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IMPROVING THE HEAT TRANSFER RATE OF CONDENSER REFRIGERATOR BY USING DIFFERENT REFRIGERANTS

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ABSTRACT: Air conditioning systems have condenser that removes unwanted heat from the refrigerant and transfers that heat outdoors. The primary component of a condenser is typically the condenser coil, through which the refrigerant flows. Since, the condenser coil contains refrigerant that absorbs heat from the surrounding air, the refrigerant temperature must be higher than the air. In this thesis heat transfer by convection in by varying the refrigerants are determined by CFD and thermal analysis. The assessment is out on an air-cooled tube condenser of a vapour compression cycle for air conditioning system. The materials considered for tubes are Copper and Aluminium alloys 6061 and 7075. The refrigerants varied will be R 22, R 134 and R407C. CFD analysis is done to determine temperature distribution and heat transfer rates by varying the refrigerants. Heat transfer analysis is done on the condenser to evaluate the better material. 3D modeling is done in CREO and analysis is done in ANSYS.

Key words: condenser, CFD analysis, refrigerants, ANSYS

INTRODUCTION

In systems involving heat transfer, a condenser is a device or unit used to condense a substance from its gaseous to its liquid state, 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 (hand-held) to very large industrial-scale units used in plant processes. For example, a refrigerator uses a condenser to get rid of heat extracted from the interior of the unit to the outside air

Examples of condensers: A surface condenser is an example of such a heat-exchange system. It is a shell and tube heat exchanger installed at the outlet of every steam turbine in thermal power stations. Commonly, the cooling water flows through the tube side and the steam enters the shell side where the condensation occurs on the outside of the heat transfer tubes In chemistry, a condenser is the apparatus which cools hot vapors, causing them to condense into a liquid. See "Condenser (laboratory)" for laboratory-scale condensers, as opposed to industrial-scale condensers. Examples include the Liebig condenser, Graham condenser, and Allihn condenser. This is not to be confused with a condensation reaction which links two fragments into a single molecule by an addition reaction and an elimination reaction.

Other Types of Condensers

- **Water-cooled**
- **Air-cooled**
- **Evaporative**

Applications:

Air cooled – If the condenser is located on the outside of the unit, the air cooled condenser can provide the easiest arrangement. These types of condensers eject heat to the outdoors and are simple to install. Most common uses for this condenser are domestic refrigerators, upright freezers and in residential packaged air conditioning units. A great feature of the air cooled condenser is they are very easy to clean. Since dirt can cause serious issues with the condensers performance, it is highly recommended that these be kept clear of dirt.

AIR CONDITIONER CONDENSER: Air conditioner (A/C) condenser is an essential part of a car air conditioning system. Let's review how the vehicle A/C system works: The A/C system is a closed loop filled with refrigerant (typically R134) under pressure. The A/C compressor circulates the refrigerant through the system. The evaporator is a small heat exchanger installed inside the vehicle ventilation system.

A/C condenser replacement: There are two types of replacement parts, the OEM (original) and A/M (aftermarket). An OEM A/C condenser can be ordered from a dealer but it's usually more expensive ($250-850). An aftermarket part is cheaper ($70-$320) and can be purchased online or from an auto parts supplier. The labor is more expensive, since in many cars, the front bumper and many other parts might need to be removed in order to get to the A/C condenser. Also the air conditioning system refrigerant must be recovered before and recharged after the A/C condenser is replaced.

Air Conditioning System

A simple stylized diagram of the refrigeration cycle:

1) Condensing coil,

2) Expansion valve,

3) Evaporator coil,

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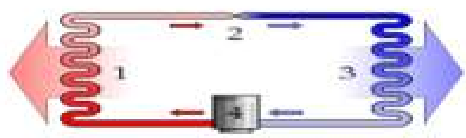
4) Compressor.



LITERATURE REVIEW

Balaji N*et al* [1]The majority of the research work focused large chillers. But in this paper discusses the single split air conditioning system using instead of air coolingusing liquid based cooling. The coolant used in the heat exchanger pure ethylene glycol. Compare the experimental results value of existing system withnew modified system. The compressor running time for the pure ethylene glycol based cooling system is less than the existing system. The compressor'srunning time is reduced from 44 minutes 30 seconds to 33 minutes and 4 seconds.

