# A SCHEMATIC APPROACH ON PERFORMANCE ANALYSIS OF AIR CONDITIONER FOR AUTOMOTIVE APPLICATION

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## ABSTRACT:

*In this paper, the operation features of automotive air conditioning are all performed. The main aim of the study is to evaluate the performance automotive air conditioning (AAC) system theoretically and experimentally. The operation of automobile air-conditioning system is powered by the turning of RPM engine. The changes of spinning at low and high rate will provide substantial impact to the machine. This project introduces mathematical modelling and evaluation computer simulation of electrical ac systems together with the four standard elements composed of compressor, condenser, evaporator and expansion valve.Aluminum 204, 1100 and 6063 materials is used for condenser. This air conditioning system will probably use a condenser using five sliding vanes. ANSYS simulation model was developed and the consequences of system functionality are signalled by condenser rate, pressure ratios are assessed.*

***Keywords:*** *Automotive Air Conditioning, condenser, Performance*

## INTRODUCTION:

A/C's Are intended to absorb heat in a low temperature and reject it at a higher temperature also it play an incredibly significant function in industrial, domestic, and industrial industries for heating, heating, and food conserving software. From the developing nation like India, the majority of the vapour compression-based pipes, air-conditioning and heat pump systems are still operate on halogenated refrigerants because of their exceptional thermodynamic and thermo-physical possessions aside from the minimal price. In the industrial grade cooling or air conditioning plants large number of low-grade warmth being refused. On account of the high price related to the retrieval of these heating and also the availability of alternative means for fulfilling this Low-grade waste heating, it's normally rejected to the air.

The biggest application of pipes, that's the Procedure for cooling system, is in air conditioning. From the tropics that an AC system is commonly utilized in vehicles such as automobiles, buses, trains, trucks and recreational vehicles and air ships and craft. Its principal objective is for relaxation cooling since these vehicles are directly exposed to solar power and receive heat from other source such as individual being, engine and surroundings at higher temperatures. The significant contributions to the heating load from the transportation will be the heat from solar power and the warmth from individual particularly from public transportation. The operation of automobile ac system is powered by the turning of RPM engine. The changes of spinning at low and high rate will provide substantial impact to the machine. As stated by the occurrence, this project introduces mathematical modelling and evaluation computer simulation of automobile air conditioning systems together with the four standard elements composed of compressor, condenser, evaporator and expansion valve. This air conditioning system will probably use a rotary compressor with five sliding vanes since the ability and the operation of compressor will be much better compare with other compressor. Computer simulation model was developed and the consequences of system functionality are signalled by compressor rate, pressure ratios are assessed.

## OBJECTIVES:

The main aims of the project are

- To Determine and compare the operation of ac system utilizing rotary compressor.
- Automotive Air conditioning is done with streamlined compressor operating within large domain of spinning rate. On other hand, the mass flow speed and computational capacity might need to be considered for higher and low rates speed compressor.
- The Compressor version is evaluation with all the mathematical models and simulated using a computer application.
- The Simulation application will create result to compare with preceding experimentation information and confirm the accuracy and dependability program of ac system being developed.

## LITERATURE REVIEW:

1. **Ghodbane et.al, (2017)** Simulated the operation of automotive ac systems with different hydrocarbons. He ascertained the systems with R152a and R270 yield a better performance compared to one with R134a. Additionally, a comparative evaluation of the operation of a secondary loop system utilizing these refrigerants has been supplied.
2. **E. Navarro, et al, (2017)** presented a comparative study between R1234yf, R134a and R290 into a open piston compressor of automotive air conditioning in various working conditions. The evaluation matrix contained two compressor rates, evaporation temperatures and condensation temperatures. They reasoned that R290 has revealed that a significant progress in compressor and volumetric efficiencies while R1234yf enhances its efficiencies in comparison to R134a for pressure ratios greater than 8.
3. **J. Navarro-Esbrı, et al, (2016)**Completed an experimental evaluation of R1234yf as a drop-in substitute for R134a at a vapor compression program. The experimental tests have been carried out changing the condensing temperature, the evaporating temperature, the superheating level, the compressor speed, and also the inner heat exchanger usage. Comparisons are made carrying refrigerant R134a as baseline as well as the results reveal that the heating capacity acquired with R1234yf is about 9 percent lower than that obtained by R134a.
4. **Claudio Zilio, et al, (2015)** studied experimentally a automotive ac They reasoned the R1234yf systems pose lower functionality compared to R134a system in a given Cooling capability.

