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PERFORMANCE IMPROVEMENT OF SOLAR PANEL BY DESIGN AND ANALYSIS OF TILT ANGLE

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Abstract - In today's era, it can be assumed that nation utilizing more energy is more developed. The diminishing fossil fuel resources has made compulsory to use renewable energy resources. Present study aims to enhance the energy absorption of sun light by modified solar panel to attain maximum efficiency. An experimental setup is fabricated to conducted test on solar panels towards achieving maximum power output. The power output of solar panel has been examined with different tilt angles (0°, 20°, 35°, 50°, 90°) of the solar panel. The solar panel showed maximum power output at a tilt angle of 35°. The power output of PV solar panels decreases when the tilt angle increased from 35° to 90° or when the tilt angle is decreased from 35° to 0°. It may be concluded that PV solar panels must be installed at 35° tilt angle to south direction to get maximum power output. Which means that at an approximately 35°, throughout the entire day, the solar ray's impact perpendicularly on the solar panel. So, it is required to modify the whole solar panel in such a way that it always receives the solar radiation normally throughout the day time that is from morning to evening.

Keywords: Modified solar panel, tilt angle, intensity of sun light, solar radiation

I. Introduction

A significant amount of the energy available from commercial energy sources is used for the production of electricity. Data on the installed capacity and the electricity produced in the world from these sources is represented. It shows that the electricity produced has increased more or less linearly from 6117 TWh in 1973 to 17450 TWh in 2004, the average annual increase being about 365 TWh every year.

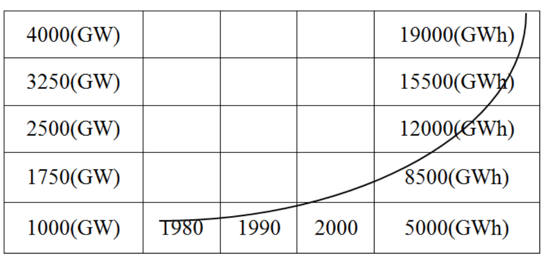

Fig. Worldwide electricity production GW/yr

In 1973, the other major contribution was from water power (21%). In 2004, this declined a little to 16.1% . On the other hand, the contribution from nuclear power increased significantly from 3.3 to 15.7 per cent. Also the contribution from miscellaneous sources (essentially wind power) has increased slightly from being less than 1 per cent to a little over 2 per cent.

About solar option, solar energy is a very, inexhaustible source of energy. The power from the sun intercepted by the earth is approximately $1.8*10^{11}$ MW which is many thousands of times larger than the present consumption rate on the earth of all commercial energy sources. Thus, in principle, solar energy could supply all the present and future energy needs of the world on a continuing basis. This makes it one of the most promising of the unconventional energy sources. In addition to its size, solar energy has two other factors in its favour. First unlike fossil fuels and nuclear power, it is an environmentally clean source of energy. Second it is free and available in adequate quantities in almost all parts of the world where people live

However, there are many problems associated with its use. The main problem is that it is a dilute source of energy. Even in the hottest regions on the earth , the solar radiation flux available rarely exceeds 1.4 KW/m^2 and the total radiation over a day is at best about 7 KW/m^2. A second problem associated with the use of solar energy is that its availability varies with time widely. The variation in availability occurs daily because of the day-night cycle and also seasonally because of the earth's orbit around the sun.

The real challenge in utilizing solar energy as energy alternatives is of an economic nature. One has to strive for the development of cheaper methods of collection and storage so that the large initial investments required at present in most applications are reduced.

II. Solar Energy

The sun is source of all energy.The sun provides us heat and light energy free of cost.The nuclear-fusion reaction taking places inside the sun keep the liberating enormous amounts of heat and light energy. This heat and light energy is radiated by sun is all directions in space in form of solar-energy. The energy coming from the sun contains heat-rays (called infrared rays), which light, ultra-violet rays and some Y-rays (electromagnetic rays).

A little less than half (about 47%) of solar energy which falls on the periphery of atmosphere actually reaches the surface of earth (rest of solar –energy isReflected back into space by the atmosphere).The atmosphere also absorbs a

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lot of solar energy as it comes down through it towards the surface of earth .so, the solar-energy which reaches us on theearth's surface is mostly in the form of heat –rays (infra-red rays) and visible light (and very little ultra-violet rays).

