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Increasing the Heat Transfer Rate of AC Condenser by Optimizing Fin Material

Omkar Kurri [1] Ninad Mali [2] Parag Jain [3] HarshalKachare [4] Kiran Chaudhari [5]

(UG Scholar, Dept of ME , Rajiv Gandhi Institute of Technology ,Mumbai

Email: omkarkurri95@gmail.com)

(UG Scholar, Dept of ME , Rajiv Gandhi Institute of Technology ,Mumbai

Email: ninadmali53@gmail.com)

(UG Scholar, Dept of ME , Rajiv Gandhi Institute of Technology ,Mumbai

Email: jainparag603@gmail.com)

(UG Scholar, Dept of ME , Rajiv Gandhi Institute of Technology ,Mumbai

Email: harshalkachare13@gmail.com)

(Assistant Prof., Dept of ME , Rajiv Gandhi Institute of Technology ,Mumbai

Email: kiran.chaudhari@mctrgit.ac.in)

ABSTRACT:

Air conditioning systems have condenser that removes unwanted heat from the refrigerant and transfers that heat outdoors. condenser coil is the primary component of a condenser , through which the refrigerant flows. Refrigerant absorbs heat from the surrounding air which flows through condenser hence, the refrigerant temperature must be higher than the air. In this thesis heat transfer by convection in AC by varying the refrigerants are determined by CFD and thermal analysis. The problem defintion is out on an air-cooled tube condenser of a vapour compression cycle for air conditioning system. The materials considered for tubes is Copper . The fin material is varied which includes aluminium , copper and brass. The refrigerants used is R 407c (mixture of hydrofluorocarbons used as a refrigerant. It is a zeotropic blend of difluoromethane (R-32), pentafluoroethane (R-125), and 1,1,1,2-tetrafluoroethane (R-134a)) , CFD analysis is done to determine the variations in temperature 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 AUTODESK INVENTOR and analysis is done in ANSYS.

Keywords: Finite Element Analysis, Ac Condenser, CFD Analysis, Thermal Analysis.

I. INTRODUCTION

Typically two types of air conditioner fins are used: condenser fins and evaporator fins. Both the types of fins performs a similar job of allowing air to flow smoothly through and out of an air conditioner, while each does this in a unique way. The heat disperses more quickly because the air conditioner fins are a part of the condenser that assists heat in moving away from the air conditioner .In todays generation an air conditioner is used as a common home appliance, system, or mechanism designed to dehumidify and extract heat from an area. A simple refrigeration cycle is used for cooling purpose."HVAC" is referred to as construction, a complete system of heating, ventilation and air conditioning . It is mostly used , in a building or an automobile, is to provide comfort during either hot or cold weather. A diagram of the refrigeration cycle Air-cooled finned-tube condensers are widely used in refrigeration and air-conditioning applications. For the same amount of heat transfer, the operation of water cooled condensers is less economic as compared with air cooled condensers . Air-cooled condensers are mostly of the round tube and fin type. Multiple techniques can be achieved to improve the performance of aircooled condensers such as enhancements on inner pipe surface, changing the tube geometry from round to flat shape and external fins A micro-channel flat tubes heat exchanger is one of the potential alternatives for replacing the conventional finned tube heat exchangers.

II. LITERATURE REVIEW:

1) Jameel and Syed (1999) :

- Developed a thermodynamic model to simulate the working of actual refrigeration system.
- The COP and other system parameters were calculated with ± 2% accuracy

2)Liang and Wong (2001):

- Conducted experiments and developed a model to exploit the possibility of applying the equilibrium two-phase drift flux model to simulate the flow of refrigerant R134a in the capillary tube expansion device
- Such as distribution of pressure, void fraction, dryness fraction, phase's velocities and their drift velocity relative to the center of the mass of the mixture are presented

3)Corberan et al (2004)

- Predicted a model to calculate the mass flow rate of refrigerant in a capillary tube by means of the conservation equations.
- A simulation with different operative conditions and capillary geometry is done and the results are compared for R22

4)Sarntichartsak et al (2007)

- Conducted experiments on inverter air conditioner with variation of capillary tube using R22 and R407C and predicted model
- The model prediction agrees with the experimental data in the range of 40 -50

III. PROBLEM DESCRIPTION:

The objective of this project is to make a 3D model of the ac condenser and study the CFD and thermal behavior of the ac condenser by performing the finite element analysis.3D modeling software (PRO-Engineer) was used for designing and analysis software (ANSYS) was used for CFD and thermal analysis.

