Hybrid Cooler Works on DC Motor

Pranali Nitnaware
Department Of Mechanical Engineering
VDCET, Mouda
Nagpur, India
08956387359
pranalinit@gmail.com

Ajay Mahawadiwar
Department Of Mechanical Engineering
AGPCE
Nagpur, India
07774046618
hod.mechanical@agpce.com

***Abstract*—**Science is basically "passive" observation of the universe, as it exists to generate knowledge. Engineering is making use of that knowledge to meet human needs by creating machine, systems, process and technologies that have not previously existed. Design and manufacturing are the synthetic part of engineering practice. Manufacturer has received a lot of attention recently for very good economic reasons.

The use of renewable energy resources is increasing rapidly. Following this trend, the implementation of large area solar arrays is to be considered. Due to energy drivers that include uncertainty in oil prices and environmental concerns, effective management of energy system is a priority. Energy policy can focus on three areas to improve energy system like renewable energy supply, efficiency improvement and demand reduction.

The functionality of solar cooler is dissimilar as that of the traditional coolers. The solar energy is harvested and stored in a battery. The battery is in turn connected to the solar cooler for the power sources. This is very innovative mechanical project on solar air cooling. Solar air conditioning has great potential. Sunlight is most plentiful in the summer when cooling loads are highest.

It don't create the overheads of maintenance or purchasing of pump neither it has to be sent for servicing every season. The concept of solar cooler sounds good and economical hence almost every class of our society can bear its expenses.

***Keywords*—** *Renewable Energy, Solar Cooler, Environment, Conditioning, Solar Air .*

*****

I. Introduction

Renewable energy is rapidly gaining importance as an energy resource as fossil fuel prices fluctuate. At the educational level, it is therefore critical for engineering and technology students to have an understanding and appreciation of the technologies associated with renewable energy.

One of the most popular renewable energy sources is solar energy. Many researches were conducted to develop some methods to increase the efficiency of Photo Voltaic systems (solar panels). One such method is to employ a solar panel tracking system.

The functionality of solar cooler is dissimilar as that of the traditional coolers. The solar energy is harvested and stored in a battery. The battery is in turn connected to the solar cooler for the power sources. This is very innovative mechanical project on solar air cooling. Solar air conditioning has great potential. Sunlight is most plentiful in the summer when cooling loads are highest.

It don't create the overheads of maintenance or purchasing of pump neither it has to be sent for servicing every season. The concept of solar cooler sounds good and economical hence almost every class of our society can bear its expenses.

This project is to control the position of a solar panel in accordance with the motion of sun. Brief Methodology: This project is designed with solar panels, LDR, ADC, Microcontroller, Stepper Motor and its driving circuit. In this project two LDRs are fixed on the solar panel at two distinct points.

LDR (Light Dependent Resistor) varies the resistance depending upon the light fall. The varied resistance is converted into an analog voltage signal. The analog voltage signal is then fed to an ADC. ADC is nothing but analog to digital Converter which receives the two LDR voltage signals and converts them to corresponding digital signal. Then the converted digital signal is given as the input of the microcontroller. Microcontroller receives the two digital signals from the ADC and compares them. The LDR signals are not equal except for normal incidence of sunlight. When there is a difference between LDR voltage levels the microcontroller program drives the stepper motor towards normal incidence of sunlight.

A. Base line condition

Renewable energy is rapidly gaining importance as an energy resource as fossil fuel prices fluctuate. At the educational level, it is therefore critical for engineering and technology students to have an understanding and appreciation of the technologies associated with renewable energy.

One of the most popular renewable energy sources is solar energy. Many researches were conducted to develop some methods to increase the efficiency of Photo Voltaic systems (solar panels). One such method is to employ a solar panel tracking system .This project deals with a micro-controller based solar panel tracking system. Solar tracking enables more energy to be generated because the solar panel is

always able to maintain a perpendicular profile to the sun's rays. Development of solar panel tracking systems has been ongoing for several years now. As the sun moves across the sky during the day, it is advantageous to have the solar panels track the location of the sun, such that the panels are always perpendicular to the solar energy radiated by the sun.

