MULTIPURPOSE SOLAR DEVICE

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Abstract— India is a tropical country which experiences a very high temperature during summer and becomes highly uncomfortable for the people. Inadequate preservation techniques and poor storage provisions lead to deterioration in the quality of agricultural products. Advanced processing techniques have been used to reduce postharvest losses of agricultural goods. In this paper, a attempt have been taken on the effective use of solar energy on the device which will work on multiple applications like cooking, hatching, drying food and water heating with or without storing material. Thermal energy storage technology in materials as sensible and latent heat. Applications with storage unit is very beneficial for the humans and as well as for the energy conservation.

1INTRODUCTION

The need to put in place alternative energy policies stems from the awareness that fossil fuels are exhaustible and harmful to the environment. For this reason, during the last decades the scientific world has focused on systems able to use and convert renewable energy sources, particularly solar radiation. Nowadays, solar thermal collectors use solar energy to distribute low-cost domestic and industrial heating. In this paper, a comprehensive analysis of peer-reviewed journals and relevant papers on solar thermal collectors and devices are provided, different types of solar devices are provided. Theoretical analyses, latest developments related to the functional elements, and hybrid systems have been considered throughout this analysis. Performance test methods for solar thermal collectors and reflectors standards are discussed. This project aims to make a solar device which is having low cost and can be used in 4 to 5 applications.

The main purpose of our device is to help farmers for value addition in their work, by using solar energy which is available free of cost.

We are blessed with Solar Energy in abundance at no cost. The solar radiation incident on the surface of the earth can be conveniently utilized for the benefit of human society. One of the popular devices that harness the solar energy is solar hot water system (SHWS). 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 an attractive source of renewable energy that can be used for water hearing in both homes and industry. Solar energy is the energy which is coming from sun in the form of solar radiations in infinite amount, when these solar radiations fall on absorbing surface, then they gets converted into the heat.

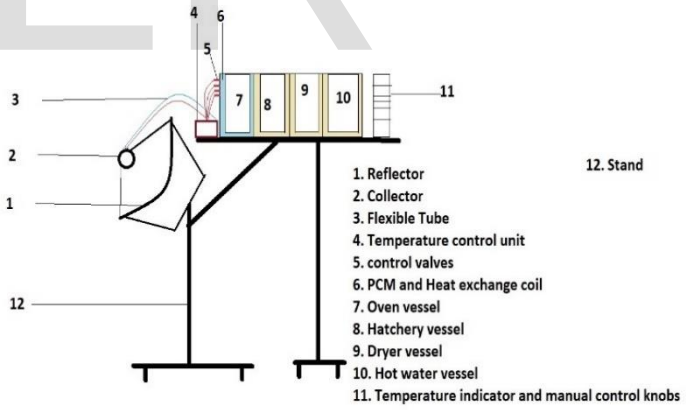
2PROBLEM STATEMENT

Due to electricity issues in villages, farmers face many problems. That's why we made a device which works on solar energy, will do value addition for farmers in applications like solar hatchery, water heater, solar oven and solar dryer and create a second source of income.

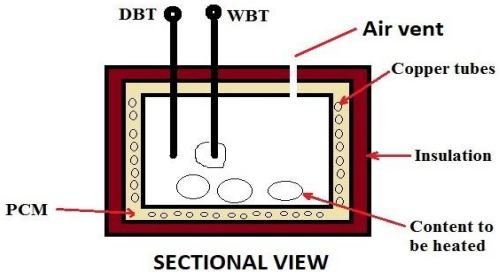
3OBJECTIVE AND SCOPE

1) Use of non-conventional energy and should be economical for farming and could use in farms.
2) Conclusion on usefulness of the device.
3) Compare the cost estimation of the non- conventional and conventional energy using devices.

4DESIGN OF THE DEVICE



We used a parabolic reflector will be used to heat from which the solar rays will get reflected and solar energy will get stored in collector tube. This energy will be used to heat the water, the heated water will flow through all four chambers via copper tube. We used temperature sensors to sense the temperature achieved by a chamber.



4.1MATERIAL SELECTION

The materials of the setup are easily available. The selected material must be robust and must be able to withstand maximum temperature. Availability and cost also forms a major part in material selection.

Parameters considered while selection of materials are: -

- Weight
- Durability
- Availability
- Cost

4.2COMPONENTS

1) REFLECTOR

Fig. Design of Reflector

We used aluminum reflector having reflectance 0.6 to 0.8 & 2m² area. It gives 1600 watts of output.

