DESIGN PROCEDURE OF HYBRID AIR-CONDITIONER WITH THERMAL ANALYSIS

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ABSTRACT

In the world scenario the biggest problem is always attach with energy. We are facing a large scarcity of energy and for that it will always beneficial to minimize the energy consumption. So for that this paper contain an experimental method by which we can see how much energy we can save by applying three different energy source for establishing an air conditioning system. While in three energy source one is conventional energy source and another two is non conventional energy source.

The conventional energy source is applied to simple vapor compression cycle and non conventional energy source is applied to extract energy from peltier effect and earth heat exchanger. This paper also contain a big role of heat pipe which is used to transport energy from on point to other.

This paper also contain the compression of energy consumption with three different conditions which are:

1. *When only vapor compression cycle is used.*
2. *When vapor compression cycle is used with earth heat exchanger.*
3. *When vapor compression cycle is used with earth heat exchanger as well as peltier modue.*

Keywords: Air Conditioning, Non-Conventional Energy Source, Earth Heat Exchanger, Heat Pipe, Peltier Model.

I. INTRODUCTION

In the refrigeration cycle, a heat pump transfers heat from a lower-temperature heat source into a higher-temperature heat sink. Heat would naturally flow in the opposite direction. This is the most common type of air conditioning. A refrigerator works in much the same way, as it pumps the heat out of the interior and into the room in which it stands.

This cycle takes advantage of the way phase changes work, where latent heat is released at a constant temperature during a liquid/gas phase change, and where varying the pressure of a pure substance also varies its condensation/boiling point.

The most common refrigeration cycle uses an electric motor to drive a compressor. In an automobile, the compressor is driven by a belt over a pulley, the belt being driven by the engine's crankshaft (similar to the driving of the pulleys for the alternator, power steering, etc.). Whether in a car or building, both use electric fan motors for air circulation. Since evaporation occurs when heat is absorbed, and condensation occurs when heat is released, air conditioners use a compressor to cause pressure changes between two compartments, and actively condense and pump a refrigerant around. A refrigerant is pumped into the evaporator coil, located in the compartment to be cooled, where the low pressure causes the refrigerant to evaporate into a vapor, taking heat with it. At the opposite side of the cycle is the condenser), which is located outside of the cooled compartment, the refrigerant vapor is compressed and forced through another heat exchange coil, condensing the refrigerant into a liquid, thus rejecting the heat previously absorbed from the cooled space.

By placing the condenser (where the heat is rejected) inside a compartment, and the evaporator (which absorbs heat) in the ambient environment (such as outside), or merely running a normal air conditioner's refrigerant in the opposite direction, the overall effect is the opposite, and the compartment is heated. This is usually called a heat pump, and is capable of heating a home to comfortable temperatures (25 C; 70 F) , even when the outside air is below the freezing point of water (0 C; 32 F).

Cylinder unloaders are a method of load control used mainly in commercial air conditioning systems. On a semi-hermetic (or open) compressor, the heads can be fitted with unloaders which remove a portion of the load from the compressor so that it can run better when full cooling is not needed. Unloaders can be electrical or mechanical..

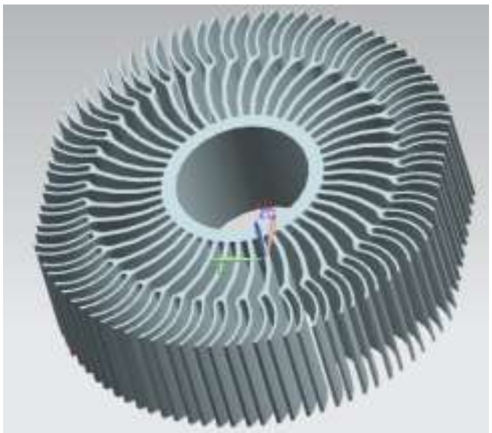
II. RELEVANCE

The increasingly worldwide problem regarding rapid economy development and a relatively shortage of energy, for residential homes, some countries set minimum requirements for energy efficiency. In the some countries, the efficiency of air conditioners is often rated by the seasonal energy efficiency ratio*)*. The higher the SEER rating, the more energy efficient is the air conditioner. The SEER rating is the BTU of cooling output during its normal annual usage divided by the total electric energy input in watt hours (W·h) during the same period.

In the present age with depleting sources of energy there is always a target to get the best energy ratios so that there will be minimum electric power consumption in operation of the air conditioning units. Many methods and ideas from evaporative cooling, thermoelectric cooling etc have been tried to keep the electricity consumption to a minimum in air conditioning applications. Individually these ideas do not stand good but by combination of two or more concepts in a collaborative manner stands a possibility to develop an energy efficient method of air conditioning. Thus there is a proposal to use the conventional vapor compression cycle in conjunction to thermoelectric cooling and earth heat exchanger technique to reduce the power consumption of the air conditioner and thereby increase the COP of system.

