Design and flow analysis of Condenser Fins by using CFD

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Abstract— A refrigeration and air conditioning engineer works on commercial, residential, public and industrial projects, including transportation and storage. Refrigeration is a process of removing heat from a low-temperature reservoir and transferring it to a high-temperature reservoir.A condenser is a device or unit used to **condense** a substance from its **gaseous state** to its **liquid** state, by cooling it. The **latent heat** is given up by the substance and transferred to the surrounding environment. Condensers can be made according to numerous designs, and come in many sizes ranging from rather small to very large (industrial-scale units used in plant processes).

In this project we will design condenser fins with proper dimensions and with different materials. The material of tubes is made up of copper and fins are varying with different materials like Aluminum 1100 and Aluminum 1050.The refrigerants varied will be R 12, R 22 and R134. The refrigerants are used for analysis on condenser by using ANSYS CFD (Fluent) and modeling of the condenser tubes is done in SOLIDWORKS. CFD Fluent is used for to determine the flow rate, temperature and velocity of refrigerant flow.

The materials considered for tubes are Copper and material considered for fins are Aluminum alloys 1100 and 1050. The refrigerants varied will be R 12, R 22 and R134. 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.

From the analysis results, when compared the results for fin material between Alu-minum alloy 1100 and 1050, using Aluminum alloy 1050 is better

Keywords—condensor,fins,refrigrents,alluminuim alloys,CFD.

I. INTRODUCTION

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.

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.

The idea behind the proposed system is to design optimi¬zation technique that can be useful in assessing the best configuration of a finned-tube condenser. Heat transfer by convection in air cooled condensers. Modeling is done in Pro/Engineer. Heat transfer analysis is done on the con denser to evaluate the material and refrigerant. The mate¬rials considered for tubes are Copper and Aluminum al¬loy 1100 and for fins are 1050 and 1100. The refrigerants varied are R12, R 22 and R 134. 3D modeling is done in Pro/Engineer and analysis is done in Ansys.

Air cooled condensers are used in small units like house¬hold 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 refrig¬erant in the refrigeration cycle is small. Air cooled con¬densers 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 the present work, the performance analy¬sis of air cooled condensing unit has been carried out by varying the fin material and fin thickness. At present alu¬minum alloy 204 is being used for fins.

Two fin materials namely, Aluminum alloys

1100 and 1050were considered to study the effect of fin's thermal conductivity on the performance of the condenser. Pro Engineer is

Property	Value
Density	2.71 g/cm^3
Melting Point	689 °C
Modulus of Elasticity	74 GPa
Thermal Conductivity	218 W/m.K
Thermal Expansion	23.6 x10^{-6} /K

used to model the system. For thermal analy¬sis purpose ANSYS Works software is used. Consider¬ing different factors for a condenser, such as heat transfer, density etc., and Aluminum alloy 1100is found to be the best fin material.

II. MODELLING

Materials selected:-

Alluminium 1050

This alluminium 1050 alloy used in extrusion or rolling.

This material having high electrical conductivity& high corrosion resistance.

It is used in manufacturing of heat skins it has higher thermal conductivity than other alloys.

It can be strengthen by cold working

Alluminium 1100

This alluminium 1100 is mechanically

Property	Value
Density	2.71 g/m^3
Melting Point	650°C
Modulus of Elasticity	71 GPa
Thermal Conductivity	222 W/m.K
Thermal Expansion	24x10^{-6} /K

strongest alloy in the series

It is lightest alloy compared to other series

It is having high electrical conductivity,thermal conductivity,corrosion resistance & work ability.

It can be strengthen by cold working

Table 1

Material properties of Aluminum 1050

Table 2

Material properties of Aluminum 1100

Two fin materials namely, Aluminum alloys 1100 and 1050were considered to study the effect of fin's thermal conductivity on the performance of the condenser. Pro Engineer is used to model the system. For thermal analy¬sis purpose ANSYS Works software is used. Consider¬ing different factors for a condenser, such as heat transfer, density etc., and Aluminum alloy 1100is found to be the best fin material.