2) FLEXIBLE TUBE

Two tubes are used which connect collector inlet & outlet to heat exchangers.

3) HEAT TRANSFER COIL

To conduct heat from collector to heat exchanger we used brine solution which can conduct temperature up to 130 degrees.

4) COLLECTOR

We used tube in tube evacuated type of collector having 1meter in length, which have low thermal losses & maximum heat absorption characteristics.

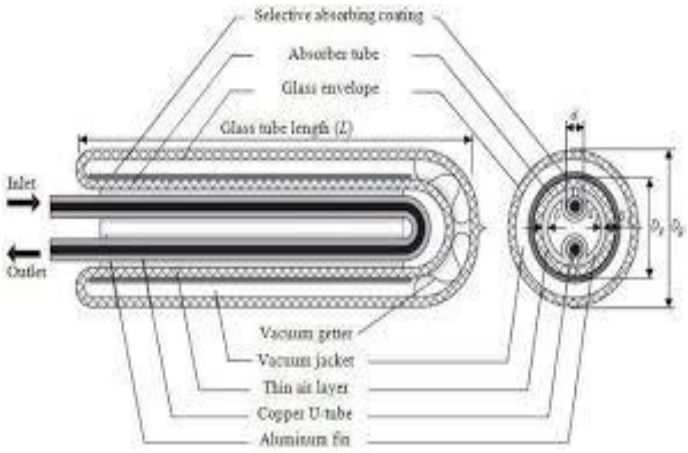


Fig. Evacuated tube collector

5) COPPER TUBE COIL

Copper tube of 6.35 mm diameter is used as heat exchanger. It takes heat from heat transfer fluid & gives to phase change material & output vessel. Each chamber requires 3.35 meter of copper tube.

Fig. Copper Tube

6) PHASE CHANGE MATERIAL (PCM)

It stores heat during day period & releases heat to vessel after sunset. PCM material stores heat up to 7 to 8 hours. For different applications we have used different phase change materials like mixture of NaNO3+KNO3 is used for solar oven and Paraffin wax used for hatchery, dryer and water heater.

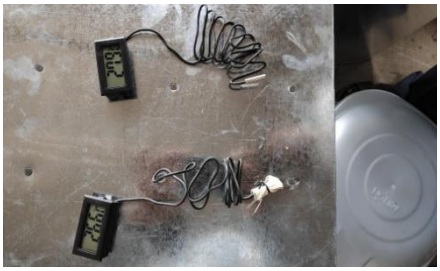
7) OUTPUT VESSEL

It is the place where actual heat load is applied to the device. We have used 4 output vessels for 4 applications. Every vessel is surrounded by individual copper tube coil & phase change material.

8) ELECTRONIC CONTROL CIRCUIT

We have used a microcontroller which controls temperatures of vessels. After certain temperature reaches in vessel, control circuit gives signal to the control valve to divert the hot fluid flow towards next copper tube coil to heat the vessel.

9) TEMPERATURE SENSORS

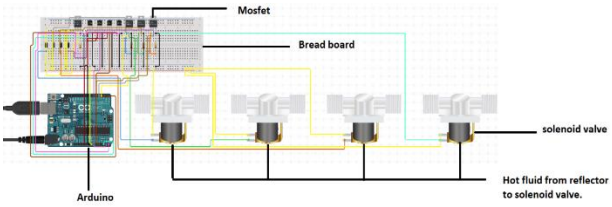


It senses temperature and gives signals to electronic control circuit.

5 WORKING

The sun rays which are falling on the reflectors are being reflected. These reflected rays are concentrated on the collector tube. Due to concentration of sun rays, temperature of collector tube increases. This collector converts the solar radiations into heat energy. Brine solution which is present inside the collector absorbs that heat energy. The brine solution passes through the flexible tubes to the application. This Brine solution releases the heat copper tubes (heat exchanger) and copper tube passes the heat in phase change material.

