Hybrid Technology for the use of Solar Energy: The Challenge towards Green Energy

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Abstract

Large areas in many countries are populated but have no connection to a national electricity grid. Centralized electricity generating facilities burning fossil fuels have been the normal. Renewable energy resources, especially solar energy is now penetrating this sector. Long-term energy storage is the universal challenge in providing renewables-based electricity with high availability across the seasons. Solar domestic hot water system is widely used and developing fast in recent years. However many problems occur at the same time, for example more energy consumption by circulation pump, water reheating, long investment payback period, and etc. The motivation for the development of a combined hot water and sorption store is to complement the advantages and to reduce the disadvantages of the two particular storage technologies. Hot water stores offer high heat supply rates but are particularly suitable for short term storage due to heat losses whereas for a sorption store the power drain is low but it shows the advantage of a high storage density and long-term heat storage almost without losses. We investigated the demonstration project and discuss the need for authoritative system modelling in order to size the system components for minimum cost at a designated availability of supply.

Keywords: Solar energy; hot water, sustainable development, green technology.

1.0 Introduction

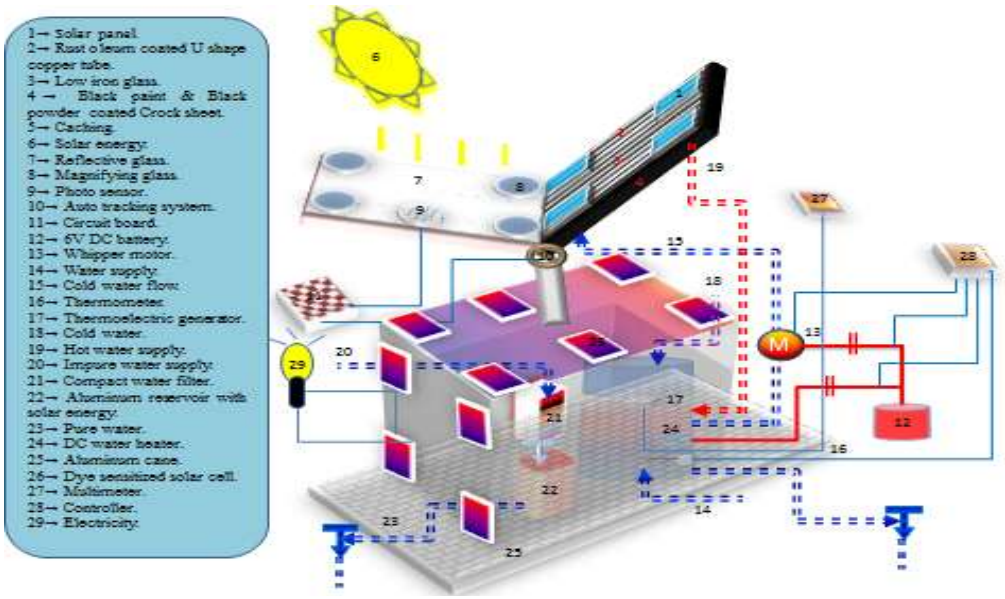
The solar energy is the most capable of the alternative energy sources. Due to increasing Demand for energy and rising cost of fossil type fuels (i.e., gas or oil) solar energy is considered as an attractive source of renewable energy that can be used for water hearing in both homes and industries [1-5]. Heating water consumes nearly 20% of total energy consumption for an average family. Solar water heating systems are the cheapest and most easily affordable clean energy available to homeowners that may provide hot water required by a family. Solar heater is a device used for heating the water which produces steam for domestic and industrial purposes by utilizing the solar energy [2]. Solar energy is energy which comes from the sun in the form of solar radiations in infinite amount. When these solar radiations fall on absorbing surfaces, it converts into heat, thus this heat is used for heating the water. This type of thermal collector suffers from heat losses due to radiation and convection. Such losses increase rapidly as the temperature of the working fluid increases. Solar hot water system may dominating over the solar heating system as it is easy to maintain, relatively low manufacturing and maintenance cost [4]. Being a part of a developing country, which has crisis of electricity and unavailability of natural gas,may disconnect remote places. To reduce the pressure on the power sector where we already have a lot of crisis, we need an alternative water heating system that provides continuous hot water supply without consumption of electricity. The system can be implemented perfectly, when a system has greater efficiency value. Solar water heating is an accepted technology and is increasingly being used as one of the cost-effective means of heating water in residential and public buildings such as hotels, laundries, restaurants, hospitals and health centres [3]. Hot water is also required in large quantities in hotels, hospitals, hostels, and industries such as textile, paper, and food processing of dairy and edible oil. Solar water heating systems can heat water from ambient temperature to temperatures over 80 °C depending on the collector type employed in a given locality. In 1891, Kemp patented a way to combine the old practice of exposing metal tanks to the sun with the scientific principle of the hot box, thereby increasing the tanks' capability to collect and retain solar heat [5]. He called his new solar water heater the Climax - the world first commercial solar water heater. By 1983, 60% of the population heated their water with the sun.The extrapolated results based on the experimental study showed that the solar domestic water heating unit is capable of an annual heat recovery of 789 kWh electricity [6]. In this analysis, we use a thermoelectric generator that is capable of heat recovery of 869 kWh electricity,because of auto circulation

