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HEAT TRANSFER ANALYSIS FOR AC CONDENSER FINES BY MATERIAL G AL CU 4IMG 204, MAGNESIUM ALLOY AND ALUMINIUM ALLOY AL99

B RAMESH
Assistant Professor, Department of Mechanical Siddahartha Institute of Technology and Sciences, Narapally, Hyderabad, Telangana, India

ABSTRACT:
Air conditioner condensers are a heat exchanger device; AC condenser units are grouped according to how it rejects the heat to the medium (surround air). The primary component of a condenser is typically the condenser coil, through which the refrigerant flows. Since, the AC condenser coil contains refrigerant that absorbs heat from the surrounding air, the refrigerant temperature must be higher than the air. In this project designed an air-cooled Condenser fins for an air conditioner. Presently the material used for coils is Copper and the material used for Fins is Copper or aluminium G Al Cu 4IMG 204 whose thermal conductivity is 110-150W/m K. the condenser fines design using computer aided software catia. We are optimizing the design parameters by changing the thickness of the fin for the same length without failing the load conditions. To validate the temperatures and other thermal quantities like flux and gradient, thermal analysis is done on the condenser fines by applying copper for coil and Fin materials G Al Cu 4IMG 204, Aluminium Alloy A199 and Magnesium alloy. Heat flux, directional heat flux, convection, Thermal analysis is done in ansys. And also we are varying inside cooling fluid Hydrocarbon (HC) and Hydro chloro flouro carbon (HCFC). The best material and best fluid for the condenser of our design can be checked by comparing the results. Optimization is done by changing the thickness of the catia is a parametric 3D modelling software and ansys is analysis software.

Key words: ac condenser, G Al Cu 4IMG 204, Aluminium Alloy A199 and Magnesium alloy, catia, thermal analysis

1. 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. Condensers are used in air conditioning, industrial chemical processes such as distillation, steam power plants and other heat-exchange systems. Use of cooling water or surrounding air as the coolant is common in many condensers

A condenser unit used in central air conditioning systems typically has a heat exchanger section to cool down and condense incoming refrigerant vapor into liquid, a compressor to raise the pressure of the refrigerant and move it along, and a fan for blowing outside air through the heat exchanger section to cool the refrigerant inside. A typical configuration of such a condenser unit is as follows: The heat exchanger section wraps around the sides of the unit with the compressor inside. In this heat exchanger section, the refrigerant goes through multiple tube passes, which are surrounded by heat transfer fins through which cooling air can move from outside to inside the unit. There is a motorized fan inside the condenser unit near the top, which is covered by some grating to keep any objects from accidentally falling inside on the fan. The fan is used to blow the outside cooling air in through the heat exchange section at the sides and out the top through the grating. These condenser units are located on the outside of the building they are trying to cool, with tubing between the unit and building, one for vapor refrigerant entering and another for liquid refrigerant leaving the unit. Of course, an electric power supply is needed for the compressor and fan inside the unit

About condenser coil:

Heat transfer enhancement techniques have been one of the main thermal engineering research fields since the fuel crisis in 1970s. Active, passive and compound heat transfer enhancement methods have been developed. Helical coils, additives to fluids, swirl flow devices, rough and extended surfaces are all passive enhancement techniques while application of electric, acoustic and magnetic fields and fluid /system vibration are active techniques (Bergles, 2002). Passive methods were preferred due to their simplicity in manufacturing, lower cost and longer operating life.Many researchers are currently interested in investigating flow boiling inside channels with small diameters due to their high surface area to volume ratio and the increase of heat transfer coefficients leading to high heat transfer rates (Thome, 2010). The heat transfer coefficient is inversely proportional to the channel diameter (α=Nu×k/d). As a result, decreasing the channel diameter would result in higher heat transfer coefficient. Additionally, for the same cross sectional flow area, dividing the flow to large number of channels produces larger surface area for heat transfer compared to flow in single tube with large diameter leading to high heat transfer rates.