III. CAD MODEL OF TUBES AND FINS

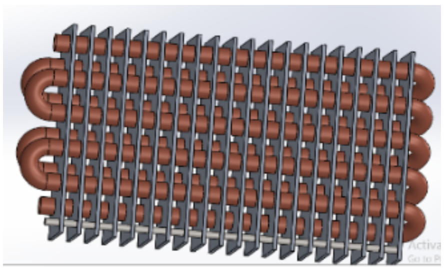

Figure 1:Condensor fins

condenser tubes are made of copper shown in above fig and fins are made of alluminium 1050 &1100 alloys.

refrigrent flows R12,R22 & R134 through copper tubes

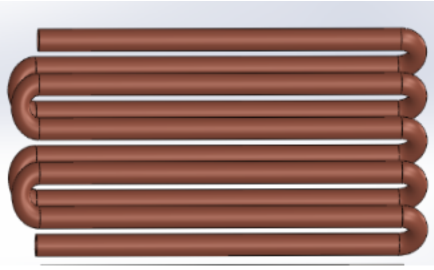

Figure 2: Condensor Tubes

A condenser is a heat exchanger, allowing condensation, by means of giving-off, or taking-in heat respectively Refrigerant and air will be physically separated, at air conditioner condenser, and evaporator. Therefore, heat transfer occurs by means of conduction.

ANSYS:

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).

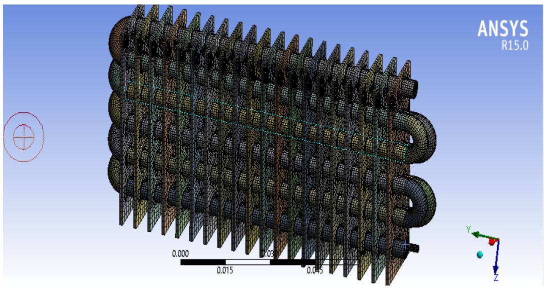

Figure 3: condenser fins in ansys

IV. LITRATURE REVIEW

P. Sathiamurthi, PSS.Srinivasan[1] energy saving is one of the key issues, not only from the view point of fuel consumption but also for the protection of global environment. So, it is imperative that a significant and concrete effort should be made for conserving energy through waste heat recovery too. The main objective of this paper is to study and analyse the feasibility of retrofitting the waste heat recovery system for hot water generation.

N.Balaji, P.Suresh Mohan Kumar[2]., on energy saving methods for air conditioning have focused on large chillers as their subject. A majority of the office buildings, classrooms and residential buildings are equipped with single window air conditioning systems. This research paper discusses energy conservation in a single Window air Condition system.

V. Methodology Of Software

- Create a 3D model of the ac condenser assembly using parametric software pro-engineer.
- Convert the surface model into Para solid file and import the model into ANSYS to do analysis
- Perform CFD analysis on the existing model of the surface ac condenser for Velocity inlet to find out the mass flow rate, heat transfer rate, pressure drop.

