SOLAR POWERED REFRIGERATOR

R.MANOHAR BABU, AsstProfessor, Department of Mechanical Engineering, Narayana Engineering College (Autonomus),Gudur, Andhra Pradesh

[2]A.SURESH BABU, [3]E.GURUDEVA,[4]D.RAJASEKHAR ,[5] CH.SRI HARSHA UG Students Department of Mechanical Engineering, Narayana Engineering College (Autonomus),Gudur, Andhra Pradesh

ABSTRACT : Refrigeration may be defined as the process of reducing and maintaining a temperature of a space or material below that of the surroundings. This is accomplished by removing heat from body being refrigerated and transferred it to another body whose temperature is higher than that of the refrigerated body or space. For doing of this we generally use the machine called Refrigerator. This refrigerators work by the source of electrical energy, in this project we are trying to produce the electrical energy by using of a photovoltaic cell. A photovoltaic cell is a device which converts the solar energy in to the electrical energy. This electrical energy stored in a battery and use to run the refrigerator

Keywords: Condenser, compressor, capillary tube, photovoltaic cell, evaporationchamber.

1. INTRODUCTION

A solar-powered refrigerator is a refrigerator which runs on energy directly provided by sun, and may include photovoltaic or solar thermal energy. Solar-powered refrigerators are able to keep perishable goods such as meat and dairy cool in hot climates, and are used to keep much needed vaccines at their appropriate temperature to avoid spoilage. Generally Solar-powered refrigerators are typically used in off-the-grid locations where utility provided AC power is not available. In this project we are converting dc power of the battery which is charged by the solar energy, intact by using of an extra component called invertors.

About solar energy.

Solar energy is generated by nuclear reactions within the body of the sun. This energy reaches the surface of the earth in the form of electromagnetic radiation. The composition of this radiation as it travels through space towards the earth is around 56% infrared, 36% visible radiation and 7% ultraviolet with the remainder belonging to regions of the electromagnetic spectrum outside the energy ranges covered by these three.

Not all this radiation reaches the surface of the earth. Some is scattered by dust and molecules in the atmosphere. This scattering is a random process, sending the radiation in all directions so that much goes directly back into space. The remainder reaches the surface, but as diffuse, indirect radiation. Clouds act to reflect more Sunlight back into space and they play an important role in regulating the temperature on the surface of the earth. Another part of the radiation is absorbed by molecules such as water, carbon dioxide, ozone and oxygen within the atmosphere. Water and carbon dioxide absorb energy from the infrared region, while oxygen and ozone absorb from the ultraviolet. All these interactions reduce the solar energy flux by around 40% while at the same time changing its composition so that the sunlight which reaches the earth's surface comprises 50% visible radiation and 47% infrared. The energy emitted by the sun is known as solar radiation. The incoming solar radiation to the earth is known as insulation.

Thanks to the modern technology for making the easy way to harness the solar energy. Solar energy systems are often classified into two categories, passive and active. A passive solar system uses the light and heat from the sun directly for heating, cooling and lighting.

II.LITERATURE REVIEW

M.M. Hussain [1]-28-10-2014**,** the simulation of thermal energy storage (TES) system for HVAC system has been dealt within this paper. To store cooling capacity, HVAC system.

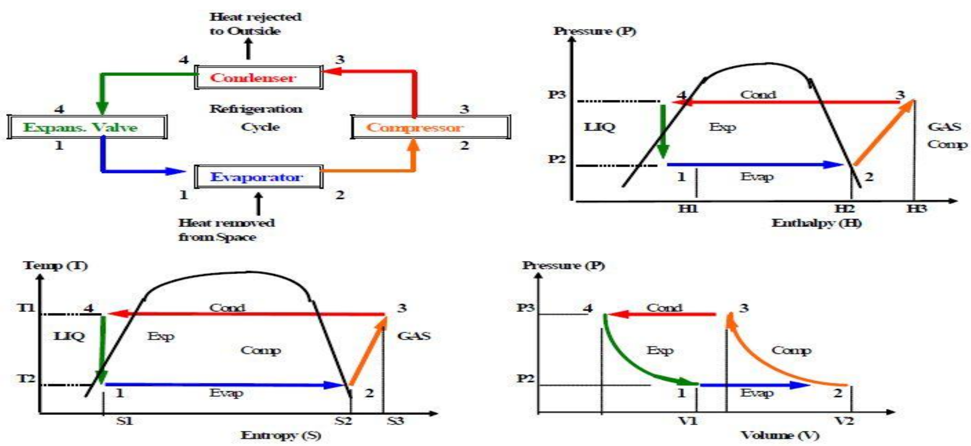
Fakeha Sehar[2]-08-05-2012, Impact of ice storage systems on the chiller energy consumption for large and medium-sized office buildings in diverse climate zones has been investigated.

Mehmet Azmi Aktacir[3]-2011, the highest energy amount produced by PV panels was recorded between 11:00 am and 14:00 pm, amount energy consumed by the refrigerator was determined to be 347.7 Who/day, the amount of energy stored in the battery bank was 78.2 Who/day while the amount of electric energy produced by photovoltaic panel was 425.9 Who/day.