1.4 Equation for condenser coil:

For an ideal single-pass condenser whose coolant has constant density, constant heat capacity, linear enthalpy over the temperature range, perfect cross-sectional heat transfer, and zero longitudinal heat transfer, and whose tubing has constant perimeter, constant thickness, and constant heat conductivity, and whose condensible fluid is perfectly mixed and at constant temperature, the coolant temperature varies along its tube according to:

Where:

x is the distance from the coolant inlet;

T(x) is the coolant temperature, and T(0) the coolant temperature at its inlet;

TH is the hot fluid's temperature;

NTU is the number of transfer units;

m is the coolant's mass (or other) flow rate;

c is the coolant's heat capacity at constant pressure per unit mass (or other);

h is the heat transfer coefficient of the coolant tube;

P is the perimeter of the coolant tube;

G is the heat conductance of the coolant tube (often denoted UA);

L is the length of the coolant tube.

1.5 Types of Condensers

In the world of Heating, Ventilation, and Air Conditioning (HVAC), condensers happen to be a topic of great importance. Instead of confusing information, the goal is to provide some basic information on the different types of condensers and their applications.

There are three other condensers used in HVAC systems.

- Water-cooled
- Air-cooled
- Evaporative

1.6 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.

- Water cooled – Although a little more pricey to install, these condensers are the more efficient type. Commonly used for swimming pools and condensers piped for city water flow, these condensers require regular service and maintenance.

They also require a cooling tower to conserve water. To prevent corrosion and the forming of algae, water cooled condensers require a constant supply of makeup water along with water treatment.

Depending on the application you can choose from tube in tube, shell and coil or shell and tube condensers. All are essentially made to produce the same outcome, but each in a different way.

- Evaporative – While these remain the least popular choice, evaporative condensers can be used inside or outside of a building and under typical conditions, operate at a low condensing temperature.

Typically these are used in large commercial air-conditioning units. Although effective, they are not necessarily the most efficient.

Chapter-2

LITERATURE REVIEW

With the advent of computers, the study of various components of a domestic air conditioning system under a range of operating conditions has become possible through mathematical modeling, saving thus a huge amount of time and money. Subsequently, simulation of an air conditioning system demands a thorough knowledge on simulation techniques.

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Hence an elaborate literature survey has been conducted and it is presented in this section.

- Jameel and Syed (1999) have developed a thermodynamic model to simulate the working of actual refrigeration system. Simple cycle used for the analysis showed that the super heating has more influence on the COP of the system. Using this model, the COP and other system parameters were calculated with ± 2% accuracy.

- 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. The details of flow characteristics of R134a in a capillary tube, 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.

- 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 (mass, momentum and energy) over individual control volumes and included in IMST-ART, software for simulation and design of refrigeration equipment. The addition of capillary tube model allows calculating the superheat at the evaporator giving the capillary tube geometry. A simulation with different operative conditions and capillary geometry is done and the results are compared for R22 with those given by ASHRAE correlations.

- Li et al (2004) presented a general model format for Adjustable Throat Area Expansion Valves (ATAEV), including TEV and EEV that utilizes manufacturer's rating data. Model structures for three types of valve geometries are derived. The model format for ATAEV was validated by using manufacturer performance rating data and the flow through the adjustablearea expansion device is not chocked. Two model formats and parameter estimation procedures were considered and their predictions were compared with laboratory measurements. The non linear modeling approach only requires data at a rating condition to obtain parameters and gave good predictions over a wide range of operating conditions when compared with laboratory data.

- Sarntichartsak et al (2007) conducted experiments on inverter air conditioner with variation of capillary tube using R22 and R407C and predicted model. The two zone model, the distributed model and combined model were compared to estimate the optimal charge inventory. The model prediction agrees with the experimental data in the range of 40 - 50 HZ.

- Beghi et al (2009) reported some results of a research project aimed at deriving simple, high-performance, adaptive and robust control algorithms for EEV to control dry expansion evaporators superheat temperature. The adaptation scheme is based on the on-line identification of asimplified, first order plus dead time (FODPT) model of the process. The Zhaung-Atherton method is then used to derive a new set of ProportionalIntegral-Derivatives (PID)

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parameters, which allow the system to improve the closed- loop performance. The control algorithm has been evaluated by restoring to a detailed, a particular virtual prototyping software environment. The algorithm exhibits better performance than other auto tuning approaches, such as the one based on relay feedback. The performance has been evaluated by resorting to standard indexes such as Integral Squared Error (ISE) and Integral Squared Time Weighted Error (ISTE).