This will tend to maximize the amount of power absorbed by PV systems. It has been estimated that the use of a tracking system, over a fixed system, can increase the power output by 30% - 60%. The increase is significant enough to make tracking a viable preposition despite of the enhancement in system cost. It is possible to align the tracking heliostat normal to sun using electronic control by a microcontroller.

- The human body can be considered as thermal machine with 20% thermal efficiency. The remaining 80% heat must be disposed of from the body to the surroundings otherwise accumulation of heat results and causes discomfort.
- The human body works best at a particular body temperature like any other machine but cannot tolerate wide range of variation in environmental temperature like thermodynamic machines.

B. Direct Method Of Utilization Of Solarenergy

- The solar energy harnessing can be done by directly converting it into electricity with the help of photovoltaic cells.
- Sunrays are incident on Solar cells, in this system of energy Conversion that is direct conversion of solar radiation into electricity.
- In the stage of conversion into thermodynamic from is absent. The photo-voltaic effect is defined as the generation of an electromotive force as a result of the absorption of ionizing radiation.
- Energy conversion devices, which are used to convert sunlight to electricity by use of the photo-voltaic effect, are called solar cells.

C. Photovoltaic\Principles For Solar Energy

The photo-voltaic effect can be seen in nature in a variety of materials that have shown that the best performance in sunlight is the semiconductors.

When semiconductor absorbed photons from the sun which create free electrons with higher energies than the created. There must be an electric field to induce these higher energy electrons to flow out of the semi-conductor to do useful work.

In most solar cells a junction of materials, which have different electrical properties, provides the electric field.

D. Need For Solar Cooler

As Human beings give off heat, from the body at around an average of 100 kcal per hour per person, due to the process known as 'metabolism'.

The temperature mechanism within the body maintains a body temperature of around 36.9 degree C (98.4degree F). But the skin temperature varies according to the surrounding temperature and relative humidity.

E. Aims and Objectives

The solar panel will give the output to the battery but sometimes there might be chances of an increase in the intensity of the sunlight so it may cause a possibility of having damage to the battery.

- So here a controller circuit will be used to provide constant voltage to the battery even when the intensity of the sunlight is high because when the intensity is high the solar panel will give double the voltage than it is required by the battery.
- This circuit will run pump and filters will be attached to the pump.A charge controller, charge regulator or battery regulator control the rate at which currents added to or drawn from electric batteries. It prevents overcharging and may prevent against overvoltage, which can reduce battery performance or lifespan, and may pose a safety risk.
- It can also prevent completely discharging ("deep discharging") a battery, or controlling discharges, depending on the battery technology, to protect battery life.
- The terms "charge controller" or "charge regulator" may refer to either a stand-alone device, or to control circuitry integrated within a battery pack, battery-powered device, or battery recharger.
- The dc gear based mechanism will be used for moving the solar panel.

II. Literature REVIEW

There are only a few publications on the applications of RFID in academic journals. The following presents a brief review of the few studies that we have found in the research literature.

Laboratory evaporation studies were conducted to assess the role of the various stages of evaporation on heat reduction from wet soil surface. Undisturbed soil columns from three different field viz.,cocoa, oil palm and arable were collected from the 0-10cm depth at the plantations section of the department of crop and soil sciences, KNUST, Kumasi. The samples were initially saturated with water at an initial temperature of 65^{O}c. The soil columns were subjected to surface to surface evaporation by placing them under a Sanyo (40 cm) dynamics wide desk oscillating fan.[1]

Evaporation and temperature readings were taken at 5 minutes interval for 1 hour. Two homogeneous soil columns

were used as for reference tests (control). Evaporation analysis showed 1st and 2nd stages of evaporation with cumulative evaporation being proportional to the square root of time at the 2nd stage. Temperature decreased rapidly with increasing evaporation during the 1st stage of evaporation till the falling and slow rate stages, during which change in temperature was minimal and almost constant. A 1 mm increase in evaporation showed a decrease in mean temperature by 7.53oC, 7.35oC and 7.10oC from cocoa, oil palm and arable fields, respectively at 1% significant level. The results of this study indicated that under a constant atmospheric evaporativity, 1 mm increase in evaporation would cause a significant decrease in soil temperature.[1]

