ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 11, Issue 10, October 2024

Choosing An Efficient Heat Accumulator For Solar Air Heating Collectors With Flat Reflectors

Toshmamatov B.M., Muradov I. , Khusenov A.A.

Senior Lecturer, Department of "Alternative Energy Sources" of the Karshi Engineering Economics Institute
PhD, Docent, Department of "Heat Power Engineering" of the Karshi Engineering Economics Institute
Assistant, Department of "Heat Power Engineering" of the Karshi Engineering Economics Institute

ABSTRACT: In the countries of the world, the energy problem is becoming global, and there is a need to rebuild the energy base and find ways to use environmentally friendly renewable energy sources. In this article, the author has researched the process of using efficient thermal accumulators to increase the energy efficiency of the solar air heating collector.
There are various ways to solve this problem, and it is the use of solar air heating collectors in autonomous energy supply systems, and the author proposed an energy-efficient thermal scheme of a solar air heating collector with a flat reflector with a heat accumulator. The method of using different heat accumulators was used to increase the energy efficiency of the solar air heating collector with a flat reflector with a heat accumulator, and the energy efficiency of using pyrolysis liquid and paraffin with heat-technical parameters close to the water as a heat accumulator was also shown.
The created solar air heating device with a flat reflector with a heat accumulator can be used in autonomous heat supply systems, which allows for covering 60% of the heat load during the year in the climatic conditions of the city of Karshi.

I. INTRODUCTION

Today, the reforms in the direction of energy efficiency and economy in our country allow not only to increase the volume of production but also to save a large amount of fuel and energy resources. In a series of decisions of the President of the Republic of Uzbekistan, priority tasks have been given to achieve the economy of natural fuel and energy resources, wide introduction of renewable energy sources, increase the efficiency of energy resource use, effective use of solar energy devices and the use of heat-saving energy-efficient substances in them [1].

As a solution to the above priorities, the important parameters for improving the energy efficiency of the solar air heating collector with a heat accumulator with a flat reflector are the introduction of scientific and technical innovations and innovations to various industries, as well as the construction industry, as well as energy-saving materials with improved thermal properties and high efficiency related to the use of heat accumulators. The development of scientific and innovative innovations in the field of renewable energy sources, in particular, the creation of solar energy devices, is associated with the development of new types of materials that accumulate heat. used for accumulation. As a result, this leads to the development of research and development of energy-efficient solar air heating collectors, and heat storage materials [2].

II. MATERIALS AND METHODS

Heat accumulators are divided into the following types [3-5]:
1. Sensible heat accumulators. These materials accumulate heat energy only by increasing the temperature without phase transition. Their main characteristic are high heat capacity. Such materials include:

- Water. The most common material for thermal energy storage. Water has a high heat capacity and is found in large quantities in nature. It is used in accumulators and heating systems.
- Stone and concrete: It accumulates heat energy well. It is used in heat accumulators of buildings or special heat accumulators.
- Oils (heat transfer fluids): Used in solar energy storage systems.

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2. Phase transition materials (FCM). Phase transition materials accumulate and release thermal energy during the process of phase change, i.e. melting and solidification, during which the temperature does not change significantly. This makes them effective for accumulating thermal energy even at low temperatures. FCM can be used repeatedly and serve as a sustainable energy source. Such materials include:
- Paraffins: Paraffin belongs to the group of organic phase transition materials with a unique ability to accumulate and release thermal energy during phase transition. It is used in domestic heat accumulators and heating systems. Their melting temperature is in a wide range.

- Salts (salt hydrates): Salt hydrates undergo a phase change by dissolving or crystallization of their hydrates. During this process, a large amount of heat energy is accumulated and gradually gives off heat. They have a high thermal capacity and are used in solar energy storage because they can collect solar energy, store it for a long time and reuse it at night or on cloudy days. In addition, salt hydrates are used in industrial systems and heat storage systems of buildings to accumulate a large amount of thermal energy. Salt hydrates are promising materials for efficient energy accumulation and reuse, and their use allows increasing energy efficiency in various fields. However, some salt hydrates are highly corrosive and can damage the materials they interact with. In order to prevent this corrosion, it is necessary to be careful in choosing materials.

