

MULTI PURPOSE SOLAR APPLIANCE USING TIMER IC(NE555)

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Abstract: A 15 V DC Supply obtained from Solar panel is given as input to a simple inverter circuit through voltage regulator. The circuit mainly consisting of a 555 timer IC, an NPN and PNP Transistors and a Step up Transformer. The 555 timer IC is powered by a 15V obtained from solar cell. The timer IC(NE555) is wired as an ASTABLE MULTIVIBRATOR in this circuit. It will generate Alternating non sinusoidal output wave form at the instant we giving supply Voltage (15V). Thus primarily we generated Alternating Voltage from direct Current (Battery). The output from 555 Timer is given to the base of two transistors, PNP and NPN. These transistors help the output Voltage to increase its Current for both the positive and negative cycles. The output from these transistors are again fed to the input(primary) of a Step up Transformer. This will up convert the input Voltage to desired level (230V). The frequency of power supply is determined by Resistors R1, R2 and C, connected with 555 timer. Here i am using 50Hz power supply, so it is enough to use 10K, 150K and 0.1mF for R1, R2 and C respectively. The output is taken across the secondary winding of Transformer. Again the 15 V obtained from solar panel is given as input to peltier heat pump. It produces both heating and cooling effect. Thus with 15 V given as input 230 V is obtained as output from Inverter circuit and also heating and cooling effect is produced from pettier heat pump.

Keywords: solar panel, solar energy conversion, Pettier Effect, Astablemultivibrator

1. Introduction

The burning or combustion of fossil fuels for heating operations introduces many harmful pollutants into the atmosphere and contributes to environmental problems like global warming and acid rain. Solar energy is an

optimum solution as an alternate fuel and absolutely non-polluting, free of cost, and present in huge amount of the earth. The working principle is straightforward; the collector simply collects the radiation that falls on it and converts a fraction of it to other forms of energy [1]. Solar energy has been continued to utilize by various countries since 1900's. In the present era a variety of the techniques are there, to utilize solar energy in various aspects of households and commercial sectors. Cooking, water heating, desalination, power generation, heating and cooling of buildings, even lightening now can be operated on solar energy in different households and commercial sectors worldwide [2-6]. Although separate solar energy devices are individually capable for the principle purpose like; cooking and drying etc. Apart this, it has been noticed that specially designed hybrid solar energy systems (multipurpose devices or a combination of different devices) not only reduce the humanitarian efforts, but saves time, fuels, and provides economical and ecological benefits to its user as well as to the society. Likely systems are very beneficial to various societies in this present time, when the demand for oil and fuels is rapidly increasing with each new day. The use of the solar energy was started in the beginning of 1800's and it is continued to optimize the problems associated with heating and cooling processes. In the past an individual device/system was used for the purpose of cooking and other heating tasks.

Later on some pioneers optimized their designing characteristics and designed them as a multipurpose device/system for heating and cooling operations [7-10]. Goyal et al. has been developed a techno-economic model for a hybrid solar forced- convection water heating system by considering two options (first was an instant electric heater while the second was the use of diesel as the auxiliary energy fuel). Calculations were made equivalent to the two envoy demand patterns, viz. (i) Hot-water demand of big residential buildings and (ii) industrial hot-

water demand. Taking into account the life and all investment costs of the solar and auxiliary systems, the cost of useful energy was calculated for different values of collector area and tank capacity.

The effect of subsidies on the optimum values of the collector area, tank capacity and the minimum cost of the useful energy was also discussed [11-16]. Nandwani designed a hybrid solar oven (electric cum solar oven) and described the working. This oven could be used for cooking and baking almost all types of meals at any time during the year employing solar and/or electric energy. The quality of the system was that it can be automatically switched from solar to electric energy when required [17-22]. Choudhury and Garghave been carried out the simulation study of a forced-circulation solar hybrid domestic hot water system that circulates air through a rock-bed air heater and employs an external air-to-water, transverse fin, shell-and-tube heat exchanger to transfer heat from the air to the water without the use of any auxiliary power. The performance was evaluated to the hot water demand of 4-person residential building. In addition, the study was extended to compute the pumping power expended in air and water circulation throughout the system [23-25]. Stahl et al. has built a self-sufficient solar house in Freiburg.

