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THERMAL ANALYSIS OF A CAR AIRCONDITIONING SYSTEM BASED ON AN ABSORPTION REFRIGERATION CYCLE USING ENERGY FROM EXHUAST GAS OF AN IC ENGINE

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ABSTRACT

An absorption refrigerator is a refrigerator that uses a heat source (e.g., solar, kerosene-fueled flame, waste heat from factories or district heating systems) to provide the energy needed to drive the cooling system.In this thesis, energy from the exhaust gas of an internal combustion engine is used to power an absorption refrigeration system to air-condition an ordinary passenger car. All the required parts for the absorption refrigeration system is designed and modeled in 3D modeling software Pro/Engineer. Thermal analysis is done on the main parts of the refrigeration system to determine the thermal behavior of the system. Modeling is done in Pro/Engineer and analysis is done in Ansys.

Keywords: PRO-E CFD ANSYS

1. INTRODUCTION

Air conditioning is the process of altering the properties of air (primarily temperature and humidity) to more favorable conditions. More generally, air conditioning can refer to any form of technological cooling, heating, ventilation, or disinfection that modifies the condition of air An air conditioner (often referred to as air con, AC or A/C, and not to be confused with the abbreviation for alternating current) is a major or home appliance, system, or mechanism designed to change the air temperature and humidity within an area (used for cooling and sometimes heating depending on the air properties at a given time). The cooling is typically done using a simple refrigeration cycle, but sometimes evaporation is used, commonly for comfort cooling in buildings and motor vehicles. In construction, a complete system of heating, ventilation and air conditioning is referred to as "HVAC".

Chapter -2

LITERATURE REVIEW

Investigated The theoretical analysis, is verified by both laboratory and road tests through the results obtained. This work results from a prototype which will have to be improved for further development. The claim that is made from this work is that it has shown the feasibility of such a system in a positive frame. It can be concluded that: 1. In the exhaust gases of motor vehicles, there is enough heat energy that can be utilized to power an air-conditioning system. Therefore, if air-conditioning is achieved without using the engine's mechanical output, there will be a net reduction in fuel consumption and emissions. 2. Once a secondary fluid such as water or glycol is used, the aqua-ammonia combination appears to be a good candidate as a working fluid for an absorption car air-conditioning system. This minimizes any potential hazard to the passengers. 3. The low COP value is an indication that improvements to the cycle are necessary. A high purity refrigerant would give a higher refrigeration effect, while the incorporation of a solution heat exchanger would reduce the input heat to the generator. The present system has both a reflux condenser and a heat exchanger. However, the reflux condenser is proved inadequate to provide high purity of the refrigerant and needs to be re-addressed. The evaluation of the COP, with and without the heat exchanger also proves that unless there is a high purity refrigerant, the effect of the heat exchanger to the generator's heat is small.[1]Investigated the coefficient of performance of the system is low, that means that the system is expected to use a lot of energy with respect to the cooling it offers. But this is not a disadvantage in the case of our air-conditioner. This is because the energy we use is the engine waste heat energy which is available in automobile vehicles. Also, this safeguards the interest of the future generations who would be able to get air conditioning without use of electricity also. This is going to make the operational cost of the air conditioner very low. Moving parts are also not there in the system. Noise and vibrations are decreased to a minimum. Ammonia is a very cheap gas. This reduces the cost of the system. Waste heat is all what is needed for the system to operate. This project hence has a very bright future in the commercial market as well as in the industrial market. Investigated the Thermal analysis was done in two main components i.e. condenser & evaporator though the results obtained. This result will have to be improved for further development It can be concluded that: i. For the working of vapour absorption refrigeration system generally achieved by burning the fuel in a separate combustion chamber and then supplying the Generator of a Vapour Absorption Refrigeration System with the products of its combustion to produce the required refrigerating effect. However this prospect is eliminated since it requires a separate fuel and a separate combustion chamber which makes it uneconomical and the system becomes inefficient. ii. The above draws back will eliminated by utilizing the heat of combustion which is wasted into the atmosphere. By designing a generator capable of extracting the waste heat of an IC engine without any decrease in engine efficiency, a Vapour Absorption Refrigeration System can be brought to work. Since this arrangement does not require any extra work expect a small amount of work required for the pump, which can be derived from the battery, this system can be used in automobiles where engine efficiency is the primary consideration. iii. In this thesis use pro/engineer for the design of components & use ansys for the analysis iv. By observing the analysis results, thermal flux is more for aluminum alloy 204 than copper for both condenser and evaporator. so using aluminum alloy 204 is better.[3]