Oil blends: A mixture of two or more substances that melt and solidify in the same phase at the eutectic point. These materials combine the advantages of both components and often have a low melting point. Including:
- Organic-organic mixtures: Fatty acids and paraffin mixtures.
- Organic-inorganic mixtures: Salt hydrates and mixtures of organic substances.
- Inorganic-inorganic compounds: Various salts and hydrates.

3. Heat accumulating materials based on thermochemical reaction.
These materials use reversible chemical reactions to accumulate and release heat. An example is the reaction of water with salt hydrates or other substances. Such materials include:

- Salt hydrates: These materials accumulate thermal energy during water evaporation (dehydration) from hydrates and release it during the reverse reaction.
- Absorption/desorption-based thermochemical reactions: Absorption/desorption-based thermochemical reactions are one of the effective methods that use chemical interactions and chemical changes for heat accumulation and subsequent use. These systems accumulate thermal energy during thermochemical reactions and can store energy in chemical bonds for long periods without change, and then release this energy again when needed. These processes can be repeated many times due to the reversibility of chemical reactions, which ensures the long-term operation of the system.

4. Sand and metal. Heat accumulators.

- Sand: Sand and metal heat accumulators are heat accumulation technologies using two different materials for energy accumulation. They have good thermal efficiency and are used to accumulate thermal energy in solar energy devices or industrial furnaces. A sand heat accumulator is often used to store energy at high temperatures because sand has a high heat capacity and stability. Sand is a cheap and widely available material, which allows it to be used in large-scale systems.
- Metals: Metal heat accumulators use the high heat capacity of metals to accumulate and store energy. Metal absorbs heat efficiently and releases it quickly, which ensures high efficiency and fast transfer. Some metals, including aluminum or copper, can be used in the process of accumulating thermal energy due to their high heat capacity and thermal conductivity.

5. Liquid salts (molten salts). They are often used in solar thermal power plants and solar pools to accumulate a large amount of thermal energy. Mixtures of sodium and potassium nitrate melt at a temperature of 220÷240 °C and can work at temperatures up to 600 °C.

In the research work, thermal-physical properties of various heat accumulators used in solar air heating collectors were investigated using thermodynamic analysis, thermal-technical and experimental research methods. Based on the analysis of thermal-physical properties of various heat-accumulating materials, we analyze their relative heat capacity, energy

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efficiency, and thermal-physical properties, as well as the possibility of using them as heat-accumulating materials in solar air heating collectors [6].

An experimental industrial copy of a flat reflector solar air heating collector with a heat accumulator was created at the “Alternative Energy Sources” educational and scientific site of the "Alternative Energy Sources" department of KEEI, shown in Fig. 1 and 2 [7-8].

