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REVIEW OF MATERIALS FOR SOLAR THERMAL COLLECTORS

Sachchidanand kumar[1], Raj kumar[2], Mukesh Gupta[3]

[1] M.Tech.,Student, Department of Mechanical Engineering, JCBUSTYMCA, Faridabad-121006, Haryana, India

[2]Professor, Department of Mechanical Engineering, JCBUSTYMCA, Faridabad-121006, Haryana, India

[3] Professor, Department of Mechanical Engineering, JCBUSTYMCA, Faridabad-121006, Haryana, India
Email: sachit355@gmail.com[1], rkumar_08@yahoo.com[2]

Abstract

To cover the principle contributions and advancements in solar thermal collectors through concentrating on materials, heat transfer qualities and assembling difficulties. A scope of distributed papers and web inquire about including research work at different solar collectors (flat plate, heat pipe tube, evacuated tube) were utilized. This paper satisfies recognized data about materials and heat exchange properties of materials and assembling difficulties of these three solar collectors.

Keywords: *physical properties of materials, energy - saving, heat transfer, solar energy*

1.Introduction

The most common use of solar collectors is the heating of water for household purposes. This type of solar water heater has been designed, developed and studied in detail [1]. The base unit in this system is the solar collector. Depending on the type of solar collector used, solar energy can be absorbed more efficiently. Each type of solar collector is designed to absorb shorter wavelengths of light received from the sun, but the greenhouse effect prevents the wavelengths from leaking heat and then supplies energy directly or indirectly to a hot water storage tank. Flat collectors have been the subject of many studies. The flat plate collectors are either corrugated, with a connecting tube or with a tube in a plate, with different clamping arrangements [2]. The performance of the flat collector sensor depends on various design parameters, such as Number of covers, type and thickness of the glazing, antireflective coating of the protective glass, heat mirror coating of the inner glass Type of coating on the sensor plate, distance between sensor and inner glass, gap between sensor and inner glass, stopping the convection movement between sensor plate and inner glass with a transparent insulating material (TIM), type of insulation used, etc., which are all responsible for the performance of a flat plate collector. There are various other operating parameters such as fluid mass flow, solar radiation, inlet temperature, ambient temperature, wind speed, sky conditions, dust on the glass, which are also affected by sensor performance. The heat loss is indicated by the heat loss factor or k value. This is expressed in watts per square meter of sensor area and the respective temperature difference between the absorber and its surroundings. The higher the temperature difference, the greater the heat loss. From a certain temperature difference, the heat loss is equal to the energy efficiency of the sensor, so that no energy is supplied to the solar circuit. A good collector has a high conversion factor and a low k value.

2. Appropriate features of solar thermal collector materials

2.1 Transparent cover

The transparent cover serves as a heat sink for infrared radiation (heat radiation). Therefore, radiation losses and convection to the atmosphere are reduced. Along with the frame, the cover protects the absorber from adverse weather conditions. Transparent cover materials properties: low iron content glass, UV-resistant plastic coating, fiberglass and reinforced plastic with "TEDLAR" coating. Among the different types of tempered glass sheets, the low-iron glass has maximum transmission and the lowest reflection of sunlight. Since the cost of low-iron glass is lower than the increase in efficiency, it is worth it. Some types of plastic glazing are still used on some solar collectors to reduce weight and costs, but can reduce performance and durability. Plastics inside a well-sealed collector can deteriorate rapidly and disperse by depositing a cloud of oily liquid condensed on the inner surface of the glazing. This fog will seriously reduce the efficiency of the collector. Plastic used in a collector may also result in limitations or restrictions on use in residential areas with high fire risk by local buildings and security services.

2.2 Insulation

The solar collectors are insulated with CFC-free polyurethane foam (PUF) as an insulating material. The use of an insulated PUF manifold and tank ensures superior performance with minimal heat dispersion. In conclusion, the PU rigid foam is an extremely effective material for thermal insulation and with a high strength / weight ratio at low temperatures. These intrinsic physical characteristics allow it to be extremely efficient compared to alternative products. The insulation must remain dry or lose all or most of its insulating value. Once the manifold has been assembled, the air trapped inside will contain moisture that will eventually condense and penetrate the insulation. To avoid this, quality collectors contain:

Porous bags of desiccating silica gel to absorb moisture. If the collector is properly sealed, it is not necessary to have access to the desiccant as it does not require renewal. Desiccant is also required for the space between windows when two covers are used. In general, the desiccant is contained in the hollow spacers that separate the two glass collectors and small holes on the surface of the spacers in front of the space between the panes allow trapped air to come in contact with the desiccant. If the desiccant is not used in single- or double-glazed collectors, it will become evident by the condensation of drops of water on the inner surface of the glass.

