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METHODS OF APPLYING A SOLAR AIR COLLECTOR IN PRIVATE HOUSES FOR HEATING AND HOT WATER SUPPLY

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Abstract

At present, the problem of using economical, renewable and clean energy sources is very important and attracted not only by scientists but also by politicians and organizations, because of this interest, in almost every country there are centers for studying, researching and using non-traditional energy sources, and they are taken into account in the country's economic strategy. The purpose of this article is to study and study the local thermal characteristics of flat solar air collectors, the choice of the best type for use in the heating system and hot water supply at home.

Key words: solar air collectors (SAC), active SAC, thermal accumulator, thermal-absorber, recuperator

СПОСОБЫ ПРИМЕНЕНИЕ СОЛНЕЧНОГО ВОЗДУШНОГО КОЛЛЕКТОРА В ЧАСТНЫХ ДОМАХ ДЛЯ ОТОПЛЕНИЯ И ГОРЯЧЕГО ВОДОСНАБЖЕНИЯ

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Аннотация

В настоящее время проблема использования экономичных, возобновляемых и чистых источников энергии является очень важной и к ней обращают интерес не только ученые, но и политики и организации, из-за этого интереса почти в каждой стране появились центры для изучения, исследования и использования нетрадиционных источников энергии, и они учитываются в экономической стратегии страны. Целью данной статьи является изучение и исследование локальных тепловых характеристик плоских солнечных воздушных коллекторов, выбор наилучшего типа для применения в системе отопления и горячего водоснабжения дома.

Ключевые слова: солнечные воздушные коллекторы (СВК), Активные СВК, термический аккумулятор, термоабсорбер, рекуператор

The comfort of living in a country house largely depends on the quality of the engineering communications that maintain a healthy microclimate all year round. Effectively solve the problems of ventilation and heating allows an air solar collector in a private house. When designing ventilation and heating for a cottage, it is important not only to ensure the hygiene of air and maintain a certain temperature in the winter season. The owner strives to make the work of engineering communications safe, energy efficient, reduce the consumption of electricity and other resources. The solar col-

lector in a private house allows you to achieve these goals with minimal financial costs. It is a fully autonomous equipment that operates on renewable solar energy. Depending on the model, the collectors differ in their purpose - the creation of ventilation or heating, capacity, productivity, cost. A wide variety of devices allows you to choose a solar collector for any private house, regardless of its area and geometry.

Solar equipment solves the main tasks of ventilation in a country house: it removes mustiness and does not allow air masses to stagnate in rooms; provides fresh air inflow from the calculation of at least 30m3/h per each adult person; regulates the humidity, not allowing condensation to form[1]. The rooms are equipped with a healthy and comfortable microclimate for human and domestic animals. Ventilation in a private house, built on the use of air solar collectors, prevents the growth of mold, which contributes to an increase in the life of the cottage. The principle of the collector is as follows: fresh outdoor air enters the device and heats up under the influence of sunlight. Then, with the help of a fan, it is injected into the room, where it begins to circulate due to the difference in temperature and pressure. The exhausted air masses are removed through the ventilation shafts and natural gaps. The equipment turns on every time the sun shines on it, so it's usually mounted on the south and east side of the house, or on the roof. An air solar collector in a private house is used to create centralized and local ventilation in bathrooms, in the kitchen, in the pool.

Solar air collectors (SAC) is a thermal absorber in which air is used as a working medium, and solar radiation is used as a source of heat. Cold air enters the canal system, where it is heated by solar heat, and then enters a heated room.

SAC is so simple that the home craftsmen themselves undertake to make them literally from improvised materials. In the course are even empty aluminum cans (Figure 1). The author of this design shared his developments in the social network and reported that in the autumn and spring in such a "window" collector the air heats from 10-12 ºC to 80-85 ºC, and in the winter on a sunny day from -15 ºC at the entrance to the SAC to + 40-45 ºC at the outlet to the room. If in a warm season such a solar heater is no longer needed - it is simply cleaned[2].

When the EU developed standards and standards for heating and thermal insulation, it turned out that their first versions contained significantly overstated standards. It turned out that at first they did not take into account the whole amount of solar heat falling outside on the shell of the building and getting inside through the windows. This corrected and introduced the term solar gain - the amount of "free" heat from solar radiation, which even in winter there are so many that it must be protected, and which must be taken into account in all thermal calculations for buildings and structures.

Fig. 1. Self-made window-sill solar air collector made of aluminum cans

A simple solar air collector consists of air ducts that absorb solar radiation well. Then this heat energy is transferred to the air. Heated in the SAC air is connected to the ventilation duct, which feeds it inside the building.

The thermal conductivity of water is approximately 28 times greater than the thermal conductivity of the air. At the same time, the specific heat of air is about 4 times less than the specific heat of water, and the density of water is greater than the air density by about 816 times[3].

It follows that as a coolant, air is less beneficial than water. To transfer the same amount of heat to the air, it must be fed hundreds of times more than water. In this case, there is an "intermediary" between the liquid coolant and the air. But we live in the air. And to heat, after all, you need air.