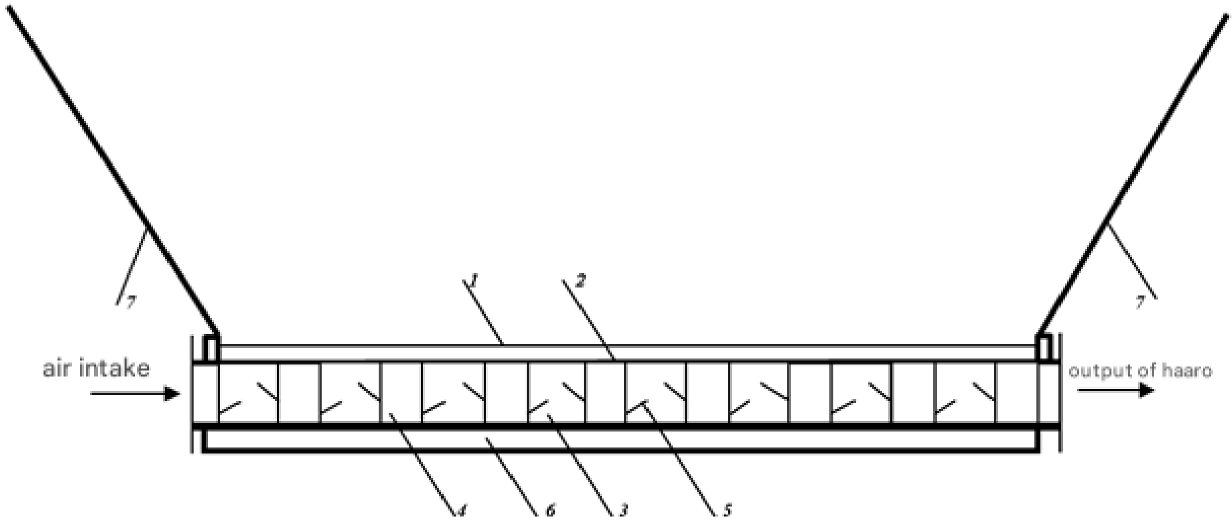

Figure 1. Scheme of a solar air heating collector with a flat reflector with a heat accumulator.
1-transparent window, 2-absorber, 3-air channel, 4-heat accumulator (water, transformer oil) channel, 5-wing ribs, 6-heat insulation, 7-flat reflectors.

Figure 2. Front and back view of flat reflector solar air heating collector with heat storage.

III. RESULTS AND DISCUSSIONS

In a hybrid heating system for typical rural houses, we determine the thermal power of the heat carriers using the following formula [9-10]:

$$Q = G_{hc}\mathrm{Cp}(t_{hc1} - t_{hc2}) \tag{1}$$

where, G_{hc} – coolant flow rate, kg/s; Cp –теплоемкость теплоносителя, $\frac{kDj}{(kg\cdot℃)}$; t_{hc1}, t_{hc2} –temperature of the coolant at the inlet and outlet of the solar air heater, ℃.

We determine the heat capacity of the heat accumulating material of the solar air heating collector from the following formula.

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International Journal of AdvancedResearch in Science, Engineering and Technology
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$$Q = m_{h.acc.}\mathrm{Cp}(t_{h.acc.2} - t_{h.acc.1})/\tau \qquad (2)$$

where, $m_{h.acc.}$ – mass of the heat accumulator, kg; Cp –heat capacity of heat accumulator, $\frac{kDj}{(kg\cdot℃)}$; ρ – heat accumulator density, $\frac{кг}{м^3}$; $t_{h.acc.1}, t_{h.acc.2}$ – initial and final temperature of the heat accumulator, °C, τ – charging time, sec.

The calculated values of the amount of heat with a temperature difference at the inlet and outlet of the heat carriers in a heating system with a warm floor equal to 15 °C and 20 °C are presented in Figures 3 and 4.

