2. Шацких Е.В., Фадеева Т.А. Продуктивность и биологические особенности свиней при выпаивании органического подкислителя // Пермский аграрный вестник. – 2018. – №3. – С. 131–136.

3. Элизбаров Р.В., Рогов Р.В., Матяш А.В. Перспективы применения органических кислот в свиноводстве // Ветеринария и зоотехния. – 2017. – №6. – С. 50-53.

4. Стрельников П.А. Подкислители в свиноводстве: ключ к здоровью и продуктивности животных // Свиноводство. – 2024. – №3. – С. 36–39.

5. Евдокимов Н.В. Использование органической кислоты для реализации потенциала продуктивности свиней и снижения потерь их живой массы при транспортировке // Научный журнал. – 2023. – С. 68–78.

6. Садомов Н.А., Шамсуддин Л.А. Особенности использования подкислителя в кормлении свиней // Кормление сельскохозяйственных животных и технология кормов. – 2021. – С. 145–152.

7. Маслова Н.А., Хохлова А.П. Эффективность использования подкислителя «Еврогард» в рационах свиноматок // Свиноводство. – 2023. – С. 45–52.

8. Евдокимов Н.В. Использование органической кислоты для реализации потенциала продуктивности свиней и снижения потерь их живой массы при транспортировке / Н.В. Евдокимов // Современные направления развития науки в животноводстве и ветеринарной медицине: Материалы международной научно-практической конференции, Тюмень, 11 февраля 2021 года. Том Часть I. – Тюмень: ГАУ Северного Зауралья, 2021. – С. 68–78.

9. Кормовые добавки с подкисляющим эффектом в рационах поросят-отъемышей в условиях теплового стресса / С.В. Абрамов, И.Ф. Горлов, М.И. Сложенкина [и др.] // Свиноводство. – 2024. – №8. – С. 50–54.

10. Маслова Н.А., Хохлова А.П. Эффективность использования подкислителя «Еврогард» в рационах свиноматок // Актуальные вопросы сельскохозяйственной биологии. – 2020. – №1(15). – С. 66–75.

UDK 662.997

J.D. Sadikov
Karshi State Technical University, Karshi, Uzbekistan

IMPROVING THE EFFICIENCY OF HEATING AND VENTILATION OF LIVESTOCK BUILDINGS AND STRUCTURES USING A PASSIVE SOLAR HEATING SYSTEM

Keywords. renewable energy sources, solar energy, passive solar system, animal husbandry.

Annotation. The article considers the design of a passive solar system for heating and ventilation of livestock facilities, which allows saving fuel and energy resources.

Currently, energy conservation and rational use of energy resources in agriculture is an urgent problem for many enterprises in the industry. High energy intensity of agricultural products, limited energy resources and high cost of energy are the main energy indicators of agricultural production today.

Today, animal husbandry is a major consumer of energy. A significant share of energy consumption is spent on maintaining optimal microclimate parameters on farms, which contributes to increased productivity. To achieve maximum productivity, it is necessary to create and maintain regulatory parameters of the microclimate, which are individual for each type of animal and bird, but this does not guarantee the minimum cost of production. Therefore, optimal microclimate parameters should be maintained in livestock facilities. Indoor temperature and humidity are the main factors in the process of ensuring the normal physiological condition of animals. The efficiency of animal husbandry largely depends on the use of resource-saving technologies and equipment to ensure the microclimate of livestock facilities. Deviations of the microclimate parameters from the recommended standards lead to a deterioration in the technological parameters of production: a decrease in body weight gain, a decrease in the resistance of animals to diseases, and the consumption of additional amounts of feed. Optimal air parameters in livestock premises, temperature +12...16oC, relative humidity 60...70% [11]. The stability of the thermal equilibrium of the animal's body depends on the stability of the ambient temperature. When maintaining the required temperature in combination with other necessary room parameters, the output can increase by 30% [8]. Therefore, livestock facilities should be equipped with an effective ventilation and heating system.

Every year, the earth's surface receives energy from the Sun. If we compare this energy with estimates of the energy contained in the proven reserves of natural gas, coal, oil and uranium, it becomes clear that in one week the Earth receives from the Sun an amount of energy that is more than twice as much as all known energy reserves on Earth.

Solar energy has virtually unlimited resources and installations based on it are more environmentally friendly than other energy sources. They are not related to environmental pollution issues.

The conversion of solar energy into heat of low potential, sufficient for hot water supply and heating of residential, public, industrial buildings and structures, is achieved using relatively simple technical means. In many countries, more and more attention is being paid to the practical use of solar energy, primarily for hot water supply and heating of buildings, and sufficient experience has been gained in the development and operation of heat supply systems in which solar energy is effectively used for a significant part of the year [4]. From an economic point of view, it is necessary to design a solar heat supply system in such a way that it provides only part of the annual heat load, and adds the missing amount of heat as needed due to an additional energy source [2].