of hot water in the flat plate solar collector.It mainly depends on the space of reservoir. We can also larger amount of thermoelectric generator by using series connection for obtaining the higher heat recovery.

The aim of the project is to study thermal behavior of two basic configurations of solar water heating systems, for a generic hot water demand and to investigate the efficacy of the thermal stratification on performance of the system as a whole. It also includes study of temperature control in the tank and the auxiliary heater control on the performance of the solar domestic hot water system. It also improving environmental impact & reduces greenhouse gas emission through reduced of electricity & burning fuel, because of fossil fuel combustion produces greenhouse gases.
The objectives of the project was to understand the heat transfer characteristic of solar domestic water heating system and to explore the fact that these modified hot water cylinder could be controlled in such a way that it operate efficiently and can produce hot water cheaply.

2.0 Methodology

By switching on motor, water from the reservoir first comes to the bend copper tube which thermal conductivity is high i.e.400Wm/K & 3/8 inch diameter through the insulating pipe. The catching is covered with a black coated cork sheet which coustic resistivity is 1.2×10^5& rust oleumappearing with a 7375 white 7394 black semi-glossthatis added to the cork sheet surface. The catching front surface is closed with a low iron glass (approximately .85-.90 at normal incidence). The catching is kept in a hot, shiny place where the copper tube gets greater amount of heat. Solar energy is energy that comes from the sun in the form of solar radiations in infinite amount, when these solar radiations fall on absorbing surfaces of the catching, it then converts into heat, thusheat is used for heating the water. The hot water which comes from the copper tube goes to the reservoir through another insulating pipe and this hot water is again re-circulated several times through the copper tube in a similar manner. Thus when our required temperature is achieved the motor is switched off. For backup support or for rapid heating process a heating coil is also used in the reservoir. This heating coil is also driven by dc battery (6V).Another pot which contains cold or normal room temperature water comes in contact with the reservoir which contains hot water with the help of two heat sinks joined with a thermoelectric generator (40mm X 40mm) and a thickness of 1.8mm.As a result for temperature difference according to Peltereffect, it will produce electricity. This electricity is used for lighting and also in charging dc battery which is used here.



Scheme 1: Proposed model of using solar energy for multipurpose use.

3.0 Results & Discussions:

We get maximum heated temperature water during summer compared to the winter season. It is observed that we get maximum heated temperature water at the time period of 11:00 AM To 1:00 PMDuring the summer season. The reason is , at that time the sun is kept inclined over the catching. As a result the intensity of the heat on the catching is too high & the copper tube becomes highly heated. We also get minimum heated temperature water at the time period of 8.00-10.00 AM during winter season.as a result of intensity from the heat on the catching is too lower and the copper tube becomes slightly heated. Again we can see that the higher the temperature difference between the normal & hot water is, the greater the amount of current in which we can achieve fromthePelter effect.

Effect during summer season: At 06.05.2015, duration of 8.00 to 10.00 where the room temperature was 25°C and water temperature was 24°C,duration of 11.00 to 1.00 where the room temperature was 31°C and water temperature was 29°C,duration of 2.00 to 4.00 where the room temperature was 28°C and water temperature was 26°C respectively.