IV. RESULTS AND DISCUSSIONS

Condenser tube is designed into two parts later it assembled in pro-e assembling software. Part design and assembled part is indicated below:

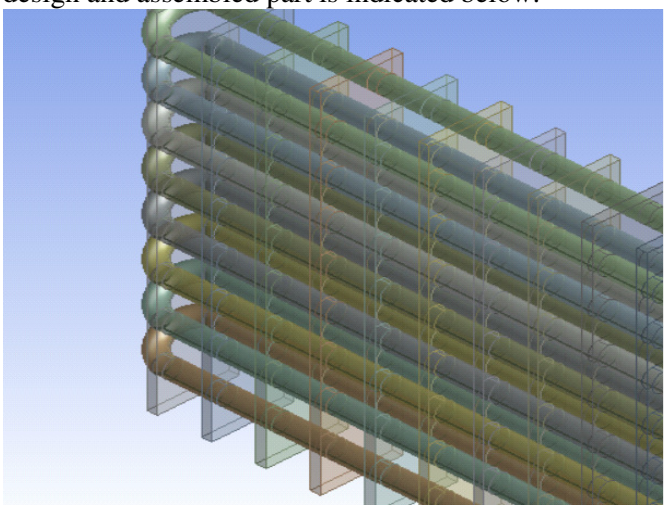


fig 4.1 Image represents 3D model of condenser.

This model is uploaded further for meshing using ANSYS software for thermal analysis.

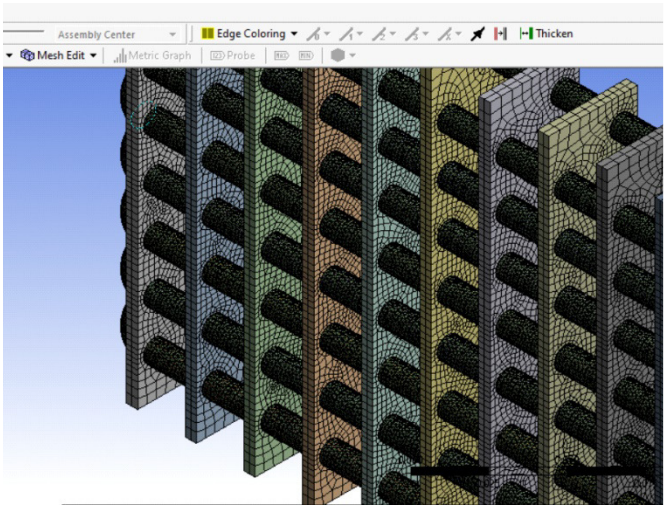


fig 4.2 Image represents mesh model of condenser.

ANALYSIS OF CONDENSER:

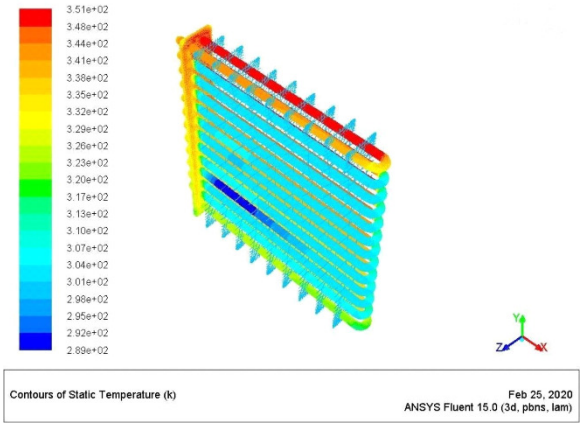


fig 4.3 static temp. in condenser with Al fins

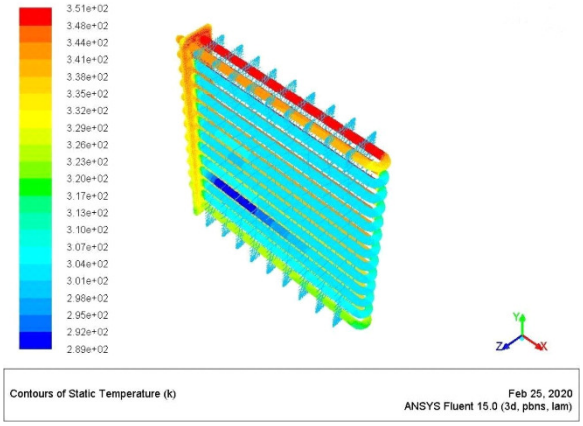


fig 4.4 static temp in condenser with copper fins

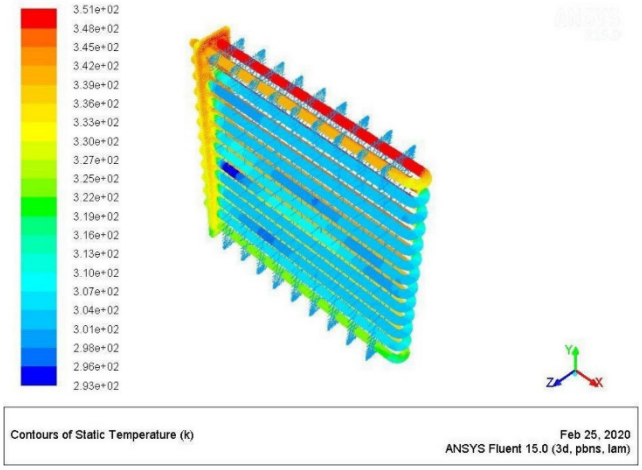
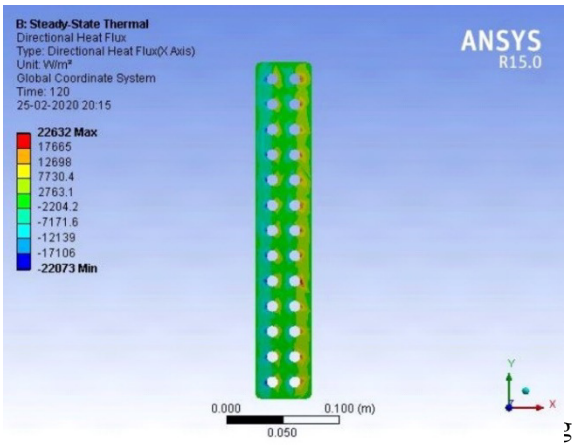
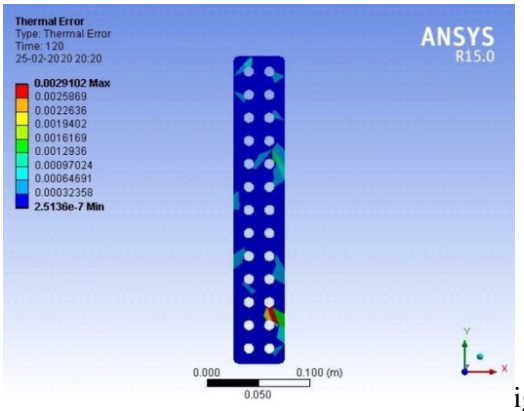


fig 4.5static temp in condenser with brass fins

ANALYSIS OF FIN:



4.7 heat flux of copper fin in steady state thermal analysis



ig4.8 heat flux of al fin in steady state thermal analysis

- Results for steady state thermal analysis:

In this table, copper has low heat flux and low temperature as compared to other materials i.e. aluminium and brass.Hence table shows that copper is better material than aluminium and brass.

Material	Temp.	Thermal error	Heat flux
Brass	60	0.0029923	22994
Aluminium	60	0.0031029	23001
Copper	60	0.0071695	22641

Table 4.1Temperature ,thermal error and heat flux for all the three materials .

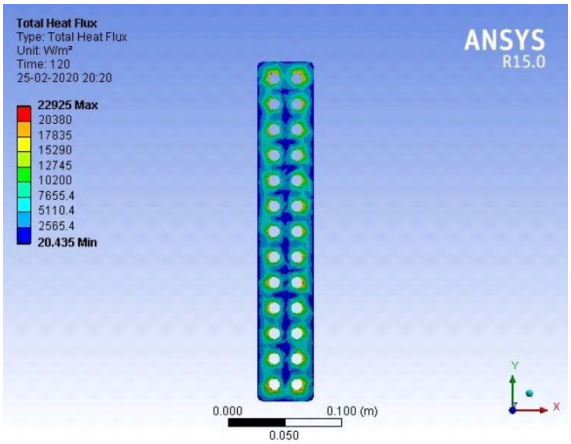


fig 4.9 heat flux of brass fin in steady state thermal analysis

- Results for analysis of fluent R407c :-

In the table given below, it shows that thecontours of enthalpy "j/kg" and contours of static temperature "k" of copper with refrigerant R407c is much better than aluminium and brass. So we conclude at the end that copper is better material than aluminium and brass

Materials	Contours of enthalpy "j/kg"	Contours of static temp. "k"
Brass	3580	323
Aluminium	3160	327
Copper	4250	305

Table 4.2 Indicating contours of enthalpy "j/kg" and contours of static temperature "k" for R407c

V. CONCLUSIONS

In this research paper, we are optimizing the AC condenser by selecting three different fin materials. Presently , in market aluminium alloy is used for fins material and HCFC for cooling fluid.

But in thisresearch paper , we are using three different materials i.e copper, aluminium and brass for better results. so, we have built 3D model for condenser in solid works.To optimize the condenser, thermal analysis is done on the condenser by using 'ANSYS' software. During analysis we have consider three materials for fin i.e. copper, brass, aluminium because of their high thermal conductivity. For refrigerant, we have use R407c fluent because it is less flammable, it has zero ozone depletion, no global warming and it has been observed that the characteristics of R22 and R407are quitesimilar.

From the above results, it can be deduce that using R407c as a refrigerant and copper as a fin material, thermal flux of copper is low as compared to the aluminium and brass. Finally, I conclude in our thesis that using copper as a fin material gives better results for condenser.

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