Solar –energy which reaches the earth is absorbed by land of and water-bodies (Like rivers, lakes and oceans), and plants. The solar trapped by land and water-Bodies cause many phenomena in nature like winds, storms, rain, and shortfall, and sea –waves, etc. And plants solar energy to prepare food by process of photosynthesis.The energy near earth space receives from sun is about 1.4 kj/sec/m2, and this quantity is called solar-constant.Basically, solar-constant tells us the amount of energy which falls in 1-second on a 1-square meter area of the near earth space at an average distance between the sun and earth.

Solar constant=1.4 KJ/sec/m^2

Solarconstant =1.4KJ/sec m^2=1.4KW/m^2

III. Solar Radiation

Every The sun is the source of most energy on the earth and is a primary factor in determining the thermal environment of a locality. It is the important for engineers to have a working knowledge of the earth relationship to the sun. they should be able to make estimates of solar radiation intensity and know how to make simple solar radiation measurements. They should also understand the thermal effecs of solar radiation and know how to control and utilise them.

The earth is nearly spherical with the diameter of about 7,900 miles(12.7*10^3km). it makes one rotation about its axis every 24 hours and completes a revolution about the sun in a period of approximately 365 days. The earth revolve around the sun in a nearly circular path, with the sun located slightly of center of the circle. The earth's mean distance to the sun is about 9.3*10^7miles. Around January 1, the earth is closest to the sun while on around july 1 it is most remote ,about 3.3 % farther away.since the intensity of solar radiation incident upon the top of the atmosphere varies inversely with the square of the earth-sun distance, the earth receives about 7% more radiation in January than in july. The earth axis of rotation is tilted 23.5 degrees with respect to its orbit about the sun. the earth tilted position is of profound significance. Together with the earth daily rotation and yearly revolution ,itacconuts for the distribution of thesolar radiation over the earth surface, the changing length of hours of day light and darkness, and the changing of the season.

From figure, the effect of the earth tilted axis at various time of the year. Figure 2 shows the positin of the earth relative to the sun's rays at the time of winter solstice. At the winter solstice(around the December 22), the north pole is inclined23.5 degrees away from the sun. all points on the earth's surface north of 66.5 degrees north latitude are in total darkness while all regions with in 23.5 degrees of the south pole receive continuous sunlight. At the time of the summer solistice (around june 22), the situation is reversed. At the times of the two equinoxes(around march 22 and September 22), both poles are equidistant from the sun and all points from the earth's surface have 12 hours of daylight and 12 hours of dark light.

IV. Solar Radiation Data

Most radiation data is measured for horizontal surfaces. A typical daily record of the global and diffuse radiation flux measured on a clear day is shown in Fig. It is seen that a fairy, smooth variation with tha maximum occurring around noon is obtained on a clear day. In contrast ,an irregular variation with many peaks and valleys may be obtained on a cloudy day. We will use the symbols I_g and I_d to represent the instantaneous values of the global and diffuse flux plotted in Fig. and express these quantities in w/m^2. Since, solar radiation fluxes do not normally change rapidly with time,wewill use the same symbols I_g and I_d to represent hourly values also. These quantities will be expressed in KWh/m^2 or KJ/m^2-h. The shaded areas below the graphs represent the global and diffuse flux incident over a whole day.

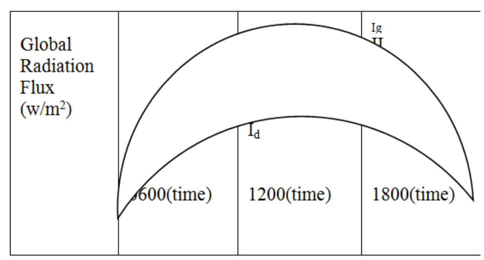


Fig. Record of global and diffuse radiation flux measured on a clear day.

Solar radiation flux is sometimes reported in Langleys per hour or per day (1 Langleys = 1 1.163*10^{-2} KWh/m^2). The unit 'Langleys' has been adopted in honour of Samuel Langley who made the first measurements of the spectral distribution of the sun. A solar designer is primarily interested in average values fot allocation. The averaging is usually done over all days of a month and indicated by a bar over the symbol. Tabulations showing the hourly variation of global and diffuse radiation($I_g$and I_d), the amount received per day and the sunshine hours per day.

