

FEASIBILITY STUDY OF SOLAR POWERED AIR CONDITIONER WITH DC COMPRESSOR

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ABSTRACT

There is a need of focusing on to the growing demand of energy, and to develop alternatives to the conventional and non renewable resources which would be vanished completely soon. Soon the world is going to rely on the alternate sources like solar energy, wind energy, tidal energy, geothermal energy and other non-conventional sources which are renewable and environmental friendly.

Many of the companies are working on the equipments which could use the non-conventional energy for the purpose. Air conditioning system is the system which requires a great amount of energy, and so many companies are trying to work on the Solar Air Conditioner. As air conditioning is required for the cooling and comfort in the summers.

Our paper focuses on to make an Air Conditioning System which would be operated solely on Solar Energy. For that we are using a DC Compressor in place of an AC one. Because DC Compressor is self starting and do not require high starting power. Our proposed Air Conditioner would be a one Time Investment Air Conditioning System. As the running cost of our AC would be zero, but only maintenance required. And it might be a blessing for the areas where there is no reach of electricity, but Air conditioning is required.

1. INTRODUCTION

We all love the chilled fresh air to work in a hot day. Not only comfort, we require air conditioning to increase our productivity at work. But it is also true that every comfort owing thing has a price. And in the case of Air conditioning we are using energy which is obviously not free and has a great price. Now the thing matters more is the source of extraction of energy. Currently we are relying more on conventional sources of energy which are non-renewable in nature and also causing environmental problems. The speed at which we are using these resources, it is obvious that one day or the other we are going to finish them up. And so there is a need of developing the alternative non-conventional sources which can replace them. Solar energy is one of the sources which soon will take up this responsibility. It is just that we are required to adjust ourselves such that we can move on to these alternatives.

What we are working upon is a Solar Powered Air Conditioner which solely works on solar energy for its operation. The motivation behind this project is to find the best alternative to conventional sources of energy to drive the compressor of the Air Conditioner, and for that we chose the Solar Energy. Because somewhere in rural areas there is no reach of electricity, our product would be beneficial for different cooling purposes over there. We are spending blasts on Air conditioning purpose across the world but using our Air conditioner we can save it all. And also, using of non-conventional energy resources to derive the Air conditioner will surely help us controlling the global warming to great extent.

Our objective is to make an Air conditioner which can operate on Direct Current. This direct current would be derived from solar panels. And we will use a DC compressor in place of alternating current compressors. DC compressors are self starting and do not require very high starting power as required by the alternating current compressors. Also solar powered AC does not require working on full load capacity all the time hence consuming comparatively less power.

2. METHODOLOGY

The approaches used in this project are as follows:

- Collection of required data: Various type of data required to work upon our Air Conditioner is collected from various books and internet.

- Determining the components to be used to make the proposed Air Conditioner.
- Estimation of the intensity of solar radiation and load calculation for the purpose to run our Solar Air Conditioner.
- Market Research is being done by every individual of our team to find different equipments and parts to be needed to make the Air conditioner: Danfoss is the only company situated in Nordborg, Denmark which was able to supply us the DC compressor of about 1tonn but in 4-5 months which was again too long to work on the project.
- Collection of analytical data: Some companies like Exalta are working on Solar Air Conditioner using DC compressors. We collected the possible information and data from over there.
- Result Analysis: The result of overall effectiveness and efficiency are analysed by our team. Also we estimated the economical and social benefit of our proposed project towards the society. Any recommendations or suggestions are welcomed. And we would love to carry our research so forth.

2.1 SYSTEM DESCRIPTION

The proposed system has the following components:

1. DC compressor
2. Expansion Device
3. Evaporator Coil
4. Condenser Coil
5. Fan
6. Photo Voltaic System
7. Battery Unit

Each Component must be taken as a single unit for the determination of characteristics and properties of all the above components. The system must be able to work in proper way so as to achieve the goal of cooling and dehumidification as a normal Air Conditioner performs.

2.2 DC Compressor

DC compressors are the brushless compressors which are operated on Direct Current extracted from the non-conventional sources of energy. These compressors can be powered by photovoltaic cells due to their low energy consumption. There are some manufacturers which are working on DC compressors. One of them is Danfoss which have a wide range of DC compressors. They have marked them as BD range of Compressors.



Fig. DC Compressor

2.3 Expansion Device

A thermal expansion valve is a component in air conditioning system that controls the amount of cooling into an occupied space by controlling the refrigerant released into the evaporator.



Fig. Thermal Expansion Valve

2.4 Evaporator Coil

An evaporator coil is the part of the air conditioning system where the refrigerant absorbs heat from the inside space where the occupants are residing. And so it is the place from where the cold air comes and though the fan is blown to the space for the comfort of the occupants and for other such purposes. Evaporator coils are made from copper and other such metals which are good conductors of heat.