The total energy demand for heating, electricity, and cooking was supplied by the sun. The combination of highly efficient solar systems with conventional means to save energy was the key to the booming operation of the house. The energy for electricity and hydrogen generation was supplied by solar cells. Hydrogen would be reconverted to electricity with a fuel cell or used for cooking [26-30].

2. Proposed Method

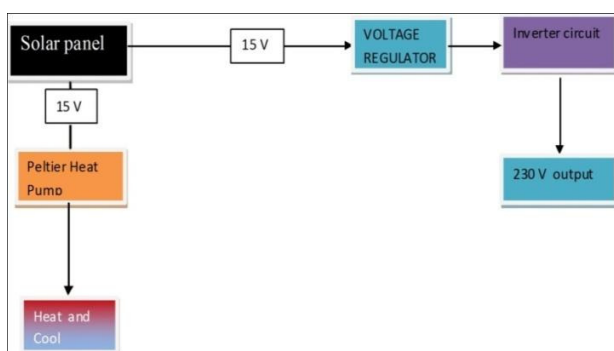


Figure 1.Block diagram of multi purpose solar appliance

3. Performance Testing of MSES

A solar still is a very simple way of distilling water, which is powered by the heat energy from the sun. Impure water is inserted into the container, where it is evaporated by the solar energy through transparent glazing (plastic sheet or toughened glass). The pure water vapor condenses on top and drips down to side due to a slope of glazing and then it is collected and removed. Solar still consists of an insulated black painted aluminum pan where impure water stands at shallow depth. The slope glazing was supported by an appropriate frame at a certain height usually less than the opposite one, covers the pan and is sealed tightly with an adhesive to make the system leak proof. During the water heating process inside the cabinet the water gets evaporated and due to this the salts and microbes present in the original water are left at the rear. After this condensed water trickles down the inclined glass cover to an internal assortment trough and out of a storage tank.

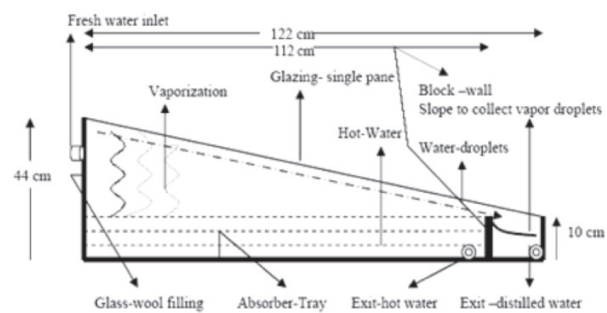


Figure 2.Schematic of solar still cum water heater

The performance testing of the first component of MSES (solar still cum water heater) has been carried out on a sunny day (05.03.2012) in the month of March. Heat energy from the sun was permissible into the collector to heat the water in single slope solar still block. The water evaporates only to condense on the underneath of the glass. When water evaporates, only the water vapor rises, leaving contaminants behind the slope of the glass directs the condensate to a collection trough (see in Fig 2), which in turn delivers the water to the outlet of the system then to a collection bottle scaled with liters.

The basin area of the still was $112 \times 61.6 \text{ cm}^2$. The vertical heights of the outer glass cover of the still were 44 cm and 10 cm with a slope of 15° along the breadth of the still. The height of the water inside the still was maintained at 9 cm by an auto flow arrangement above this height. A trough was placed to collect distilled water on the separation wall of still as in figure 2. The hot water inside the still was used for the dual purpose, as inside the chamber it was continued to phase change (evaporation) as well as the water was heating, that can be taken for cooking purpose for the 3rd component of the MSES. Definitely the use of pre hot water reduces the time taken for cooking and can be used for other works like drinking (in cold season)

and washing. Water, glass and vapor temperatures were recorded with the help of calibrated copper constantan thermocouples and a digital temperature indicator.