From several experiment, it is seen that the annual average daily global radiations received over the whole country is around 450 langleys per day. Peak values are generally measured in April or May, with parts of Rajasthan and Gujarat receiving over 600 langleys per day. In contrast, during the monsoon and winter months, the daily global radiation decreases to about 300-400 langleys per day. It is observed that the annual average daily diffuse radiation received over the whole country is around 175 langleys per day. The maximum values measured over the whole country are about 300 langleys per day in Gujarat in July, while minimum values, between 75 and 100 langleys per day, are measured over many parts of the country during November and December as winter sets in.

V. Solar Panel Orientations And Tilting

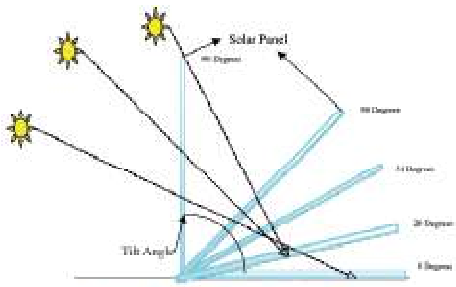
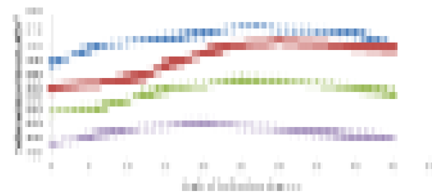


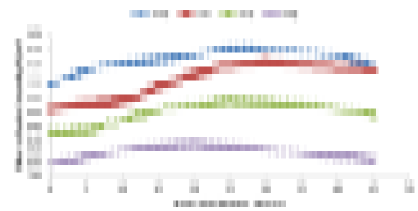
Figure 1. Different Tilt Angles of Solar Panel

solar module in optimal position and power obtained		
Time	Direction and angle of maximum power	Power (W)
8	East 60 degree	2810
9	East 45 degree	2960
10	East 45 degree	2999
11	East 30 degree	2828
12	south 30 degree	2920
13	south 30 degree	3015
14	west 30 degree	2750
15	west 30 degree	2860
16	west 45 degree	2750
17	west 60 degree	3230

Table 1 Average value of measured and calculated solar radiation intensity and energy gain for a flat plate collector

Months of the year	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Feb	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
March	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
April	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
May	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Jun	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Jul	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Aug	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sept	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Oct	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Nov	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Dec	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]





VI. Conclusion

The optimum angle of inclination for maximum collection of solar energy radiation intensity varies with each month of the year. Optimum angles of inclination at which solar panels can be mounted to harness maximum collection of solar energy radiation intensity for each month of the year were identified. It was found that solar flat collector can be fixed permanently in at 22.5^{o}. When the average annual solar energy radiation intensity obtained at the optimum angle of inclination was compared with that from the horizontal zero degree position, 4.23 % average yearly increase in solar energy radiation intensity was achieved. Also an average annual solar energy gain of 370,670 MJ/m^2, over the horizontal position, was achieved, when the flat plate was inclined at optimum angle for harnessing maximum solar radiation intensity.

From all of the above studys, it may be conclude that solar panel is have to be fixed at an appropriate angle of 34^0, to obtaining maximum solar radiation intensity. From the all above statement we may also conclude that, solar panels receives maximum radiation when the sun rays impact the solar panel perpendicularly.

Now, our main motive is to keep the solar panel in such a way that it always receives the maximum radiation throughout the day. For this, we have to make an arrangements that solar panel rotates with time, such that solar radiation always impact perpendicularly. Our project aim is to rotate the solar panel by using epicyclic gear train mechanism which is attached to the clock.

The entire epicyclic gear train mechanism is operated by the energy supplied by the battery, which is to be charged with the same solar panel. Suppose our solar panel taken under consideration is consists of 100 solar cells, out of these 100 cells, 4 or 5 solar cells are more than enough to rotate the solar panel. Measurements indicate that the energy flux received fron the sun outside the earth's atmosphere is essentially constant. The solar constant 'I_{sc}' is the rate at which energy is received from the sun on a unit area perpendicular to the rays of sun, at the mean distance of the earth from the sun. The value of the solar constant has been subject of many experimental investigation.

Based on the experimental investigations, a standard value of 1.4 KW/m^2 has been recommended. The value on any day can be calculated from the equation :

$I'_{sc} = I_{sc}[1+0.033\cos(360n/365)]$ where n is day of the year. From above equation, we see that, the cosine function varies from '+1' to '-1', the radiation flux varies by '+3%' to '-3%' over a year.

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