Wet water cooling towers in high energy physics facilities are state of the art. The advantages are robustness, effectiveness and cost effectiveness. The return water temperature is lower than the air temperature due to cooling via evaporation. The disadvantages are the high water consumption, which become more costly in the future and the soiling of the heat exchangers. If the water source is taken from wells the drawdown of the ground water level has to be taken into account. [2]

The present air cooling methods are evaporative coolers, air conditioning, fans and dehumidifiers. But running these products need a source called electricity. The producing of electricity is ultimately responsible for hot and humid conditions i.e. global warming. In hot and humid conditions the need to feel relaxed and comfortable has become one of few needs and for this purpose utilization of systems like air-conditioning and refrigeration has increased rapidly. These systems are most of the time not suitable for villages due to longer power cut durations and high cost of products. Solar power systems being considered as one of the path towards more sustainable energy systems, considering solar-cooling systems in villages 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. Despite increasing performance and mandatory energy efficiency requirements, peak electricity demand is growing and there is currently no prevalent solar air cooling technology suited to residential application especially for villages, schools and offices. This project reviews solar powered air cooler for residential and industrial applications.[3]

Comparing the cost of this product with the existing products in the market is solar product appeals better and affordable by common people. This solar product perfectly suits for villages, schools and offices and thus an alternate to the power cut problems. It comprises of many attractive features such as usage of solar energy, cooler and cooling cabin at lower cost. It is eco-friendly and natural, electricity savers. Durability of the product is more thus minimizing the cost. No electricity is used so this product saves the energy and saves environment from getting polluted.[3]

Energy has become the utmost necessity of our life. It is required from dawn to dusk to fuel the world. Energy is scattered everywhere around the Earth. Man has always desired to capture it and use it for mankind. One of the most important sources of energy is solar energy. Several methods of capturing solar energy and its usage are practised. The intensity of solar rays is immense and ways are still being discovered to harness the full potential of the rays. Focussing the rays to a point will cause generation of heat. Transferring the energy towards cooking is one such method. Usually a solar cooker is a device that is placed in the open ground under direct sunlight. This causes inconvenience to the users. Recent developments are in progress to make it possible to cook under shelter harnessing energy from the solar rays. [4]

There is extensive potential in the solar rays yet to be harnessed. The existing methods, apart from being inefficient in transferring energy, it fails to store the heat effectively. Introduction of Phase Change Materials (PCM) has done the trick of harnessing sun's energy to cook. By doing so the heat energy storing efficiency is increased and thereby effectively increases the process of cooking. With prices of LPG elevating, using this method proves to be cost effective and energy conserving. Unlike induction stoves, the residential solar cooker uses energy from the solar rays and is cost effective. In the absence of sunlight, the PCM setup still increases the efficiency of heating the utensils. By implementing this system, it eradicate for cooking in night time. the overall system will work only during the daytime then it will not be compact and there will be cooker in each and every house will replace LPG and electric stove. Installation of this system in India reduces more than millions of temperature can be greatly reduced in the future.to this hectic world. The effects of thermo physical properties of PCM, installation methodology, location of pcm are scope of future work.[4]

A new hybrid system design for cold storage has been proposed. This paper describes the working principle of new hybrid solar refrigeration cycle with its different components of the machine and the test procedure. This paper is going to provide researchers a fundamental knowledge on integration of solar and conventional refrigeration systems. Furthermore, selective information of the past efforts in the field of solar hybrid refrigeration techniques has also been described. This knowledge will help them to start the parametric study in order to investigate the influence of key parameters on the overall system performance. The aim of the work described below is to combine the solar panel powered and refrigeration machine, to meet different requirement of household in different season, and to improve the efficiency of utilization of solar energy.[5]