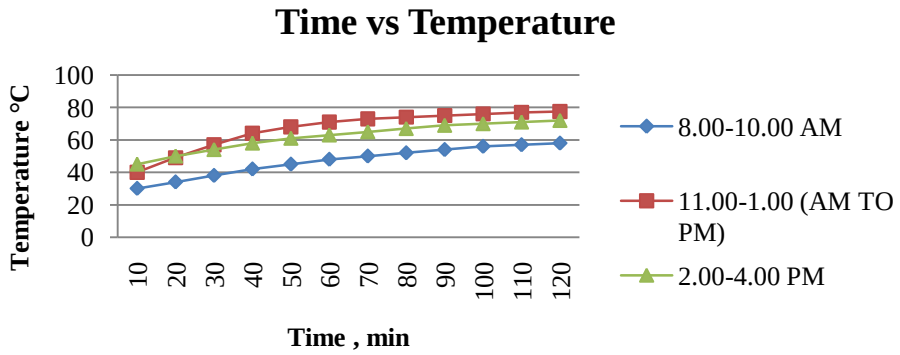


Figure 1: Effect of different season on water temperature

*Effect on Temperature by using whippermotor:*Solar domestic hot water heating systems absorb heat from the sun and transfers it to the water used for showers, cleaning, and various other tasks, reducing the amount of fossil fuel or electricity needed to heat the water. Here, the maximum amount of temperature is obtained by the auto circulation of whipper motor which is given by 6 volt dc battery and thus the temperature is higher when the full sun is inclined to a 45º angle of the solar collector. The figure shows that the maximum hot water near to about 77.5ºC during the 11.00- 1.00 (AM To PM) because of higher intensity of solar energy so that higher energy is absorbed by the rust oleum coated U shape copper tube while for the duration of 2.00-4.00PM, the hot water temperature lowers to 72ºC, because of lower intensity of solar energy as well as the temperature of 58ºC , which is because of much lower intensity of solar energy. We can also see that, the maximum temperature of hot water is produced by using auto circulation of whipper motor and each cases were run in 2 hour.

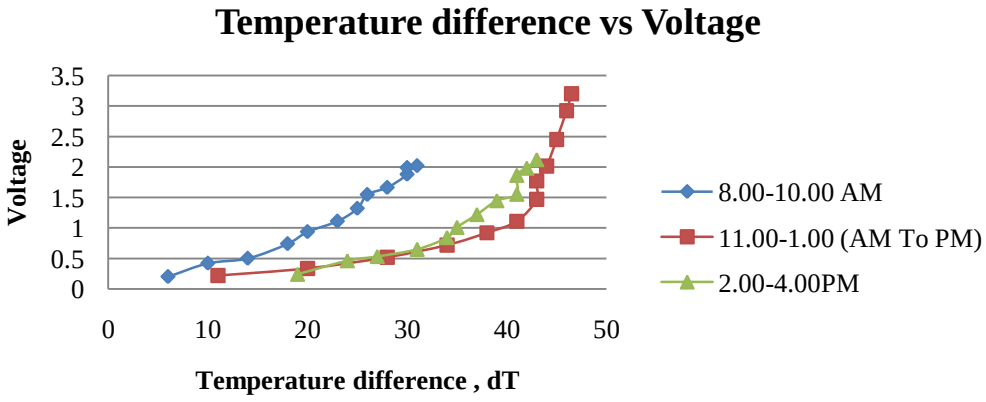


Figure 2: Effect of voltage on temperature difference

*Effect on Thermoelectric generator:*Thermoelectric generators are all solid-state devices that convert heat into electricity. Unlike traditional dynamic heat engines, thermoelectric generators contain no moving parts and are completely silent. It can become competitive because they are compact, simple (inexpensive) and scalable. A thermoelectric generator converts heat (Q) into electrical power (P) with efficiency η.

$$\therefore P = \eta Q$$

The efficiency of a thermoelectric converter depends heavily on the temperature difference $\Delta T = Th - Tc$ across the device. The Pelter effect is based on temperature difference and therefore, when the temperature difference is higher, the amount of electricity production is greater. Then the electricity is stored in the storage system.The figure shows that during 8.00-10.00 AM, the electricity is produced 2.02 volt, where the temperature difference is 31ºC and duration of 11.00-1.00 (AM To PM), the electricity is produced 3.20 volt, where the temperature difference is 46.5ºC and also duration of 2.00-4.00 PM, the electricity is produced 2.12 volt, where the temperature difference is 43ºC.

