SOLAR HYBRID MODEL FOR HEATING AND COOLING

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ABSTRACT

Operating Cost of AC is still out of the reach of common people in India and abroad. An average of 1000 W/m2 solar energy falls on earth and is free. By this project we want to make analysis on AC affordable for common people. With drastic change in environment it is very important to make AC affordable for common people in India in order to make life of people comfortable. We are trying to use solar power to heat the refrigerant due to which pressure of gas rises. By doing so our aim is to reduce the energy consumption of compressor. Since compressor is the prime consumer of energy hence by doing so we will reduce the operating cost of AC significantly. In present scenario as stated earlier there is urgent need to cut dawn the operating cost of AC. There are few companies in this field who are claiming that there product utilizes solar energy to increase efficiency of AC but the products are not satisfactory as stated. Looking at the scenario of market our aim will be to make such AC which will be commercially easy to produce and as well as easy to use.

Keyword: -*Air Conditioner, Solar Power, Compressor, and Operating Cost.*

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1. INTRODUCTION

Electricity demand for room Air Conditioning and heating's is growing very rapidly in emerging economies such as India. Even room Air Conditioners demand only is growing rapidly at rate of 20% on an average per year over the last decade due to increasing comfort expectations and is likely to be a major contributor to the need of about 239TWh/yr. electric power by year 2030. So, the demand of alternative energy resource for heating and cooling is required to meet the current and future demand of heating and cooling. In order to cater this need a concept of Solar Hybrid Model for Heating and Cooling is developed.

Solar Hybrid Model for Heating and Cooling is the model for heating and cooling of room air in winter and summer season respectively. This model will also work as a water heater. Hence, model will serve 3 main purposes:

1. Solar hybrid air conditioner.
2. Solar hybrid room air heater.
3. Solar water heater.

The input energy requirement for air conditioning and air heating for this model will be fulfilled partly by solar power (radiations) and rest by electrical power. While energy requirement for water heater will be fully met by solar power (radiations) i.e. no electrical energy required for water heater.

This model is an alteration in existing conventional model in which solar evacuated tube/solar arrangement filled with organic substances will be use between the compressor and condenser unit of conventional model. This solar evacuated tube is use to superheat the refrigerant which is coming out of the compressor which enables the refrigerant to condense rapidly in the condenser hence results in better cooling and lower electrical power consumption, as superheating of refrigerant is done before entering into the condenser using solar power.

When the operating cycle is reversed in the winter season then this model will act as an air heater. In case of water heater; water is supplied in the solar evacuated tube panel. This panel consists of heat pipes which are filled with thermally active organic fluid. This organic fluid is heated directly by solar radiation. Due to heating of fluid in the heat pipe a natural convection is established and heat of organic fluid is transferred to the water hence water is heated to the desirable temperature.

This project work will also develop a Solar Auxiliary which can be assembled with the existing air conditioning unit in homes/small commercial complexes so that air conditioners energy dependency on electric power can be reduced significantly. As in a typical house using air conditioners, the electricity required for cooling can be as high as 30-40% of the total electricity used. In commercial complexes, this percentage is even higher. Cooling demand in various sector is maximum mainly during day time when solar energy is also present in abundant, this is more so in hot summer season. This solar auxiliary will help in reducing the electrical energy input by 30-40%.

2. SYSTEM DESCRIPTION

Conventional vapor compression cycle consist of compressor, evaporator, expansion valve and evaporator. Here in hybrid air conditioning we are adding equipment called as solar compressor. The overall diagram of the system is shown below.