He also completed a short performance comparison of R1234yf and R134a at a seat tester for auto applications. They reasoned that The coefficient of operation and cooling ability of R1234yf have been 2.7 percent and 4.0% lower than that of R134a respectively.

5. **Gustavo Pottker, and PegaHrnjak, (2014)**Analyzed the impact of condenser subcooling on the operation of an ac system working with R134a and R1234yf. It was reasoned that the COP of the machine working with R1234yf can reap significantly more from the condenser subcooling compared to the R134a because differences in thermodynamic properties.
6. **J.M. SaizJabardo, W. Gonzales Mamani, M.R. Ianella (2013)**Also analyzed on a continuous state computer simulation model was created for heating circuits of auto air conditioning systems. An experimental seat composed of original elements from the ac system of a streamlined passenger car was invented so as to inspect the outcomes from this model. Effects on system functionality of these operational parameters like compressor rate, return atmosphere in the evaporator and condensing atmosphere temperatures have been evaluated and mimicked of developed version. The outcomes deviate from the experimentally obtained in 20% array however nearly all of them are within 10 percent array. Outcomes of this refrigerant inventory happen to be clinically assessed with results showing no consequences on system operation on a broad selection of refrigerant charges.
7. **Eur.Ing.IanM.Arbon,CEng (2012),** the reference book shows that the function of a compressor is to take a definite quantity of fluid (usually a gas, and most often air) and deliver it at a required pressure. The most efficient machine is one which will accomplish this with the minimum input of mechanical work. Both reciprocating and rotary positive Displacement machines are utilized for many different uses.The two types by defining the reciprocating type as having the characteristics of a low mass rate of flow and high pressure ratios(up to 500 bar and above) and the rotary type as having a high mass rate flow and low pressure ratios. The pressure range of atmospheric about 9 bars is common to both types.
8. **Tothero and Keeney (2010),** from York Company, reported on "A Rotary Vane Compressor for Automotive Air Conditioning Application". This journal is focus on the rotary sliding vane compressor with 3 vanes. He discussed the comparison between the previous reciprocating compressor and new design of rotary compressor. The previous compressor using 93 components and the new design using 61 component .From experiments, the result is the new compressor need more power and refrigerant capacity compare to previous compressor but the COP and volume efficiency is better if using old compressor. Furthermore, the experiment also prove that the mechanical aspect of rotary compressor is better compare than the reciprocating compressor

## 3.0 METHODOLOGY:

An air Conditioner (often known as AC) is a house appliance, mechanism or system designed to extract and purify heat from a place. The heating system is done utilizing a very simple refrigeration cycle. Its function, in a building or a car, is to give comfort during either cold or hot weather. From a lower-temperature heating supply to some higher-temperature heat sink. This is really the most usual sort of air conditioning.

Cooling load calculations for Ac system Layout are primarily utilized to find out the volume flow rate of the air system in addition to the coil and cooling of their gear to dimension the HVAC&R gear and to offer the inputs into the machine for electricity use calculations so as to select optimal layout options. Cooling load is classified into two different categories: internal and external.

## TOPICAL COOLING LOADS:

All these Lots are formed due to heat gains from the living space from outside resources throughout the building envelope or building shell and the trailer walls. Sources of outside loads comprise the next cooling lots:

1. Heat gain entering in the outside walls and roofs

2. Solar heat gain transmitted via the fenestrations

3. Conductive heat profit coming via the fenestrations

4. Heat gain entering in the partition partitions and Interior doorways

5. Infiltration Of outdoor air to the conditioned area

## INNER COOLING LOADS:

All these heaps are shaped by the discharge of practical and Latent heat from the heating sources within the conditioned area. These resources lead inner cooling loads:

1. People 2. Electric lighting . Appliances and Tools

If moisture transports from the building constructions and The rest of the parts have just sensible heating loads. All practical heat increases entering the conditioned area signify radiative heating and convective heating except the infiltrated atmosphere, radiative heat causes heat storage from the construction constructions, converts a portion of their heat gain into heating, making the heating load calculation more complex. Underfloor heating gains are heating profits from moisture transport from the occupants, appliances, equipment, or infiltrated atmosphere. In the event the storage impact of the moisture is discounted, all discharge heat to the distance atmosphere immediately and, thus, they are instant cooling loads.