3. MODELLING

3.1. PRO/ENGINEER

Pro/ENGINEER Wildfire is the standard in 3D product design, featuring industry-leading productivity tools that promote best practices in design while ensuring compliance with your industry and company standards. Integrated Pro/ENGINEER CAD/CAM/CAE solutions allow you to design faster than ever, while maximizing innovation and quality to ultimately create exceptional products.

Customer requirements may change and time pressures may continue to mount, but your product design needs remain the same - regardless of your project's scope, you need the powerful, easy-to-use, affordable solution that Pro/ENGINEER provides.

3.2. PRO/ENGINEER WILDFIRE BENEFITS

- Unsurpassed geometry creation capabilities allow superior product differentiation and manufacturability
- Fully integrated applications allow you to develop everything from concept to manufacturing within one application
- Automatic propagation of design changes to all downstream deliverables allows you to design with confidence
- Complete virtual simulation capabilities enable you to improve product performance and

  exceed product quality goals
- Automated generation of associative tooling design, assembly instructions, and machine code allow for maximum production efficiency

Pro ENGINEER can be packaged in different versions to suit your needs, from Pro/ENGINEER Foundation XE, to Advanced XE Package and Enterprise XE Package, Pro/ENGINEER Foundation XE Package brings together a broad base of functionality. From robust part modelling to advanced surfacing, powerful assembly modelling and simulation.

The main modules are

- Part Design
- Assembly
- Drawing
- Sheet Metal

3.2.1. MODELS OF VAPOUR ABSORPTION REFRIGERATION SYSTEM

(B). Pre Heater Pipe

(A) EXHAUST

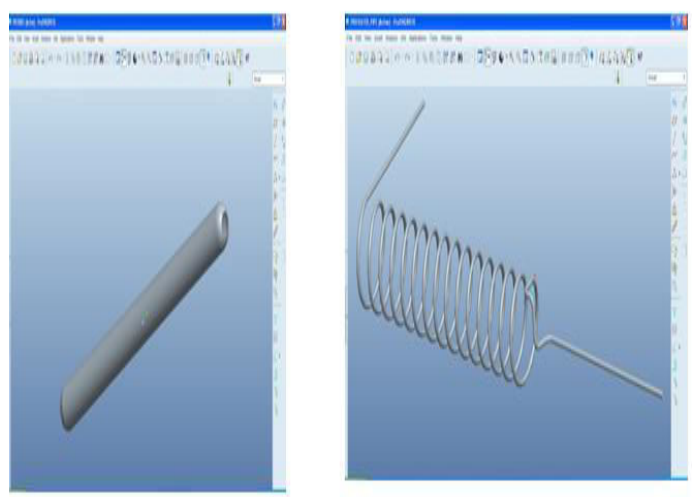

Fig 8.2.Exhaust Pipe Modeled By Using Pro/E

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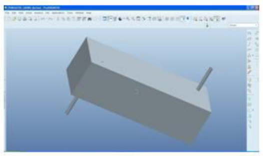
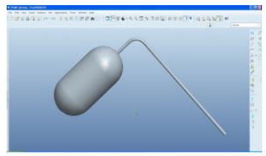
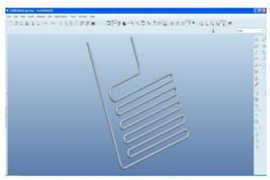
(C).PRE HEATER CASING