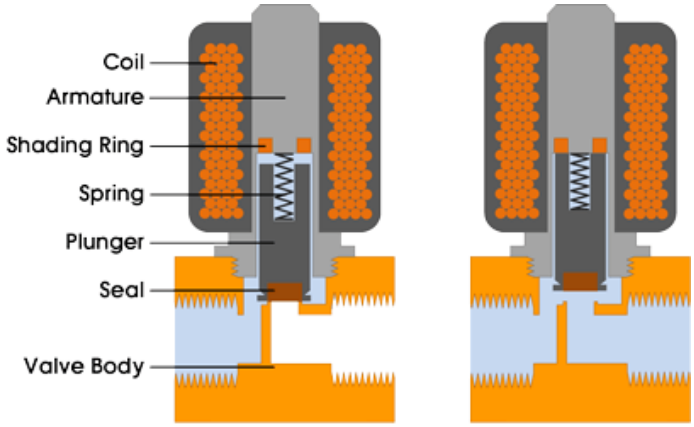
Solenoid valves are placed in between copper tube coil and flexible tube to divert the fluid flow. As temperature in first chamber reaches at desired value, temperature sensor senses the temperature & gives signal to electronic control circuit. Electronic circuit analyses the data & gives signal to solenoid valve. Then solenoid valve changes the flow of hot fluid from first chamber to second chamber & the cycle repeats.



5.1 SOLENOID VALVE

A solenoid valve is an electromechanically operated valve. Solenoid valves differ in the characteristics of the electric current they use, the strength of the magnetic field they generate, the mechanism they use to regulate the fluid, and the type and characteristics of fluid they control. The mechanism varies from linear action, plunger-type actuators to pivoted-armature actuators and rocker actuators. The valve can use a two-port design to regulate a flow or use a three or more ports design to switch flows between ports. Multiple solenoid valves can be placed together on a manifold.

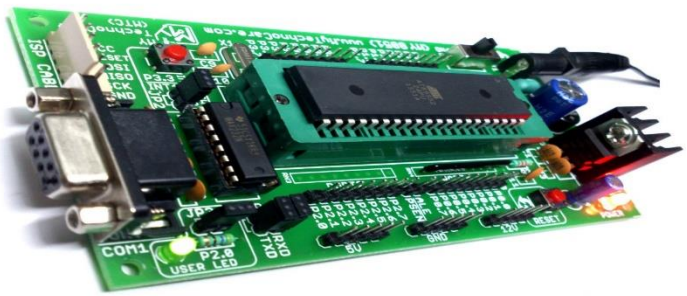
Solenoid valves are the most frequently used control elements in fluidics. Their tasks are to shut off, release, dose, distribute or mix fluids. They are found in many application areas. Solenoids offer fast and safe switching, high-reliability, long service life, good medium compatibility of the materials used, low control power and compact design.



5.2 MICROCONTROLLER

A microcontroller is a compact integrated circuit designed to govern a specific operation in an embedded system. A typical microcontroller includes a processor, memory and input/output (I/O) peripherals on a single chip.

Sometimes referred to as an embedded controller or microcontroller unit (MCU), microcontrollers are found in vehicles, robots, office machines, medical devices, mobile, radio transceivers, vending machines and home appliances, among other devices. They are essentially simple miniature personal computers (PCs) designed to control small features of a larger component, without a complex front-end operating system (OS).



A microcontroller is embedded inside of a system to control a singular function in a device. It does this by interpreting data it receives from its I/O peripherals using its central processor. The temporary information that the microcontroller receives is stored in its data memory, where the processor accesses it and uses instructions stored in its program memory to

decipher and apply the incoming data. It then uses its I/O peripherals to communicate and enact the appropriate action. Microcontrollers are used in a wide array of systems and devices. Devices often utilize multiple microcontrollers that work together within the device to handle their respective tasks.

5.3BATTERY

A rechargeable battery, storage battery, secondary cell, or accumulator is a type of electrical which can be charged, discharged into a load, and recharged many times, as opposed to a disposable or primary which is supplied fully charged and discarded after use. It is composed of one or more electrochemical The term "accumulator" is used as it accumulates and stores energy through a reversible electrochemical reaction. Rechargeable batteries typically initially cost more than disposable batteries, but have a much lower total cost of ownership and environmental impact, as they can be recharged inexpensively many times before they need replacing. Some rechargeable battery types are available in the same sizes and voltages as disposable types, and can be used interchangeably with them.
Rechargeable batteries are produced in many different shapes and sizes, ranging from button to megawatt systems connected to stabilize an electrical distribution network.
Several different combinations of electrode materials and electrolytes are used, including lead acid, nickel–cadmium(Ni-Cd), nickel metal hydride(NiMH) ,lithium-ion(Li-ion), and lithium-ion polymer(Li-ion polymer).

5.4TEMPERATURE SENSORS

A temperature sensor is an electronic device that measures the temperature of its environment and converts the input data into electronic data to record, monitor, or signal temperature changes. There are many different types of temperature sensors. Some temperature sensors require direct contact with the physical object that is being monitored (contact temperature sensors), while others indirectly measure the temperature of an object (non-contact temperature sensors). Here we use direct contact temperature sensors.