## THERMAL FLUX CALCULATIONS:

Inside temperature = 500 $^{o}$C+273 = 323K

Atmospheric temperature =400 $^{o}$C+273 = 313K

Total area = $39807.7\times 2 = 79615.4mm^2 = 0.079m^2$

Contact area =

$47.12\times 44 = 2073.28mm^2 = 0.002073m^2$

Discharge of heat flow = x = 21mm

Tube thickness = 1

Calculating heat flux for 3 different materials:

1. Copper: Thermal conductivity = K =390W/mk
2. Aluminum(204): K = 150 W/mk
3. Aluminum(1100): K = 220 W/mk
4. Aluminum(6063): K = 193W/mk

$h_b = film\ coefficient\ for\ cu = 17\ w/m^2k$
$from\ air\ to\ fin$ Aluminum(1100): $15\ w/m^2k$
$from\ air\ to\ fin$Aluminum(6063): $16\ w/m^2k$
$h_a = refrigent\ used\ for\ hydro\ carbon = 900\ w/m^2k$

For HCFC Heat Transfer Coefficient = $243\ w/m^2k$

**1. Heat flux for aluminum (204) and HCFC as refregerent**

Heat flow is given by = q = U× $A \times \Delta T_m$

$$U = \frac{1}{\frac{1}{h_a}+\left(\frac{\Delta r}{k_1}+\frac{x}{k_2}\right)+\frac{1}{h_b}} = \frac{1}{\frac{1}{243}+\left(\frac{0.5}{390}+\frac{21}{150}\right)+\frac{1}{16}} = 4.839 w/m^2k$$

Heat flow = q = U× $A \times \Delta T_m = 4.839 \times 0.002073 \times 16.6 = 0.166$ w

$$\text{Heat flux} = \frac{q}{a} = \frac{0.166}{0.079} = 2.108 w/m^2$$

**2. Heat flux for Aluminum 1100 and HCFC as refrigerant**

Heat flow is given by = q = U× $A \times \Delta T_m$

$$U = \frac{1}{\frac{1}{h_a}+\left(\frac{\Delta r}{k_1}+\frac{x}{k_2}\right)+\frac{1}{h_b}} = \frac{1}{\frac{1}{243}+\left(\frac{1}{390}+\frac{21}{220}\right)+\frac{1}{15}} = 6.07 w/m^2k$$

Heat flow = q = U× $A \times \Delta T_m = 6.07 \times 0.002073 \times 16.6 = 0.208$w

$$\text{Heat flux} = \frac{q}{a} = \frac{0.208}{0.079} = 2.64\ w/m^2$$

**3. Heat flux for Aluminum 6063 and HCFC as refrigerant**

Heat flow is given by = q = U× $A \times \Delta T_m$

$$U = \frac{1}{\frac{1}{h_a}+\left(\frac{\Delta r}{k_1}+\frac{x}{k_2}\right)+\frac{1}{h_b}} = \frac{1}{\frac{1}{243}+\left(\frac{1}{390}+\frac{21}{193}\right)+\frac{1}{16}} = 5.61 w/m^2k$$

Heat flow = q = U× $A \times \Delta T_m = 5.61 \times 0.002073 \times 16.6 = 0.193$w

$$\text{Heat flux} = \frac{q}{a} = \frac{0.193}{0.079} = 2.44 w/m^2$$

## MODEL OF CONDENSER

### Analysis Program

Cosmos functions are helpful Applications for layout investigation in mechanical technology. COSMOS Works is a layout investigation automation program completely integrated with Solid Works. This program uses the Finite Element Method (FEM) to mimic the working requirements of your layouts and predict their behaviour. Powered by Immediately solvers, COSMOS Works makes it possible for designers to Quickly Evaluate the integrity of Their Layouts and look for the best solutionTypically contains these measures:

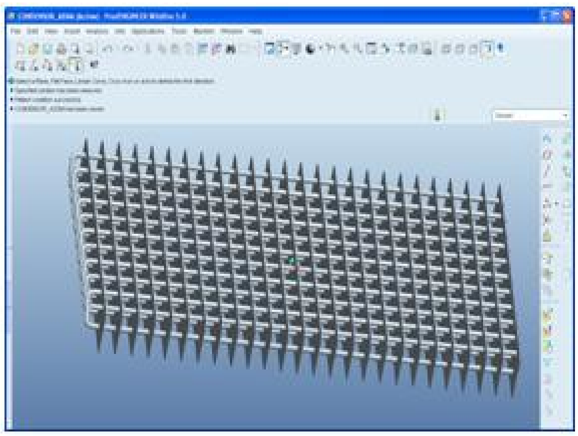
1. Build your version in theSolid Works CAD system.