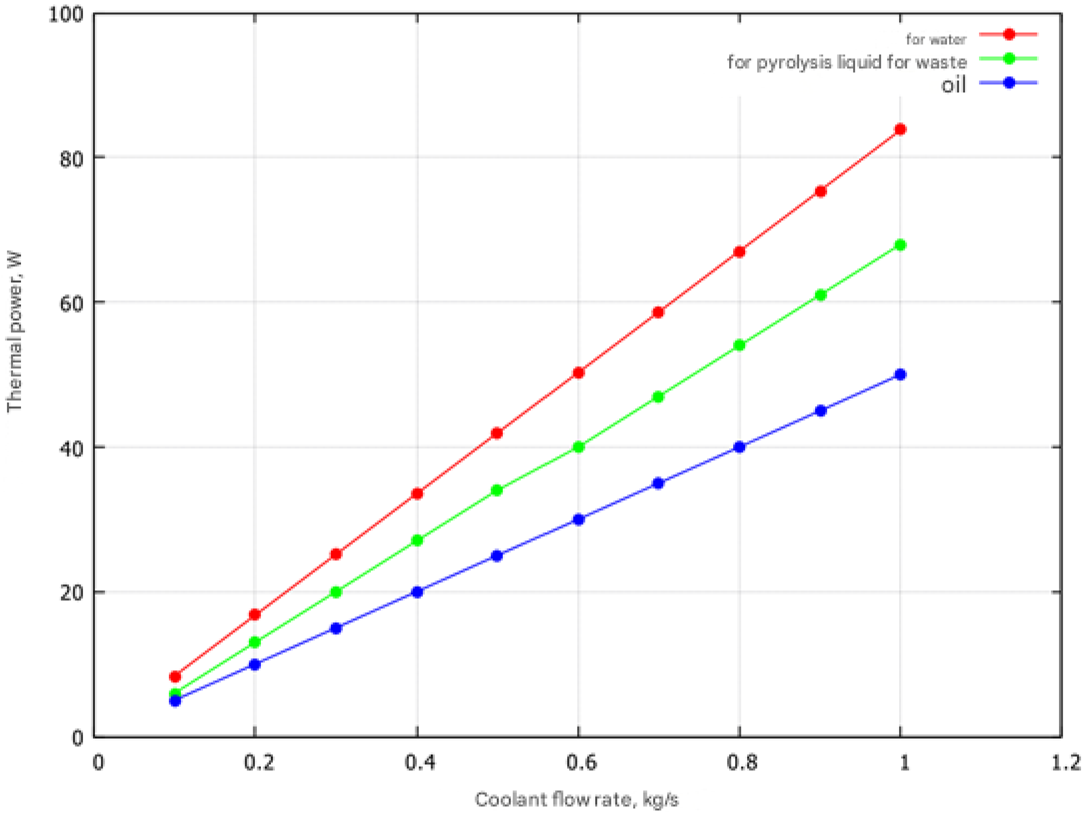

Fig. 3. Graph of change in the amount of heat with a temperature difference of coolants of 20 °C.

