APPLICATION POSSIBILITIES OF A HEAT PIPE WITH THERMAL ACCUMULATOR IN RESIDENTIAL BUILDINGS

Abdullayev Z
Bukhara State University
Ochilov L
Bukhara State University
Ashurova U.
Bukhara Technical University

Annotation. This manuscript discusses the possibilities of heating residential buildings using solar energy using heat pipes. It also presents the components, operating principle, and manufacturing schemes of the heat pipe. The application of heat pipes with thermal accumulators in residential buildings is a promising direction in terms of energy savings, environmental safety, and cost-efficiency. Implementing this technology in practice can lead to the development of sustainable and climate-adapted heat supply systems.

Keywords: heat pipe, accumulator, evaporator, adiabatic zone, condensation, renewable energy

Аннотация. В этой статье рассматриваются возможности обогрева жилых зданий солнечной энергией с использованием тепловых труб. В ней также представлены компоненты, принцип действия и схемы изготовления тепловых труб. Применение тепловых труб с тепловыми аккумуляторами в жилых зданиях является перспективным направлением с точки зрения экономии энергии, экологической безопасности и экономической эффективности. Внедрение этой технологии на практике может привести к созданию устойчивых и адаптированных к климату систем теплоснабжения.

Ключевые слова: тепловая труба, аккумулятор, испаритель, адиабатическая зона, конденсация, возобновляемые источники энергии

Annotatsiya. Ushbu qo'lyozmada issiqlik quvurlari yordamida quyosh energiyasidan foydalangan holda turar-joy binolarini isitish imkoniyatlari muhokama qilinadi. Shuningdek, u issiqlik quvurining tarkibiy qismlari, ishlash printsipi va ishlab chiqarish sxemalarini taqdim etadi. Turar-joy binolarida issiqlik akkumulyatorlari bilan issiqlik quvurlarini qo'llash energiya tejash, ekologik xavfsizlik va iqtisodiy samaradorlik nuqtai nazaridan istiqbolli yo'nalish hisoblanadi. Ushbu texnologiyani amalda qo'llash barqaror va iqlimga moslashtirilgan issiqlik ta'minoti tizimlarining rivojlanishiga olib kelishi mumkin.

Kalit so'zlar: issiqlik quvurlari, akkumulyator, evaporatator, adiabatik zona, kondensatsiya, qayta tiklanadigan energiya

Introduction

ISSN 3030-3907

Nowadays, rational use of energy resources, ensuring the stability of heat supply, and increasing environmental safety are among the most urgent issues. In particular, the demand for increasing energy efficiency in heating residential buildings through the introduction of new technologies is growing.

To address these challenges, it is essential to implement energy-saving measures and innovative engineering solutions. Modern insulation materials, automated heating control systems, and the integration of renewable energy sources play a crucial role in reducing heat loss and optimizing energy consumption. By improving building designs and adopting smart technologies, it becomes possible to significantly lower operating costs while contributing to environmental protection. Furthermore, raising public awareness and encouraging responsible energy use are key components in achieving long-term sustainability in the heating sector.

Chinese researchers Ronghua Tan and Zhigang Zhang proposed using a heat pipe for heating buildings in their article. They studied the possibilities of both heating and cooling buildings using heat pipes. According to their research, the thermal conductivity of a heat pipe can reach up to 75%. Yan and others explored cooling buildings in summer by using heat pipes while storing snow and ice during winter in thermally insulated spaces. Sun and others found that applying heat pipes to southern walls could absorb up to 93.63% of external heat. Zhang and others developed a mathematical model of a heat pipe installed on the southern wall of a building. In 2019, they applied it to a Trombe wall and observed an average temperature of 50.8 °C during the day.

These studies demonstrate that heat pipe technology has significant potential for enhancing the energy efficiency of buildings in various climates. By strategically installing heat pipes on building facades and integrating them with thermal storage systems, it becomes possible to maintain comfortable indoor temperatures year-round with minimal reliance on conventional heating or cooling systems.

Moreover, the adoption of such passive heating and cooling systems contributes to reducing greenhouse gas emissions and overall energy consumption. Continued research and development in this area may lead to even more efficient materials and system designs, making heat pipe applications more accessible and cost-effective for widespread residential and commercial use.

