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INCREASE OF EFFICIENCY OF HEAT SUPPLY SYSTEMS OF AUTONOMOUS BUILDING DUE TO APPLICATION OF SOLAR GENERATION

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One of the most promising directions of development of heat supply systems, including heating and ventilation systems of residential buildings, both worldwide and in Kazakhstan is the introduction of RES sources into traditional systems. All over the world the present trend in energy and construction takes a sustainable form of development within the framework of ensuring a “green” economy [1]. In countries with high solar radiation activity both passive and active solar generation systems are used for engineering support of residential buildings. Currently, 4 major projects of solar power plants for heating and hot water supply have been implemented in Kazakhstan in Kyzylorda city (50 MW), Zharma district (30 MW), SES Burnoye and SES Saran (100 MW). Kazakhstan has developed state regulation measures to support “green building” with minimal greenhouse gas emissions [2]. Nevertheless, despite the sufficient level of state support in the Republic of Kazakhstan, solar generation has not been widely spread in the Republic.

Prospective types of solar collectors for use in the Republic of Kazakhstan

Within the framework of development of solar generation in the conditions of Northern Kazakhstan the most promising is the use of solar collectors for energy efficient individual houses with a combined scheme. In the period of time from September to March the use of traditional gas boilers for heating and hot water supply. In the time period from March to September (warm period) solar collectors with direct heat transfer and orientation of collectors to the south.

● Flat-plate solar collectors: The most common type, easy to manufacture and install. However, their efficiency is lower than vacuum ones.

● Vacuum solar collectors: Have higher efficiency, especially in low solar radiation conditions. However, they are more expensive and difficult to install.

Concentrating solar collectors: Use lenses or mirrors to concentrate solar radiation into a small area, allowing high coolant temperatures to be achieved. They are used in systems with high coolant temperatures.

Heat storage systems

● Water accumulators: The most common type, utilizing tanks of water.

● Physical accumulators: Use phase transitions of substances to store heat (e.g. ice-water, salt-solution).

● Chemical Accumulators: Based on chemical reactions that release or absorb heat.

Control systems

Modern control systems allow optimizing the operation of solar installations, taking into account meteorological data, building heat loads and energy prices. Functions of such systems include:

● Tracking solar radiation: Determining the optimum operating time of the collectors.

● Heat flow control: Maintaining the set temperature in the system.

● Heat storage system control: Charging and discharging the accumulator according to demand.

● Integration with other systems: Cooperative operation with HVAC systems.

Economic aspects

Initial investment: Depends on the type and size of the system, climatic conditions and other factors.

● Operating costs: Minimal and mainly related to system maintenance.

Payback period: Depends on the cost of electricity, intensity of solar radiation and other factors. Typically, the payback period for solar systems ranges from 5 to 15 years.

Government support: Many countries provide tax incentives, subsidies and other support measures to encourage the development of solar energy.

Factors affecting system efficiency

● Geographical location: Intensity of solar radiation, length of daylight hours.

● Collector orientation and tilt: Optimal southward orientation and tilt angle maximize solar radiation capture.

● Heat losses in the system: Heat losses in piping, heat exchangers and other system components should be minimized.

Building insulation quality: good building insulation reduces heat losses and increases system efficiency.

Development prospects

● Integration of solar systems with other renewable energy sources: Creating hybrid systems that provide a more stable and reliable energy supply.

● Development of new materials and technologies: Increasing the efficiency of solar collectors, creating smaller and lighter systems.

Expanding the use of solar energy in various sectors of the economy: Not only for heating buildings, but also for hot water production, cooling and other purposes.

Principle of operation of solar generation in heating systems

Solar generation in heat supply systems is based on the conversion of solar energy into thermal energy, which is then used to heat the building. The main components of such a system are:

● Solar collectors: Capture solar radiation and convert it into thermal energy.

● Heat transfer fluid: Carries the heat energy from the collector to the heat exchanger.

● Heat exchanger: Transfers heat energy from the heat transfer fluid to the heat transfer medium of the building heating system.

Heat storage: Stores excess heat from sunny days for use at night or during periods of low solar activity.

● Control system: Optimizes the operation of the entire system by regulating the supply of the heating medium and ensuring maximum solar energy efficiency.

Advantages of using solar generation

Reduced operating costs: By utilizing a free energy source - sunlight.

● Reduction in carbon dioxide emissions: Reducing the consumption of traditional energy carriers such as gas or electricity.

● Increased energy independence: Reducing dependence on district heating systems.

Long service life: Solar collectors and other system components have a long service life and require minimal maintenance.

Ways to increase the efficiency of solar generation systems

Optimal selection of solar collectors: The choice of collector type (flat-plate or vacuum) should be based on the climatic conditions and heat loads of the building.

● Correct orientation and tilt of collectors: Southward orientation of collectors and optimal tilt angle maximize the capture of solar radiation.

● Use of high-efficiency heat transfer fluid and insulation: Reduces heat losses in the system.

Use of modern control systems: Optimization of system operation depending on the current weather conditions and the thermal needs of the building.

Integration with other energy supply systems: Create hybrid systems that combine solar generation with other energy sources (e.g. heat pumps or boilers).

The application of solar generation for heat supply of autonomous buildings is a promising direction of energy development. Due to their advantages, such systems make it possible to significantly improve the energy efficiency of buildings, reduce operating costs and reduce the negative impact on the environment. However, for successful implementation of such projects, many factors such as climatic conditions, architectural features of the building, and economic considerations must be taken into account.

References

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