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Solar Water Heating System

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Abstract

In solar heater water is heated by the use of solar energy. Solar heating systems are generally composed of solar thermal collectors, fluid system to move the heat from the collector to its point of usage. The systems may be used to heat water for a wide variety of uses, including home, business and industrial uses. In many climates, a solar heating system can provide up to 85% of domestic hot water.

Solar energy provides power security, enabling you to continue getting power even when utility power is disrupted.

Business can save 40% to 80% on electric or fuel bills by replacing their conventional water heater with a solar water heating system.

Home solar heating can lead to saving of 85% on utility bills over the costs of electric water heating.

Using solar energy is free and it is an environmentally friendly source of power. Solar energy can be integrated with existing energy methods, such as wood stove and demand boiler, to produce 100% of the required thermal loads.

Keywords-Solar Energy, Solar Thermal collectors, Passive Solar water heater system (PSWHS), Active Solar water heater system (ASWHS).

1. Introduction

A low cost pipe type solar water heater having a capacity of 100 liter for the storage use in urban as well as rural areas has been developed. To minimize the cost, the absorber and the storage tank has been integrated together i.e. it is built storage tank. The unit works on push through principle i.e. hot water will come out from the outlet when the cold water in it through the outlet. The unit consist of ten number of pipe fabricated from 34SWG copper pipe. The entire ten pipes are placed parallel to each other with a net spacing of 1201 µm between them. The free edge at the sites not to exceed 60 mm from centre of the extreme and riser tube.

The unit as a whole is housed in aluminum sheet cover box with ordinary window glass in front. The whole unit has been placed in an inclined position, depending upon the latitude of the place and oriented towards south direction. A number of tests has been conducted for it . The maximum temperature of water at 1500hrs in winters is 60-70 degree Celsius. The hot can be withdrawn at the rate of 15-30 liters hourly or two hourly.

This water heater can be easily coupled with electric geyser. This combined system will conserve electricity and result in overall economy. Feasibility studies carried in this respect show that about 50% electrical energy consumed in the geyser can easily be saved by integration of solar water heater with electric geyser. Considerable amount of fuel can be saved by using this water heater for daytime use for taking bath and washing clothes, utensils etc.

2. PRINCIPLE:

This is passive type solar water heater. This requires no pumping for circulation of water. Water is circulated with the function of natural convection. Thus this solar heater is based on the principle of natural convection. In this solar water heater. Collector absorbs the radiation from the sun. Cold water comes from the storage tank flows through collector pipe and gets heated there. Now the density of hot water is low as compared to cold water .So the hot water start flowing in upward direction and goes to storage tank .The hot water stored in the tank can be used for various applications.

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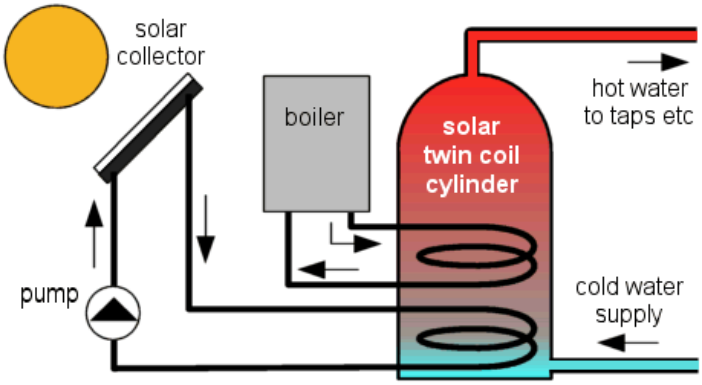
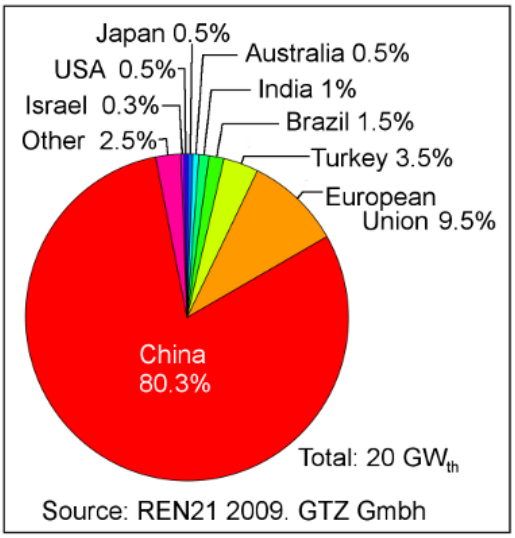