There are two types of solar energy systems for heating purposes: active and passive. Passive systems do not require energy to activate them, and when using active systems, additional energy is needed.

Currently, the attention of specialists is attracted by "passive" solar heating systems, the main advantages of which are cost-effectiveness and ease of operation. In buildings equipped with passive heating systems, heat absorption, storage and transportation in such buildings occurs naturally using architectural, planning and design solutions without the use of special expensive solar engineering and engineering equipment. Along with cost-effectiveness, the introduction of passive systems is a very effective means of combating environmental pollution. Buildings equipped with passive heating systems, the southern wall of which has single or double-layer glazing. Simplicity and relatively low cost are good reasons for widespread use of passive systems. It has been established that passive solar systems can be more economical than active ones and even compete with liquid fuel heating systems. The cost of a building with a passive solar energy use system is approximately equal to the cost of a conventional residential building of the same category.

The introduction of passive solar energy systems into practice will make it possible to significantly reduce the consumption of thermal energy for heating residential, public buildings and agricultural structures based on widespread use. Livestock premises using a passive solar heating and ventilation system allows [2,3]: - to reduce heat losses through a transparent coating by reducing the temperature of the blackened surface while increasing heat transport through the heat storage wall; - it is possible to supply heated fresh supply air to the room during the cold season; - to improve room ventilation in a natural or forced manner.

It should also be noted that the use of solar energy for heat supply has great prospects for widespread use in individual households, where the use of solar energy is already advisable. Widespread and targeted energy conservation will save fuel and energy resources.

In agriculture in the southern regions of the republic, there are opportunities to introduce solar technology (the use of solar energy), it is possible to develop and improve the construction of agricultural buildings - this will give, firstly, fuel savings for space heating, and secondly, the cost of production will be lower than natural heating, and thirdly, the construction of such systems will not more expensive and simpler than with heating systems, etc.

For the future, it is planned to use more advanced types of solar installations in the field of heat supply in agriculture in the southern regions of the republic with active and passive heating systems in a wide range.

The purpose of the work is the efficient use of solar energy for heating and ventilation of livestock facilities. The most common type of heating in animal husbandry is water heating. In some places, according to climatic zones and taking into account the duration of the heating season in agricultural facilities, preference is given to air heating combined with supply ventilation. Boilers are built for water and steam heaters, which is not always economically profitable.

One of the main elements in creating the necessary microclimate in the premises of agricultural facilities is ventilation. The presence of an unorganized influx of cold air into a heated room leads to the need for additional consumption of 40...62 kJ of heat per 1 m3 of cold air [2,11].

Passive solar heating systems are based on collecting solar radiation energy on blackened surfaces protected by a transparent coating, heating them with subsequent heat transfer by thermal conduction and free convection into a heated room.

The advantage of a system with a heat storage wall compared to a direct heating system through glazed openings is the most efficiently organized heat supply to a heated room, which reduces heat loss by reducing waste heat due to overheating inside the room and maximizing its supply to the room during the coldest time of the day. The main advantage of passive solar heating systems with a heat storage wall is the most advantageous distribution of energy input over time, reducing the possibility of overheating and associated additional heat losses. With the help of constructive solutions, it is possible to reduce heat loss from the heat storage wall and thereby increase the efficiency of the system.

The effectiveness of passive systems is based on their relatively low cost, the ability to use both direct and diffuse solar radiation, the influx of which in the winter months to the horizontal surface can be more than half of the total. It follows from this that it is convenient to determine the efficiency of a passive system by the ratio of the heat coming from the sun to the total amount of heat needed to create comfortable indoor conditions or to the heating load.

The geographical location and climatic features of the area have a great influence on the efficiency of using solar energy. As studies show, the complete provision of the heating load by passive solar heating systems is not economically profitable and in any systems it is necessary to provide an additional low-inertia heat source - a stand-in. One of the most common disadvantages of the heat storage wall design in designed structures with solar heat supply is the use of a wall with low storage capacity with high thermal resistance. This results in a significant increase in the temperature of the outer wall surface, leading to an increase in heat losses through glazing [1,4,6,9,10].