Chapter-3

DESIGN AND MODELLING OF ENVIRONMENT TEST CHAMBER

CATIA offers a solution to shape design, styling, surfacing workflow and visualization to create, modify, and validate complex innovative shapes from industrial design to Class-A surfacing with the ICEM surfacing technologies. CATIA supports multiple stages of product design whether started from scratch or from 2D sketches. CATIA is able to read and produce STEP format files for reverse engineering and surface reuse

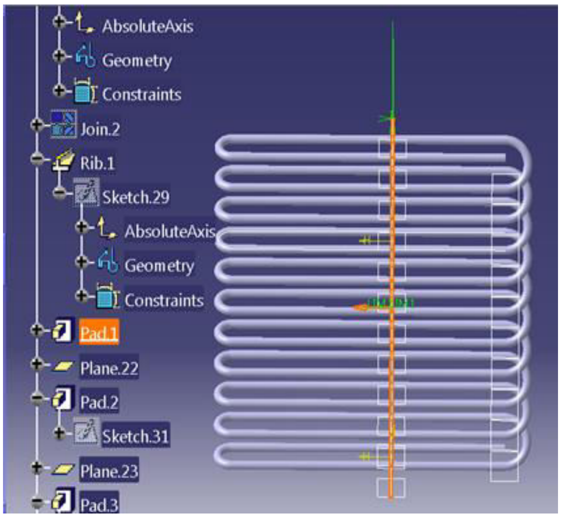

Fig1.4: Sketcher of condenser coil

Chapter-4

ANALYSIS OF TEST CHAMBER

ANSYS is general-purpose finite element analysis software, which enables engineers to perform the following tasks:

1. Build computer models or transfer CAD model of structures, products, components or systems
2. Apply operating loads or other design performance conditions.
3. Study the physical responses such as stress levels, temperatures distributions or the impact of electromagnetic fields.
4. Optimize a design early in the development process to reduce production costs.

5. A typical ANSYS analysis has three distinct steps.

6. Pre Processor (Build the Model).

ANALYSIS OF RESULTS:

In this chapter, the results obtained for the analysis of enivarmental chamber system for the original profile and dynamic structural analysis are discussed. And also explained the graphs plotted by comparing those results.

- **Material Data**

  - **Magnesium**

Density	1800 kg m^-3
Coefficient of Thermal Expansion	25.6 C^-1
Specific Heat	373 J kg^-1 C^-1
Thermal Conductivity	26 W m^-1 C^-1

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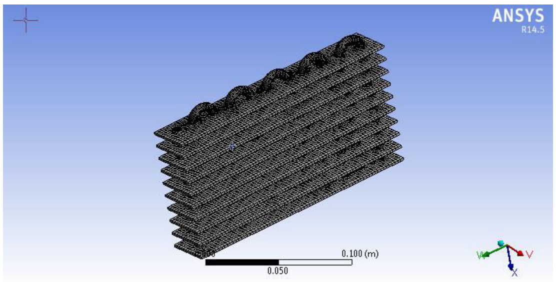
- **Mesh:**



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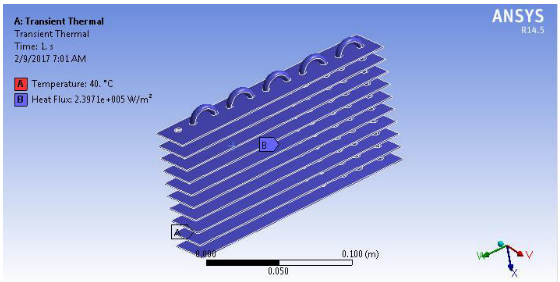

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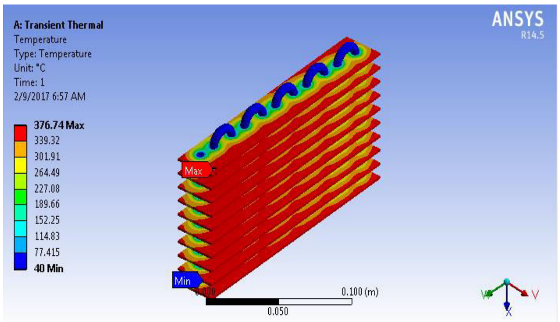
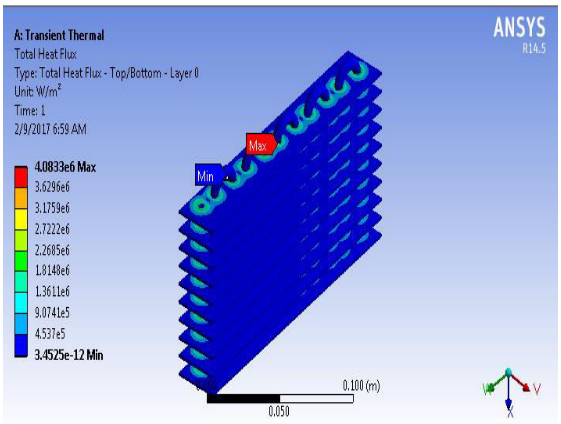