Solar Water Heater:

Solar water heater heats the water by the use of energy. These are generally composed of solar thermal collectors ,a fluid system to move the heat from the collector to its point of usage . The system may use for pumping the fluid, and have a reservoir tank for heat storage and subsequent use. The system may be used to heat water for a wide variety of uses including homes, business and industrial uses. Heating swimming pool, under floor heating or energy input for space heating or cooling are more specific examples.

In many climates, a solar heating system can provide up to 85% of domestic hot water energy. This can include domestic hot water energy.

System design requirements

The type, complexity, and size of a solar water heating system is mostly determined by:

• Changes in ambient temperature and solar radiation between summer and winter.
• The changes in ambient temperature during the day-night cycle.
• The possibility of the potable water or collector fluid overheating.
• The possibility of the potable water or collector fluid freezing.

The minimum requirements of the system are typically determined by the amount or temperature of hot water required during winter, when a system's output and incoming water temperature are typically at their lowest. The maximum output of the system is determined by the need to prevent the water in the system from becoming too hot.

Freeze protection

Freeze protection measures prevent damage to the system due to the expansion of freezing transfer fluid. Drainback systems drain the transfer fluid from the system when the pump stops. Many indirect systems use antifreeze (e.g.Propylene glycol) in the heat transfer fluid. In some direct systems, the collectors can be manually drained when freezing is expected. This approach is common in climates where freezing temperatures do not occur often, but is somewhat unreliable since the operator can forget to drain the system. Other direct systems use freeze-tolerant collectors made with flexible polymers such as silicone rubber. A third type of freeze protection is freeze-tolerance, where low pressure polymer water channels made of silicone rubber simply expands on freezing. One such collector now has European Solar Keymark accreditation, following extra durability testing.

Overheat protection

When no hot water has been used for a day or two, the fluid in the collectors and storage can reach very high temperatures in all systems except for those of the drainback variety. When the storage tank in a drainback system reaches its desired temperature, the pumps are shut off, putting an end to the heating process and thus preventing the storage tank from overheating. One method of providing over heat protection is to dump the heat into a hot tub. Some active systems deliberately cool the water in the storage tank by circulating hot water through the collector at times when there is little sunlight or at night, causing increased heat loss. This is most effective in direct or thermal store plumbing and is virtually ineffective in systems that use evacuated tube collectors, due to their superior insulation. No matter the collector type, however, they may still overheat. High pressured sealed solar thermal systems versions ultimately rely on the operation of temperature and pressure relief valves. Low pressure, open vented ones have simpler, more reliable safety controls, typically an open vent.

Passive and active systems

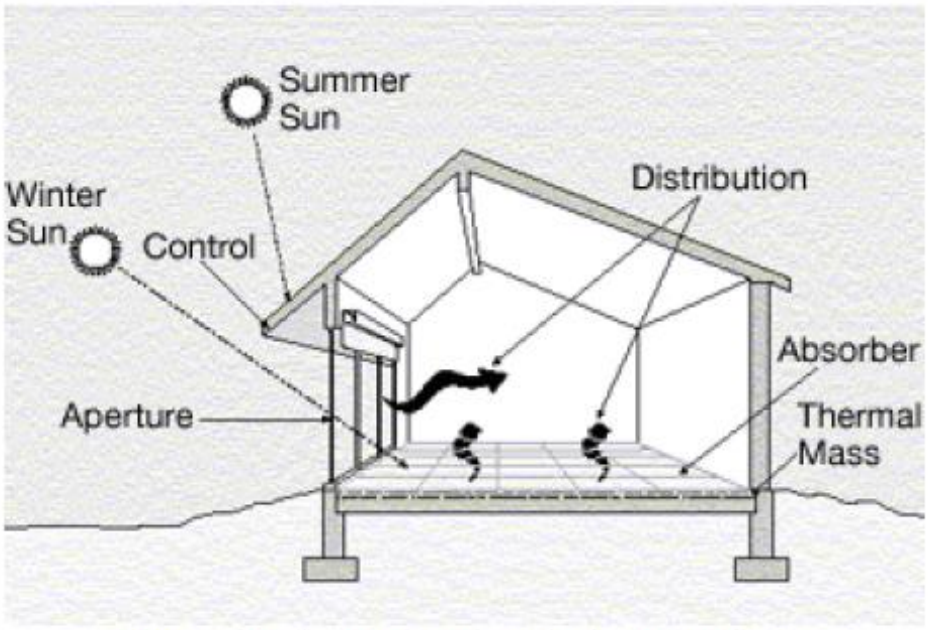
Passive systems rely on heat-driven convection or heat pipes to circulate water or heating fluid in the system. Passive solar water heating systems cost less and have extremely low or no maintenance, but the efficiency of a passive system is significantly lower than that of an active system. Overheating and freezing are major concerns.
Active systems use one or more pumps to circulate water and/or heating fluid in the system.