Thus the design of hybrid systems for cold storage becomes more important due to limitations of fossil fuels and the environmental impact during their use. Hybrid system is complex as they involve in economic, technical and environmental factors. It shows that solar hybrid refrigeration technologies are attractive alternatives that not only can serve the needs for air-conditioning and refrigeration, and ice making purposes, but also can meet demand for energy conservation and environment protection. However, a lot of research work still needs to be done for large-scale applications in industry and for the replacement of conventional refrigeration machines. [6]

In hot and humid conditions the need to feel relaxed and comfortable has become one of few needs and for this purpose utilization of systems like air-conditioning and refrigeration has increased rapidly. These systems are most of the time not suitable for villages due to longer power cut durations and high cost of products. Solar power systems being considered as one of the path towards more sustainable energy systems, considering solar-cooling systems in villages 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. Despite increasing performance and mandatory energy efficiency requirements, peak electricity demand is growing and there is currently no prevalent solar air cooling technology suited to residential application especially for villages, schools and offices.[7]

This project reviews solar powered air cooler with cooing cabin for household food items hence their viability for residential application. So as comparing the cost of this product with the existing products in the market is, solar product appeals better and affordable by common people. This solar product perfectly suits for villages, schools and offices and thus prevention from the power cut problems. It comprises of many attractive features such as usage of solar energy, cooler and cooling cabin at lower cost. The above method is eco-friendly and natural, electricity savers. Durability of our product is more thus minimizing the cost. No electricity is spent so this product saves the energy and saves environment from getting polluted.[7]

III. CONSTRUCTION & WORKING

A. Component Used

Bars size 1.5 feet aluminum material
Coupling round 6mm width.
Motor 1800rpm without gear box
With gear box 24 rpm
Input voltage 14 volt.
Power 60 watt.

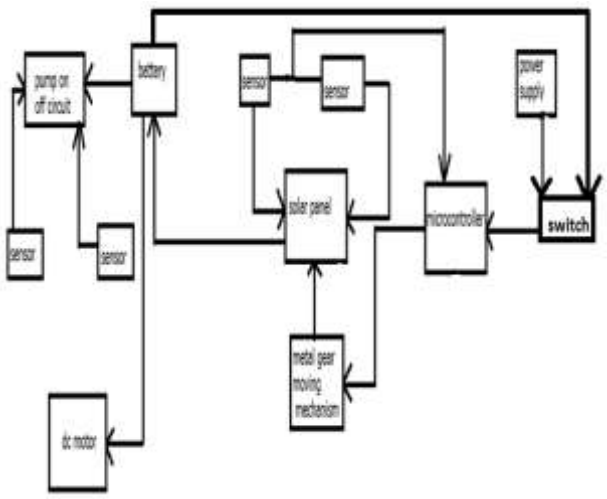

Figure No.1.proposed layout of hybrid cooler

B. Construction

First of all the wooden plates will take and the two bars of equal size will be fitted on the board. After that the L type design clamps will be fitted to the bars and the bars will be placed vertically. Then the solar panel will be taken and the holes will be designed in to the solar panel. Then the coupling of 6mm width will be placed onto the solar panel. The coupling will be made up of steel material.

Then the motor will be placed to the bars using the Type design clamps and the clamps will hold the motor. Here the low rpm and high torque concept will be used.

Then the motor will be placed into the coupling attached to the solar panels. Here solar will be used the electricity will be converted from solar energy. The solar energy will be stored in the battery. The sunlight intensity changes anytime so this process will lead to battery damage. Saving the battery from damage the controller circuit is required. The brushless dc fan of high rpm will be used.

The fan will run on battery and after that the pump section will run on the battery for saving the water. There will be sensor wires attached on the bottom of the cooler water tank and another sensor will be attached at the upper portion of the net of the cooler. The upper sensor will detect that the net of the cooler is dry then the pump will automatically on and it will be in the same position till the net is filled with water or wet and it will soon switch off the pump.