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 11, Issue 10, October 2024

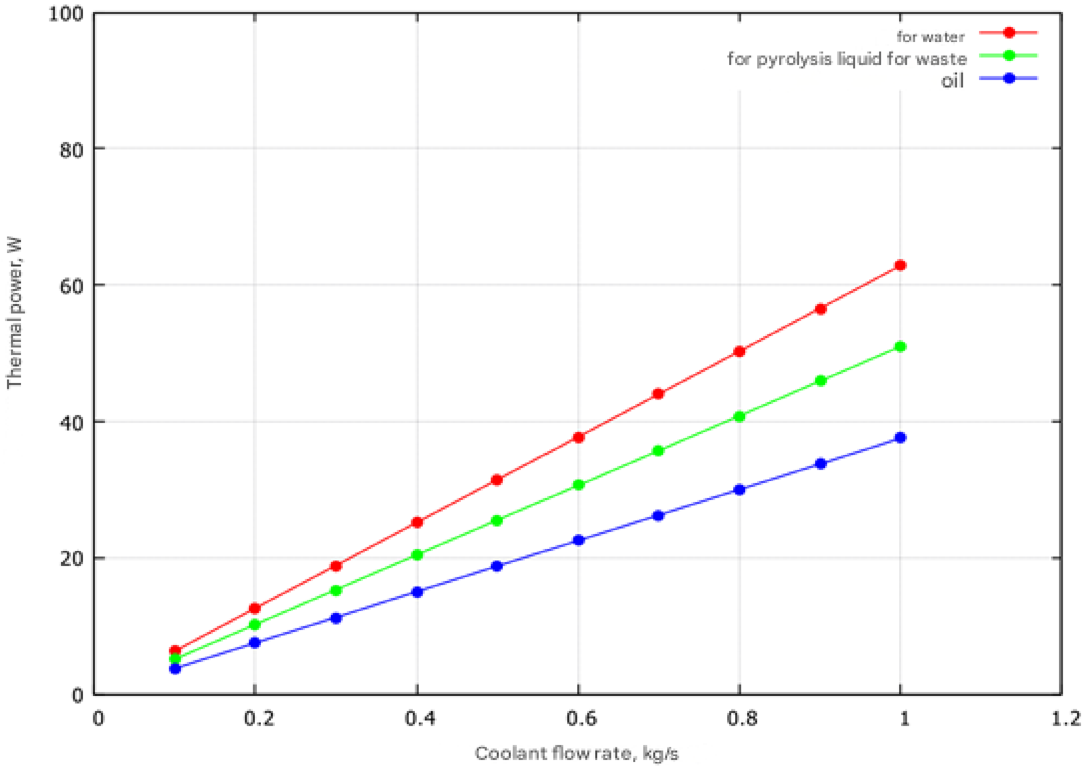

Fig. 4. Graph of change in heat quantity with a temperature difference of heat carriers of 15 °C.

IV. CONCLUSION

An energy-saving thermal circuit and experimental research device of a flat reflector solar air heating collector with a heat accumulator was developed. According to the conducted experimental research and calculations, the method of using different heat accumulators was used to increase the energy efficiency of the flat reflector solar air heating collector with heat accumulator, and the energy efficiency of using pyrolysis liquid and paraffin, whose heat-technical parameters are close to water. when the indicators are analyzed, it can be seen in pictures 1 and 2 that the use of paraffin and pyrolysis liquid as a heat accumulator instead of water in the winter months is considered energy efficient.

REFERENCES

[1]. Uzakov G. N., Bazarov O. Sh., Davlanov Kh. A., Toshmamatov B. Scientific and innovative developments of the Karshi Engineering and Economics Institute on the use of renewable energy sources Belarus-Uzbekistan: formation of the market for innovative products Collection of materials of the scientific-practical conference (Minsk, March 14-15, 2023), pp. 353-356.

[2]. Uzakov G. N., Davlanov Kh. A., Toshmamatov B. M. Analysis of hybrid heating systems for residential buildings using renewable energy sources // Alternative energy. Scientific and technical journal. 2023. Vol. 8. No. 1. P. 9-15.

[3]. Uzakov G.N., Davlanov H.A., Kamolov B.I., Toshmamatov B.M. Integrated Autonomous Power Supply Systems for Facilities Located in Rural Areas//Alternative Energy. Scientific and Technical Journal. No. 2, 07/03/2023. Pp. 9-14.

[4]. Kudratov J., Toshmamatov B. Justification of heat-technical parameters of hybrid heat and hot water supply system//European international journal of multidisciplinary research and management studies. Volume 03 Issue 09. 30.09.2023

[5]. Sattorov B., Davlonov Kh., Toshmamatov B. and Arziev B. Increasing energy efficiency combined device solar dryer-water heater with heat accumulator. // BIO Web of Conferences , 2023.-No71. – pp. 02471024.

[6]. Toshmamatov B., Kodirov I. and Davlonov Kh.Determination of the energy efficiency of a flat reflector solar air heating collector with a heat accumulator. // E3S Web of Conferences, 2023. -No402.-pp. 05010.

[7]. Toshmamatov B., Shomuratova S., Safarova S.. Improving the energy efficiency of a solar air heater with heat accumulator using flat reflectors. // E3S Web of Conferences, 2023 - No411. – pp. 01026.

[8]. Toshmamatov B.M., Shomuratova S.M., Mamedova D.N., Samatova S.H.Y., Chorieva S. 2022Improving the energy efficiency of a solar air heater with a heat exchanger – Accumulator.// IOP Conference Series: Earth and Environmental Science, 2022. - No 1045(1). -pp. 012081.

[9]. Kodirov I.N., Toshmamatov B.M., Aliyarova L.A., Shomuratova S.M., Chorieva S. Experimental study of heliothermal processing of municipal solid waste based on solar energy. // IOP Conference Series: Earth and Environmental Science, 2022. -No1070(1). – pp. 012033.

[10]. Toshmamatov B.M., Valiev S.T. Calculation of the parameters of the solar heat supply system for a medical and health center. // Alternative Energy, 2022. - T. 5. - № 2. -C. 26-34.