III.METHODOLOGY

Refrigeration is a process in which work is done on a system to move heat from lower temperature to higher temperature to get cooling effect. Refrigeration is done to maintain the temperature of certain space at a temperature lower than the surrounding. The mechanical device extracts heat from the refrigerated space maintained at a lower temperature and rejects it to the surrounding that is at relatively higher temperature to achieve the cooling effect. Refrigeration is used to provide favourable condition for storing of food products and preservation of medicine. It is also used to provide comfort through the process of air conditioning in hot and humid places. Solar refrigeration system is operated using electricity directly produced from solar radiation using photovoltaic cell or using radiant heat from the sun collected by the different types of solar collectors. It is expected that this type of refrigeration system will be used more and more with the decrease of conventional energy sources and the increase of environmental pollution in future. Solar refrigeration can be used in freezers, refrigerators, building air conditioning systems, food preservation, ice-making, cooler etc.

TS, PV AND PH diagram for the Vapour compression refrigeration cycle



IV . EXPERIMENTATION

Experimental Setup

The experimental set-up comprises of two components, a cooling system and a power supply unit. The cooling unit consists of a household cooler used as a container, an AC-operated compressor, an evaporator, a condenser and an expansion valve. The total size of the cooler is 50 litres. The maximum compressor power consumptionis 138W, whereas the ozone-friendly R134a is used as a coolant.

Solar Power Unit :In this photovoltaic powered device, using semiconducting materials, solar radiation is converted directly into direct current electricity [7]. The mechanism that makes it possible to refrigerate is to convert sunlight into DC electrical power, done through the PV board. The unit is fitted with a charge controller and an inverter. A charging controller is used to regulate the amount of electricity stored by the battery so that it is not charged beyond the threshold level, resulting in battery damage.

Therefore, the battery stores DC, which requires an inverter to convert its DC output to AC which can be used by the cooling unit. Under sunny conditions, the cooling unit can be powered directly from the output of the solar cells, and when the intensity of the sun is reduced, the battery will become the cooling unit's main source of power. DC electrical power pushes the compressor through a steam compression cooling loop to circulate refrigerant which removes heat from an isolated enclosure. This enclosure features a thermal reservoir and a phase change component.

The components that make up the solar unit are given below:

Solar panel: Solar cells convert sunlight to DC power, which is stored by a charging regulator in batteries. The amount of energy generated by the solar panel is directly proportionate to the sunlight intensity it receives. Such batteries can be powered directly from DC loads. The cables from the batteries are attached to the inverter to convert the DC produced from the solar system to AC so that the refrigerator can work

SOLAR PANNEL each150 watts
Needed 2 solar panels.
=150*2
=300
Total =300W
Voltage :-12v

Figure 1: Solar Panel

Battery: It is vital for later use in the storage of electrical energy. The size of the battery bank shall be calculated on the basis of the average watt-hour and the required days of storage capacity. The current is transferred to the rechargeable battery from the panel. The battery function stores energy from the solar cell that is subsequently supplied to the load when the solar cells do not have direct power. This project uses a 100AH battery running at 12V DC.

Capacity =200 Ah
voltage:-12v

Figure 2: Battery

Inverter with an inbuilt Charge controller: This project uses an inverter with an integrated charge regulator. A solar inverter is a type of electrical converter which transforms a photovoltaic (PV) solar panel's variable direct current (DC) output into a utilities alternating current (AC) [8].

A charge controller adapts to the amperage of the solar array's incoming power. This avoids overcharging of the battery A system that incorporates a single unit with an inverter and a charge controller.

Figure 3: Inverter and charger.

VAPOUR COMPRESSION REFRIGERATION PROCESS

Given the figure below, the following depicts the processes involved in the vapour compression refrigeration system. Total Load =179 units per year

Per 1 day =0.490 units
=490.41 watts –hr
Considering 8 hr backup in a Day =163.47 Watts

V.RESULTS AND ANALYSIS

5.1. COOLING EFFECT CREATED BY THE REFRIGERANT

Refrigerant 134a is a working fluid in an ideal steam-compression refrigeration process that interacts thermally with a cold region and a warm region .The saturated vapour enters the compressor and the saturated liquid leaves the condenser .

5.2. TOTAL LOAD CALCULATIONS

179 units for year (as per manufacturing).
Power consumed for 1 day is = 179/ 36 = 0.49041 units
We know that 1 unit = 1000 watt-hr
0.49041 units = 490.41 watt-hr
Power consumed for 1 hour is= 490 / 24
=20.43 watts
Consider power produced for 8 hrs
Power consumed for 8 hours is= 20.43 X 8 = 163.47
Total load produced by considering 8 hours of working in a day = **163.47 watts**

5.3. INVERTOR CALCULATIONS

As our load is of 169.47 watts consider higher range inverter for the good efficiency and to improve the battery capacity.
Inverter capacity =200 watts per day
Amount of dc current needed to run the refrigerator.
Power = voltage X current
169.47 = 12 X current (I)
Current (I) = 13.66 amps
We needed 13.66 amps of dc current to run the refrigerator

