SOLAR WATER HEATER

INTRODUCTION

Solar water heating (SWH) is the conversion of sunlight into heat for water heating using a solar thermal collector. A variety of configurations are available at varying cost to provide solutions in different climates and latitudes. SWHs are widely used for residential and some industrial applications. A sun-facing collector heats a working fluid that passes into a storage system for later use. SWH are active (pumped) and passive (convection-driven). They use water only, or both water and a working fluid. They are heated directly or via light-concentrating mirrors. They operate independently or as hybrids with electric or gas heaters. In large-scale installations, mirrors may concentrate sunlight onto a smaller collector. The global solar thermal market is dominated by China, Europe, Japan and India, although Israel was one of the first countries to mandate installation of SWH in 1980, leading to a flourishing industry.

HISTORY

Records of solar collectors in the U.S. date to before 1900, involving a black-painted tank mounted on a roof. In 1896 Clarence Kemp of Baltimore enclosed a tank in a wooden box. Thus creating the first batch water heater as they are known today. Frank Suman built the world's first solar thermal power station in Maadi, Egypt, using parabolic troughs to power a 60-70 horsepower engine that pumped 6,000 gallons of water per minute from the Nile River to adjacent cotton fields.

Flat-plate collectors for solar water heating were used in Florida and Southern California in the 1920s. Interest grew in North America after 1960, but especially after the 1973 oil crisis. Solar power is in use in Australia, Canada, China, Germany, India, Israel, Japan, and Portugal. Romania, Spain, the United Kingdom and the United States.

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
- Changes in ambient temperature during the day-night cycle
- Possibility of the potable water or collector fluid overheating or 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. Drain back systems drain the transfer fluid from the system when the pump stops. In some direct systems, collectors can be manually drained when freezing is expected. This approach is common in climates where freezing temperatures do not occur often, but can be less reliable than an automatic system as it relies on an operator.

A third type of freeze protection is freeze-tolerance, where low pressure water pipes made of silicone rubber simply expand on freezing. One such collector now has European Solar Key mark accreditation.

❖ OVERHEAT PROTECTION

When no hot water has been used for a day or two, the fluid in the collectors and storage can reach high temperatures in all non-drain back systems. When the storage tank in a drain back system reaches its desired temperature, the pumps stop, ending the heating process and thus preventing the storage tank from overheating.

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, losing heat. 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. Any collector type may still overheat. High pressure, sealed solar thermal systems ultimately rely on the operation of temperature and pressure relief valves. Low pressure, open vented heaters have simpler, more reliable safety controls, typically an open vent.

SWOT ANALYSIS

STRENGTH

- Reduces electricity bills.
- Provides tax incentives.
- Pairs with solar battery storage.
- Environment friendly.

WEAKNESS

- Solar water heaters require direct sunlight to function
- The system does not function on cloudy, rainy, or foggy days.
- Installation requires the use of new hot water cylinder.
- Annual maintenance is recommended to check the pump and antifreeze.
- Solar heaters require sufficient roof space to accommodate them.

OPPURTUNITIES

Solar water heater can be used at homes for producing hot water that can be used for bathing, cleaning, and washing.

Fuel savings: A 1000 liters capacity of solar water heater can replace geyser for residential use and saves 1500 units of electricity annually.

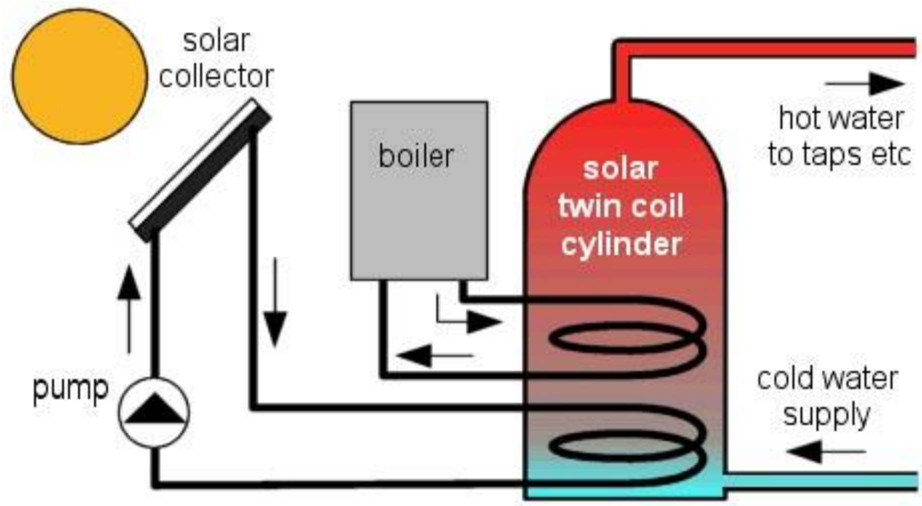
Saves cost on power generation: The use of 1000 solar water heater of 100 liters capacity each can contribute to a peak load saving of 1MW

Environmental benefits: A solar water heater of 1000 liters capacity can prevent emission of 1.5 tones of carbon dioxide per year.