2. Prototype the layout.

3. Examine the model in the Area.

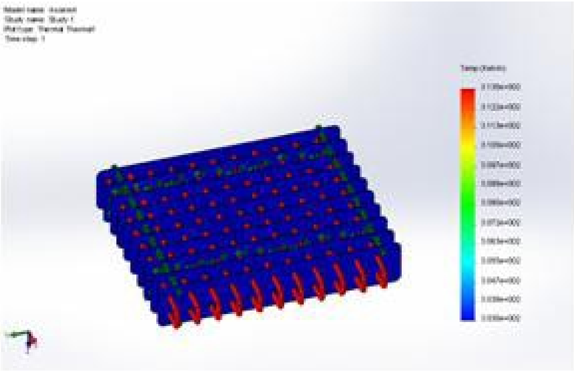
4. Evaluate the results of the field assessments.

5.Modify the design based on the field test results

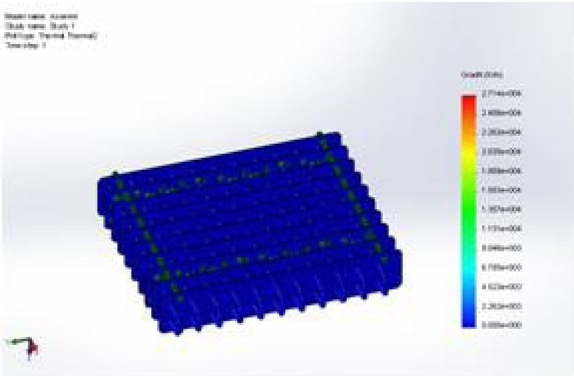


**Model of condenser**

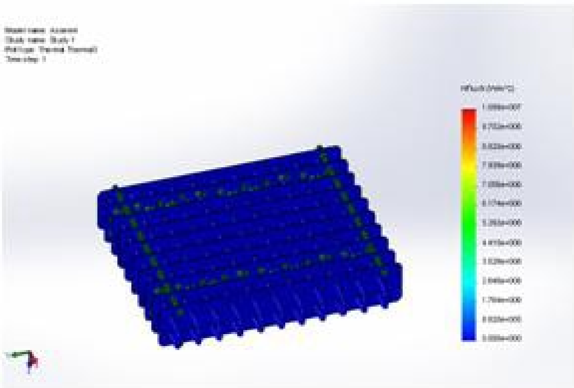
**Results and discussions:**



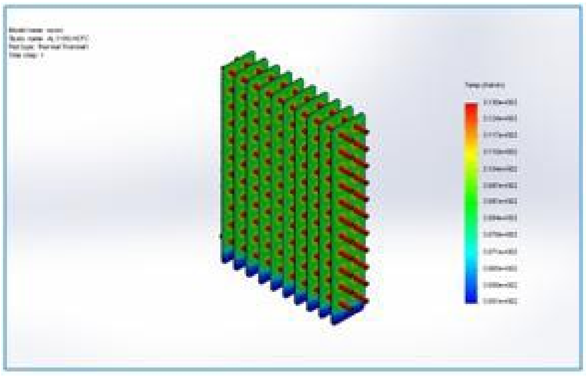
**Aluminium 204-Temperature**



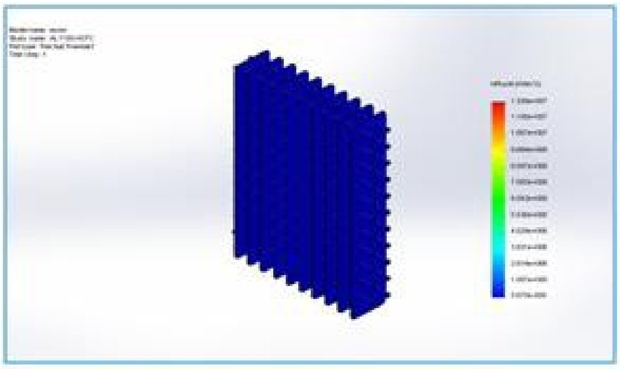
**Aluminium 204-Themal Gradient**



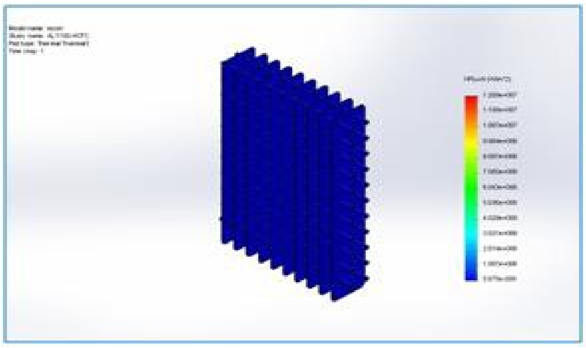
**Aluminium 204-Thermal flux**



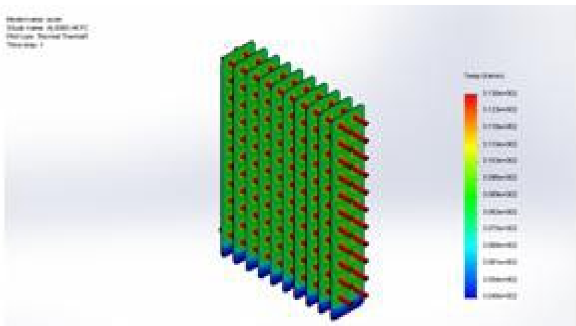
**Aluminium 1100-Temperature**



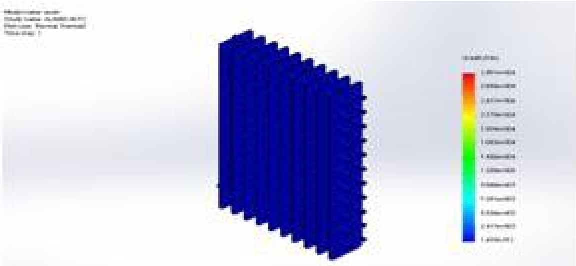
**Aluminium 1100-Themal Gradient**



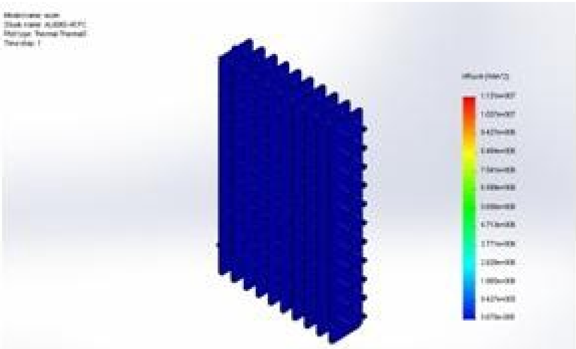
**Aluminium 1100-Thermal flux**



**Aluminium 6063-Temparature**



**Aluminium 6063-Thermal gradient**



**Aluminium 6063-Thermal flux**

The optimization is completed for the condenser to decrease the quantity, by altering the depth of the fin. By detecting optimization results, the best thickness value for diminished volume is 1mm.

## CONCLUSIONS:

In this analysis, a true condenser version was designed and incorporated in an air system. A foundation condenser version was selected and design requirements were created in 95° F. The working parameters of condenser sub cool and air face velocity were analysed over a broad assortment of neighbouring states to ascertain their impacts on the seasonal COP. It had been ascertained that there's a assortment of sub cools and confront velocities in which the consequences on the seasonal COP were negligible. The COP of the machine for an ambient temperature of 83° F has been almost equal to this seasonal COP and may be utilized for rapid comparisons. The impacts of altering the tube diameter, tube circuiting, amount of rows, and also fin pitch are researched for both fixed price and fixed frontal place. When the parameters were varied in the bottom case separately, the varying the amount of circuits into 4 or altering the tubing diameter into 1/2" gave the maximum COP's. It had been ascertained that tube diameter and tube circuiting couldn't be considered individually because they influence the refrigerant side pressure drop. After the price or area has been mended, the very best tube diameter-circuiting setup was 5 circuits of 5/16" tube.

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