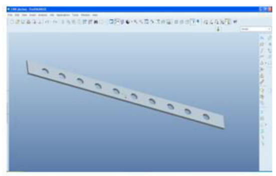
(D).PUMP



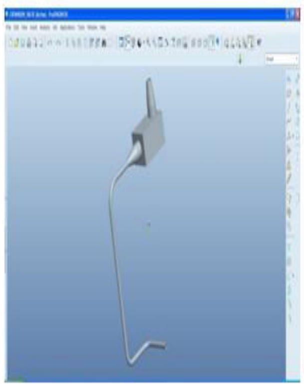
(E).CONDENSOR



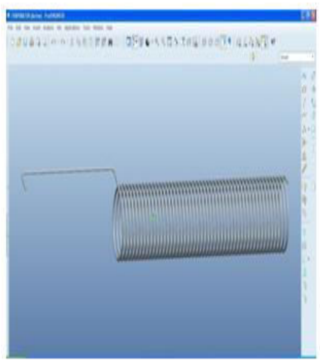
(F).SUPPORT PLATE



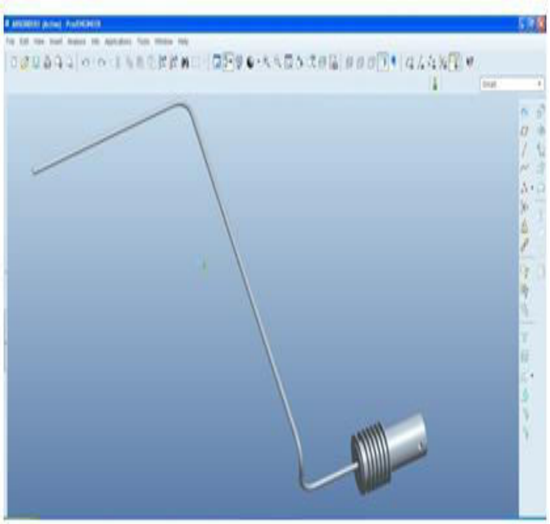
(G).EXPANSION VALVE



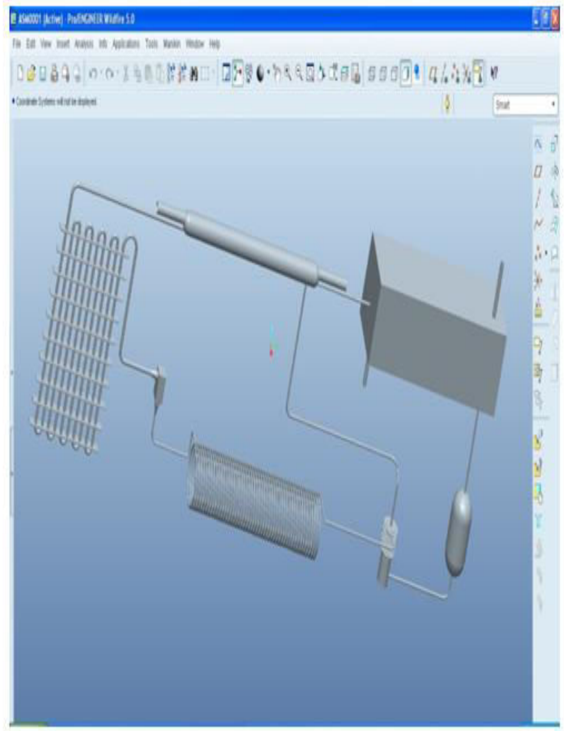
(H).EVAPORATOR



(I).ABSORBER



ASSEMBLY OF VAPOUR ABSORPTION SYSTEM



4. RESULT AND DISCUSSION

4.1 Thermal Analysis Conducting For Condenser & Evaporator by Using Two Different Materials

4.1.1 Thermal Analysis of Condenser for Copper material

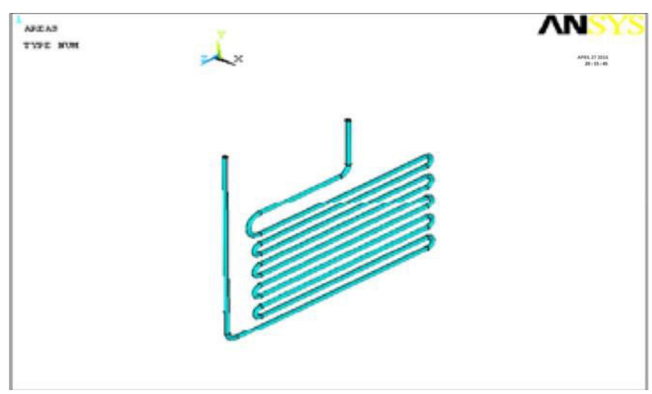


Fig 4.1.1.1 Imported Model from Pro/Engineer

Element Type: solid 20 nodes 90

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Material Properties: Thermal Conductivity – 385W/mK