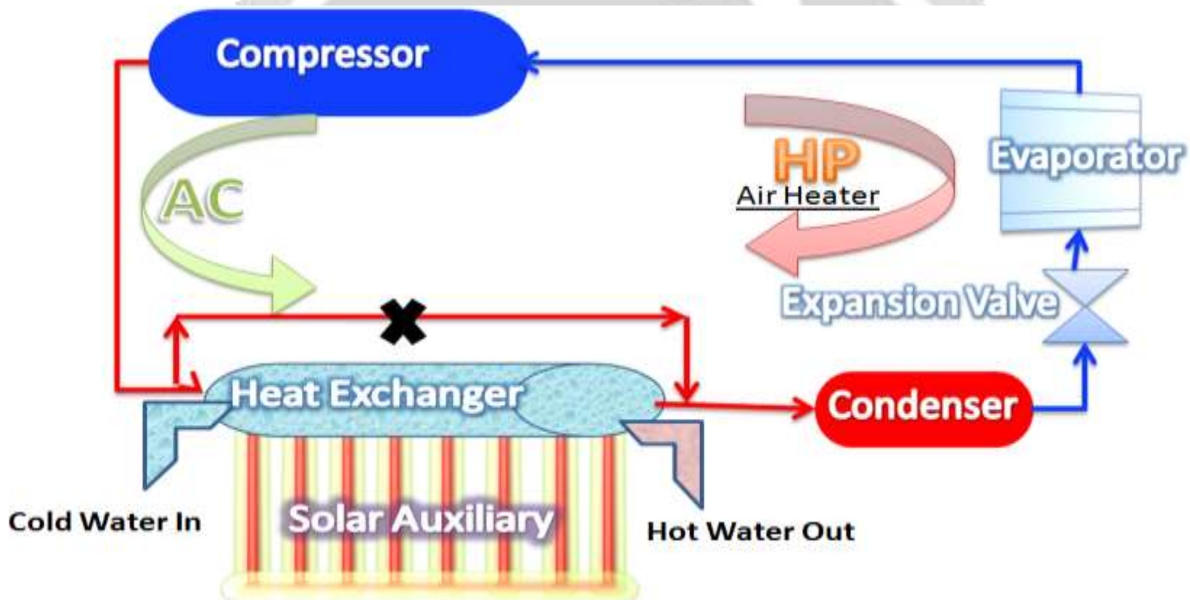

Figure no - 1

First of all refrigerant from evaporator is compressed in a 1.5 KW of compressor. Then it is compressed even further by using solar compressor. After that the refrigerant is allowed to condense in condenser followed by expansion and evaporation.

Due to heat addition in the solar compressor the condensation process takes place after $1/3^{rd}$ of the condenser tube. While in conventional vapor compression cycle this condensation takes place after $2/3^{rd}$ of the condenser pipe. Due to this efficient condensation the efficiency of the cycle increases.

Here we are using evacuated heat pipe with copper tube for solar compression which increases our efficiency of the system in comparison to market product where simple evacuated tube is being used. The solar compressor system is shown below.

Figure no - 2

3. CALCULATION OF ENERGY SAVED BY HYBRID AC

The Calculation of heat energy absorbed by solar system is below.

Solar energy falling per meter^2 in most part of India is approximately 1362 W.

Solar evacuated tube is approximately 85%.

⇒ Solar energy converted into heat = 1362*0.85= 1157.7 W

(Assuming 20% loss from walls of heat exchanger)

⇒ Energy available as heat for compression process = 1157.7*(1-0.2) = 926.16W

Suppose if the energy is supplied to the refrigerant is 60% due to heat loses in various places like copper tube etc.

⇒ Energy supplied to the refrigerant is 926.16*0.6= 555.696 W

Suppose we are using 1.5 kW of compressor for conventional AC.

⇒Energy saving due to solar compressor is 555.7W = (555.7/1500)*100= 37.04%

Hence form the above calculation we can say that energy saving of the hybrid AC is approximately 37%

4. SOLAR WATER READING

Main challenge associate with the project was solar compression. We carried out our experiments on solar compressor in various parts of the day and observed the temperature pattern shown in Table no - 1.

After making the solar compressor we integrated the whole and system and took the reading of the vapor compressor cycle at various points. We found that due to extra heat supplied after the compressor, the condenser was working efficiently. We also found that due to solar compressor we can use a smaller compressor and still we can get the same refrigeration effect.