The SAC is usually used as an additional heater to save on heating. Remember how the air is heated in a car parked in the sun. Approximately the same thing happens in the SAC.

The solar collector, working in the air - is an excellent alternative to liquid systems. In the work of the SAC there are practically no restrictions - air as a coolant does not boil and does not freeze. There is simply no such thing as a "stagnation of the solar system" that forces engineers to go for expensive constructive and technological solutions in liquid collectors.

Rapid warming up of the air in the room to the desired

temperature is also one of the features of the SAC. Despite the fact that air has a lower heat capacity than water, it is mobile, well regulated (temperature and quantity). Air provides a rapid temperature change and a more even distribution of heat inside the premises. It is fire safe. Heated air can be distributed through the channels of ventilation systems.

How much heat can be saved by applying the SAC? To do this, the amount of solar heat incident on the ground, for example, at the latitude of Tashkent (~ 1384.05 kWh / m^2 / year), multiplied by the efficiency of the solar collector ~ 65-70%[3]. As a result, we will generate about 900 kWh of heat by one square meter of the solar collector. The one shown in Fig. 1 homemade can potentially produce up to 2 MWh of heat per year. This is quite a lot.

Nevertheless, the SACs work perfectly in a cold climate. Especially when the weather is unstable and there may be an unexpected drop in temperature or frost. Here are three photos (Figures 2a, b, c) of private houses equipped with SAC. One in Richmond, Minnesota (45 ° 27'N), the other two in Methuen (42 ° 43'N) and Auburn (42 ° 12'N)), Massachusetts, USA.

Fig. 2. SAC on the walls of residential buildings:

a) Richmond, Minnesota, USA; b) Methuen, Massachusetts, USA; c) Auburn, Massachusetts, USA

When designing heating for a country cottage, the owner strives to make the house warm and at the same time reduce the costs of buying and installing equipment. Air solar collector for heating in a private house: does not require connection to the central heating station; completely autonomous; does not consume electricity or other fuel, so that during the heating season, bills from energy sales companies do not grow. With the help of a collector in the autumn-winter period, the house maintains a stable positive temperature. The rooms are heated quickly due to the circulation of warm air in them, which warms the floor and walls.

SAC is carried out according to different schemes - with the outside air intake, with the intake of internal air; with a bypass. They are made with glazing and without. They are passive and active.

There are three basic schemes for connecting the SAC: Figure 3 - with the inflow of outside air (a), with recirculation of the internal air (b), with the mixing of air heated into the SAC into the vent channel (c) and their combinations[4].

If SAC is used in winter to heat air circulating only indoors, this means that 2 collectors (figure 1) with an area of 2.5 m^2 in the coldest months of the year (January-February) will be able to provide an average heating of 150 kW · h, and for the whole winter - 630 kW · h, in the spring - 1,3 MW · h, for autumn - 0,95 MW · h. At night, the air bypass can be switched off[4].

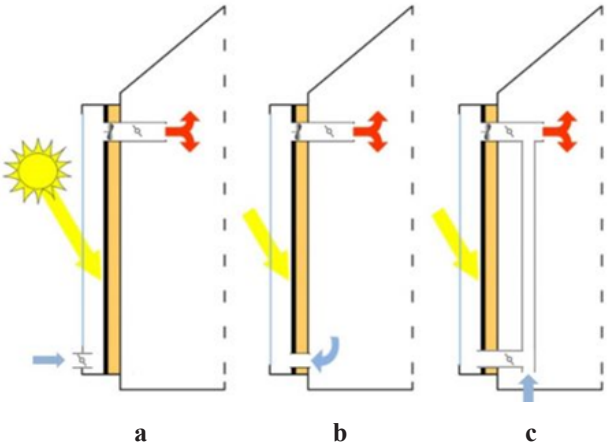

Fig. 3. The main diagrams for connecting a walled SAC

Since the coolant in the SAC is air, then, naturally, it is often used together with the ventilation system.

If the SAC is connected to the channel of the geothermal gravitational system of natural ventilation (Figure 3, c), this will significantly increase the thrust in it by increasing the temperature drop between the inflow and outlet and stabilizing its work in the off-season.

Passive schemes (Figures 3, 4) - this is an inexpensive solution, it can be fairly simple to apply in an already built house.

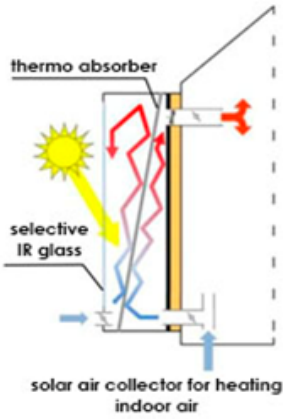

Fig. 4. SACwith heat recuperator

When connected via a recirculation circuit (Figure 3, b) or by a scheme with air mixing from the ventilation duct (Fig. 3c), it is possible to obtain an air purification system by repeatedly blowing internal air through a filter system connected to the SAC connections. Combined circuits (Figures 4, 5), as a rule, are performed according to the scheme with a heat recuperator. SAC with recuperators can be installed, both on walls and on roofs.