The thermal performance of a basin type solar still is usually based on the model proposed by Dunkle, in which a heat balance on the basin water, and on the cover glass, while a convective, radiative, and the evaporative heat transfer was established between water and glass. The energy balance equations for different components such as glass cover, water mass and base liner of a single slope passive solar still are maintained.

The values obtained, after making calculations for the distilled water daily output was observed 2.41 liters per day that was measured through a scale marked bottle (in liters) after finishing of the test at 19.15 hrs of the same day. The overall efficiency of the first component of the MSES (solar still) was obtained 31.5%. The quality of the distilled water was checked through two different TDS meters for pH value ((Model-CD600 range 10/1990) and Ppm value (Model-pH600 range 0.0 to 14.0 pH) which were measured at 100 and 8 respectively.

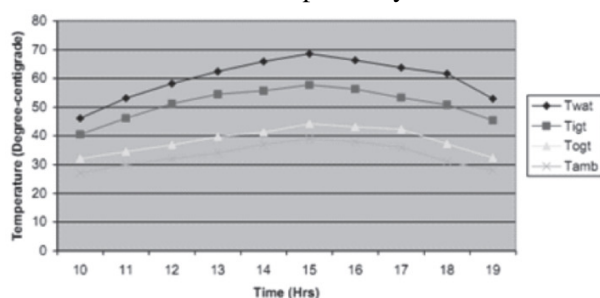


Figure 3. Performance curves of solar still cum water heater

4. Operation of Multi Purpose Solar Appliance

1. Solar panel : A solar cell which produces 12 V is used in this project.



Figure 4. Solar Panel

2. Voltage Regulator : A voltage Regulator IC LM7815 is used to provide a regulated power supply to simple inverter circuit.

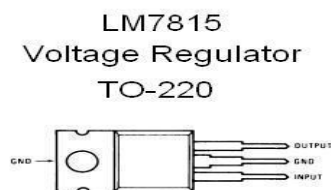


Figure 5. LM7815 Voltage Regulator

3. Simple Inverter Circuit : This circuit consists of a NE555 IC connected as Astablemultivibrator which is the n connected to a PNP and a NPN transistors. The output is obtained through a 230 V Step Up transformer.

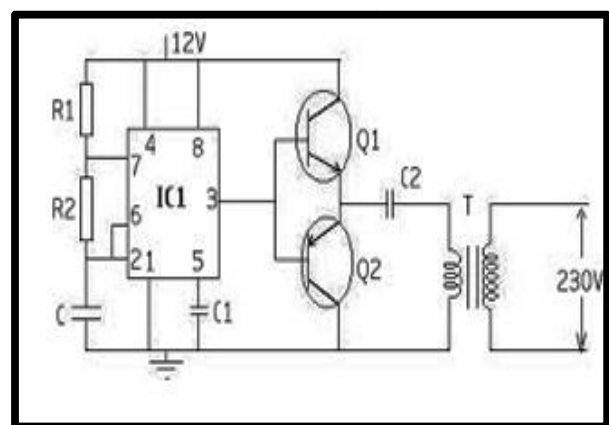


Figure 6. Simple Inverter circuit

Components used in simple Inverter Circuit:

- IC1 - NE555
- Q1 - TIP 41A (NPN)
- Q2 - TIP 42A (PNP)
- T – Step up Transformer
- R1 - 10K Ω
- R2 - 150K Ω
- C - 0.1 μ F
- C1 - 0.01 μ F
- C2 - 2700 μ F

4. Peltier Heat Pump : A 15 V supply obtained from solar panel is given as input to peltier heat pump. Peltier heat pump is suitable for with any of our range of temperature controllers, TC M, TC LV, these provide a quick and easy way to provide temperature stabilization. Simply connect the power supply and temperature controller.