III. THERMAL ANALYSIS

Thermal Analysis Of Spiral Radial Fins For Heat Pipe Module Oil Cooler



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Measurement Mass Properties

Material: Aluminium

Displayed Mass Property Values

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Mass = 0.121693261 kg

Weight = 1.193404297 N

Radius of Gyration = 31.397539329 mm

Centroid = -0.000855740, -0.001402973, 13.000000000 mm

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Detailed Mass Properties

Analysis calculated using accuracy of 0.990000000

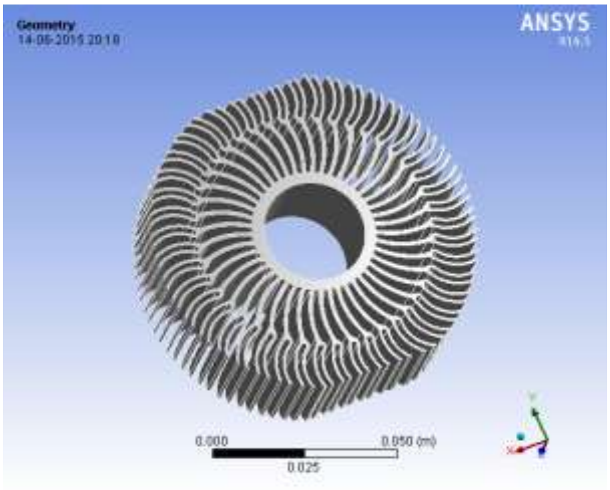
Information Units kg - mm

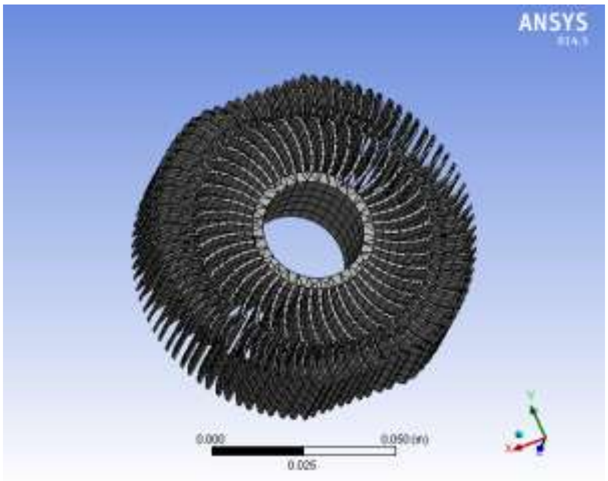
Density = 0.000002660

Volume = 45749.346346060

Area = 106970.325514622

Mass = 0.121693261





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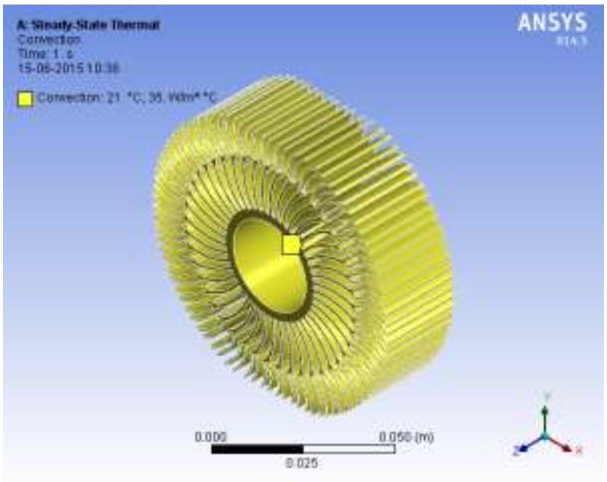

