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Air Solar Collectors in Building Use - A review

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Abstract:

It is critical to minimize global energy consumption in the present energy and environmental context by implementing systems based on renewable energy sources. Solar collectors have been investigated to improve their efficiency and cost-effectiveness for many years. Domestic hot water, heating, and industrial operations may benefit from solar water collectors, now available on the market. Air solar collectors, a potential but little-known device, might be a cost-effective solution to utilize solar energy for heating, drying, or maintaining a minimum temperature throughout the winter. The fresh air needed for these purposes can be preheated using this system. In this work, a detailed literature review is presented on-air solar collectors, which are mostly employed in buildings as solar walls. Glazed and opaque air solar collectors are the two main kinds. The classification of solar collectors uses and key factors are covered in this paper, emphasizing opaque solar collectors.

Key words: *Solar energy, Air Collectors*

1.0 Introduction

Renewable energy sources may give low-cost energy solutions when passive systems are used. The usage of solar energy systems is widely accepted since they are simple to deploy and efficient from an accessibility standpoint in areas with many solar potentials. The European Directives on the energy performance of buildings [1] may be met with such systems, which require considerable reductions in energy use. The construction industry accounts for 35.3% of total energy consumption [2, 3]. Using renewable energy to meet both of these goals is a viable option. Inertial components may be utilized to store energy, or solar energy can heat a fluid such as air or water. Water-based thermal storage systems, eutectic materials (or phase-changing materials), solar collectors, and massive walls are the four main types of thermal systems that can store heat. The other two thermal storage systems are water-based and eutectic materials (or phase-changing materials).

Thermal solar collectors are economical to use solar energy as a sustainable energy source.

Solar collectors that use water and solar collectors that utilize air have been around since the dawn of mankind. Preheating the thermal agent necessary for heating using solar collectors is becoming increasingly commonplace. Fresh air is preheated using solar thermal air collectors to heat, dry, or maintains a minimum temperature in the winter. There is no danger of freezing when using air collectors compared to water collectors, and these systems have a smaller environmental effect [4]. There is strong interest in constructing utilization of solar thermal air

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collectors, according to Goyal et al. [5]. The study of literature enables us to see the enormous potential of these gadgets in recouping energy from the Sun.

TSCs, or solar air collectors, are constructed of metal cladding with holes positioned at a particular distance from a building wall, allowing the air to circulate. Ventilation fans in the cavity produce negative pressure and remove the warm air via the perforated panel, which is heated by the solar energy from the Sun. Because of the air temperature differences in the hollow, the air is usually removed from the top of the wall, ensuring that all solar heat is gathered and then circulated throughout the structure through the ventilation system. The fluid-to-metal heat transfer is facilitated by the flow characteristics and other external elements. It is fascinating to learn about the direct options for improving these perforations, as well as the importance of the orifice shape, from studies like Van Decker et al. [6], Gunnewieck et al. [7, 8]. A specific geometry for the holes might lead to an increase in heat transmission, although no major research has been reported [9].

2.0 Classification:

Solar collectors may be broken down into several different types based on the materials used during their manufacture. They may be categorized as follows by Lai et al. [10]:Solar collectors that are transparent or translucentSolar collectors are either transparent or coated.Among the several varieties of opaque solar collectors are those with a flat absorber or those with a corrugated absorber, those with perforated absorbers, and those with a layer of glass protecting the absorber. It is possible to categories glazed sun collectors as Trombe wall (an absorbing element that serves as thermal mass) and solar collectors with a plane absorber [11]. Coils may be used in both kinds of collectors to promote heat transmission, and the heat storage medium can be used in any style of the collector (inertial materials).One technique to categories solar collectors according to heat storage capacity is shown in figure 1.

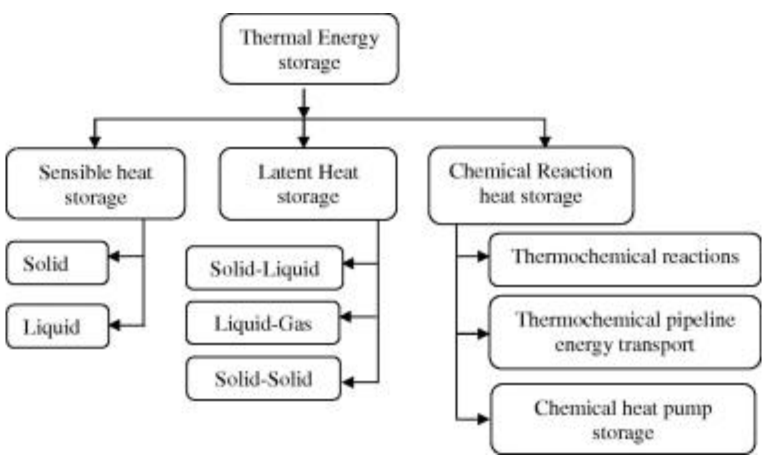

Fig. 1 Classification of solar thermal collectors

The principle of operation of solar collectors is the same regardless of the kind. Sunlight heats the air passing through the cavity produced by the absorber, which dissipates the heat back into the surrounding environment. Opaque solar collectors typically use a dark metal or perforated panel to collect heat (Figure 2), released to the airflow and circulated by a fan (in winter or during transition) into the room. The heat that accumulates throughout the day may be discharged at night if inertial components are included. When it's sunny outside, the solar collector may act as a heat sink for the building envelope or as a vented facade for the same purpose.

