3.3. What is solar water heating system?

Solar water heaters are devices that use the energy from the sun to heat water for various purposes, such as building heating, pool heating, and providing hot water for showers and other household needs. These heaters are classified into two categories based on how they transfer heat and store it. Some have a built-in heat storage tank, while others connect to a remote storage tank that is located either near the collector or inside the building.

One of the main advantages of solar water heaters is their efficiency in generating hot water. A single installation can produce up to 200 liters of hot water daily, making them a cost-effective choice for both residential and commercial use. In fact, it is estimated that the payback period for a commercial solar water heater is only 3 years.

To maximize the efficiency of solar water heaters, it is important to choose an optimal location for the collectors. These devices are typically installed on the south-facing slope of a roof to take advantage of the sun's rays and to keep them out of reach of intruders and animals. However, it is also important to ensure that there are no visible obstacles, such as trees or nearby buildings, that could block the sun's rays. Additionally, the location should be convenient for maintenance and repairs.

The angle at which the collectors are installed also plays a role in their efficiency. In the summer, the angle should be calculated using the formula: (latitude + (latitude – 22.5 degrees)) ÷ 2. In the winter, the formula is: (latitude + (latitude + 22.5 degrees)) ÷ 2. Some solar water heaters come with automated sun tracking systems that adjust the angle and position of the collectors based on the season, using an electric motor.

Proper installation of a solar water heater is important to ensure its efficiency. If the collectors are not positioned correctly, the temperature of the water may not reach its maximum potential, which can reduce the overall efficiency of the system. With the successful placement of the panel, the stagnation temperature can reach up to 300°. Such a result is not easy to achieve, most often the temperature does not exceed 60°- 65°, but it is quite an acceptable result for the heating system. It is worth taking the time to carefully consider the placement and angle of the collectors to get the most out of a solar water heater.

Solar heating system consisting of the following elements (Fig. 3.3.1):

1. **Collector:** A device that captures thermal energy and conveys it to a heat transfer medium.
2. **Accumulation tank:** A container in which heated water is stored and cooled coolant is replaced with the newly heated fluid.
3. **Heating circuit:** A system, such as a radiator system or underfloor heating system.

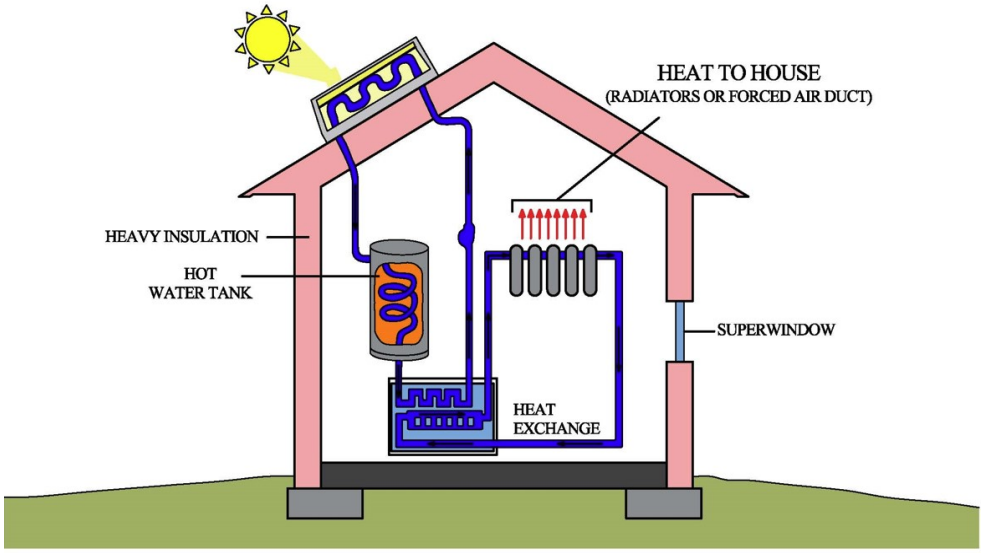

Fig.3.3.1. Solar heating system. (Source: own elaboration).

According to Jäger, K., Isabella, O., Smets, Arno H.M., René A.C.M.M. van Swaaij, Zeman, M. (2014), there are two types of solar thermal heating systems:

1. ***Passive.*** The operation of the system runs entirely independently, without any additional devices. The energy is received and transmitted directly to the heat transfer medium, which flows by gravity into the storage tank. An example of a passive system is a dark-colored water tank for better heating. Heating water in it occurs without additional assistance, it just needs to put the tank under the sunlight. Circulation is also natural, warm layers rise, giving way to cold layers, which, being heated, in turn give way to cooler layers. The simplicity and lack of maintenance of such plants are attractive, but their operation is highly unstable, and the efficiency is only a fraction of what is physically possible.