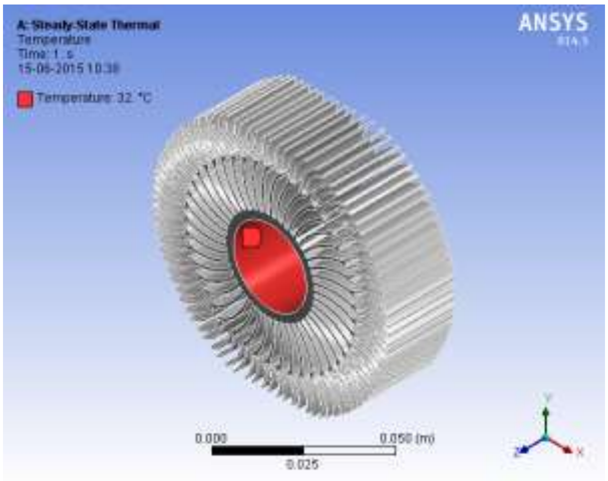

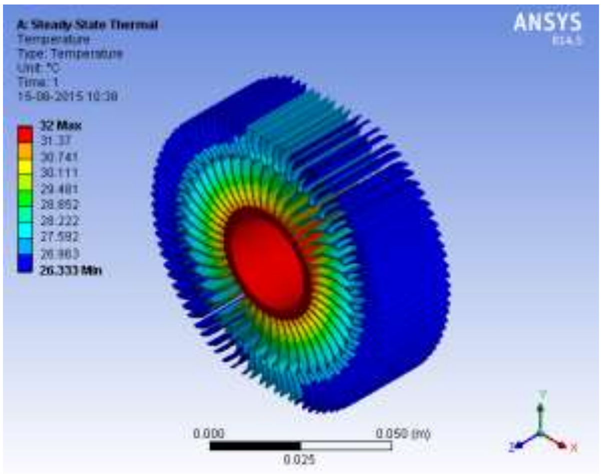

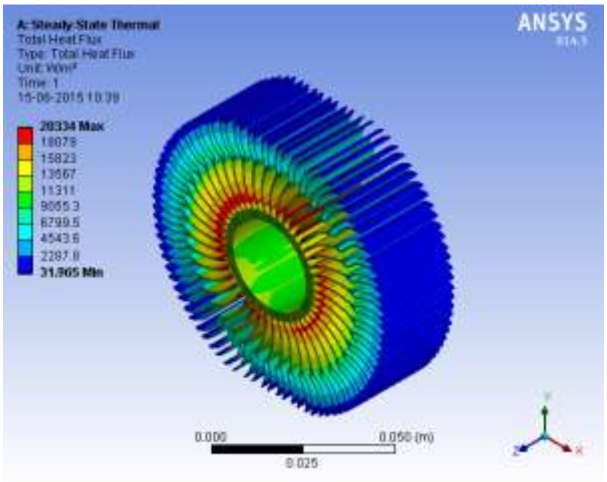

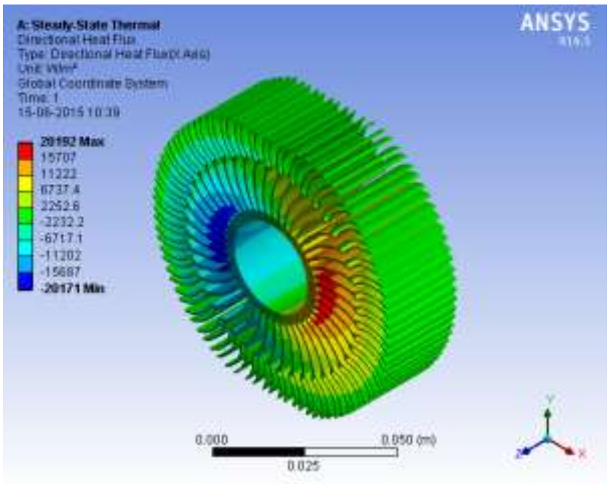

IV. OBJECTIVE

The main objective of this investigation is to study the performance of the Hybrid Air Conditioning System. The proposed work includes the determination of determination of heat load, to maintain 22 to 25ºC temperature in the cabinet of volume close to 1800 liters.

1) Determination of compressor power and specification of parts of conventional Vapor compression cycle to take 100 % of rated load

2) Determination of Peltier modules 12 V dc , to take 30 % of heat load

3) Selection of heat pipe system for earth heat exchanger module to take 20 % of heat load

4) Design and development of cabinet space with the evaporator coil of conventional AC with integrated with peltier modules Design & Development of improvised spiral fin heat exchanger with heat pipes for heat transfer enhancement with peltier modules

5) Test & Trial on hybrid peltier air conditioner determine temperature gradient , cooling ability (tonnage) and COP of system, under given conditions

- Vapor Compression Air Conditioning unit and derive performance characteristic

- Vapor Compression Air Conditioning unit with Earth heat exchanger unit and derive performance characteristic
- Vapor Compression Air Conditioning with Peltier module unit and derive performance characteristic.
  Vapor Compression Air Conditioning with Earth heat exchanger and Peltier module unit and derive performance characteristic.

V. DESIGN

We will examine each state point and component in the refrigeration cycle where design assumptions must be made, detailing each assumption. As we can see from the example design constraints, very few numbers need be specified to describe a vapor-compression refrigeration cycle. The rest of the assumptions are determined by applying reasoning and background knowledge about the cycle. The two principle numerical design decisions are determining P_{high} and T_{low}, at the cooler outlet and the compressor inlet.