Since the equation of thermal conductivity in a dimensionless form can be written

$$\frac{\partial \theta}{\partial Fo} = \frac{\partial^2 \theta}{\partial X^2} \qquad (1)$$

where $X = \frac{x}{\delta}$; $Fo = \frac{a\tau}{\delta^2}$, then in order to obtain the same solutions and the same delay of the heat wave , it is necessary that the condition:

$$\frac{\lambda}{\delta^2} = \text{idem} \qquad (2)$$

To fulfill the condition of constancy of the product of density and heat capacity of the wall material, i.e. for the analyzed conditions, various design options for the heat storage wall can be considered. For example, by adding a material with good conductivity to the base material. For such a wall, with increased thermal conductivity and storage capacity (2), a composition of the base substance of concrete with metal fiber, wire or shavings is used. In this case, the calculation of the effective thermal conductivity can be performed based on the use of the principle of generalized conductivity, assuming a parallel connection of heat conductors through the thermal resistances of the base material and metal conductors. As the calculations performed on the basis of [3] show, an insignificant addition of metal fibers to a poor heat conductor greatly increases its thermal conductivity and practically does not change its volumetric heat capacity. If we assume that the location of heat conductors (for example, metal shavings) in the main material is chaotic and the increase in effective thermal conductivity occurs equally in all coordinates (the composite substance is isotropic), then for the computational model we can imagine an element of composite material with the location of the entire mass of metal along three coordinate axes.

Using the technique described above [3], the effective thermal conductivity of a composite material with a metal fiber was determined.

To increase the heat transfer capacity of the heat storage wall, it is necessary to use a perforated heat storage wall, which can increase the intensity of heat removal from the radiation-receiving surface of the heat storage wall during the period of insolation and can be used as ventilation devices with natural or forced air supply [5,7,10].

Temperature distribution over the thickness of the perforated wall at different air flow rates with constant heat flow on the wall surface.

$$\frac{t_1 - t_r}{t_2 - t_r} = \frac{e^{K(x_1-\delta)} - 1}{e^{K(x_2-\delta)} - 1} \qquad (3)$$

where $K = \frac{GC_p}{\lambda_W (1-P)}$; G – air quantity kg/(m^{2}h); C_P – specific heat capacity of air; P – wall porosity, the ratio of the pore volume to the total volume of the material, or the cross-sectional pore area to the total cross-sectional area; λ_W – thermal conductivity of the wall; δ – wall thickness; t_r – the temperature of the inner wall surface.

To verify the validity of the obtained equation (3), an experimental setup was constructed.

The temperature of the heat-receiving surface changes rapidly as the air flow increases, and the temperature of the inner surface changes slightly, which is explained, in particular, by an increase in the heat transfer coefficient as the air flow velocity increases along this surface.

The obtained theoretical model is consistent with a sufficient degree of accuracy with the results of an experiment performed on a model of a perforated heat storage wall.

In conclusion, it can be concluded that it turns out to be advantageous to use a more thermally conductive material for the heat storage wall. In this case, the external heat transfer coefficient and the average temperature of the outer wall surface decrease, which reduces losses to the environment.

The perforated heat storage wall and the air supply through it help to increase the effect of heat transfer to the depth of the wall and into the room, reduce heat loss, and installing a ventilation device in the form of an exhaust fan improves ventilation by providing heated fresh air to the room.

In order to reduce energy consumption spent on heating and ventilation, it is necessary to purposefully expand the design and construction of agricultural structures not only with high-quality thermal insulation of building structures, but also with passive solar heating systems with a heat storage wall.

In the future, heating of agricultural facilities with organic fuels can be replaced by non-traditional renewable energy sources.

List of used literature

1. Авезов Р.Р., Орлов А.Ю. Солнечные системы отопления и горячего водоснабжения.-Ташкент.: Фан. 1988.-288 с.
2. Андерсон Б. Солнечная энергия (основы строительного проектирования) М.: Стройиздат, 1982. 376 с.
3. Васильев Л.Л., Фрайман Ю.Е. Теплофизические свойства плохих проводников тепла. – Минск: Наука и техника, 1967. – 176с.
4. Даффи Дж.А., Бекман У.А. Тепловые процессы с использованием солнечной энергии.-М.: Мир. 1977.-420с.
5. Ким В.Д., Садыков Ж.Д., Хайриддинов Б.Э. //Гелиотехника. 1998. №6. С. 38–42.
6. Садыков Ж.Д., Ким В.Д., Садыков Ж.Ж. //Гелиотехника. 2003. №3. С. 57–61.
7. Садыков Ж.Д., Хайриддинов Б.Э., Зияев Т.З., Халимов Г.Г. Пути повышения эффективности зданий с пассивным солнечным отоплением. «Фундаментальные и прикладные вопросы физики». Материалы IV-международной конференции. Тошкент 24-25 ноября. 2010. 139-141 с.
8. Сканави А.Н. Отопление. - М: Стройиздат. 1988.-416 с.
9. Чакалев К.Н, Садыков Ж.Д. Гелиотехника. 1992. №4. С. 54–56.
10. Чакалев К.Н, Садыков Ж.Д. Гелиотехника. 1994. №1. С. 53–56.
11. Л.И.Шпаков, В.В.Юнаш. Водоснабжение, канализация и вентиляция на животноводческих фермах. – М: ВО Агропромиздат. 1987. 146с.