Specific Heat – 390 J/Kg K

Density - 0.0000075 kg/mm^3

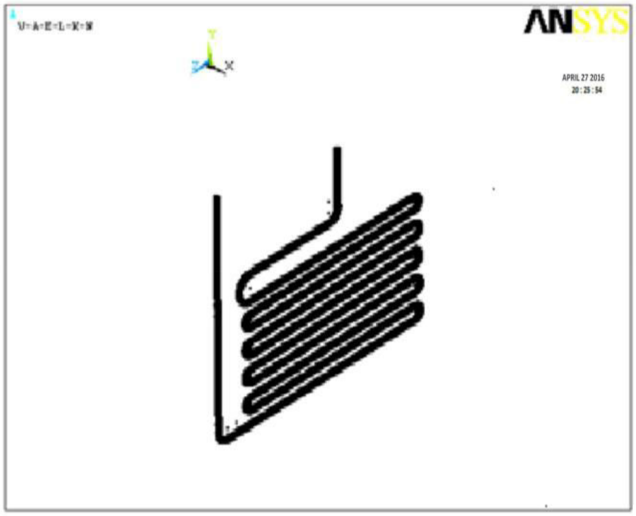

Fig 4.1.1.2 Meshed Model

- **Apply Loads**

Loads – Define Loads – Apply – Thermal – Temperature

Temperature – 313K

Loads – define Loads – Apply – Thermal – Convection – on areas

Bulk Temperature – 283K

Film Coefficient – 25 W/m^{2}K

- **Solution**

Solution – Solve – Current Ls – Ok

- **Post Processor**

General Post Processor – Plot Results – Contour Plot - Nodal Solution – Thermal Gradient Vector Sum

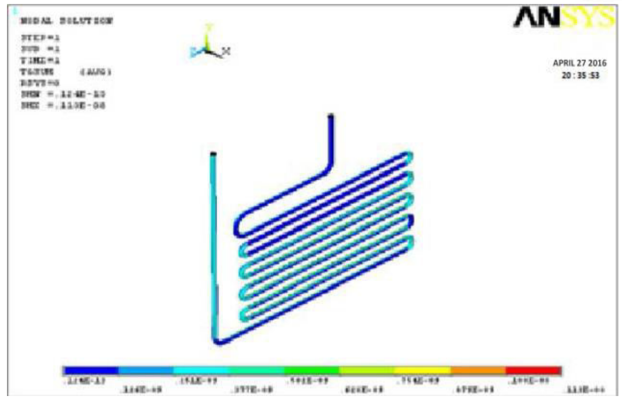

Fig 4.1.1.3 Condenser Thermal Gradient For Copper

General Post Processor – Plot Results – Contour Plot - Nodal Solution – Thermal flux vector sum