Though slightly more expensive, active systems offer several advantages:

• The storage tank can be situated lower than the collectors, allowing increased freedom in system design and allowing pre-existing storage tanks to be used.
• The storage tank can always be hidden from view.
• The storage tank can be placed in conditioned or semi-conditioned space, reducing heat loss.

• Drainback tanks can be used.
• Superior efficiency.
• Increased control over the system.

Modern active solar water systems have electronic controllers that offer a wide range of functionality, such as the modification of settings that control the system, interaction with a backup electric or gas-driven water heater,calculation and logging of the energy saved by a SWH system, safety functions, remote access, and informative displays, such as temperature readings.



Elements of passive solar design, shown in a direct gain application

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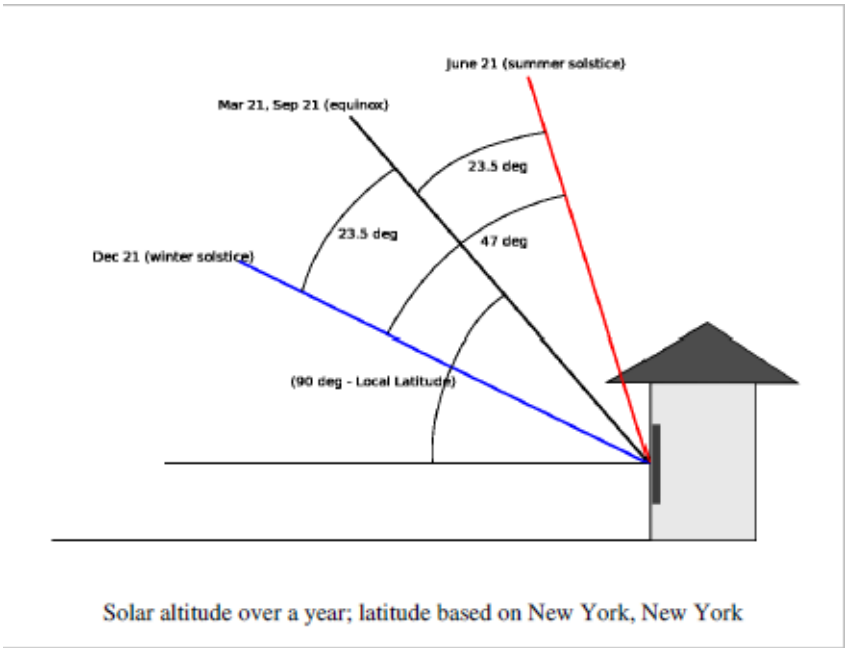
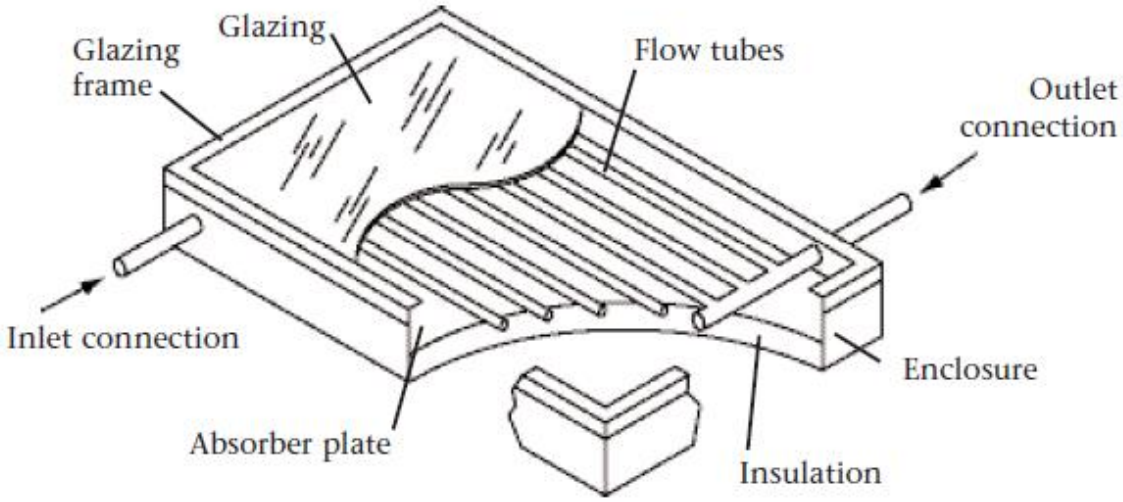


