Improving storage efficiency in the performance of a solar heater using Polystyrene

Kawthar Kazem Mankhi-
Ministry of education. Directorate Barada school. Al-Shattra. Thi-qar , IRAQ

Abstract:

The current work aims to improve the efficiency of storing thermal energy inside the solar water heater for the longest possible period, and thus increase the efficiency of performance and production of the flat-plate solar heater, through the use of environmentally available materials, like cork (Polystyrene**)**.

Introduction The solar heater is one of the most important thermal applications of solar energy. It has many advantages, including its ability to absorb and store heat(1]. It does not emit carbon monoxide as it does in a gas heater(2]. Also, solar heaters are not subject to corrosion, as is the case in gas heaters, where the burners and chimneys are exposed to corrosion and mechanical damage(3]. The solar heater is also characterized by the ease and speed of installation, in addition to the ease of maintenance, which avoids the risks of fire and suffocation. It is also characterized by the highest levels of safety compared to gas and electric heaters, and it does not make sound or noise(4]. The solar heater consists of a solar collector, heat exchangers and storage tank(5]. In our work, we designed the flat plate collector because it is easy to design and can be installed from easy materials available in nature. We seek to improve the efficiency of the heater's work by increasing the ability to store energy while radiation is present, and at the same time reducing the percentage of energy loss in the absence of radiation. The ability to retain thermal energy inside the heater for as long as possible is achieved by using heat insulating materials such as glass wool. And since this material is economically costly and due to the presence of heat-insulating materials at a lower cost, such as the cork material that is abundant and often thrown with waste, we designed a solar heater in this work using cork (polystyrene) which is the thermal insulator inside the wooden box, and test the amount of its heat insulation was compared to the glass wool material(6,7,8)

Fiberglass is one of the most common thermal insulation materials, and it consists of very fine glass fibers, where fiberglass is manufactured with a medium and high density that also depends on the area of thermal insulation, where high-density fibers are used to insulate spaces with limited voids. Glass is melted and then blown into fibers using an insulating machine.(9)

As for Polystyrene is a versatile plastic material, where styrene is known as a basic chemical used in the manufacture of many products, and there is what is called expanded polystyrene or extruded polystyrene, which is a foam material in which polystyrene is manufactured, and it is characterized by the presence of a high percentage of air inside it, estimated at about (95%), which makes it an insulator Excellent thermal (10)

Theory Insulators Some materials in pure form are insulators, but they nevertheless behave otherwise if they are mixed with small quantities of other elements, for example, most types of ceramics are excellent insulators, but if other types of materials are mixed with them, they behave as conductive materials They are not insulating materials, and also pure water is an insulator, while not completely pure water works weakly as an insulating material, and it should be noted that the shape and size of the material affects whether or not it is an insulating material, and among the insulating materials: rubber, glass, diamonds, wood, cotton, plastic and asphalt quartz and porcelain, Thermal insulators aim to reduce the rate of heat transfer through methods such as conduction or radiation, and for this purpose all insulators share some characteristics such as thermal conductivity, heat resistance, air permeability.

the thermal insulation can be achieved by special engineering methods or processes, as the heat flow occurs mainly as an inevitable result of contact between objects with different temperatures, thermal insulation provides a separate isolation area so that thermal conductivity is canceled or thermal radiation is reflected instead of being absorbed by the body with a low temperature, so low thermal conductivity is equivalent to high insulating capacity, and in thermal engineering it is Other important factors affecting insulation are the density of the object and its specific heat capacity. Thermal insulation is performed by wrapping a material with low thermal conductivity in another with a high thickness. Reducing the exposed surface area can reduce heat transfer.

Materials are classified as insulating or other materials according to their electrical conductivity, and the reasons for the occurrence of thermal insulation can be understood in atomic terms, as the electrons in the atom can contain certain well-defined energies, and according to their energies, the electrons occupy certain energy levels, in the atom Typically, there are many electrons. The lower energy levels are filled by a quantum mechanical rule known as the Pauli exclusion principle. In solids, the number of atoms and therefore the number of levels is very large. Most of the higher energy levels overlap continuously except for some ranges where there are no levels at all. Regions that do not have energy levels are referred to as band gaps. The highest energy levels that electrons occupy are the valence levels. In thermal insulation materials, electrons completely fill the valence levels. and for many materials including metals, the resistance to charge flow tends to increase with temperature, so the resistance of

insulators decreases rapidly with temperature which is often used to explain what is thermal insulation and what is electrical conductivity, as increasing thermal energy leads to Filling some electrons in the energy levels so that they are subject to the influence of the electric field affected by an external electric field. The energy difference between the valence levels has a strong effect that results in the thermal insulation of many materials. We have used cork as a thermal insulator in our current work and among its properties that distinguish it from other thermal insulators are:

• Lightness is a very light raw material, and can float. • Flexibility and Compressibility Each cork stopper is made up of approximately 800 million airtight cells. decompressed and returned to their original shape. Cork is the only solid material that, when compressed on one side, does not increase in volume on the other. This feature allows it to adapt to changes in temperature and pressure, without compromising its integrity.• Impermeability , it is practically impermeable to liquids and gases.• Decay resistance Cork is highly resistant to moisture, and therefore to subsequent oxidation and rotting.• Cork insulation is an excellent thermal and acoustic insulator and vibration insulator.• Biodegradable and Recyclable Cork is a natural raw material that is 100% biodegradable and recyclable.

work:- The first step in the work was to manufacture two heaters that are completely similar in terms of components and measurements. The only difference is the type of insulating material used. In the first heater we used glass wool and in the second we used industrial cork(Polystyrene))(11,12,13(. (The second practical step was to test the performance of the two heaters by placing them side by side under the same conditions and at the same angle of inclination (45) in the city of Shatrah located In southern Iraq.(11(Data was recorded over three days in February 2023.starting from ten o'clock until two o'clock in the afternoon.

Results and Discussion: - The most important practical step we took was the measurement and recording of temperatures as a function of daylight hours. The

temperature of the cold water and the temperature of the hot water were recorded in the two models every hour from eight o'clock in the morning until two o'clock in the afternoon for a period of three days in February 2023, then the heat gain of the two heaters was calculated. Where T1, the water temperature of the first model tank is the red line. T2 We have noticed that as shown in Figure No (2) an (3) the second heater is the most efficient in heating, although the difference is negligible in the temperature of the hot water in the two heaters. This is due to the thermal insulation efficiency of the synthetic cork and maintaining a higher temperature for the water produced from this heater**.**

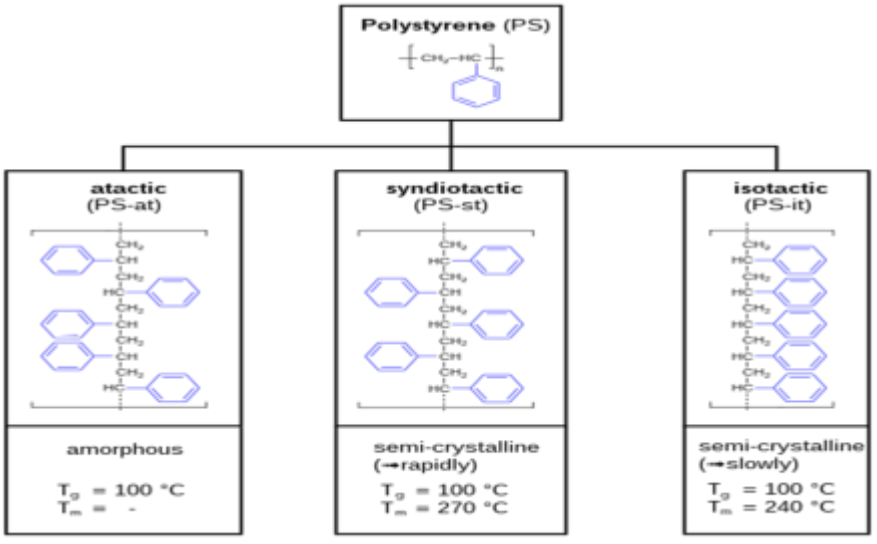


Figure (1) It represents the structural construction of polystyrene

Figure (2) temperatures in a day (15-2-2023

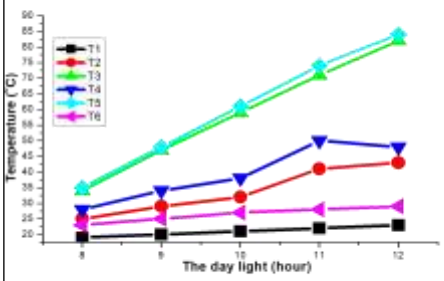
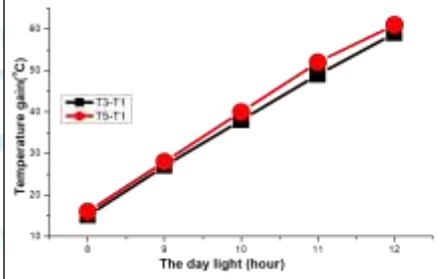


Figure (3) temperature gain in a day (15-2-2023)



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