Typical applications are for device temperature testing, temperature stabilization, device cooling and device heating. By using the pettier effect it can both heat and cool, so an THP unit can effect precise servo-controlled

thermal stabilization when used in conjunction with an Electron Dynamics' programmable temperature controller. These enable accurate temperature control in the range -100°C to $+200^{\circ}\text{C}$ with a stability of 0.001°C in varying ambient conditions. Parameters such as output limits, PID terms, temperature alarms and operating modes can be set up. In addition, advanced features have been included to offer PID auto tuning, temperature ramping and cycling.

5. Testing of the (OSD) of MSES

Last one component of the MSES, is a solar open dryer. Open sun drying is the most commonly used methods to preserve agricultural products like grains, fruits and vegetables in most developing countries. Such drying under intimidating climate conditions lead to severe losses in the quality of the dried product. Open sun drying suffers from quality considerations still it enjoys a cost advantage. Selection of the right drying system is thus important in the process of drying agricultural products.

Basically, to use the ideal space of the MSES, this was another option to utilize the extra portion gap, by bringing it to a utilizing form or gain some useful work and hence it has been utilized as an open sun dryer. The size of this component is $42 \times 112 \text{ cm}^2$. The hole of 2mm diameter, are provided for ventilation in absorbing tray, while a strong and rigid support is already provided to bear up the load for 2 to 5 kg or accordingly nature of the substance to be dried. The testing of this component was simply carried out by using the weight loss method through the sensitive balance apparatus.

Open sun drying sample was weighed every two hours on the first day of drying and every one-hour the next day, to measure start of drying and the process utilized the solar concentration for evaporation. Therefore, the temperature of the substance did not rise much more than ambient due to the cooling effect by evaporation of the moisture. During the night hours the temperature of the substance remained very close to ambient and less moisture evaporation took place. Beside this, a float glass was used to cover it, to escape it from moisture (contents present in the air), in the night hours. For the testing of the fourth component a half kg green chilies were taken to be dried. The temperature of the absorber plate of open dryer was almost near about ambient temperature due to open to the environment.

Apart this, another test was conducted with a less moisturizing containing substance. A, 400 grams (initial weight) bread slices were taken to be dried in open sun energy. After placing them in the open sun

dryer for 8 hours (from 10.00 am to 18.00 pm) of full sunshine, their final weight was noticed to be 290 grams.

The quality of the dried products in hybrid drying notably improved compared to open sun drying as well as solar drying due to the fact that drying was uninterrupted until the final moisture content was attained. This eliminated possible moisture re-absorption and mould growth during overnight storage of the product during open sun drying and solar drying. Traditionally, farmers used the open-to-the-sun or natural drying technique, which achieves drying by using solar radiation, ambient temperature, relative humidity of ambient air, and natural wind. In this method, the crop is placed on the ground or concrete floors, which can reach higher temperatures in open sun, and left there for a number of days to dry. Capacity wise, and despite the very rudimentary nature of the process, natural drying remains the most common method of solar drying. This is because the energy requirements, which come from solar radiation and the air enthalpy, are readily available in the ambient environment and no capital investment in equipment is required.

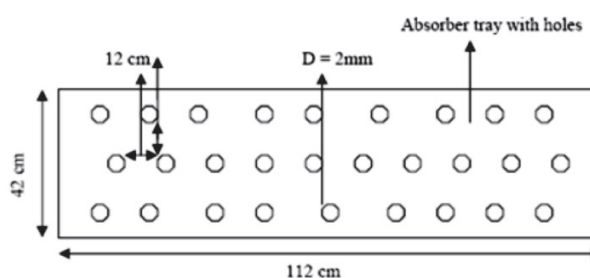


Figure 7. OSD of MSES

6. Result and Discussion

Mostly hybrid solar energy systems are typically designed and developed by integrating with PV modules. A good power backup is always required for solar energy devices for efficient operation in low ambient temperature conditions or in bad climate conditions. There are very few solar hybrid systems which directly operate only on solar energy. Reason is that, on passive mode such solar energy devices have low thermal efficiency while an integrated PV hybrid system has better efficiency over than passive type solar energy hybrid systems. But the major problem is that PV modules are available in markets for much higher cost and impracticable to afford by poor one. Accept this, to operate a solar cooker, solar dryer, and solar water heater cum still on auxiliary power as a solar Combi-system, a large PV module is required to operate the whole system as a unit.

