Design and Fabrication of Solar Powered Air-Conditioner

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Abstract— An air–conditioner is a mechanical device which is used to control the temperature, humidity, air motion and the quality of the air of the room. The demand of air conditioning is increasing due to the effect of climate change and global warming. In subtropical cities, air conditioning is a standard provision for buildings. However, Air conditioning would commonly take up half of building electricity consumption. So it is necessary to design such an air-conditioner that could work on solar power rather than electricity. As solar energy is available in larger amount compared to electricity. In order to avoid the above issues we are going to design and develop a cost effective working model solar air conditioner. Main objective behind designing and fabricating the solar air conditioner is to make the cost of air conditioning available in cheap price.

Keywords: Solar Energy, Air Conditioner, Solar Air-Conditioner, Eco-Friendly

I. INTRODUCTION

Air conditioner is a device used to control the temperature, humidity, air motion and the quality of air. Air conditioner removes heat from a space that is lower than surrounding temperature. Clausius statement says that heat cannot be flow from lower temperature to high temperature spontaneously. In air-conditioner an external work is supplied to transfer heat from lower temperature to higher. It follows the refrigeration cycle. Hot refrigerant from the evaporator coil enters into compressor. Here due to compression temperature of the refrigerant increases. Compressed refrigerant then reaches the condenser where the refrigerant losses the heat and reach the liquid phase. Refrigerant reaches the evaporator coil through expansion valve and the cycle continuous. Expansion valve reduces the pressure. Due to reduction in pressure there will be a temperature drop. This is the working of an Air conditioner. Two types of air-conditioning system as follows,

- Vapor compression system
- Vapor absorption system

A. Types of Air Conditioner

1) Window air conditioner
2) Split air conditioner
3) Packaged air conditioner
4) Centralized air conditioner

B. Solar Power

Solar power is the technology of

Solar power is the technology of obtaining usable energy from the light of the sun. Solar energy has been used in many traditional technologies for centuries and has come into widespread use where other power supplies are absent, such as in remote location and in space.

C. Solar Thermal Air-Conditioner

Solar thermal air conditioner uses the solar energy to run the air-conditioning system in the hot region. It is the one of the technologies which is used till now. Some solar air-conditioning system is working by converting the solar energy into electricity by solar panels to run the air-conditioner. In this project we convert the solar energy into electricity by means of solar panel and store it in battery. Here water is the refrigerant in this project. We used TEC as cooling component. TEC is attached with aluminium tube where the refrigerant is flowing through. When the TEC is powered by solar panel, it started cooling the aluminium coil. Hence the air conditioning is achieved.

II. PROBLEM IDENTIFICATION

In this project, we are utilizing the solar thermal energy to run the air conditioning system. It is impossible to operate the air conditioner without electricity consumption. Minimizing the electricity consumption and recover the maximizing the solar energy utilization. To increase the effectiveness of above mentioned application is the motto of our project.

The refrigerant is the stuff that your air conditioner uses to remove the heat and humidity from the air in your home or office. If your system develops leaks in the refrigerant lines, you can end up with not enough refrigerant to effectively cool the air. Unfortunately, fixing this air conditioner problem correctly is not just matter of replacing the refrigerant.

Air conditioner's evaporator coil is filled with refrigerant, and is responsible for absorbing the heat from the air like a sponge. It may sound counter-intuitive, but those coils need warm air circulating around them to work properly. When something goes wrong with the airflow and the evaporator coil gets too cold, a layer of ice can build up on the outside. When that happens, you'll get warm air or none at all coming from your air or none at all coming from your air conditioning supply registers.

III. LITERATURE SURVEY

1) Ajay Sankar N R et. al (2015) Studied the comparison the performance between conventional systems and vapour absorption system using solar thermal energy.
2) I.Daut Fitra et. al (2013) It will help to improve the stability and efficiency of the system for greener solutions to the world's energy needs.
3) Ravi Gugulothu Banoth et. al (2015) It is observed that, the energy and water are the basic necessity for all of us to lead a normal life on this beautiful earth. Solar energy technologies and its usage are very important and useful for the developing and under developed countries to sustain their energy needs. Solar cooling systems are the substitution of electricity as the premium energy sources for air conditioning system by a renewable heat source.