5.1 Cooler (Condenser) Inlet (S1)

This state need not involve any design decisions, but it may be important to come back here after the cycle has been solved and check that T_2, which is the high temperature of the cycle, does not violate any design or safety constraints. In addition, this is as good a place as any to specify the working fluid.

5.2 Cooler (Condenser): Heat Rejection (Clr1)

The cooler (also known as the condenser) rejects heat to the surroundings. Initially, the compressed gas (at S1) enters the condenser where it loses heat to the surroundings. During this constant-pressure process, the coolant goes from a gas to a saturated liquid-vapor mix, then continues condensing until it is a saturated liquid at state 2. Potentially, we could cool it even further as a subcooled liquid, but there is little gain in doing so because we have already removed so much energy during the phase transition from vapor to liquid.

5.3 Cooler (Condenser) Outlet (S2)

We cool the working fluid until it is a saturated liquid, for reasons stated above. An important design question arises at this state: how high should the high pressure of the cycle be?

We choose P_{high} so that we can reject heat to the environment. P_{high} is the same as P_2, and P_2 determines the temperature at state S2, T_2. (T_2 is just the saturation temperature at P_{high}). This temperature must at least be higher than that of the cooling source, otherwise no cooling can occur.

However, if T_2 is too high (that is, higher than the critical temperature T_C for the working fluid), then we will be beyond the top of the saturation dome and we will loose the benefits of the large energy the fluid can reject while it is being cooled. Furthermore, it is often impractical and unsafe to have very high pressure fluids in our system and the higher P_2 we choose, the higher T_1 must be, leading to additional safety concerns. To find an applicable pressure, use the saturation tables to find a pressure which is somewhere between the saturation pressure of the warm air yet still in the saturation region.

For Reference, T_C For Our Four Working Fluids Are Given Below.

Critical Temperatures of some refrigerants	
substance	T_C (°C)
R-12 (CCL_2F_2)	111.85
R-22 ($CHCLF_2$)	96.15
R-134a (CF_3CH_2F)	101.05
ammonia (NH_3)	132.35

For our example using R-22, we must be able to reject heat to air that is 32°C. We can choose if T_2 to be anywhere between that number and the 96°C T_C. We'll choose it to be 40°C for now.

Figure3: Vapor-Compression Refrigeration Cycle COP versus T_{high} in the cooler

The figure above gives a general idea of the improvements we can expect with lower temperatures in the cooler. Keep in mind that the practical limitation here is heat transfer to the surrounding air. While lower temperatures will make the cycle more efficient theoretically, setting Thigh too low means the working fluid won't surrender any heat to the environment and won't be able to do its job.

5.4 Throttling (THR1)

The high-pressure, saturated liquid is throttled down to a lower pressure from state S2 to state S3. This process is irreversible and there is some inefficiency in the cycle due to this process, which is why we note an increase in entropy from state S2 to S3, even though there is no heat transfer in the throttling process. In theory, we can use a turbine to lower the pressure of the working fluid and thereby extract any potential work from the high pressure fluid (and use it to offset the work needed to drive the compressor). This is the model for the Carnot refrigeration cycle. In practice, turbines cannot deal with the mostly liquid fluids at the cooler outlet and, even if they could, the added efficiency of extracting this work seldom justifies the cost of the turbine.

5.5 Heater (Evaporator): Heat Absorption (HTR1)

The working fluid absorbs heat from the surroundings which we intend to cool. Since this process involves a change of phase from liquid to vapor, this device is often called the evaporator. This is where the useful "function" of the refrigeration cycle takes place, because it is during this part of the cycle that we absorb heat from the area we are trying to cool. For an efficient air conditioner, we want this quantity to be large compared to the power needed to run the cycle.

The usual design assumption for an ideal heater in a refrigeration cycle is that it is isobaric (no pressure loss is incurred from forcing the coolant through the coils where heat transfer takes place). Since the heating process typically takes place entirely within the saturation region, the isobaric assumption also ensures that the process is isothermal.

VI. RESULT

1. Cop of the hybrid system increases with application of the Peltier module and Earth heat exahanger arrangement to upto 10 %
2. Tonnage of the hybrid system increases with application of the Peltier module and Earth heat exahanger arrangement to upto 11 %

REFERENCES

[1] ASHRAE Handbook of Fundamentals. SI Version, 1993. American Society of Heating; Refrigerating; and Air-Conditioning Engineers, Inc., Atlanta, GA.

[2] Ballaney, P.L., 1979. Refrigeration and Air Conditioning. Khanna Publishers, Delhi

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