Beside this, if people from rural areas purchased an individual solar device for water heating, distillation, cooking and drying (after providing a good subsidy by the

government) than the total cost of all these devices is much more than discussing HSES. If the comparison can be made between these systems (individual components and HSES) then a variation of $\pm 5\%$ in thermal efficiency may be possible due to combination system in comparison of using separate solar energy devices. The mean is that it works with a minor change in thermal efficiency or slow processing. The results obtained, after experimental testing and analysis of the HSES as a unit as well as its individual components are found adequately. The system was operated on both conditions on load and on no load for efficiency evaluation. The whole system efficiency obtained after performance testing was found 29.21%, while for solar still cum water heater 31.5%, for solar dryer 27.5%, and for solar box cooker it was 34%. A total amount of 4000/- Indian rupees was estimated after fabricating of HSES. The system is specially developed for rural areas or people below the poverty line. It has been practically observed that many households used more than one energy source for heating activities like kerosene, LPG, fuel-wood, and agriculture waste, in which kerosene and LPG are the two subsidized petroleum products used as a prime source of household energy. Coal and biomass has also been found a less consumed source of a cooking fuel.

A survey was carried out to know the consumption of fuels for heating purpose in three different types (LIH-lower income household, MIH-Medium income household and HIH- Higher income household) of households in native place for a period of three months. In a LIH, an approximately consumption of LPG was noticed for 14 kg and for kerosene it was 6 liters per month while wood fuel was the third commonly fuel used for cooking with a maximum consumption in LIH among all. Coal was used for water heating along with fuel wood, while the dry leaves or wood chips were observed to use as an initial lighter (to pre ignition). An amount of approximately 800 (INR) has been spent on different fuels used for cooking and other heating activities by an LIH per month.

MIH were found to clean cooking fuels like LPG mainly, and electricity while the other fuel like kerosene, coal and fuel wood has been noticed for a small consumption in the other heating tasks. An average amount of 925 (INR) has been spent on different fuels used for heating process by a MIH per month. The last one household was observed to be based mainly on LPG, a neat cooking fuel, while electricity (geyser) was used for water heating and other heating works as to make warm drinks and baking. This household spends an average amount of

3000 (INR) per month on heating activities. Having all the concepts of consumption of various fuels for a variety of heating works in different households, it outcomes that LIH has a limited budget to spend of fuels. By considering all those factors regarding the consumption of fuels and average expenses on them by different type of households, the HSES has been designed and fabricated purposely for the people who have a lower budget or unable to afford them due to limited monthly budget. It doesn't mean that rest two households (MIH and HIH) can't use it. It can be an additional system for them for any special purpose as drying and distillation.

This system has been fabricated by locally available materials in a very simple and user friendly way. There is no international standard is considered for its designing as a whole unit except performance testing of solar cooker (Because cooking is the prime need of every household hence the cooking device must have good efficiency). The feasibility of the system is suitable to all levels of households and climate conditions (on an average value, ambient temperature varies between 22°C to 45°C , the wind speed goes up to 3.70 m/s maximum, the sun gives good heat intensity at least for 5 hours with 500 W/m² and beside this, for purchasing of likely solar devices a local "Prathama Bank" followed by the Indian government provide loans for solar energy device or systems) round the year of Moradabad city. This system is feasible to utilize solar heat energy and can be used throughout the year in parallel of other heating device/systems like LPG burner, kerosene stove etc. The calculated PBP for the MSES is 2.88 years.

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