As energy demands continue to grow and environmental concerns become increasingly urgent, technologies like heat pipes represent a promising step toward sustainable building practices and long-term ecological balance.

ISSN 3030-3907

Experiments conducted in Germany, Japan, and Scandinavian countries demonstrated that such systems could save up to 20–40% of energy in residential buildings. In the climatic conditions of Uzbekistan, due to the high number of sunny days, these systems may operate even more efficiently.

A thermal accumulator – is a device that temporarily stores thermal energy, collects excess heat, and transfers it when necessary. These systems typically consist of the following components:

1)A heat pipe (galvanized or vacuum type)

2) A thermal accumulator (based on water, salt solutions, or phase-change materials)

3) Heating and control systems

A heat pipe system with a thermal accumulator installed in a residential building collects solar heat during the day and transfers it to the building in the evening or on cloudy days. This not only saves energy but also ensures a continuous heat supply.

A typical heat pipe consists of three main parts:

1. Evaporator,
2. Adiabatic section,
3. Condensation section.

The evaporator section consists of a solar collector that absorbs solar radiation and converts it into heat. This heat is transferred to the heat pipe and used to evaporate the working fluid inside. The generated vapor passes through the adiabatic section and condenses in the condenser section due to the temperature difference, after which it returns to the evaporator.

The application of this heat pipe system to a building is illustrated in Figure 1.

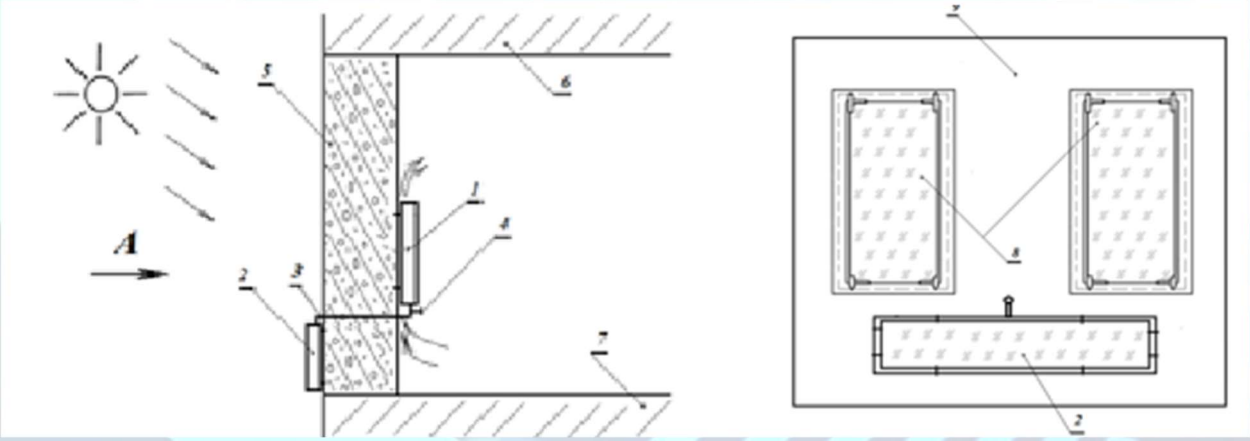


Figure 1. Schematic diagram of a heat pipe system installed in a building.

Figures 1, 2, and 3 illustrate the following components:

ISSN 3030-3907

1 - Solar collector, 2 - Thermal accumulator, 3 - Valve (tap), 4 - Outer wall of the building, 5 – Ceiling, 6 – Floor, 7 - Indoor air, 8 - Insulation layer of the solar collector, 9 - Pipe for heat transfer, 10 - Absorber (a darkened aluminum sheet welded to the pipe), 11 - Outer casing of the solar collector, 12 - Ribbed part of the thermal accumulator, 13 - Phase-change material (paraffin) in the thermal accumulator, 14 - Handle to operate the thermal accumulator, 15 - Transparent cover of the solar collector (glass), 16 - Working fluid (vapor) moving through the pipes [5].