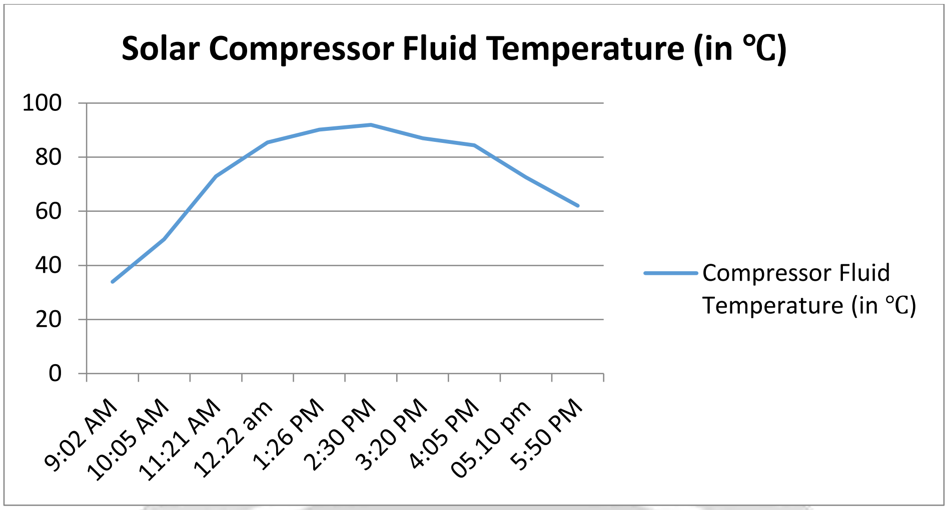

Table no-1

5. DESIGNING OF THE CONSTANT VOLUME CHAMBER

The solar collector provides part of compression pressure by heating the refrigerant under constant volume. Ideal gas law states that *PV=nRT*, where *P* is absolute pressure of gas, *V* is volume of gas, *n* is number of moles of gas, *R* is ideal gas constant, and *T* is absolute temperature of gas.

The volume of the refrigerant in a conventional A.C

Using ideal gas equation M1=1.0125kg T1=65°C=338K R=0.287 P1=13*105 Pa To Calculate V1 V1*P1=M1*T1*R V1= (M1*T1*R)/P1 V1=(1.125*338*0.287) 13*105 V1=8.39*10-5 m3 The volume of the refrigerant for Hybrid A.C M_2=1.5kg T_2=124°C=397K (R=0.287)	$P_2=13*10^5$ Pa To Calculate V_2 $V_2*P_2=M_2*T_2*R$ $V_2= (M_2*T_2*R)/P_2$ $V_2=(1.5*397*0.287)\ 13*10^5$ $V_2=1.314*10^{-4}m^3$ Now calculating the difference between $V_{1\ and}\ V_2$ Difference in the volume = V_2-V_1 $=1.314*10^{-4} - 8.39*10^{-5}$ $=4.75*10^{-5}\ m^3$ Designing of cylinder of $4.75*10^{-5}\ m^3$ volume Take R=1.75cm $4.75*10^{-5}\ m^3=3.14*R^2*L$ $4.75*10^{-5}\ m^3$=3.14*.0175*.0175*L L=0.05001m L=5 cm

6. CONCLUSION FUTURE WORK

Our aim was to reduce the operating cost of AC by 24%-40%. For this purpose it was necessary to heat the refrigerant from the compressor to approximately 120 ℃ - 160℃. We carried out our experiment on a specially designed solar compressor based on simple ideal gas equation and took readings in various parts of the day. Extra heat was problem for use for this we redesigned our condenser. We took the reading of various points of the vapor compression cycle and at the end we concluded that coefficient of performance of our system was improved to 37%.

For future it is important to add a dc compressor to the system. If we want to make the system work solar only then dc is a good choice as the starting current required for the dc compressor is low as compare to ac compressor. So comparatively small solar system can work well if we use dc compressor.

7. REFERENCES

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