The main motivating for solar cooling systems is the substitution of electricity as the premium energy sources for air conditioning systems by a renewable heat source that is low grade heat from solar collectors.

4) Zhifeng Sun et. al (2017) Remove heat from equipment, provide energy for fresh-air treatment, which depends on the number of people inside the building.
5) Ali Al-Alili et. al (2014) Desiccant evaporation cooling technology is environmental friendly and can be used to condition the indoor environment of buildings. Unlike conventional air conditioning systems, the desiccant air conditioning systems can be driven by low grade heat sources such as solar energy and industrial waste heat.
6) Ravi Gugulothu et. al (2014) This can be done through passive solar, solar thermal energy conversion and photovoltaic conversion(sunlight to electricity). We are combining the Refrigerant Cycle and Vapor Absorption Cycle.
7) Ali Al-Alili et. al (2018) Photovoltaic Cells is the main equipment for this project, sunlight is absorbed the PV cells and is converted to electricity by the inverter and battery and is passed to DC Motor and then the cooling air spreaded to the entire room. These all eco-friendly, and renewable.
8) Khaled Alqdah et. al (2011), purposed to study the design and performance of the system in AlMadinah AlMunawwarah to cool the indoor environment by solar air conditioning system because the temperature in summer is around 42□C, so the air conditioning system is almost every building of Saudi Arabia. And the coefficient of performance varies from 2.16 to 4.22 for the system and the result compare with conventional is better. The absorption cycle was found to be an ideal option. The COP values of these equipment's are directly proportional with increasing generator and evaporator temperatures. The proposed system decreases vehicle operating costs and environmental pollution caused by the heating system.
9) Reinhard Radermacher et. al (2014) The removal of moisture from the supply air using conventional air conditioner represents a considerable portion of the air conditioning load in the hot and humid areas.
10) Akeel Ahmad et. al (2017) The purpose of this is the climate panel developed is to be used as a compliment to an existing heating system in order to pre-heat and pre-cool the air coming into the house. The venture fundamental target was to build up a packed sun oriented aeration and cooling system and this has been effectively done.
11) R.Nasker et. al (2018) The design and construction of DC air conditioning system integrated with PV system which consists PV panel, battery and inverter which can be operated on solar power and can be used in non-electrified areas.
12) Pooja Abhiman et. al (2018) The use of solar energy to drive cooling cycles is attractive since the cooling load is roughly in phase with solar energy availability. In this, a focus is made on reduction in Air Conditioning capacity savings and emission reductions attainable through the use of solar energy.
13) B.Moncef et. al (2005) Energy from the collector is stored, then transferred to a heat exchanger which, in turn, transfers energy to the heat engine. The heat engine drives a vapor compressor, finally producing a cooling effect at the evaporator. Air cooler gives the cool and humid air. Humidity of air can be absorbed by cooling coil which is cheap and effective design conceptualization in comfort application.
14) Amitkumar Gupta et. al (2016) It is observed that today the human society facing problem is energy. And by using solar energy w will save our environment from greenhouse gases and keep our environment clean and green for coming generation. So using of the electrical equipment like air conditioner, fans, etc, for our comfort by using fossil fuel like coal, petrol and natural gas which from CO_2 after burning of this fuel. Many place were solar energy can be use and government also giving a good policy for solar energy user and it also have long life, investment cost can be recovered within 4-5 year of span. Today every modern IT building using air conditioning system for comfort in indoor environment.
15) Kotresh.H.M,Kallesh.H.C, 2017, solar power is stored in a battery. This power is used to run the air cooler whenever required. Solar energy means all the energy that reaches the earth from the sun. It is based on photo-voltaic or solar modules, which are very reliable and do not require any fuel or servicing.
16) Prakash.R, 2014, Solar power systems being considered as one of the path towards more sustainable energy systems, considering solar-cooling systems in village would comprise of many attractive features. This technology can efficiently serve large latent loads and greatly improve indoor air quality by allowing more ventilation while tightly controlling humidity.