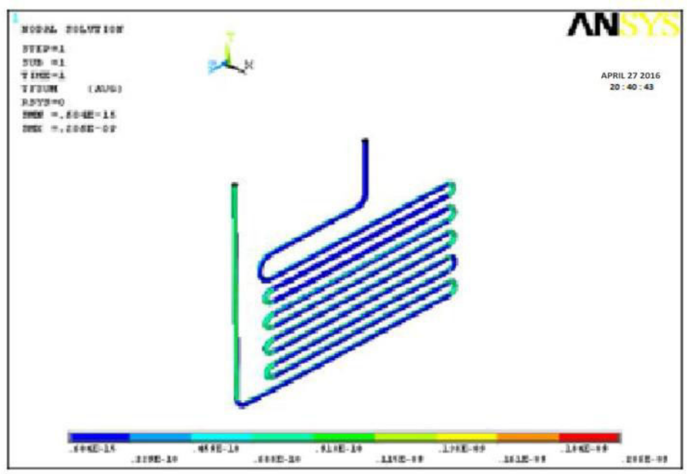

Fig 4.1.1.4 Condenser thermal Flux For Copper

4.1.2 Thermal Analysis of Condenser for Aluminum Alloy 204 material

Material Properties: Thermal Conductivity – 150 W/mK

Specific Heat – 960 J/Kg K

Density - 0.0000028 Kg/mm^3

- **SOLUTION**

Solution – Solve – Current LS – ok

- **POST PROCESSOR**

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General Post Processor – Plot Results – Contour Plot - Nodal Solution – Thermal Gradient Vector

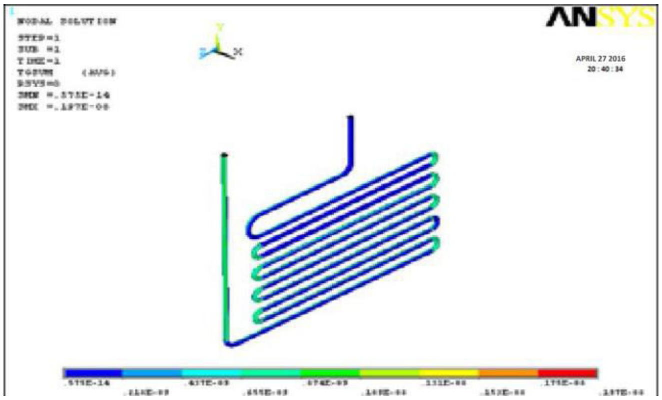

Fig 4.2.1.1.CondenserThermal Gradient for Aluminum Alloy 204

General Post Processor – Plot Results – Contour Plot - Nodal Solution – Thermal flux vector sum

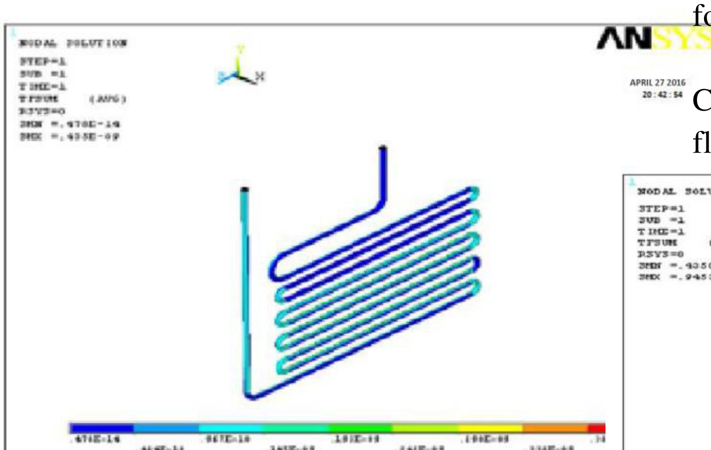

Fig 4.2.1.2 Condenser Thermal Flux for Aluminum Alloy 204

4.1.3 Thermal Analysis of Evaporator for Copper material

Element Type: Solid 20 node 90

Material Properties: Thermal Conductivity – 385W/mK

Specific Heat – 390 J/Kg K

Density - 0.0000075 kg/mm^3

- **SOLUTION**

  Solution – Solve – Current LS – ok

- **POST PROCESSOR**

  General Post Processor – Plot Results – Contour Plot - Nodal Solution – Thermal Gradient V