Solar altitude over a year; latitude based on New York, New York



Glazed flat-plate collector

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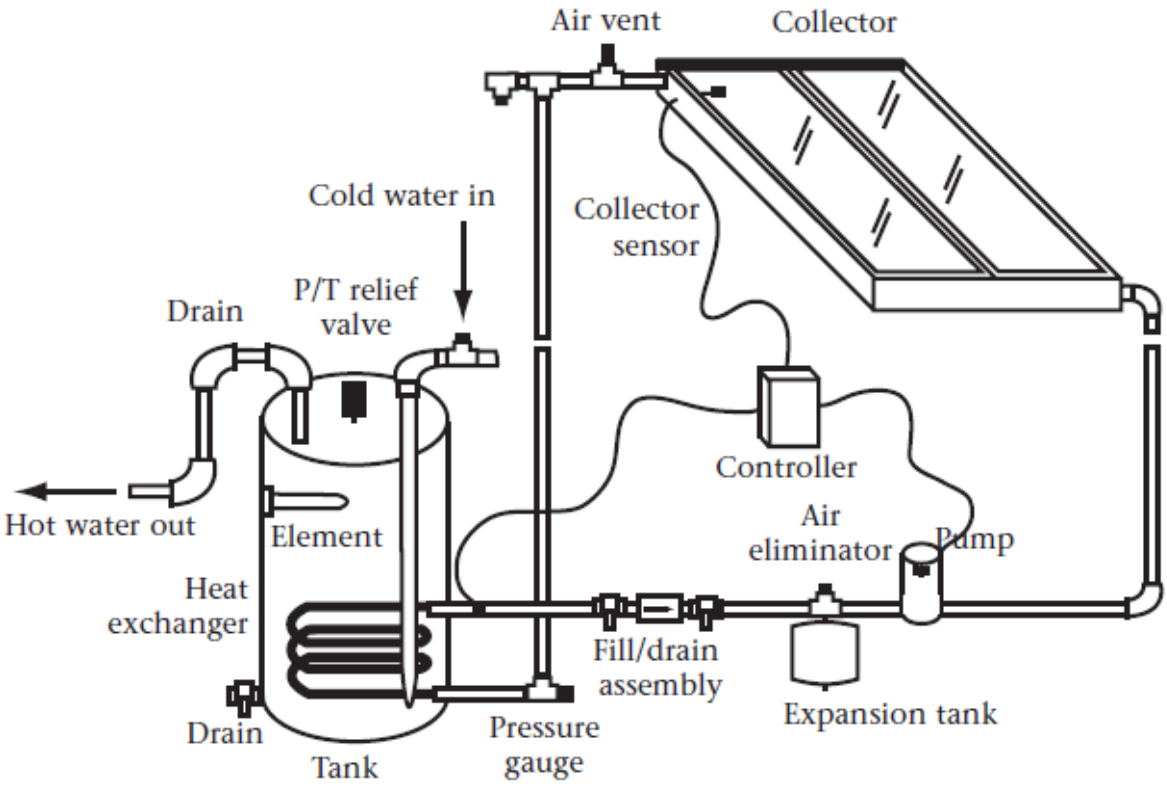

Technique and design:

In order to heat water using solar energy, a collector is fastened to the roof of a building, or on a wall facing the sun. In some cases, the collector may be freestanding. The collector could be made of a simple glass topped insulated box with a flat solar absorber made of sheet attached to copper pipes and painted black, or a set of metal tubes surrounded by an evacuated glass cylinder. A simple water heating system would pump cold water out to a collector to be heated water flows back to a collection tank.