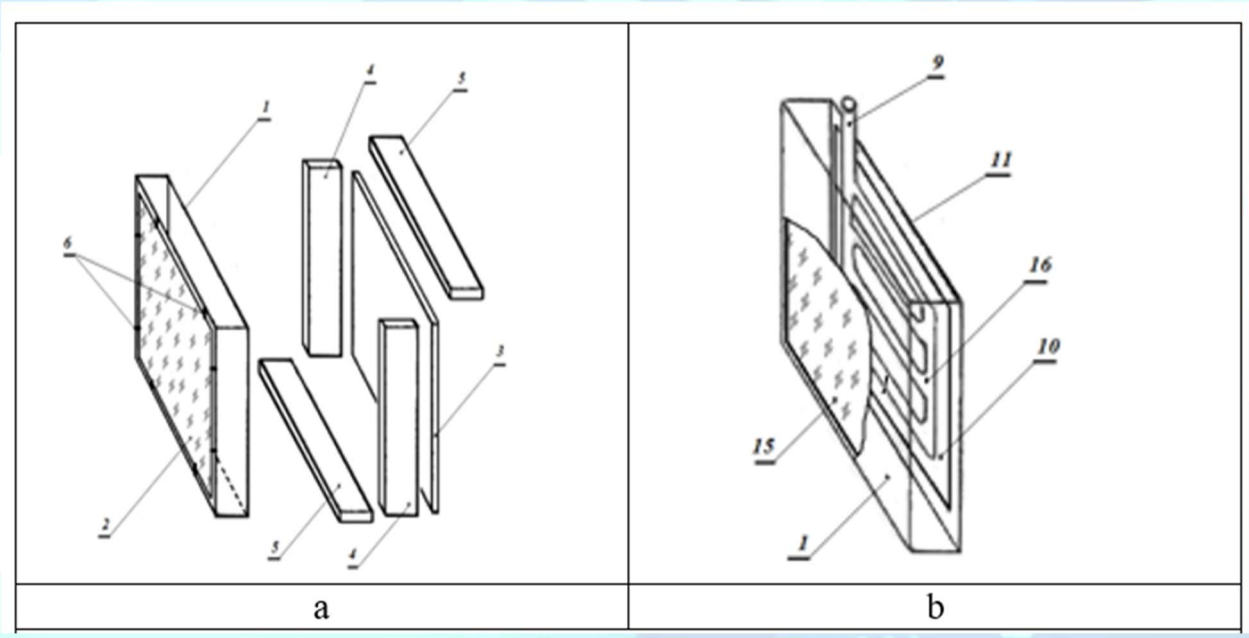


Figure 2. (a) Thermal box; (b) The evaporator section of the heat pipe placed inside the thermal box. Operating Principle:

Daytime Mode. During sunny hours, sunlight (18) passes through the transparent cover (15) of the solar collector and is absorbed by the absorber (10). The absorbed solar radiation is transferred to the working fluid (16) in the pipes via conduction and convection. As the temperature of the fluid increases, its evaporation intensifies. The resulting vapor rises due to buoyant force (Archimedes' principle) and enters the pipes inside the thermal accumulator (2), where it condenses on the pipe walls due to the temperature difference. The heat released during condensation is transferred to the phase-change material inside the thermal accumulator. This heat exchange process occurs within the pipe system based on the heat pipe operating principle [7].

Nighttime Mode. Before transitioning to nighttime mode, the vapor exchange pipe is closed using the valve (3). The thermal accumulator (2) is lowered by rotating it using the handle (14) and is fixed in place using a bracket (17) [5].