C. Working

- Microcontroller circuit will work on power supply as well on battery
- Microcontroller circuit will move the solar panel through the gear based moving mechanism.
- The sensor that will be installed on the solar panel will detect the sun movement and accordingly give the signal to the microcontroller about the movement and the microcontroller will drive the motor the solar panel will move towards the sun direction.
- Through the solar panel battery will be charged.
- The pump controller circuit will run on battery and the sensors attached will sense the level of water in the tank and the motor pump will be on as the level of water goes down and the pump will be off when the tank level is full.
- The dc fan will continuously run on battery.
- The sensors attached on the solar panel that is ldr will give changes in the resistance as received due to changes in the sun light will send the data to the microcontroller attached to the circuit.
- The regulator ic of 12vdc will give supply to the microcontroller.
- The capacitor will do the charging and discharging work band his value is 1000mfd 16 volts.

The DC motor works over a fair range of voltage. The higher the input voltage more is the RPM (rotations per minute) of the motor. For example, if the motor works in the range of 6-14V, it will have the least RPM at 6V and maximum at 14 V.

In terms of voltage, we can put the equation as:

RPM= K1 * V, where,

K1= induced voltage constant

V=voltage applied

IV. Equations And Design Calculation

A. *Solar Collector*

A solar collector consists of the following components.

- Glazing, this may be one or more sheet of glass or some other diathermanous material.
- Tubes, fines, passages or channels are integral with the collector absorber plates or connected to it, which carry the water air or other fluid.
- The absorber plate, normally metallic or with a black surface, although a wide variety of the material.
- Insulation, which should be provided at the back and sides to minimize the heat losses. Standard insulating material such as fiber glass or styro-foam.
- The casing or containers which enclose the other components and protect them from weather.

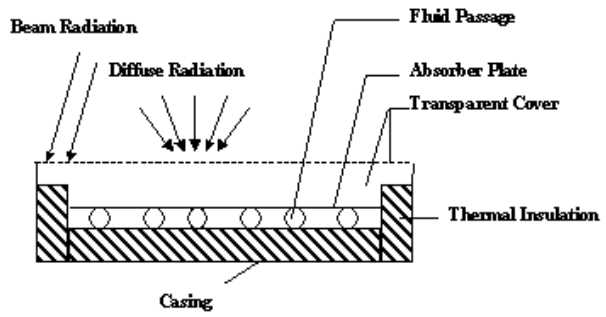

Fig. 2: cross section view of solar collector

B. *Gear Design and Calculations*

Module: Ratio of diameter to number of teeth. m= d/n

Face width: Width along the contact surface between the gears.

Tooth thickness: Thickness of the tooth along the pitch circle.

Addendum: Radial distance between the pitch circle and the top land of the gear.

Dedendum: Radial distance between the pitch circle and the bottomland of the gear.
Pressure angle: Angle between the line joining the centers of the two gears and the common tangent to the base circles.

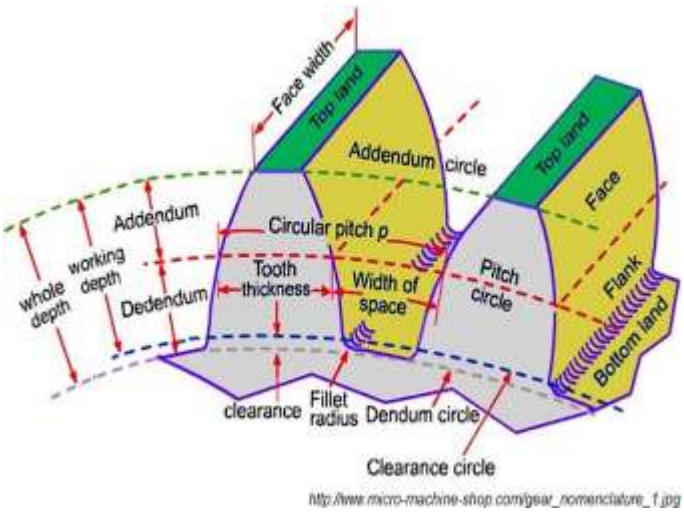

Fig. 3: gear nomenclature

Input data: Horse power, Speed of the driver, speed ratio, Working Life, Working conditions.