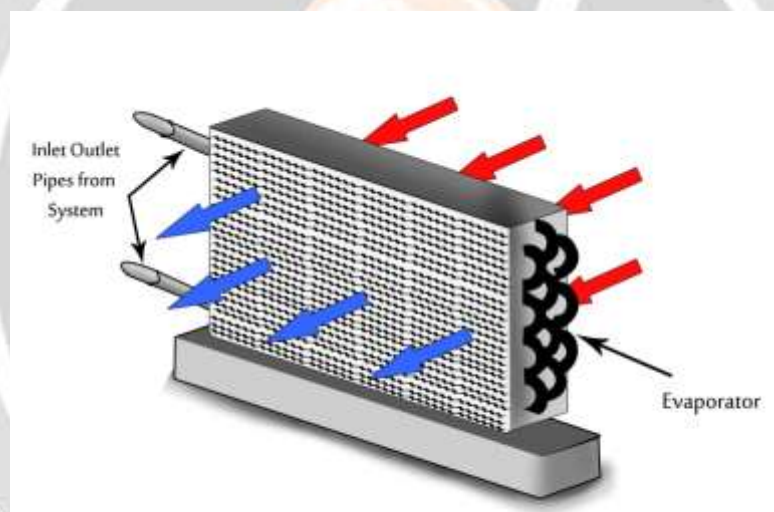


Fig. Evaporator Coil

2.5 Condenser Coil

The condenser coil has similar design to the evaporator coil. However, the difference between evaporator coil and condenser coil of an air conditioner is exactly reversed. The evaporator coil picks up heat from indoor air but the condenser coil releases heat into outdoor atmosphere. The heat load extracted from your home or office is released when refrigerant circulates into the condenser coil. A fan is used to blow out the heat load carried out by the condenser coil.

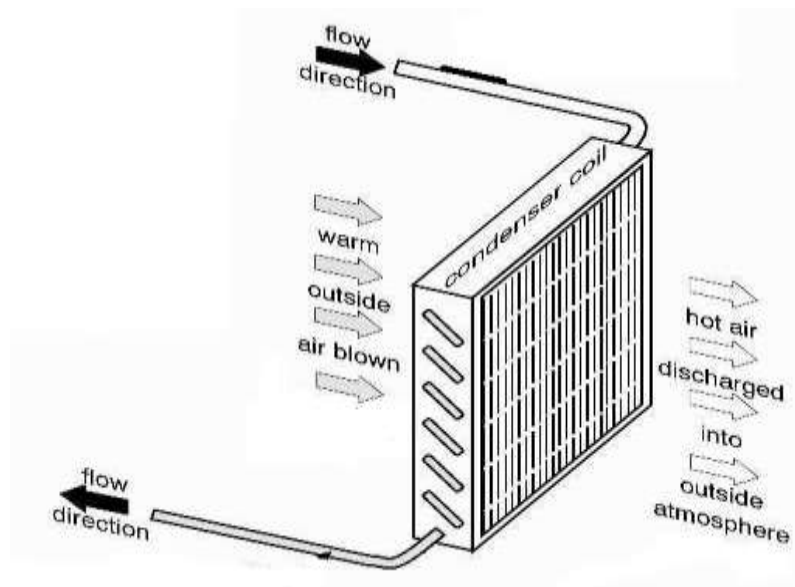


Fig. Condenser coil

2.6 Photovoltaic system

The basic element of a PV System is the photovoltaic cell, called as a Solar Cell. An example of a PV Cell made of Mono-crystalline Silicon. A PV Cell is a semiconductor device that converts solar energy into Direct Current electricity. When light shines on a PV Cell, it can be reflected, absorbed, or passes right through. But only the absorbed light generates electricity.

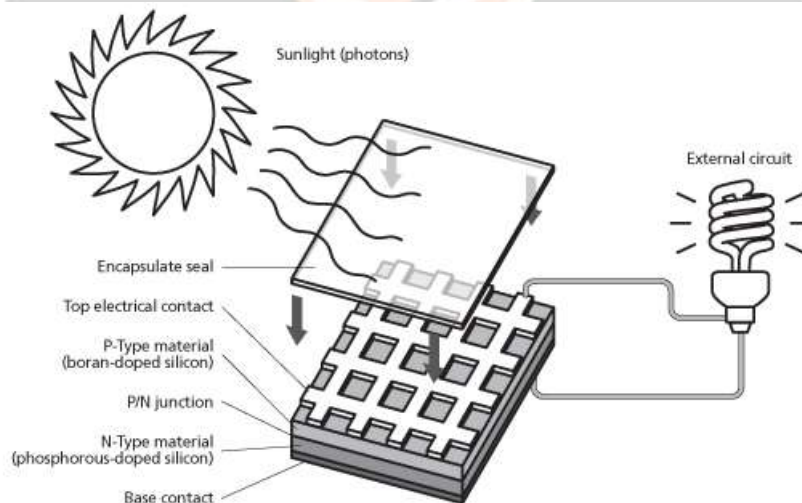


Fig. Photovoltaic System

2.7 Battery unit

A battery unit stores electrical energy in a reversible chemical reaction. The PV source produces the energy, and the battery stores it for times. Also they are specifically designed for deep cycling.



