.00010001358	-5.326416

COMPRESSOR
LOW PRESSURE COMPRESSOR

Fluids	Pressure (Pa)	Temperature (K)	Velocity (M/Sec)	Wall Function Heat Transfer Coefficient (W/M2-K)	Mass Flow Rate (Kg/Sec)	Total Heat Transfer Rate (W)
R22	618120	337.2	9.8896	279.93	-0.27691	10425.809
R134A	562448.2	335.97	8.359242	271.2692	0.0499	7898.7874

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HIGH PRESSURE COMPRESSOR

Fluids	Pressure (Pa)	Temperature (K)	Velocity (M/Sec)	Wall Function Heat Transfer Coefficient (W/M2-K)	Mass Flow Rate (Kg/Sec)	Total Heat Transfer Rate (W)
R22	4866064	346.99	41.47	279.9091	-0.4362	101977.76
R134A	4310480	339.5323	36.21076	271.23	-1.1725349	77965.76

CONDENSER

LOW PRESSURE CONDENSER

Fluids	Pressure (Pa)	Temperature (K)	Velocity (M/Sec)	Wall Function Heat Transfer Coefficient (W/M2-K)	Mass Flow Rate (Kg/Sec)	Total Heat Transfer Rate (W)
R22	1817868	337.329	12.8313	216.9602	0.0036125	167.45703
R134A	1606323	335.12	10.74	210.24	0.001159	72.3125

HIGH PRESSURE CONDENSER

Fluids	Pressure (Pa)	Temperature (K)	Velocity (M/Sec)	Wall Function Heat Transfer Coefficient (W/M2-K)	Mass Flow Rate (Kg/Sec)	Total Heat Transfer Rate (W)
R22	1.65e+7	348.85	50	216.96	-0.006256	-259.41074
R134A	1.5752e+7	342.48	48.041	210.24	-0.0080	466.789

CONCLUSION

In recent years, the escalating cost of energy has drawn much more attention on improving the energy efficiency of super market operations. In a supermarket refrigeration system consume a large amount of energy in maintaining chilled and frozen food. Meanwhile a HVAC (heating, ventilating and air conditioning) system is used to assure thermal comfort for occupants and suitable climatic conditions for refrigerated cases.

In this thesis, the thermal performance of combined air conditioning and refrigeration unit will be analyzed by CFD. 3D model and assembly of the combined air conditioning and refrigeration unit done in creo.

By observing above CFD results comparing of two refrigerants R22 and R134a of combined refrigeration unit R134a is getting low temperature comparatively with R22 for various condensers are placed for various applications. While, AC supply point of view we placed condenser at high pressure compressor in this R134a shows less temperature (17^0c) is comes out from the condenser, in the same way temperature(-25^0C) is observed at condenser which is placed at low pressure condenser which is supplied to refrigerators placed in super markets.

Author Details

Madaraboina Prakash received the B.TECH degree in Mechanical Engineering from Jawaharlal Nehru Technological University, Jagtial,Telangana, India, in 2014 year and pursuing M.TECH in Thermal Engineering from Ellenki College of Engineering and Technology, JNTU, Hyderabad, Telangana, India.

Smt.V.Saritha, M.TECH, Assistant Professor, Ellenki College of Engineering and Technology, JNTU, Hyderabad, Telangana, India.