3D MODELING OF CONDENSER

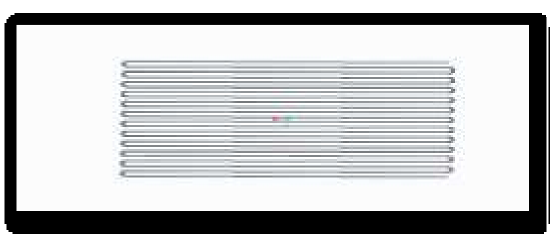
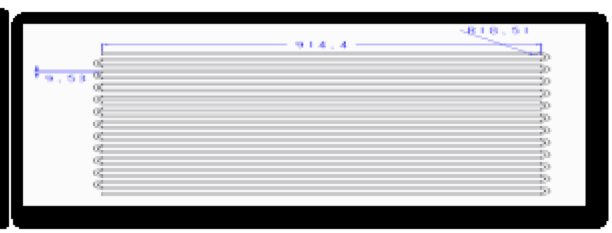



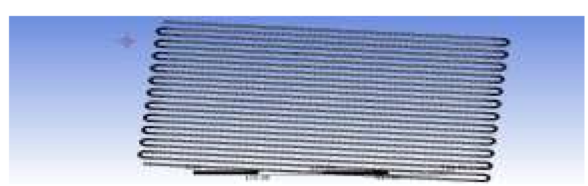
Fig - 3D Model

Fig – 2D Drafting

CFD ANALYSIS FOR CONDENSER

Imported model

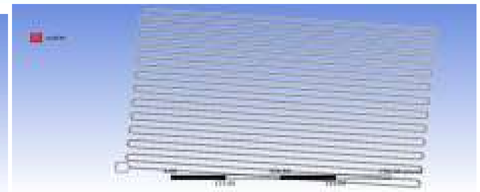
Meshed Model



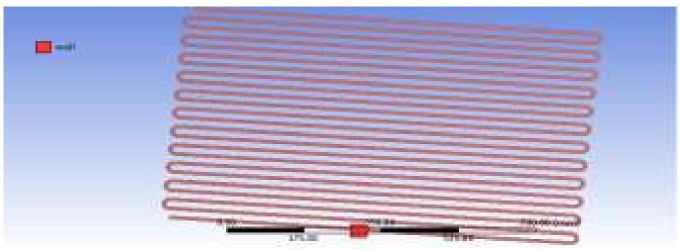
SPECIFYING BOUNDARIES FOR INLET AND OUTLET

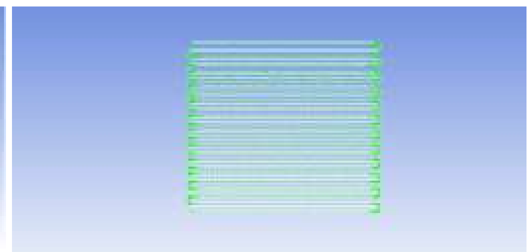
Fluid inlet

Fluid outlet

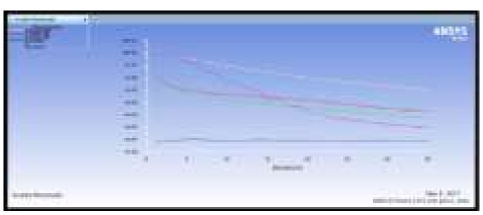


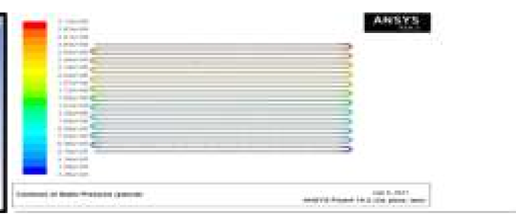
Wall



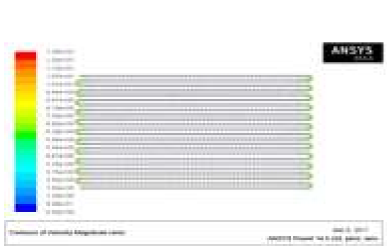


Iterations





Contours of Velocity Magnitude **Contours of Static Temperature**



Contours of Wall function Heat Transfer Coefficient

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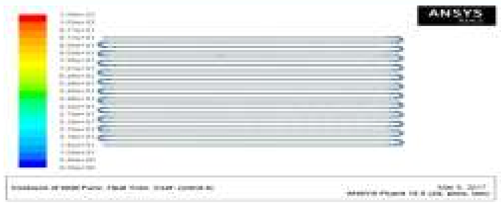


Mass Flow Rate	(kg/s)
inlet	100
interior-_trm_srf	-35415.109
outlet	-100.02785
wall	0
Net	-0.02784729

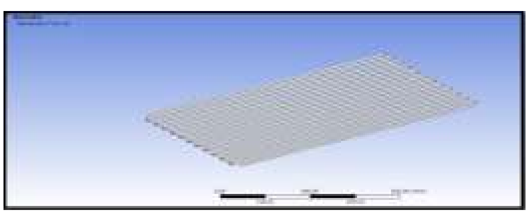
Total Heat Transfer Rate	(w)
inlet	-1439.2496
outlet	2389.7905
wall	-94.993591
Net	855.549