ISSN 3030-3907

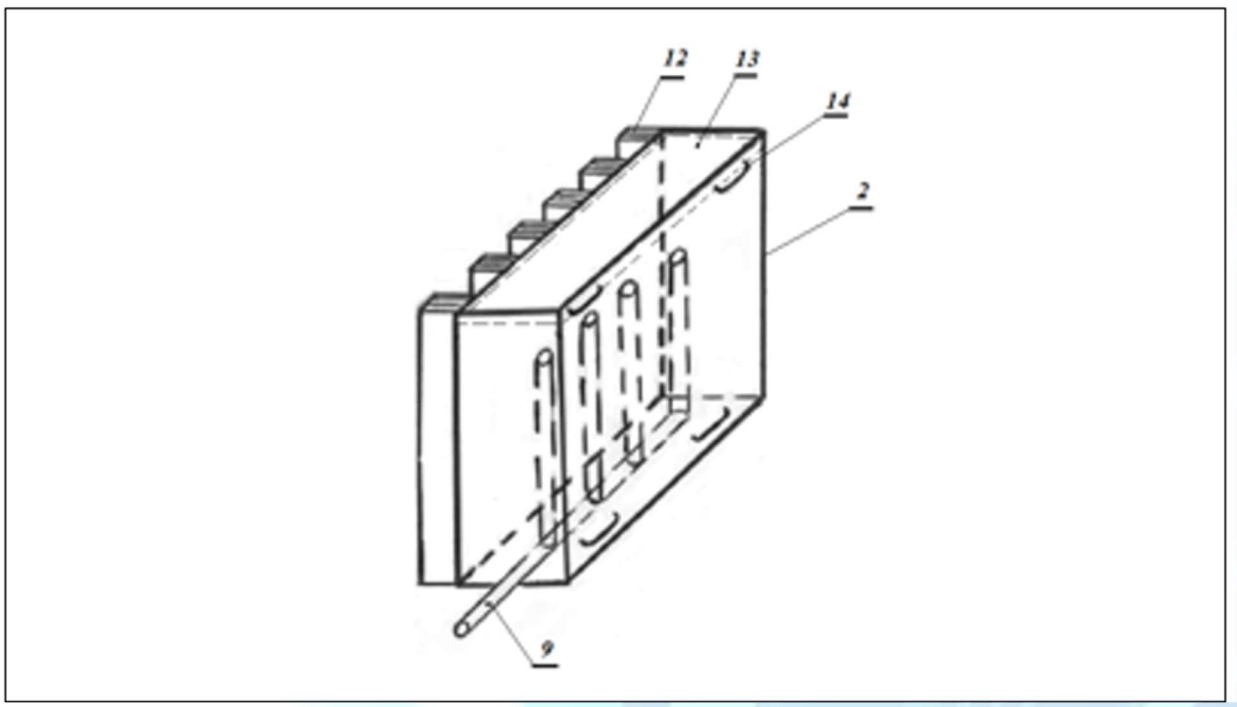


Figure 3. View of the condensation section of the heat pipe.

Conclusion:

The application of heat pipes with thermal accumulators in residential buildings is a promising direction in terms of energy savings, environmental safety, and cost-efficiency. Implementing this technology in practice can lead to the development of sustainable and climate-adapted heat supply systems.

LIST OF USED LITERATURE:

1. Ronghua Tan, Zhigang Zhang Heat pipe structure on heat transfer and energy saving performance of the wall implanted with heat pipes during the heating season // Applied Thermal Engineering 102 (2016) 633–640.

2. Chengchu Yan , Wenxing Shi, Xianting Li, Shengwei Wang A seasonal cold storage system based on separate type heat pipe for sustainable building cooling// Renewable Energy 85 (2016) 880e889

3. Zhijian Sun, Zhigang Zhang, Caixia Duan The applicability of the wall implanted with heat pipes in winter of China// Energy and Buildings 104 (2015) 36–46.

4. Zhigang Zhang, Zhijian Sun, Caixia Duan A new type of passive solar energy utilization technology—The wall implanted with heat pipes// Energy and Buildings 84 (2014) 111–116.

5. L.I. Ochilov, B.SH. Ganiyev, M.S. Mirzayev, K.A. Samiyev Определение тепловых свойств различных смешанных парафинов методом «T-history» // Problems of energy and resource conservation 2024. –№85. – p 162-128.

ISSN 3030-3907

6. Ochilov L.I., Mirzayev M.S., Samiyev K.A. Issiqlik quvurida sodir bo‘luvchi issiqlik va massa almashinish jarayonlari // "Development of Science and Technology" Scientific and Technical Journal №1/2024 – 142-148 .
7. Axatov J.S., Samiyev K.A., Rashidov K.Y., Ochilov L.I. Пассивная теплоаккумулирующая система солнечного отопления с тепловой трубой Patent for utility model, No. FAP 02206 dated 18.05.2022 // Official Bulletin. Intellectual Property Agency of the Republic of Uzbekistan. 2023. Vol.263, No.2. –p.186.

ISSN 3030-3907