The typical 50 gallion electric water heater uses 11.1 barrels of oil a year, which translates into the same amount of oil used by a typical 4-door sedan driven by the average consumer. Electrical utility companies often provide electricity by burning and releasing energy from fuels such as oil, coal and nuclear energy. An electrical home hot water heater sits on an electrical grid and may be driving the use of unclean fuels on the other end of the grid.

So using the solar water heaters to heat water is much reliable and appropriate thing than using our preciously non-renewable fuels.

SPECIFICATION OF COMPONENTS

Solar panel: Specification of different parts of solar panel is as below. This specifications is taken according to INDIAN STANDARD (IS 12933 PART : 5) for solar panel.

1 Absorber material: Absorber shall be of copper sheet and copper tube
Thickness of copper sheet : 34SWG
Riser specification:

Diameter of riser tube: 12.7+0.5mm
Thickness: 0.56mm
Number of riser tubes: 9

Header specification:

Diameter: 25.4+0.5mm
Thickness: 0.71mm
Projection outside: 40mm+0.5mm including flanges of the collector box
Number of header tubes:2

Space between riser tubes: 120mm maximum for centre to center of the riser. The free edges at the sides not to be exceed 60 mm from the centre of the extreme end riser tubes. For independent tins or joints in the sheet an overlap of minimum 2mm shall be provided.
coating of copper tubes and sheets: contain of this part is done with absorbability>0.92 and emmissivity<0.2. This is achieved by black powder coating.

Collector box materials:

Minimum aluminum extruded sections of size approximately 100mm*25 mm channel section and
thickness 1.6 mm for the sides.
sheet for bottem :
Thickness:0.71nun
Material: aluminium

Angles for cover box:
Thickness: 1.5mm
Dimensions:25mm*25mm*1.2mm
Material:aluminium

Front glazing:

Material: single piece glass plain.
Thickness: 4.8+0.3mm
Transmittance: 80'1"0(min)
General appearance of glass: free from bubbles/rough surface.
spacing between : 20 to 40 mm.

Collector box insulation:

Black insulation:
Material: rock wool
Thickness: 50 mm

Side insulation:
Material : rock wool
Thickness 25mm

Aluminium foil of thickness 0.01 mm to 0.015 mm is used of covering the side insulation

Header flange:
Material: brass
Diameter: 75 mm
Thickness: 4 mm

Grommet:
It is used for sealing between the inlet and outlet of header.
Materials : silicon rubber or butyl rubber
Outer diameter: 40mm
Inner diameter: 25mm
Grommet shall be suitable for a temperature up to 200°c.

Gasket:
It is in between flange and pipe.

Storage tank
The specification of different part of storage tank is as below.
Material : stainless steel with epoxy coating.
Shape : cubic
Length: 32cm
width: 32cm
Height: 102cm
Volume of tank: 32*32*102cm3= 104448 cm3
Now 1liter= 10UO cm3
So that the tank having capacity about 104.4 liters
Thickness of stainless steel sheet:20SWG

Insulation:

Material: glass wool
Thickness:1no. mm approx.
Density:48kg/cu.m.
Temperature limit: upto 250 °c
Chicken mesh is used as retaining material

Cladding of insulation:
Material: aluminium sheet
Thickness: 24SWG

Wooden Frame
It gives support to cladding. Aluminium sheet cover wooden frame along with glass wool
Length:18 inch
Width:19 inch
Weight: 47inch

Nipples:
Material: grey iron
Diameter:0.75mm
Length: 6 inch

Valves:

Gun metal valves are used.

Elbows:

Diameter: 0.75 inch
Material: mild steel.

Angles for fitting aluminium sheet:

Material: aluminium
Dimensions: 0.75* 0.75 inch

Instrumentation:
Temperature gauge: It is for hot water storage tank/outlet
Gun metal stainer at cold water inlet.piping:
Diameter:1inch
Material: grey iron.
Cock valve and tap:

Cock valve at cold water inlet and tap at hot water outlet.