1. *Select suitable materials for pinion and wheel*

From the design data book first we will select the type of material for pinion and wheel based on the input parameters.

$[\sigma_b]$ of wheel and pinion for minimum module and $[\sigma_c]$. Surface hardness (We will check the difference between the surface hardness values of pinion and wheel, and it should be $\geq$ 30 HB, if both pinion and wheel surface hardness values is< 350 HB. Pinion must be harder than wheel)

2. *Assume the pressure angle, if not given*

There are three pressure angle values for spur gear $14\,^1/_2{}^\circ$, 20° and 25°. Usually it is 20° values considered.

3. *Find the design torque transmitted by pinion*

Then we will calculate the design torque based on the equation, $P = \frac{2\pi n M_t}{60}$, where P is given power in *kW*, n is the speed of pinion in rpm and M_t is the torque. Then we will assume the value of k_dk from the design data book and finally design torque will be calculated by the equation shown in (c)

a. Calculate M_t. Use the eqn. $M_t = 97420\,\frac{kw}{n}$

b. Initially assume k_dk value

c. Calculate the design torque $[M_t] = M_t\, k_dk$

4. *Determination of minimum Centre Distance (C.D)*

After calculation of design torque we will calculate the centre distance between the wheel and pinion by the eq. represented in step (c). But before that E_{eq} which is equivalent young's Modulus for wheel and pinion will be calculated which appears in centre distance eq. We will also assume the value of ψ=b/a, where 'b' is face width of the gear and 'a' is centre distance.

a. Determine $E_{eq} = \frac{2E_1E_2}{E_1+E_2}$, based on the selected materials.
b. Selectψ.
c. Calculate the minimum centre distance 'a'. Use $[\sigma_c]$ of weaker material.

$$a \geq (i+1)\sqrt[3]{\left(\frac{0.74}{\sigma_c}\right)^2 \frac{E_{eq}[M_t]}{i\psi}}$$

5. *Determination of minimum module*

After calculation of centre distance we will calculate the minimum module based on the bending strength $[\sigma_b]$ by the eq. shown in step (e). For this we will assume the minimum number of teeth for pinion then we will assume the value of ψ_m=b/m, where 'b' is width of the gear and 'a' is module of the gear. We will calculate the values of from factor from design data book based on the number of teeth on the pinion. We will calculate the value of module and will round it to the standard value from design data book.

a. Assume Z_1. number of teeth on pinion (minimum 18)
b. Select ψ_m
c. Select form factor Y corresponding to Z_1
d. Calculate minimum module. Use $[\sigma_b]$ of weaker material
e. Round off to standard value.

$$m \geq 1.26\sqrt[3]{\frac{[M_t]}{Y[\sigma_b]\psi_m Z_1}}$$

6. *Determination of centre distance, pitch circle diameter and width of the gears*

After calculation of the updated module the necessary terms will be calculated like gear ration, updated centre distance, pitch circle diameter of the wheel and pinion, face width of the gear 'b' based on both the modules calculated ψ and ψ_m and will choose the higher value.

a. Determine Z_2 so that $i = \frac{Z_2}{Z_1}$
b. Determine the Centre Distance a'
c. If a' >a (minimum C.D. already calculated), take a' as the final centre distance (Don't change to Standard value)
   If a'<a, increase Z_1& Z_2 (or) module and again calculate a' so that a'>a.
d. Calculate d_1& d_2, the pitch diameters of pinion and wheel respectively
e. Calculate b (width of the gear wheel) using the values of ψ and ψ_m and take the bigger value.