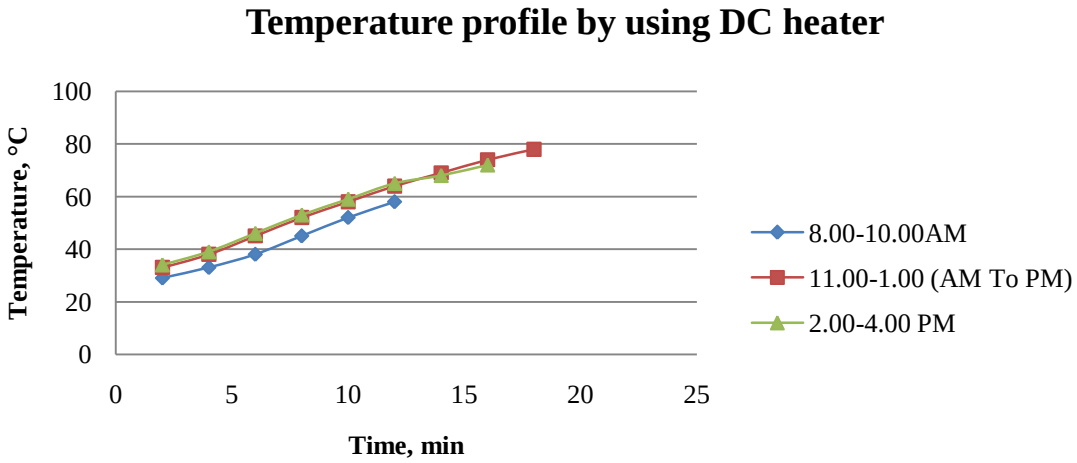


Figure 3: Effect of DC heater on temperature profile

*Effect on Resistance:*Theresistor reduces the velocity of the electron momentarily, but at the same time the field gives extra velocity to the electron. Effectively the mean velocity will settle at an equilibrium between these two processes, so the potential and field in fact determine the velocity of the electrons. The voltage however depends on speed of the electrons and also the density of the electrons. The density is adjusts to make the voltage constant.

Calculation of Efficiency of Solar Water Heating System in Summer Season:Efficiency of solar water heating system is given by the ratio of energy released from the solar water heating system to energy gained by this solar water heating system.

Energy input or energy gained by solar water heating system $E_{in} = m \times C_P \times T$
E_{in}=0.5kg × 4.186kj/kg ^oC × 48.5^oC =101.51 kj
Now we know, Power,P=Voltage × Current = V × I = 3.20 × 1.288 = 4.1216W
Energy released by solar water heating system or output of energy,E_{out}=Power × time duration = 4.1216W × 2h (as 11 am to 1pm)
= 8.2432 W-h = (8.2432 × 3600)/1000 = 29.68kj
Efficiency=29.68kj/101.51kj = 0.2924
If we want to represent it by percentage then efficiency=0.2924 × 100% =29.24%
Our solar water heating system was able to heat 0.5 liters of water from a starting temperature 29^{o}C to final temperature 77.5^{o}C on that day at 11 am to 1 pm.The efficiency of that solar water heating system in summer was 29.24% which means that 29.24% energy created by the sun's heat was captured by the model thus able to heat water by 77.5^{o}C and also helps to produce 3.20 volt.
Similarly,
If we want to represent it by percentage then efficiency=0.1475 × 100% =14.75%

This study determining the effects of the climate, season, and culture of different regions on hot water use patterns will need to be conducted before the findings of this study can be applied to domestic purposes in other regions. Also water heaters can be installed only in locations that require good amount of sunlight. It is not possible install them indoors.

4.0 Conclusion

The purpose of this work was to develop a low cost solar water heater. The scarcity of electricity and gases in our country is too high. Our natural resources are limited. Moreover, the cost of gases and electricity is increasing rapidly. As a result, it would not be possible to use hot water for all types of domestic work by using gas or electricity. So, we have tried to invent this type of solar water heater so that it can meet all types of demand when needed hot water without using gas or electricity. Currently the instrument cost is slightly above the target. Our target is to make the instrument cost as low as possible and brings to come cheaply to all classes of people. Although, there are several opportunities to significantly reduce the cost. Future tests will focus on durability, material selection and cost reduction. Financing options will be further investigated. Eventually a business plan will be developed for the mass production and marketing of the product.In this analysis, the flat plate collector is considered for analysis purpose with 50-60 liters capacity of hot water tank. It would be a good initiative to explore the impact of other types of solar collector panels such as an evacuated tube or a concentrated collector on the solar domestic water heating performance or more than one panel. Same point is also applicable to higher capacity storage tank such 100-200 liters capacity water tanks.Our solar water heating system was able to heat 0.5 liters of water from a starting temperature 24^{o}C to final temperature 69^{o}C on that day at 11 am to 1 pm. The efficiency of that solar water heating system in winter was 14.75% which means that 14.75% energy created by the sun's heat was captured by the model thus able to heat water by 69^{o}C and also helps to produce 2.10 volt.

5.0 References

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