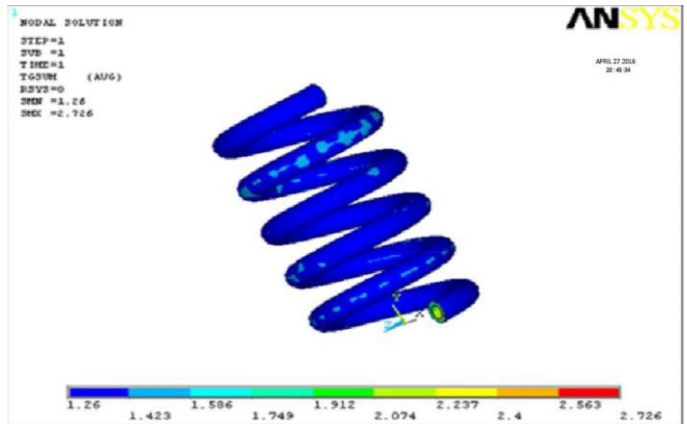

Fig 4.1.3.1 Evaporator Thermal Gradient for Copper

General Post Processor – Plot Results – Contour Plot - Nodal Solution – Thermal flux vector

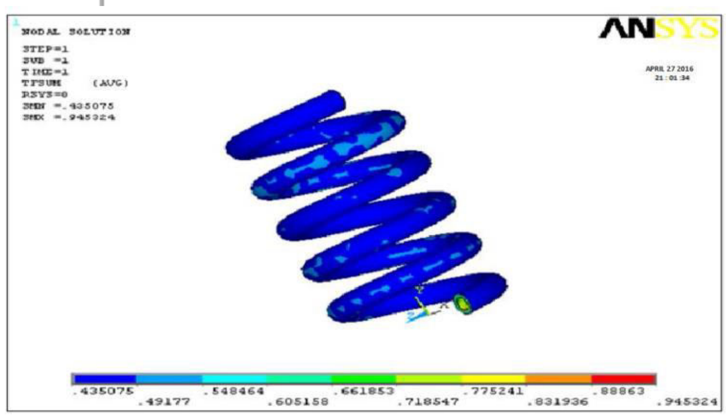

Fig 4.1.3.2 Evaporator Thermal Flux For Copper

4.1.4 Thermal Analysis of Evaporator for Aluminum Alloy 204 material

Material Properties: Thermal Conductivity – 150 W/mK

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Specific Heat – 960 J/Kg K

Density - 0.0000028 Kg/mm^3

- **SOLUTION**

Solution – Solve – Current LS – ok

- **POST PROCESSOR**

General Post Processor – Plot Results – Contour Plot - Nodal Solution – Thermal Gradient

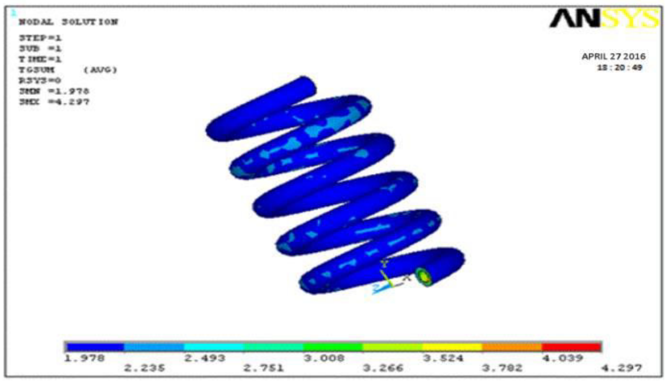


Fig4.1.4.1 Evaporator Thermal Gradient for aluminum alloy 204

General Post Processor – Plot Results – Contour Plot - Nodal Solution – Thermal flux vector

Sum.