THREATS

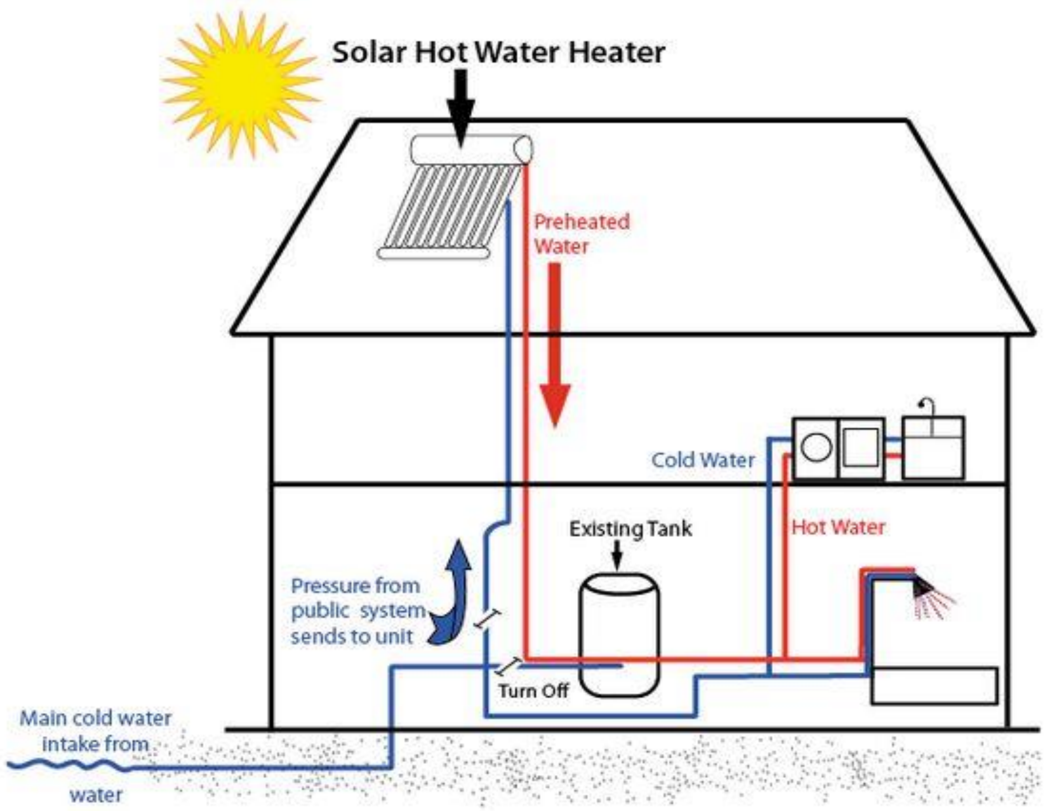
Although solar energy has been called as one of the clean energy sources, it still provides some sort of risk to the environment when being used in public.

BLOCK DIAGRAM



WORKING

- It is an array of solar collectors to collect solar energy and an insulated tank to store hot water.
- Both are connected to each other.
- During the day time, water in solar collectors gets heated.
- Hot water then stored in the tank can be used for various applications.



COMPONENTS

- ✓ Solar panels
- ✓ Inverters
- ✓ Electric meter
- ✓ Storage tank
- ✓ Connecting pipes
- ✓ Temperature sensor
- ✓ Circulating pump

❖ COLLECTOR

Solar thermal collectors capture and retain heat from the sun and use it to heat a liquid. Two important physical principles govern the technology of solar thermal collectors

Any hot object ultimately returns to thermal equilibrium with its environment, due to heat loss from conduction, convection and radiation. Efficiency (the proportion of heat energy retained for a predefined time period) is directly related to heat loss from the collector surface. Convection and radiation are the most important sources of heat loss. Thermal insulation is used to slow heat loss from a hot object. This follows the Second law of thermodynamics (the equilibrium effect').Heat is lost more rapidly if the temperature difference between a hot object and its environment is larger. Heat loss is predominantly governed by the thermal gradient between the collector surface and the ambient temperatures. Conduction, convection and radiation all occur more rapidly over large thermal gradients (the delta-t effect).

❖ CONTROLLER

A differential controller senses temperature differences between water leaving the solar collector and the water in the storage tank near the heat exchanger. The controller starts the pump when the water in the collector sufficiently about 8-10 C warmer than the water in the tank, and stops it when the temperature difference reaches 3-5 °C. This ensures that stored water always gains heat when the pump operates and prevents the pump from excessive cycling on and off. (In direct systems the pump can be triggered with a difference around 4 "C because they have no heat exchanger.)

❖ TANK

The simplest collector is a water-filled metal tank in a sunny place. The sun heats the tank. This was how the first systems worked. This setup would be inefficient due to the equilibrium effect as soon as heating of the tank and water begins, the heat gained is lost to the environment. and this continues until the water in the tank reaches ambient temperature. The challenge is to limit the heat loss

- ✓ 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 be hidden from view.
- ✓ The storage tank can be placed in conditioned or semi-conditioned space, reducing heat loss.

ADVANTAGE

- Simple to construct and install
- No or negligible running cost
- Almost free from maintenance.
- It saves time and high grade from of electric energy.
- Cost is low and economically competitive.
- They are efficient. Approximately 80% radiation is turned into heat energy.

DISADVANTAGE

- Freezing problem.
- Solar thermal panels can only heat water.
- There are a few parts of the system like the pump and antifreeze which need to be checked to ensure that they are performing optimally. That's why annual maintenance is recommended.
- A new hot water cylinder will need to be installed so space is required to install this.

BENEFITS OF SOLAR WATER HEATER

The energy saved from using a solar water heating system helps to reduce domestic energy demand from power utilities. A solar water heater is a long-term investment that will save money spent on water heating after the system has paid for itself. In addition to the reduced electrical energy and cost savings from water heating, there are several other benefits derived from using the sun's energy to heat water. Most solar water heaters come with an additional water tank, which feeds the conventional hot water tank. Users benefit from the larger hot water storage capacity and the reduced likelihood of running out of hot water. Some solar water heaters do not require electricity to operate. For these systems, hot water supply is secure from power outages, as long as there is sufficient sunlight to operate the system. Solar water heating systems can also be used to directly heat swimming pool water, with the added benefit of extending the swimming season for outdoor pool applications.