Total heat flux:



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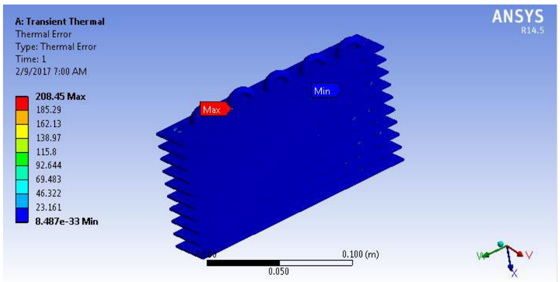
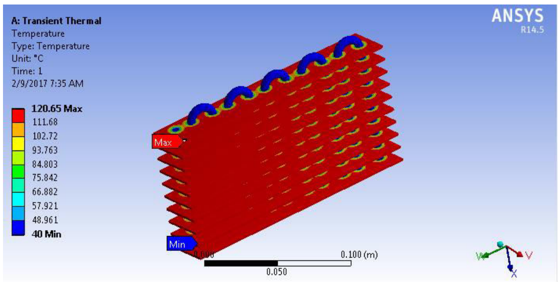


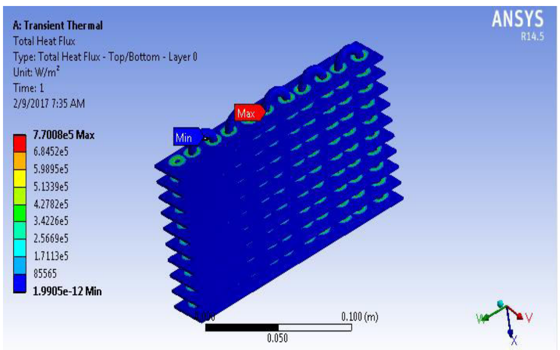
Type	Temperature	Total Heat Flux	Thermal Error	Directional Heat Flux
Minimum	40. °C	3.4525e-012 W/m²	8.487e-033	-3.4574e+006 W/m²
Maximum	376.74 °C	4.0833e+006 W/m²	208.45	3.1245e+006 W/m²

<u>Aluminium Alloy Al99 :</u>

Temperature:



Total heat flux:



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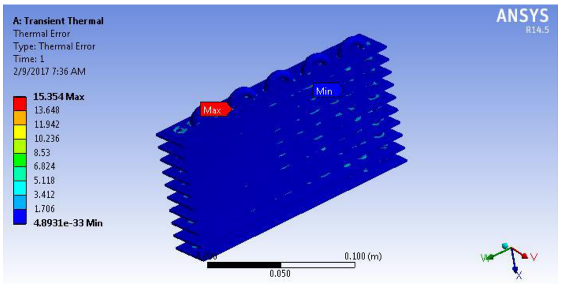
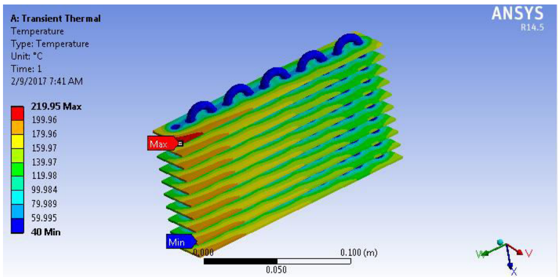
Thermal Error:



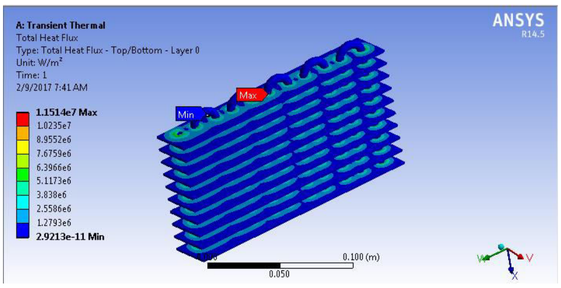
Object Name	Temperature	Total Heat Flux	Thermal Error	Directional Heat Flux
Minimum	40. °C	1.9905e-012 W/m²	4.8931e-033	-7.0698e+005 W/m²
Maximum	120.65 °C	7.7008e+005 W/m²	15.354	7.1126e+005 W/m²

g al cu 4img 204:

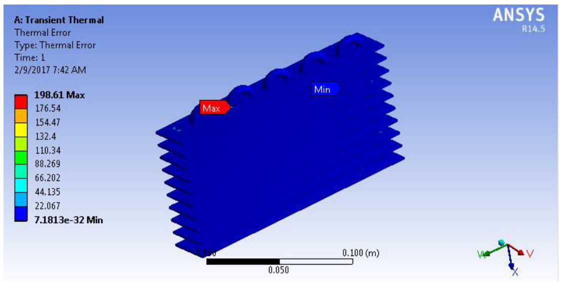
Temperature:



Total heat flux:



Thermal Error:



Object Name	Temperature	Total Heat Flux	Thermal Error	Directional Heat Flux
Minimum	40. °C	2.9213e-011 W/m²	7.1813e-032	-9.9316e+006 W/m²
Maximum	219.95 °C	1.1514e+007 W/m²	198.61	8.3827e+006 W/m²

Conclusion:

In this project I have designed an air conditioner condenser. Present used material for fin is Aluminum alloy 204.I has modeled the condenser in 3D modeling software catia v5. To optimize the condenser for best result, thermal analysis is done on the condenser. Analysis is done using fin materials Aluminum Alloy 204, Aluminum Alloy 99 and Magnesium alloy. And also by changing the condenser fines angle.By observing the thermal analysis results, by using fin material Aluminum alloy Al99, thermal flux is more than by using other two materials. So by using Aluminum alloy A99, the heat transfer rate increases and also Aluminum alloy A99 is less thermal error. Magnesium alloy is more temperature value is obtained I have optimized the condenser to changing the fines inclination angle, by changing the thickness of the fin. By observing optimization results, the optimum thickness value for decreased volume is 1mm.So I conclude that using condenser with fin thickness of 1mm and fin material Aluminum alloy Al99 gives better result.

References

- Agostini, B., Bontemps, A. (2005). Vertical flow boiling of refrigerant R134a in small channels. International Journal of Heat and Fluid Flow 26: 296-306.
- Akhavan-Behabadi, M. A., Aria, H., and Shemirani, F. M. (2009). Flow boiling heat transfer of HFC-134a inside helically coiled tubes. In Proceedings of International Conference on Applications and Design in Mechanical Engineering (ICADME), Malaysia.
- Akhavan-Behbadi, M.A., Hashemi, S.M.(2010).Pressure drop characteristics of nanofluid flow in horizontal coiled tube under constant heat flux. In: Biennial Conference in Engineering Systems Design and Analysis, ASME, Turkey.
- Balakrishnan, R., Santhappan, J. S. and Dhasan, M. L. (2009). Heat transfer correlation for a refrigerant mixture in a vertical helical coil evaporator. Thermal Science 13(4), 197-206.
- Bradshaw, C., Groll, E.A.,Garimella, S.V.(2011). A comprehensive model of a miniature-scale linear compressor for electronics cooling. International Journal of Refrigeration (2011), 34:63-73.
- Bergles, A. E. (2002). ExHFT for fourth generation heat transfer technology. Experimental Thermal and Fluid Science, 26: 335–344.
- Bejan, A., and Kraus, A. (2003). Heat Transfer Handbook. J. Wiley.
- Bell, K. J. and Owhadi, A.(1969) . Local heat transfer measurements during forced convection boiling in a helically coiled tube. Proceedings of the Institution of Mechanical Engineers, 184(3C): 52-58.
- Bi, Q., Chen, T., Tian, Y., Chen, X. (1997). Experimental Study on steam-water two-phase flow frictional pressure drops in helical coils. Nuclear Science and Techniques 8(3): 149-153.
- Bianco, V., Manca,O., and Nardini, S. (2011). Numerical investigation on nanofluids turbulent convection heat transfer inside a circular tube. International Journal of Thermal Sciences 50: 341-349.

- Cary,V.P. (1992).Liquid-vapor phase-change phenomena: an introduction to the thermophysics of vaporization and condensation processes in heat transfer equipment. Hemisphere publisher.