The housing is used to contain the insulation, to support the absorber and the glazing, to protect the sensor against the dispersion of heat due to the wind and to protect the insulation from rain and dew. The enclosures are produced in an almost infinite variety of materials and designs, including wooden boxes, aluminum extrusions with backs in aluminum sheet, welded or formed galvanized steel (GS), and even collectors without a back cover. Regardless of the material and construction of the housing, it must be weatherproof, fireproof, durable, dimensionally stable, solid and completely and permanently sealed against moisture intrusion. As a general rule, the number of seams and seams must be reduced to a minimum and completely sealed. The steel must be galvanized and primed before being painted and fired and the paint must be resistant and scratch resistant. Aluminum should be used with caution in areas exposed to salt air or industrial pollution and air smog. Most high quality collectors use architectural anodized aluminum casings similar to those used for exterior windows. Typical frame materials include aluminum and GS, although sometimes glass fiber reinforced plastic can be used.

2.3 PCM for solar heat storage

Phase change materials (PCM) are "latent" thermal storage materials. They use chemical bonds to store and release heat. Thermal energy transfer occurs when a material passes from solid to liquid. This is called a state change, or "phase". Initially, these solid liquid PCMs function as conventional storage materials; their temperatures increase by absorbing solar heat [3]. When PCMs reach the temperature at which they change (their melting point), they absorb large amounts of heat without becoming hotter. When the ambient temperature in the space around the PCM material drops, the PCM solidifies and releases its latent heat stored. PCMs absorb and emit heat while maintaining a near constant temperature. In the human comfort range of 20 to 30 ° C (68-86 ° F), latent thermal storage materials are very effective. They store 5 to 14 times more heat per unit volume than

sensitive storage materials such as water, masonry or rocks. It is clear that PCM has the best qualities. provides a minimal amount of melting heat, in addition to a low melting point, and therefore PCM can be used as a good means of storing heat. Glauber salt (sodium sulphate decahydrate), calcium chloride hexahydrate and paraffin wax are the most commonly used PCMs in solar heating systems. Although these compounds are relatively inexpensive, the conditioning and processing necessary to achieve consistent and reliable performance is complicated and expensive. Steel and polyethylene are common packaging materials. The use of latent heat storage is particularly suitable for solar energy storage as it can generate high solar capture efficiency, which can reduce the surface area of solar collectors up to 30% [4].
Research on solid-liquid PCM has focused on the following materials: linear crystalline alkyl hydrocarbons, fatty acids and esters, polyethylene glycols, long-chain alkyl side polymers, the solid-state series of pentaerythritol, pentaglycerin and neopentyl glycol, low melting metals and alloys, quaternary ammonium clathrates and semiclathrates, and salt hydrides. Further research has led to the development of PCM materials that can be designed for applications in the temperature range just above 32 to 257 ° F (0-125 ° C). By mixing adjacent alkyl hydrocarbon chains, a mixture having a desired unique melting temperature can be produced without a significant decrease in thermal energy storage [5].

2.3 Polymer materials in solar thermal collectors

The cost of energy produced by solar thermal collectors depends on the costs of the different materials that make up the system, on maintenance costs and, of course, on the amount of solar energy collected. Important efforts are currently underway to make solar collector technology more economically competitive [6]. Since the early stages of the evolution of science and solar technology and polymers, solar system designers have received considerable attention due to their favourable properties for solar design. These are inexpensive and widely available materials that lend themselves to mass production of lightweight, low-cost, corrosion and freeze sensors; However, their reliability, durability and long-term performance have not yet been fully demonstrated.
The use of polymeric materials reduces the weight of the collector by 50% compared to a conventional metal collector; which makes the installation much easier [7].

3. Conclusion

To minimize the cost of materials and improve their efficiency, the recommended materials for solar collector construction are: Low-iron glass as a transparent cover - relatively inexpensive; Vacuum insulation: material without cost; Elective coating material - which is relatively inexpensive compared to the high energy efficiency of the solar collector; and Superconductive working water - water (at very low cost). Finally, much needs to be invested in improved production techniques to reduce high production costs. At the same time, during the writing, the author received much more material and help from different people and departments. Therefore, the author wishes to express his sincere thanks for their help. In addition, some points will be addressed in the future in this section. The author hopes that most researchers will study the subject in the future and exchange ideas with researchers and academics in the near future. As everyone knows, the materials are deeper than people's expectations, they need all the efforts of people from different fields and different countries of the world.

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