5.4. Battery calculations

Size of the battery is = Total load X backup time (in hours) / Voltage
= 163.47 X 8 12 /12
= 108.98 AH
Current required to charge the battery = Battery size / 10
= 108.98 / 10
= 10.8 amps

5.5 Solar panel calculations

Total current required = home current + battery charge current
= 13.66 + 10.898
= 24.55 amps
Total power production of the solar panel
Power = voltage * current
= 12 * 24.55
= 294.6 watts per day
Number of solar panels required = Total power required /Power of single panel
No of solar panels required is = 2

5.6 Coefficent of performance

Suction temperature T_1 =2^0c
Discharge temperature T_2=43^0c
Condenser Coil TemperatureT_3=39^0c
Evapourator Coil Temperature T_4=-3.2^0c
From the PH-chart (R-134n)
h_1=384 KJ/Kg ;
h_2=426 ;
h_3=hf_3=279;
h_4=279 Kj/Kg
Coefficent of performance = Refrigerant effect/ Work Done

Refrigerant Effect (R E) = h_1-hf_3 or h_1-h_4
=384-279
=105 kj/Kg

Work Done (W) = h_2-h_1
=426-384
= 42 Kj/kg

Coefficent of performance (COP) = h_1-hf_3/h_2-h_1
=105/42
=2.5

CONCLUSION

➢ Although figuring out how much solar power you need to run your refrigerator is not an easy task, the given analysis and calculations are practical and understandable.

➢ So you can just have a try. Work it out by the given ways and see how much money you will save when using solar power to operate your refrigerators.

➢ Of course, you should pay attention to the electing of all the necessary components, and make precise calculations of their specifications.

➢ Then you can have a satisfying user experience. If you don't want to calculate, buying a solar-powered refrigerator is a good choice.

➢ The cops average was obtained and it was concluded that the overall performance coefficient for the efficiency is 2.5

REFERENCES

1. M. M. Hussain, I. Dincer and S. M. Zubair "A feasibility study of using thermal energy storage in a conventional air-conditioning system" International Journal of Energy Research, Int. J. Energy Res. 2004; 28:955–967 (DOI: 10.1002/er.1006).
2. Fakeha Sehar, Saifur Rahman, Manisa Pipattanasomporn "Impacts of ice storage on electrical energy consumptions in office buildings" Energy and Buildings 51 (2012) 255–262, journal homepage: www.elsevier.com/locate/enbuild , Received 23 October 2011, Accepted 8 May 2012.
3. Mehmet Azmi Aktacir "Experimental study of a multi-purpose PV-refrigerator system" International Journal of Physical Sciences Vol. 6(4), pp. 746-757, 18 February, 2011 , DOI:10.5897/IJPS11.152 , ISSN 1992-1950 ©2011 Academic Journals, Accepted 15 February, 2011.
4. Sanford A. Klein and Douglas T. Reindl "Solar Refrigeration" American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (www.ashrae.org). Reprinted by permission from ASHRAE Journal, (Vol. 47, No. 9, September 2005).
5. S.M. Hasnain, S.H. Alawaji, A.M. Al-Ibrahim, M.S. Smiai "Prospects of cool thermal storage utilization in Saudi Arabia" Pergamon, Energy Conversion & Management 41 (2000) 1829-1839 , www.elsevier.com/locate/enconman , Received 18 August 1999; Accepted 7 February 2000.
6. Todd Otanicar, Robert A. Taylor, Patrick E. Phelan "Prospects for solar cooling – An economic and environmental assessment" Elsevier, Solar Energy 86 (2012) 1287–1299, www.elsevier.com/locate/solener , Received 25 August 2011; received in revised form 16 November 2011; accepted 21 January 2012, Available online 17 February 2012.
7. David MacPhee, Ibrahim Dincer, Asfaw Beyene "Numerical simulation and exergetic performance assessment of charging process in encapsulated ice thermal energy storage system" Elsevier, Energy 41 (2012) 491-498, Received 3 November 2011, Accepted 18 February 2012, Available online 27 March 2012, journal homepage: www.elsevier.com/locate/energy .
8. B. Rismanchia, R. Saidur, H.H. Masjuki, T.M.I. Mahlia "Energetic, economic and environmental benefits of utilizing the ice thermal storage systems for office building applications" Elsevier, Energy and Buildings 50 (2012) 347–354, journal home page: www.elsevier.com/locate/enbuild, Received 29 September 2011, Accepted 2 April 2012.
9. David MacPhee, Ibrahim Dincer "Performance assessment of some ice TES systems" Elsevier, International Journal of Thermal Sciences 48 (2009) 2288–2299, Received 20 September 2008, Accepted 7 March 2009, Available online 3 June 2009, journal homepage: www.elsevier.com/locate/ijts
10. P. Mahendru, S. K. Agrawal and P. Pachorkar, "Steady-State Analysis of Vapour Absorption Refrigeration System using li-br-h2o as a vol. 2, no. 9, pp. 328-332, 2012.