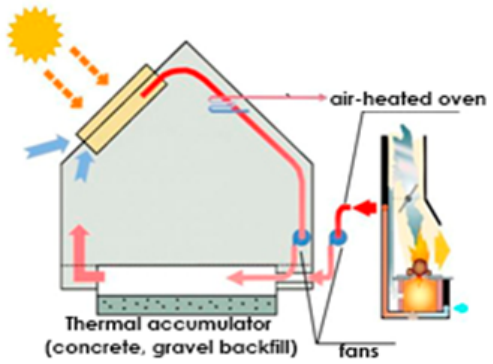

Fig. 5. SAC in combination with an air heat recuperator, a heat exchanger for hot water, a heat accumulator and an air oven

Active system with SAC (Figures 5, 6, 7) for air circulation has a fan drive. In the active system, there is no need to "correctly" vertically install inlet and outlet openings, since air is sucked or forced, and gravity and convection currents, as in the natural system, are not used. Therefore, the SVK in the active system can be installed on an inclined roof under the horseshoe, and then the heated air is directed downwards by the fan[5].

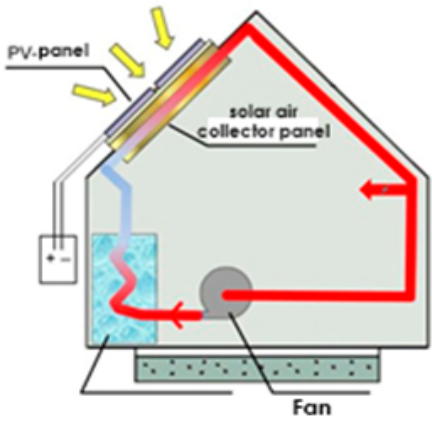

Fig. 6. Cogeneration SAC in combination with PV-module, heat recuperator, heat exchanger for hot water

Another way that is now gaining popularity is the combination of a solar photovoltaic collector (PV-panel) and an SAC located below. The essence of this method is the recovery of heat taken from the lower (shaded) side of the PV modules (it is often 3 to 4 times greater than the electricity produced by the module).

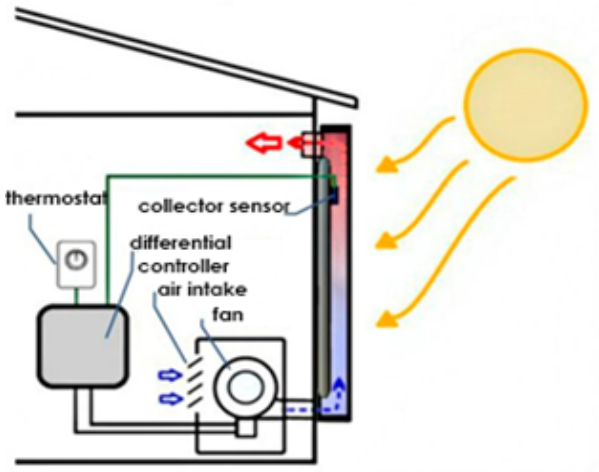

Fig. 7. Active CWR with temperature monitoring system and variable flow fan

Conclusion

Here there is an obvious technical advantage - in addition to receiving electricity from the PV panel, and from the SAC - heat energy (cogeneration), the selection and recovery of heat by the air collector improves the operating mode and efficiency of the PV module. SAC allows the PV system to work closer to its best efficiency (usually around 25 ° C). This reduces the overall payback period of the entire combined system[6]. Excess heat, which enters the room "not on time", can be reset to a HW tank. If the SAC have a large area, and are located on walls that are differently oriented to the sides of the light, then it makes sense to install an automation system (Figure 7), which monitors the operation of the system. The market offers a large selection of different universal sensors and programmable controllers that can be selected to a variable speed fan, and then assemble such an active system yourself.

Air solar collectors are successfully used for the needs of housing and communal services in the US, Canada, Russia, Europe and the CIS. Due to their low cost, simple installation, and lack of commissioning, they can significantly reduce the cost of creating ventilation and heating in private homes. Suitable for use in remote, non-electrified settlements, in towns with difficult fuel supplies. The air solar collector in a private house is environmentally friendly, autonomous, easy to operate. This is a modern solution aimed at creating engineering communications with minimal costs.

SAC appeared and began to be actively used not so long ago. Much later, than, for example, photovoltaic and liquid photothermal collectors. All the features and advantages of ICS have not yet been revealed. Special studies conducted in the USA and Canada showed that SAC systems (façade and modular) reduce the energy consumption of the building by approximately 10-50% of the usual heat load for heating in winter and cooling in the summer[3]. Joint use of SAC with heating, ventilation and air conditioning systems, as well as an external protective shield of the building, is very promising.

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