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PROSPECTS FOR THE USE OF GROUND HEAT EXCHANGERS AND SOLAR COLLECTORS IN THE HEATING SYSTEMS OF MEDICAL FACILITIES

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Анотація: *Досліджено ефективні системи теплопостачання для енергозбереження в медичних закладах, зокрема для зниження енергетичних витрат на опалення та водопостачання. Запропоновано використання енергоощадного обладнання, яке дозволяє оптимізувати енергоспоживання при створенні комфортних параметрів мікроклімату в будівлях медичних установ. Визначено, що застосування новітніх технологій у системах теплопостачання дозволяє значно зменшити витрати енергії, підвищити ефективність роботи інженерних мереж та сприяти поліпшенню умов для пацієнтів і персоналу.*

Ключові слова: енергоощадне обладнання, енергозбереження, опалення, водопостачання, медичний заклад, мікроклімат.

Abstract: *Effective heat supply systems for energy saving in medical institutions have been studied, in particular to reduce energy costs for heating and water supply. The use of energy-saving equipment is proposed, which allows optimizing energy consumption while creating comfortable microclimate parameters in the buildings of medical institutions. It has been determined that the use of the latest technologies in heat supply systems allows significantly reducing energy costs, increasing the efficiency of engineering networks and contributing to improving conditions for patients and staff.*

Keywords: energy-saving equipment, energy saving, heating, water supply, medical institution, microclimate.

Introduction

The supply of thermal energy to indoor spaces is essential for maintaining comfortable indoor air parameters, heating water for sanitary and hygienic needs, and supporting technological processes in industrial enterprises. This requires the organization and functioning of specialized heating systems, which can be either local—where heat is generated at the consumption site—or centralized, where heat is produced by specialized enterprises.

Heat supply sources are designed to convert the energy contained in organic or nuclear fuel into heat, which is then transferred to a heat carrier (such as water or steam) that transports the heat to consumers [3].

In urban areas, heat supply sources include combined heat and power (CHP) plants and boiler houses, while in rural areas, small boiler houses and heating stoves are commonly used. Unlike CHPs and large centralized heating boiler houses, heat production in small boiler houses and heating stoves requires significant amounts of unskilled labor and contributes to substantial environmental pollution.

Currently, one of the most relevant solutions in Ukraine for heating buildings and providing hot water is the use of ground heat exchangers and solar collectors [4].

Modern solar water heating systems can meet 60-80% of hot water demand at the latitude of Kyiv, while in the southern regions of Ukraine, they can provide nearly 90-100% of the required hot water supply [5]. The use of such solar systems makes consumers energy-independent from rising gas and electricity prices.

Research Results

A study was conducted on modern heating and heat supply systems, along with their auxiliary equipment, which ensures a stable indoor microclimate in medical facilities. These systems maintain a consistent thermal regime that prevents both hypothermia and overheating of the human body while also supporting the necessary technological processes.

The proposed solar system model features an improved design, as the building's roofing material simultaneously functions as an absorber. This innovation reduces costs, increases efficiency, and simplifies the structure of the solar collector.

The combined solar heating system operates according to the following scheme. Solar radiation is absorbed by the solar energy absorber and the heat transfer tubes, causing them to heat up. When the shut-off and control valves are opened and adjusted, water enters the solar collector. Due to the temperature difference and, consequently, the difference in the density of the heat carrier, circulation occurs between the inlet and outlet pipes. The heated heat carrier is then transferred through the supply pipeline to the hot water storage tank. The cooled heat carrier returns to the solar collector through the return pipeline, where it is reheated. The system includes air release mechanisms, thermal insulation materials, drain pipes for water discharge, and pipelines for delivering the heat carrier to the consumer. Additionally, a transparent cover is installed to prevent intensive convective air currents that could significantly reduce the absorber's efficiency.

An essential condition for the efficient use of solar energy is the rational design of the building itself to reduce heat demand. Active systems are complemented by elements of passive solar energy utilization.

Heat pump systems utilize low-grade thermal energy from the environment and renewable energy sources (RES) for heating purposes. Integrating solar and heat pump systems into a unified system offers several technical and economic advantages:

• heat transfer from the solar collector (SC) at a temperature range of 3...40°C, which enables a high coefficient of performance (COP) for the heat pump (approximately 3...7) when operating in a vapor-compression cycle. Additionally, within this temperature range, the SC maintains high efficiency;

• presence of a specialized heat pump;

• High efficiency of such combined systems, ensuring a significant share of solar energy in covering thermal loads. In cold climate conditions, larger SC surface areas are required;

• Use of an additional electrical energy source, for which the conversion coefficient is equal to 1, significantly reducing the seasonal coefficient of performance of the system.

An important characteristic of such combined systems is the share of solar energy in covering the thermal load or the fuel substitution rate. This is defined as the ratio of the amount of heat supplied by the solar collector (SC) to consumers to the total heating load over a given period (month, season, or year). The key efficiency indicator of a heat pump is the coefficient of performance (COP), which represents the ratio of the useful heat released by the heat pump's condenser to the work consumed for compressing the working fluid in the compressor. For combined systems, both efficiency indicators can be used. Additionally, the substitution rate can be extended to include both solar energy and the environmental energy extracted by the heat pump's evaporator.

From the comparison of heat pump integration schemes, the following conclusions can be drawn:

• the highest fuel substitution rate by solar energy is achieved in a combined system with a series heat pump connection;

• the parallel scheme provides the lowest relative share of energy from an additional source; however, electricity consumption is higher compared to the series scheme;

• a combined heating system with two evaporators (one extracting energy from the environment and the other from the solar circuit accumulator) has characteristics similar to the series scheme.

In terms of overall fuel substitution by solar and environmental energy, the parallel system and the two-evaporator system are nearly equivalent. However, the two-evaporator system is less technologically efficient. When the solar collector (SC) surface area is small, the series scheme's fuel substitution rate is close to that of a solar heating system without a heat pump, while the parallel scheme is more similar to a conventional heat pump system.

Conclusion

The selection of the proposed technological equipment will help reduce energy consumption during operation and provide comfortable microclimate conditions in medical facilities. The environmental safety, reliability, and economic feasibility of these systems make them an essential part of modern energy-saving strategies in the healthcare sector. Further research and the implementation of innovative approaches in this field will contribute to the development of sustainable energy supply for medical institutions.

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