VI. RESULTS

Results of Aluminum alloy 1050 & 1100

Temperature

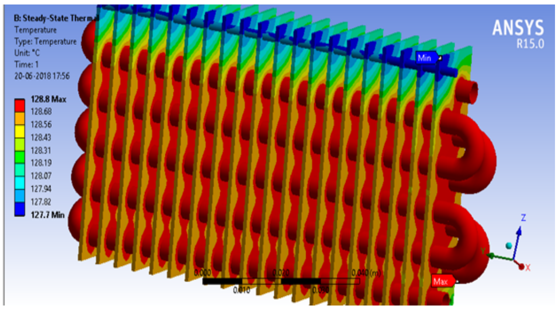

Figure 4 : Temperature

Total Heat Flux

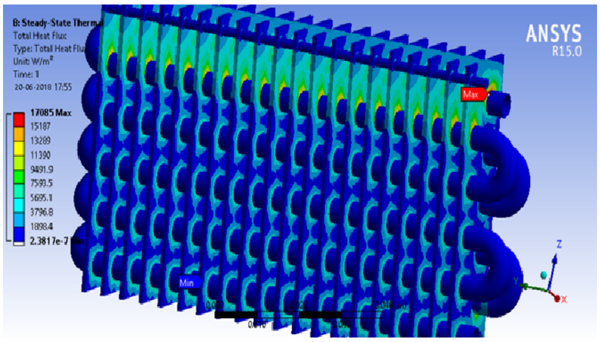

Figure 5 : Total heat flux

Fins Alluminium alloy 1050

Refrigrents	Temperature °c	Total Heat Flux W/mm²	Directional Heat FluxW/mm²
R-12	90.482	5.6647	0.576544
R-22	90.622	6.74462	0.65312
R-134	89.375	1.35686	0.24664

Fins Alluminium alloy 1100

Refrigrents	Temperature°c	Total Heat Flux W/mm²	Directional Heat FluxW/mm²
R-12	95.455	5.4823	0.56062
R-22	93.593	6.2395	0.78633
R-134	83.372	1.38561	0.37589

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.

From the analysis results, the heat transfer rate is more when refrigerant R22 is used since heat flux is more.. When compared the results for fin material between Alu¬minum alloy 1100 and 1050, using Aluminum alloy 1050 is better. Heat transfer analysis is done on the condenser to evaluate the material and refrigerant.

VII. CONCLUSION

. The materials considered for tubes are Copper and material considered for fins are Aluminum alloys 1100 and 1050.

The refrigerants varied will be R 12, R 22 and R134. CFD analysis is done to determine temperature distribution and heat transfer rates by varying the refrigerants.

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VIII. REFERENCE

[1] P. Sathiamurthi, PSS.Srinivasan, design and development of waste heat recovery system for air conditioner, European Journal of Scientific Research ISSN 1450-216X Vol.54 No.1 (2011), Pp.102- 110.

[2] N.Balaji, P.Suresh Mohan Kumar, Eco friendly Energy Conservative Single window Air Conditioning System by Liquid Cooling with helical inter cooler ISSN 1450-216X Vol.76 No.3 (2012), pp.455-462.

[3] Comparative Analysis of Various Condenser in Va-pour Compression Refrigeration System by Patil Deepak P., Prof. Bhangale J.H., Prof. Palande D.D, [Patil, 3(9): September, 2014], ISSN: 2277-9655, International Jour-nal of Engineering Sciences & Research Technology,

[5] S.C.Kaushik, M.Singh."Feasibility and Refrigeration system with a Canopus heat exchanger", Heat Recovery Systems & CHP, Vol.15 (1995)665 - 673.

[6] R.TugrulOgulata, "Utilization of waste-heat recovery in textile drying", Applied Energy.

[7] A mathematical model of a steam condenser inoff-design operation by RafałMarcinLaskowski, Journal of Power Technologies 92 (2) (2012) 101–108.

[8] Performance analysis of finned tube air cooled con-densing unit of split air conditioner by B. Sreelakshmi, Advanced Engineering and Applied Sciences: An Inter-national Journal Universal Research Publications, ISSN 2320–3927

[9] Improving the Heat Transfer Rate for Ac Condenser By Material And Parametric Design Optimization by V Srividhya, G VenkateswaraRao, International Journal of Engineering Research & Technology, Vol.2 - Issue 1 (January - 2013), e-ISSN: 2278-0181

[10] Experimental Study of Solar Powered Air Condition-ing Unit Using Drop – In Hydro Carbon Mixture to Re-place R-22 by AnasFarraj, Mohammad Abu Mallouh, Abdul-Rahim Kalendar Abed Al-Rzaq Al-Shqirate and Mahmoud Hammad, Jordan Journal of Mechanical and Industrial Engineering, Volume 6, Number 1, Feb. 2012, ISSN 1995-6665, Pages 63 – 70

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