Gear input parameters

1. Power to be transmitted = 60 W
2. Speed of pinion in rpm = 1800 rpm
3. Speed of gear in rpm = 24 rpm
4. Pressure angle =20°
5. Number of teeth in pinion =25
6. Life of gear

C. Coupling

A coupling is defined as mechanical device that permanently joins two rotating shafts to each other's. The shafts that are connected by the coupling can be disengaged only after dismantling the coupling

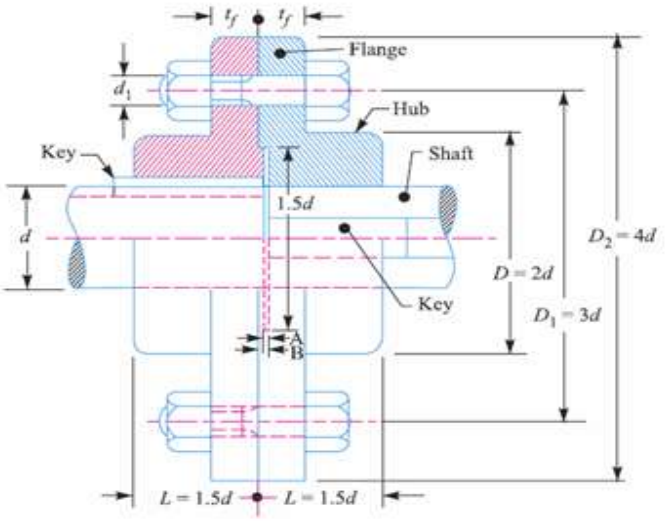

Fig. 4: flange coupling

Notations

d= Diameter of shaft

D= Diameter Of hub

D1= P.C.Diameter of Bolt circle

D2= Outer diameter Of Flange

L= Length of flange

tf=Thickness of flange

tp=Thickness of protected portion.

dc=Core diameter of bolt

do= Outer diameter of bolt.

n=no of bolts

t= thickness of key

w=width of key

l= length of key

Dimension of flange:

d1 = 2d

d2 = 3d

t = 0.5 d

d3 = d2+2db+10

Dimension of bolts:

n = (d / 50) +3 db = (0.5 d) / √n

Design of key:

l = L/2

b = d/4,

h = d/6

Conclusion

All these mechanism will give effective MMPT that is maximum power point tracking and most probably with the help of gear section that will rotate the solar panel simultaneously and effectively according to the sun's rays and the battery will be charged properly and the other loads can be easily run on this system.

References

[1] Henry Oppong Tuffour, Mensah Bonsu,Williams Kwame Atakora, Awudu Abubakari,"Evaporative Cooling Of wet Soil Surface Under Different Agricultural Land Use Systems", International Journals of Scientific Research in Sciences (IJSRPUB-14), Ghana

[2] J-P. Jensen, B. Conrad, U Schuetz, F-R Ullrich, A. Wanning, DESY, Hamburg, "Hybrid cooler in Cooling Systems Of High Energy Physics Accelerators", Proceedings Of EPAC 2004, Lucerne, Switzerland

[3] Vijaykumar Kalwa, R. Prakash, "Design and Development of Solar Powered Air Cooler", International Journal of Science and Research (IJSR), ISSN (Online): 2319-7064 (2012)

[4] Srinivasan.S, Tinnokesh, Siddharth , "Residential Solar Cooker with Enhanced Heat Supply", International Journal of Scientific and Research Publications, Volume 3, Issue 10, October 2013 1 ISSN 2250-3153

[5] Dr. R.S. Bharj, Surender Kumar, Rajinder Kumar, "Study on Solar Hybrid System for Cold Storage", International Journal of Research in Management, Science & Technology, E-ISSN: 2321-3264, Vol. 3, No. 2, April 2015

[6] Zhaohui, Q., (2005), "Study on hybrid system of solar powered water heater and adsorption ice maker", *International Journal on Architectural Science*, Vol. 6, No. 4, pp.168-172

[7] Vijaykumar Kalwa And R Prakash, "Modelling And Fabrication Of Solar Powered Air Cooler With Cooling Cabin For Household Food Items", International Journal Of Mechanical Engineering And Robotics Research, *Issn 2278 – 0149 Vol. 3, No. 3, July 2014*