IV. DESIGN AND CALCULATION

A. Components

- Solar panel
- Battery
- Condenser coil
- TEC
- Fan
- Pump
- Water tank
- Evaporator coil

S.No	Component	Material
1	Solar cell	SILICON
2	Battery	LI-Fe
3	Thermo Electric Cooler	Moulded Plastic
4	Dc pump	Moulded Plastic
5	Condenser Coil	Aluminium
6	Evaporator Coil	Aluminium
7	Water Tank	Moulded Plastic
8	Fan / Blower	Mild Steel

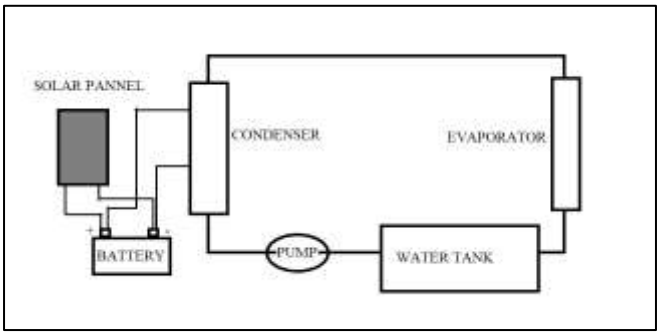

Fig. 1: Fabrication model

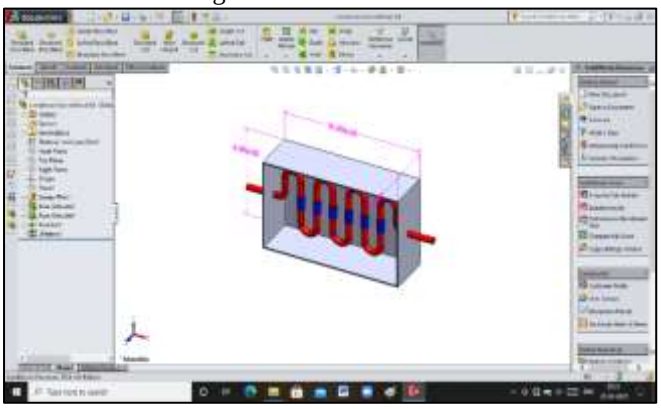

Fig. 2: Condenser coil design

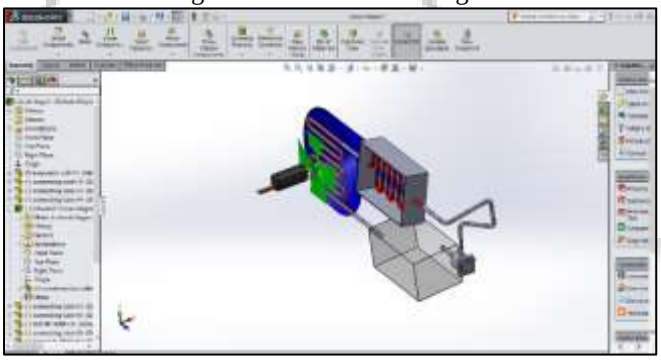

Fig. 3: 3D model of the design

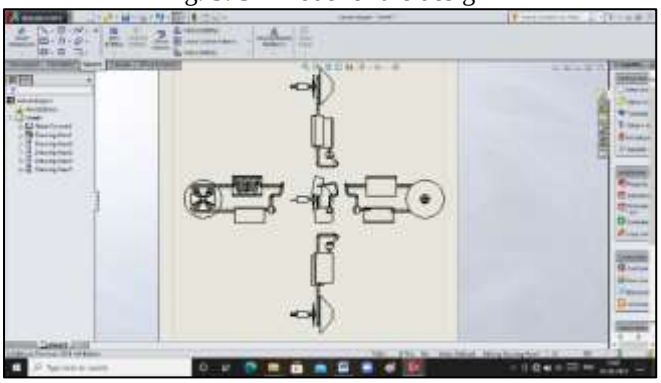

Fig. 4: Different views of the design

B. Calculation

1) Battery

12 volt, 7 amps

Battery watts = volt*amps
= 12*7
= 84 watts

2) Solar panel

3 watts solar panel

Solar panel output power = watts*solar panel 1hr of sunshine*0.85
= 3*1*0.85

Output power in one hour= 2.4 WH

C. Pump

To find out the power required to drive the pump
To find the flow rate of pump
flow rate
Continuity equation, Q = Area of pump shaft x Velocity
Dia of pump shaft(D) =15mm
Dia of outlet of the pump (d) =3mm
Speed of the pump shaft =3000rpm