2. ***Active.*** An active solar water heating installation can solve all the problems with the circulation mode and get the maximum heat transfer efficiency (Fig. 3.3.2). Typically, the heating circuit has a closed design for the circulating water or oil. In the normal state, the natural circulation of the oil can not be obtained, but, with the help of a circulating pump, you can get a high degree of heat transfer inherent in oil due to the physical characteristics.

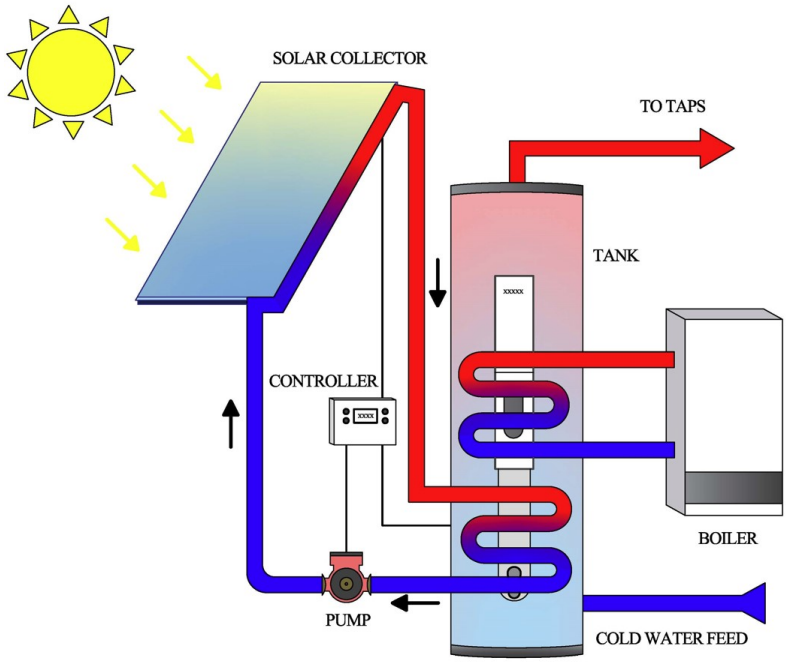

Fig.3.3.2. Solar termal system circuit. (Source: own elaboration).

There are several factors that can impact the effectiveness of a solar water heater, including the type of collector used and the external conditions of the region. The climate, weather, and number of sunny days can all play a role in the performance of the system.

Collectors for solar water heaters come in a variety of types, each with its own method of absorbing or accumulating heat. The most appropriate type for a particular installation will depend on the specific needs and conditions of the building.

All equipment is divided into two groups:

1. ***Vacuum tube collectors*** – Vacuum tube collectors use a process called "thermosyphon" to heat water. In this process, a fluid with a low boiling point, such as water or a glycol-water mixture, is circulated through tubes that are coated with a material that absorbs solar energy efficiently. The fluid is heated as it passes through the tubes, and then rises to a storage tank where the heat is transferred to the water. The cooled fluid then returns to the bottom of the tubes to be reheated. This process is aided by the fact that the vacuum inside the tubes helps to prevent heat loss, allowing the system to be highly efficient even in cold weather (Fig. 3.3.3).

Fig.3.3.3. Solar vacuum tube collectors. (Source: https://commons.wikimedia.org/wiki/File:Col%C2%B7lectors_solars_de_tub_de_buit.JPG, 2021).

2. ***Panel collectors*** – Panel collectors are another type of solar water heater that uses the greenhouse effect to generate heat. These collectors consist of a transparent surface, such as regular or tempered glass, that allows sunlight to pass through and hit an absorber inside. The absorber is usually made of a copper plate placed between two panes of glass, and its job is to absorb the heat from the sun's rays and transfer it to a circulating fluid. The quality of the absorber coating is important because it determines the thermal efficiency of the panel collector. Panel collectors are typically housed in a casing made of anodized aluminum and may have additional features such as anti-vandal or self-cleaning properties (Fig. 3.3.4).

Fig.3.3.4. Flat plate solar thermal collectors. (https://commons.wikimedia.org/wiki/File:MT-Power_Masdar_City.jpg, 2021).

References

1. Jäger, K., Isabella, O., Smets, Arno H.M., René A.C.M.M. van Swaaij, Zeman, M. (2014). *Solar Energy. Fundamentals, technology and systems*. Delft University of Technology.