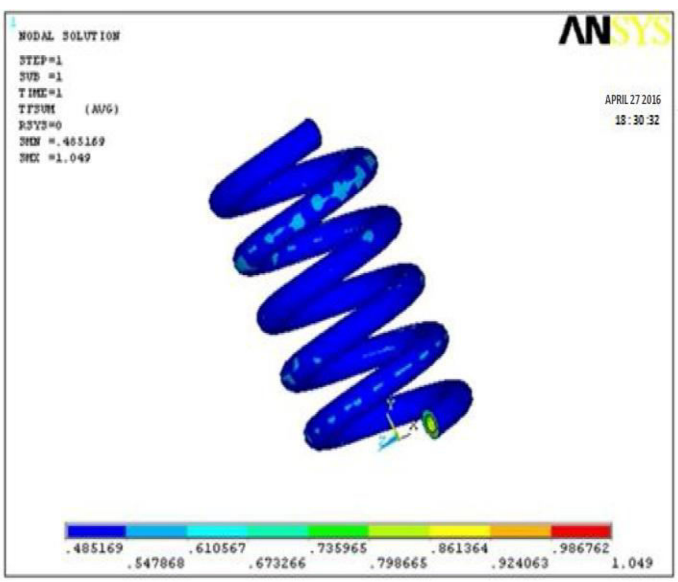
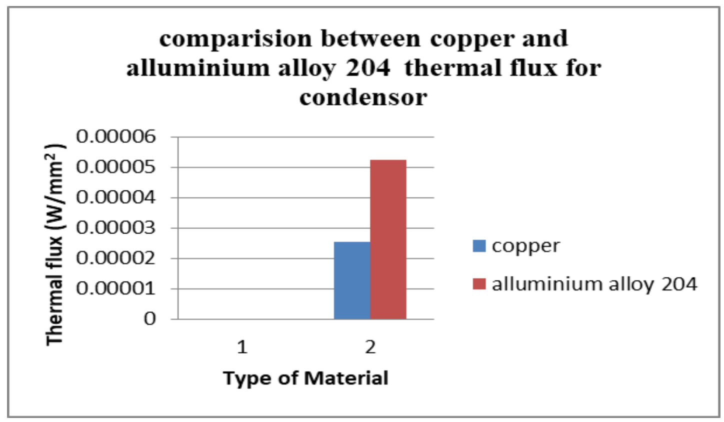


Fig4.1.4.2 Evaporator Thermal Gradient for aluminum alloy 204

4.2 ANALYSIS REPORTS

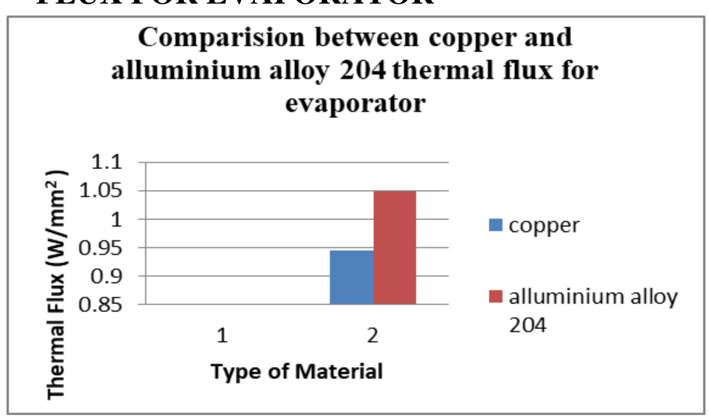
	ALUMINUM ALLOY 204		COPPER	
	THERMAL GRADIENT (K/mm)	THERMAL FLUX (W/mm^2)	THERMAL GRADIENT (K/mm)	THERMAL FLUX (W/mm^2)
CONDENSER	0.197e^{-8}	0.425e^{-9}	0.113e^{-8}	0.206e^{-9}
EVAPORATOR	4.297	1.049	2.726	0.945324