Area = $\pi \times d^2/4$
$= \pi \times (0 .003)^2/4$
$= 7.06 \times 10^{-6} m^2$

Velocity = $\pi \times D \times n / 60$
$= \pi \times 0.015 \times 3000/60$
=2.35 m/s

Therefore, Q = $7.06 \times 10^{-6} m^2 \times 2.35$ m/s
$= 0.0014 m^3/min$

To find power

1) Power = force X velocity
2) Force = pressure X area
3) Pressure =ρ X g X h

ρ = density of water =1000Kg/m^2
g = acceleration due to gravity =9.81 m/s^2
h = water head 3m

1kg =10N
Pressure=ρ X g X h
=1000X10 X9.81X3
$=2.9X10^5$ N/m^2

p=2.9 bar
Pressure =F/A
F =P/A
F =$2.9X10^5 \times \pi/4 \times (d)^2$
$=2.9 X10^5 \times \pi/4 \times (3X10^{-3})^2$
= 2.05 N

Power = force X velocity
=2.05X2.35
= 4.8 W

Therefore power required to pump 4.8w

V. CONCLUSION

Design of solar thermal air conditioner is done in this project. As we know solar energy is abandonedly available energy resource and readily available than any other resources. Air conditioning is much needed in hotter region. It is easy to collect solar energy in hotter region. By using this type of refrigerators, electricity consumption will reduce which results the reduction in cost of air conditioning. SOLID WORKS is used to design the air conditioner model. This paper concludes that the system design needs to consider both air conditioner and PV system in order to achieve the space cooling. There are several characteristics that are needed to know either on the PV system or air conditioning system. Electrical equivalent, IV characteristic curve and factors affect the output of PV cell is an important characteristic in photovoltaic. As for the air conditioning, cooling capacity

must be determined first as it will give a rough idea on how to design and construct the system with enough electrical energy supplied to it. With considering of these several factors, it will help to improve the stability and efficiency of the system for greener solutions to the world's energy needs.

REFERENCES

[1] Ajay Sankar N R, Dr. S. Sankar "Solar Thermal Absorption Air Conditioner" (2015) in International Journal of Advanced Technology in Engineering and Science
[2] Akeel Ahmad, Ahsan Kamal, Pravesh Chandra, "Design and Fabrication of Compressed Solar Air Conditioner" in International Journal of Refrigeration (2017)
[3] Ali Al-Alili, Yunho Hwang, "Fabrication of Modern Solar Air Cooler" in International Journal of Refrigeration (2018).
[4] Ali Al-Alili, Yunho Hwang "Review of solar thermal air conditioning technologies" at 2014 in International Journal of Refrigeration.
[5] B.Moncef, M.H.Chahbani, G.Amenallah, "Solar Powered Air Conditioning" in European Commission (2005)
[6] I.Daut, M. Adzrie, M. Irwanto, P. Ibrahim, M. Fitra, "Solar Powered Air Conditioning System" (2013) in Science direct
[7] Khaled Alqdah, Sameh Alsaqoor, Assem Al-Jarrah, "Design and Fabrication of Auto Air Conditioner Utilizing exhaust waste energy from a diesel engine" in International Journal of Refrigeration (2011)
[8] Pooja Abhiman, K.D.Thanekar , "Study on Solar Air Conditioning System" in International Research Journal of Engineering and Technology (2018)
[9] R.Nasker, A.Ghosh, R.Mandal , "Solar Air Conditioner of Vapor Compression Cycle and Refrigerant Cycle" in International journal of Scientific Research (2018)
[10] Ravi Gugulothu, Kishan Banothu, Naga Sarada Somanchi, Hima Bindu Banoth "A Review on Solar Powered Air Conditioning" at 2015 in Science Direct
[11] Ravi Gugulothu, Yaohua Zhao, Wei Xu, Xinyu "Renewable Energy Technologies and Systems" in International Journal of Solar Air Conditioner in 2004
[12] Reinhard Radermacher, Yunho Hwang , "A Hybrid Solar Air Conditioner" in International Journal of Refrigeration (2014)
[13] Zhifeng Sun, Yaohua Zhao, Wei Xu, Xinyu Zhang, Huai Li. "A Solar Heating and Cooling System in a Nearly Zero-Energy, Building" at 2017 in International Journal of Photoenergy