5.5STEPS TO FOLLOWED WHILE CONDUCTING EXPERIMENTATION

1) Build a circuit diagram of work mechanism.
2) Connect all the components.
3) Test the working of mechanism.
4) Take a trial on heat storage chambers one by one.
5) Then take readings.
6) Do calculation.

6INSTRUMENTS USED

6.1 MULTIMETER

A multi meter or a multi tester, also known as a VOM (Volt-Ohm-Milli meter), is an electronic measuring instrument that combines several measurement functions in one unit. A typical multi meter can measure voltage, current, and resistance. Analog multi meters use a micro ammeter with a moving pointer to display readings.

6.2WEIGHING MACHINE

Digital Weight Indicator also commonly called Weight Indicator is a system of indication or recording of the selector type or one that advances intermittently in which all values are presented digitally, or in numbers. In a digital indicating or recording element, or in digital representation, there are no graduations. We used this device to measure PCM.

6.3GLUE GUN

Hot melt adhesive (HMA), also known as hot glue, is a form of thermoplastic adhesive that is commonly sold as solid cylindrical sticks of various diameters designed to be applied using a hot glue gun. The gun uses a continuous duty heating element to melt the plastic glue, which the user pushes through the gun either with a mechanical trigger mechanism on the gun, or with direct finger pressure.

The glue squeezed out of the heated nozzle is initially hot enough to burn and even blister skin. The glue is tacky when hot, and solidifies in few seconds to one minute. Hot melt adhesives can also be applied by dipping or spraying. In industrial use, hot melt adhesives provide several advantages over solvent-based adhesives. Volatile organic compounds are reduced or eliminated, and the drying or curing step is eliminated.

7CALCULATIONS

1) Area of reflector= $l * b$= 2*1
= 2 m^2
2) Useful energy in collector can be calculated by,
$Q_u = m \cdot C_p (T_{out} - T_{in})$
Where, m= mass flow rate (Kg/s)
C_p= Specific heat capacity (kJ / Kg-K)
T_{out}, T_{in} = Temperature at inlet and outlet
3)Solar energy in the trough aperture
$Q_s = A_a * G_b$
Where, A_a= Area of aperture
G_b = Solar beam radiation
4)Efficiency
$\eta = Q_u / Q_s$
5)Total Heat (Q)
$Q = m \cdot C_p \cdot dt$
Where, m = mass
C_p = Specific heat
dt = temperature difference
6) Heat conduction Equation = $- k \cdot A \cdot dt$
Where, k= coefficientof heat conduction
A= area
7) Heat convection Equation = $h \cdot A \cdot dt$
Where, h = convection coefficient

7 SPECIFICATIONS OF THE DEVICE

Sr. No.	Application	Maximum Temperature required	Time
1	Solar Oven	100 – 130 degrees Celsius	1 hour
2	Solar Hatchery	30 – 45 degrees Celsius	22 days
3	Solar Dryer	30 – 60 degrees Celsius	2 days
4	Solar water heater	40 – 80 degrees Celsius	1 hour

8PROPERTIES OF PHASE CHANGE MATERIAL

Phase Change Materials (PCM)	Paraffin wax (Dryer, Hatchery, Heater)	KNO3 +NANO3 Salt (Oven)
Melting point	51 – 60 degrees Celsius	220 degrees Celsius
Maximum Temperature	80 degrees Celsius	220 degrees Celsius
Density	835	2200 Kg/m^3
Latent heat	176 KJ/kg	146 J/kg

Specific heat	2.8 KJ/Kg K	4.10 J/kg k

9 PRICE ESTIMATION

Components	Price (in Rs.)
Steel box	3200
PCM	4000
Copper tubes	1320
Temperature sensors+Valves	1500
Reflector	1000
Collector tube	500
Electronic circuit	1000
Insulation	500
Travelling charges	2000
Efforts taken	2000
Total	17020

9ADVANTAGES

1) It does not create any pollution.
2) It can provide relief to those who don't have Electricity connection.
3) Low investment cost.
4) Low maintenance cost.

10DISADVANTAGES

1) It uses potentially harmful chemicals
2) It is not really proven to be effective
3) It can pose a negative risk for living organisms.

11CONCLUSION

In light of this evidence, it is crystal clear that the device is used for multiple purpose and the efficiency is increased as per application. Farmers can get the direct advantage by using the device on their own. Use of solar energy reduces the load on power grid and also helps in reducing pollution.

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