THERMAL ANALYSIS

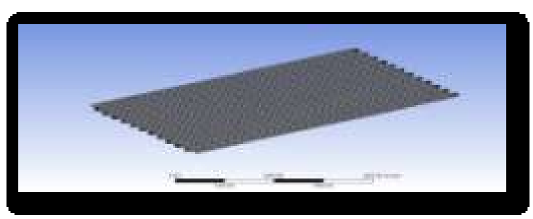
MATERIAL – ALUMINIUM 6061

FLUID – R22

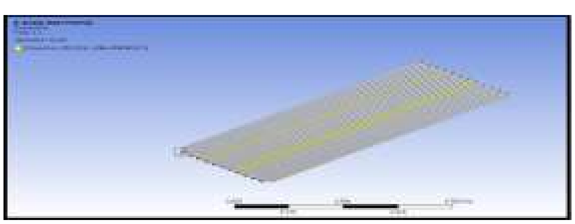
Imported model



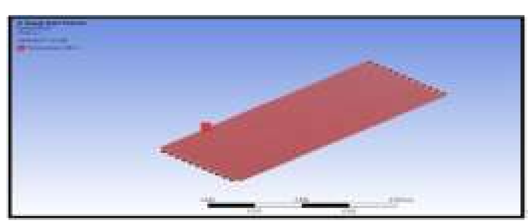
Meshed model



Convection



Temperature



Temperature

Heat flux

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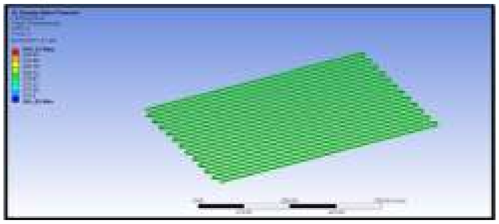

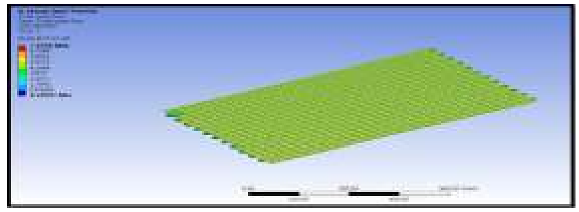

COMPARISON OF CFD RESULTS AT DIFFERENT FLUIDS

Fluids	Pressure (Pa)	Temperature (K)	Velocity (m/Sec)	Function Heat Transfer Coefficient (W/m²-K)	Mass Flow Rate (Kg/Sec)	Total Heat Transfer Rate (W)
R22	$3.12e^{+06}$	$2.80e^{+02}$	$1.26e^{+01}$	$1.08e^{+02}$	-0.0278429	855.549
R134A	$3.37e^{+06}$	$2.83e^{+02}$	$1.36e^{+01}$	$1.56e^{+02}$	0.013374329	-181.78711
R407C	$1.52e^{+06}$	$2.83e^{+02}$	$1.47e^{+01}$	$1.47e^{+02}$	-0.01423645	-48.704102

COMPARISON OF THERMAL ANALYSIS AT DIFFERENT MATERIALS

Materials	Fluids	Convection (W/m² K)	Temperature (°C)	Heat flux (W/mm²)
ALUMINIUM 6061	R22	108	303.15	7.5558
	R134a	156	303.15	6.5842
	R407c	147	303.15	6.5831
ALUMINIUM 7075	R22	108	303.15	7.2285
	R134a	156	303.15	6.2986
	R407c	147	303.15	6.2976
COPPER	R22	108	303.15	13.137
	R134a	156	303.15	11.457
	R407c	147	303.15	11.454

CONCLUSION

In this thesis heat transfer by convection in AC by varying the refrigerants are determined by CFD and thermal analysis. The assessment is out on an air-cooled tube condenser of a vapour compression cycle for air conditioning system. The materials considered for tubes are Copper and Aluminum alloys 6061 and 7075. The refrigerants varied will be R 22, R 134 and R407C. CFD analysis is done to determine temperature distribution and heat transfer rates by varying the refrigerants. Heat transfer analysis is done on the condenser to evaluate the better material. By observing CFD analysis results, the heat transfer coefficient is more when R134A is used and heat transfer rate is more when R22 is used than other fluids.By observing thermal analysis results, the heat flux is more when R22 is used and when material Copper is used. (i.e) The heat transfer rate is more when fluid R134A and material Copper is used.

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