Fig. Battery unit with solar panels

3. ANALYSIS

3.1 Air Conditioning

Air conditioning can be used in domestic and commercial environment to remove the heat and to control the moisture of the interior of an occupied space, improving the comfort of occupants. Not only for the comfort of humans or animals, air conditioning systems has its applications in cooling and dehumidification of computer servers and other heat producing electronic devices.

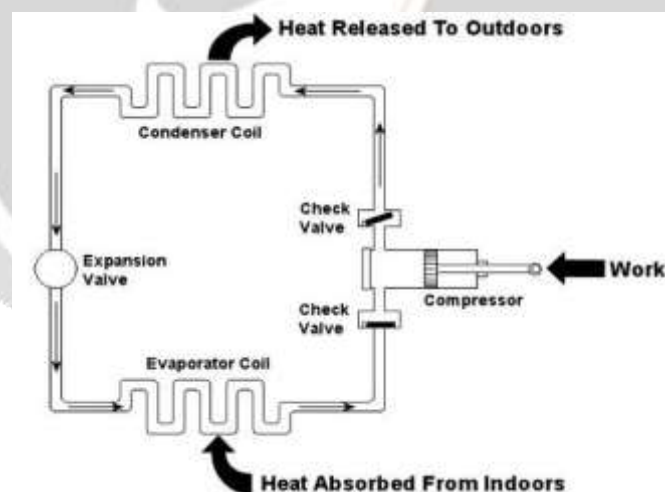


Fig. Air Conditioning System

The power produced by the solar panels is used to charge the battery using a charge controller in between. Battery unit is for the purpose of operating the Air conditioner in unfavourable weather conditions and in nights also when there is no sun to drive the compressor of the air conditioner. Here we are using a Direct current Compressor in place of an alternating current compressor. As a direct current compressor requires very less power for its operation and also they are self starting and do not require very high starting current.

3.2 Performance Analysis

A normal air conditioner of 1tonn capacity requires about 1000 watts of electricity. While starting the compressor it requires more than around thrice the rated energy. So on an average we can say that a normal Air Conditioner requires about 1200 watts of electricity.

While in our Proposed Air Conditioner we are using a DC compressor whose requirement is 250 watts of Direct Current. So we can say that our Air Conditioner can run on 250 watt of Direct current which is derived from solar panels.

3.3 Cost Analysis

For a normal Air Conditioner if we estimate the cost of running it for 6 months, it would be;

If we consider a 1 ton AC operating for 10 hours a Day for 6 months of summers,

1 ton AC typically uses 1,200 watts of electricity.

Operating for 1 hour consuming 1.2kWh means 1.2unit of BOTU in 1 hour.

Now, operating for 10hours a day and for a month number of units spent

$$= 1.2*10*30 = 360\text{units}$$

Cost of 1 unit = 7 Rupees

Cost of 360 units = $360*7 = 2,520/-$ (for a month)

Cost of operating the AC for 6 months = $2,520*6 = 15,120/-$

Our proposed project is one time investment only, so we can assume the running cost of the solar powered air conditioner is zero, but only maintenance charge.

Cost of manufacturing of a prototype of our proposed project would be;

Cost approximation of DC Air conditioner is:

Compressor- **35,000/-**

Other component of an AC like Evaporator, Condenser, Expansion valve, Fan, etc- **15000/-**

Battery- **12,000/-**

Solar panel- **15,000/-**

Charge controller- **1,500/-**

Total = 78,500/-

4. CONCLUSION

Today one of a big problem the human society facing is regarding energy. And by using solar energy we can save our environment from greenhouse gases and keep it clean and green for coming generation. Using of the electrical equipment like air conditioner, fans, air cooler etc, for our comfort consumes fossil fuel like coal, petrol and natural gas which results in carbon emission and release of CO₂ after burning of such fuel. In many places government has also giving good policies for solar energy usage. And we must be aware that the investment cost in the installation of the solar energy extraction system can be surely recovered within a span of 4-5 years. Solar energy technologies are very important for the developing nations to sustain their energy needs. The main motivation for solar air conditioning system is the substitution of energy extraction from non-renewable resources to the renewable one.

This research provides the comprehensive comparison of energy consumption and the cost related to the conventional system of air conditioning to the solar air conditioning system. The main modification needed is the replacement of alternate current compressor to a DC compressor. And the system is able to achieve up to 75% of energy savings.

5. REFERENCES

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