4.1.COMPARISION OF THERMAL FLUX FOR CONDENSOR



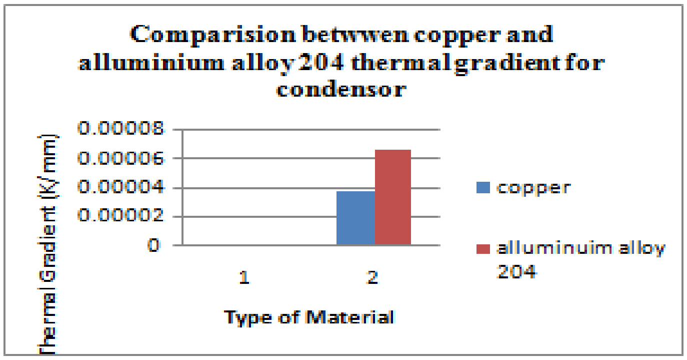
Grp1. Comparison between Copper and Aluminum Alloy 204 Thermal Flux For Condensor

4.2. COMPARISION OF THERMAL FLUX FOR EVAPORATOR



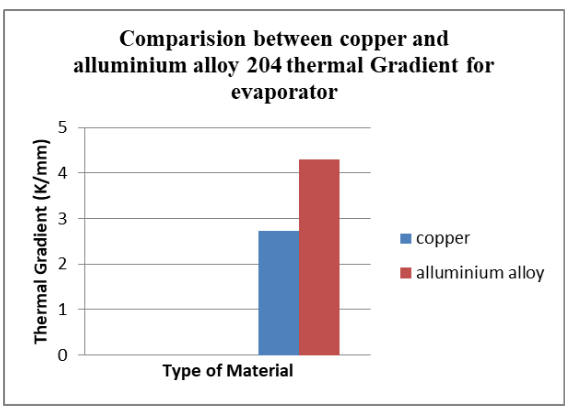
Grp.2: Comparison between Copper and Aluminum Alloy 204 Thermal Flux For Evaporator

4.3.COMPARISION OF THERMAL GRADIENT FOR CONDENSOR



Grp.3: Comparison between Copper and Aluminum Alloy 204 Thermal Gradient For Condesor

4.4.COMPARISION OF THERMAL GRADIENT FOR EVAPORATOR



Grp: 4: Comparison between Copper and Aluminum Alloy 204 Thermal Gradient for Evaporator

5 CONCLUSIONS

- By Conducting Experimental Test On Vapour Absorption Refrigeration System Using Exhaust Gases From The IC Engine For Heating The Solution In Generator Using PRO/E And ANSYS Software's. For Design And Analysis Of Components The Following Conclusions Were Made:
- Vapor Absorption Refrigeration System Required Separate Fuel For Its Working But In This Thesis Fuel Cost Is Eliminated By Using Exhaust Gases For Heating And Working.
- Designing And Thermal Analysis Of Components (Condenser And Evaporator)Can Be Done Accurately By Using PRO/E And ANSYS Software's.
- Designing And Thermal Analysis Of Components Were Made With Less Time By Using PRO/E And ANSYS Software's It Was Observed From The Result 42.6% Thermal Gradient And 51.5% Thermal Flux Of Aluminum Alloy 204 Is Higher Than Copper. Therefore Aluminum Is Suitable For Best Result.
- Heat And Products Of Combustion In Exhaust Gases Of IC Engine Pollutes The Atmosphere, This Pollution Can Be Reduced By Utilizing The Exhaust Gases In Vapor Absorption Refrigeration System.
- Experimental Results Will Have To Be Improved For Further Developments By Using Different Materials For Condenser And Evaporator.

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