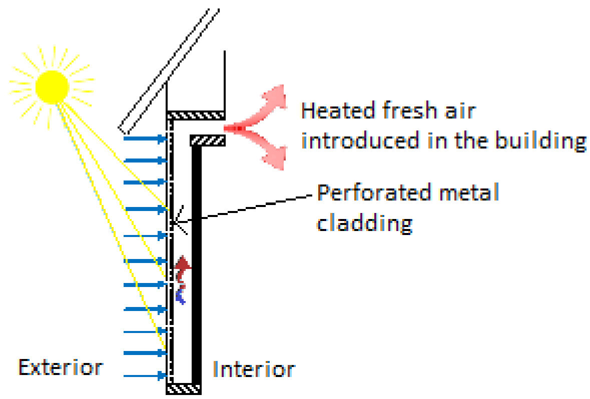

Fig. 2. Opaque solar thermal collectors

The same holds for solar glass collectors. The sun's energy may pass through the system's covering material (often glass) for greater illumination, creating a greenhouse effect. During convective airflow, incident solar energy is collected by an absorbent layer, which may or may not include inertial components. Heating and fresh air may be provided by hot air throughout the transition time and winter.Trombe walls and glazed solar collectors are the most common forms of collectors, according to Hami et al. [11].

According to different studies [12, 14, 15, 18-22], solar air collectors can be used for the following applications, with enormous potential to reduce energy consumption and operating costs [19]: buildings heating, maintaining a low functioning temperature in industrial areas (for heating and drying of industrial halls), drying food, preheating necessary fresh air, heating and drying of greenhouses, improving the efficiency of photovoltaic system. According to Leon and Kumar [19], solar air collectors have often been used for drying, using collectors with surfaces ranging from 90 to 1300 m2 which have provided an air temperature between 27-70 ° C. In terms of building implementation, solar air collectors have been installed [9, 12, 14, 18]: in external walls (such as solar façades or ventilated facades), in the roof (as a ventilated roof) or as individual systems mounted on the roof, facade or exterior of the building. Another interesting solution involves the use of solar air for heating the air or other thermal agent for heat pumps [23, 24]. This way the performance coefficient of the air-to-water heat pumps can be improved. Accordingly to Ciriminna et al. [21] the main obstacle to the implementation of solar collectors with air is low market reputation and difficult access to this type of technology

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3.0. Functioning parameters

Many studies have shown that perforated opaque solar collectors operate best when the perforations (and plate porosity) are spaced at a reasonable distance from each other and the diameter and shape of perforations. The plenum size (airflow cavity) and the absorption coefficient (as well as the ambient temperature, air density, and kinematic viscosity) of the absorbent element are also important factors.

Heat exchanger efficiency (HX), solar collector efficiency, and the temperature differential (T) between incoming air and exhaust air are all factors that go into determining the collector's thermal performance.

For an opaque solar collector with holes, the heat exchange efficiency is critical, according to Criminal et al. [21]. This value is determined from the diameter and pitch of the perforations, the absorbent plate's thickness, and the material from which it is built. There are several ways to boost the thermal efficiency of solar air collectors, such as utilizing baffles or barriers to increase heat exchange surface area [27]. Goyal et al. [5] claim that this method may boost collector efficiency by 10-15% for a little expenditure. Razak et al. [30] conducted a detailed bibliographic review of absorbent components that might be utilized to increase heat transfer. Its performance is controlled by porosity, shape, thickness, heat exchange surface, and the particular qualities of the materials used to manufacture the absorbing element.

The efficiency of solar collectors is strongly influenced by plate emissivity. According to thorough bibliographic research, low emissivity absorbent plates may boost yearly solar thermal output by up to 40%. Using absorbent plates with high absorption coefficients but low emissivity (the latter of which has less influence) improves heat transfer efficiency. The table 1 shows the important parameters for solar collector efficiency.

Parts Description	Dimensions
Inner Tube Diameter	1 (cm)
Thickness of Flat Plate Collector	0.05 (cm)
Width of Flat Plate Collector	100 (cm)
Length of Flat Plate Collector	200 (cm)
Absorber Area	20,000(cm^2)
Gross Area	23,100(cm^2)
Number of Tubes	10

Table 1. Dimensions of Flat Plate Solar Collector

4.0 Conclusions:

In recent years, academics have been more interested in solar air collectors well-researched technology. This research examines solar air collectors that function as solar walls, emphasizing transpired solar collectors. A categorization of solar air collectors based on their many services is presented in the paper. Additionally, the essential characteristics of opaque solar collectors are discussed and a few noteworthy examples. The orifice geometry has received little attention from researchers, even though it significantly influences the flow, collector geometry, orifice size, and pitch. The use of thermal energy storage materials (sensible or latent heat storage/phase shifting materials) plays a major role in solar air collectors for solar collectors for building applications. When solar radiation is available, this method may help improve the overall efficiency of the collectors by delaying the release of stored thermal energy.

5.0 References

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