The storage tank has five opening.

1 For cold inlet(from cold water tank)
2 For hot water outlet (for use)
3 ventilation.
4 Cold water to solar panel.
5 Hot water from solar panel

For cold water circulation black flexible pipes can be used

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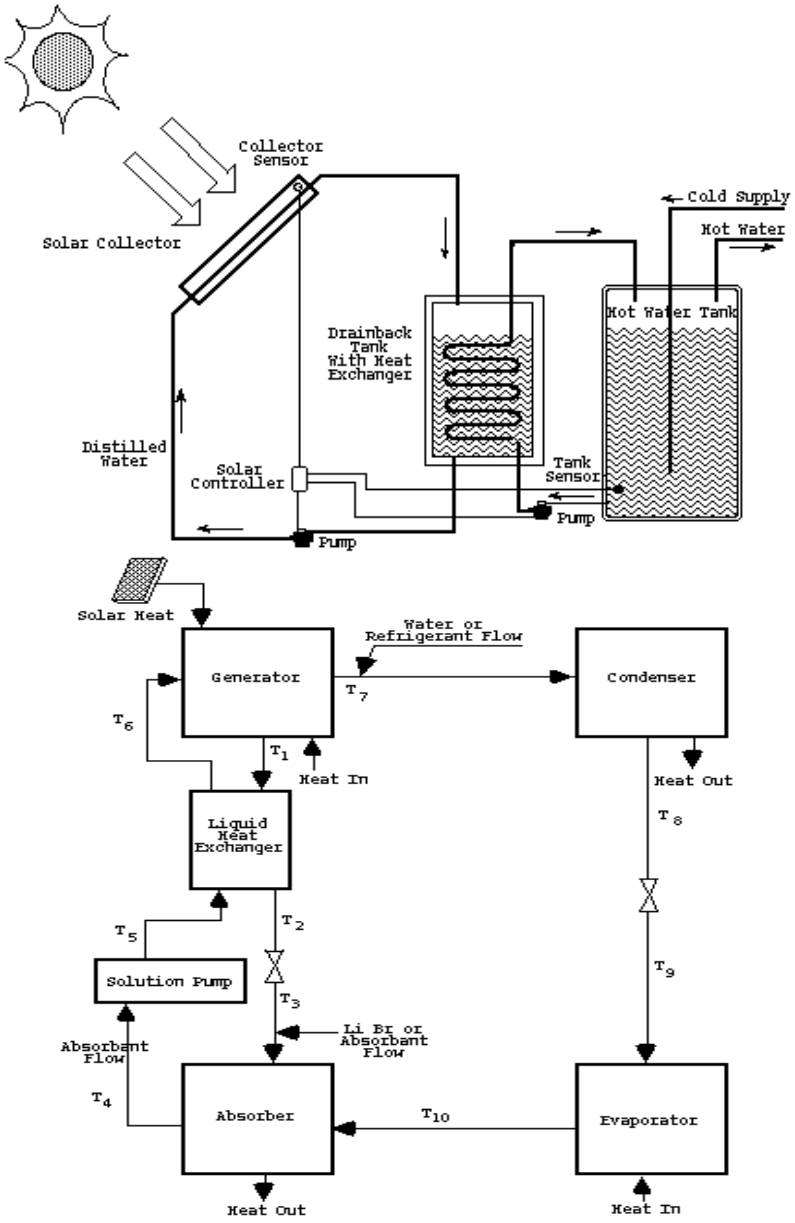

WORKING:

As we discussed in the principle, our solar water heater is based on the principle of natural convection. We supply old water to storage from external tank or water supply. Then cold water from tank flows through solar collector. As radiation fall on the collector, so the water flows through collector tube get heated and shirts flowing in upward

direction through outlet valve of panel and goes to storage tank for storage. We can use this water for various applications as discussed earlier. The flow of cold water from tank to solar panel is due to gravitational forces as height of tank provides head. Hot water flows from panel to storage tank due to the conventional process. As hot water has lower density than cold water, so hot water lift up and cold water occupy its position of hot water.

This is the working of solar water heater system. After assembling of different parts i.e. after completion of project, we made it work. We mount it at suitable place. We found that it heats the water. We measure the temperature of water. We found that it heats the water up to 70 °c.

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