CALCULATION OF UTILIZATION OF SECONDARY ENERGY RESOURCES IN THE LIVESTOCK-HELIOGREENHOUSE COMPLEX WITH THERMAL ACCUMULATOR

Sh.H. Ergashev
Dotsent (PhD), Department "Thermal Power Engineering"- Karshi engineering-economics institute.
J.T.Abdurakhimov
Magistr, Department "Thermal Power Engineering"- Karshi engineering-economics institute.

Abstract: *In the article, the method of selecting the working area of the heliogreenhouse in the use of secondary energy resources of the livestock building in the "livestock-heliogreenhouse complex" is developed. When creating a microclimate in typical livestock buildings, ventilation with outside air is carried out to reduce the amount of harmful gases in the air. As a result, a large amount of heat is lost, which in turn leads to environmental pollution. A solution to the above problems was found by implementing this air exchange with a solar greenhouse built next to the livestock building.*

Key words: *microclimate, moisture regime, heat regime, heliogreenhouse, optimal area, heat balance, solar energy.*

The strategic directions of energy development in the Republic of Uzbekistan provide for the widespread use of non-traditional energy sources, including the energy of organic animal biomass. Calculations show that when processing organic biomass into biological gas, 4.2 times more energy can be produced annually than is produced at power plants in the Republic of Uzbekistan. Closely related to the problem of waste management is another - increasingly exacerbating - environmental protection, which also requires intensive and rational processing of organic biomass. The use of renewable energy in the world is becoming increasingly important because traditional sources of energy (coal, oil, natural gas) are limited, and their use for the production of heat and electricity causes great harm to the environment. In this regard, solar energy is becoming increasingly important, which can be used to produce environmentally friendly heat and electric energy.

The sun is a giant source of "clean" energy, not polluting the environment. Efficient use of solar energy can significantly reduce the consumption of natural resources. Climatic and weather conditions in the south of Uzbekistan create wide opportunities for the efficient use of solar energy in the Kashkakdarya region [1,2,3,4,5,6,7].

By utilizing the free heat emanating from the cattle into the greenhouse in the livestock building, we can also meet the need for CO_2 gas in the plants. If the plant a by red and blue rays in a ratio of 1:4, the photosynthesis intensifies, its efficiency increases. The amount of CO_2 gas required for photosynthesis in atmospheric air is relatively short (0,03%). Photosynthesis begins when the amount of CO_2 in the atmosphere is 0,008%. With the increase in the amount of this gas, photosynthesis also reaches its highest level in the figure of 0,3%, accelerated. Therefore, it is possible to increase the yield on account of an extra feeding of greenhouse plants with [8,9,10].

We can decide the daily need of the greenhouse for carbon dioxide with the help of the following expression[11]:

$$M_{CO_2} = 1{,}25 \cdot P \cdot \tau_p \cdot F_{gr} \qquad (1)$$

where: P- an extra norm of feeding plants in the greenhouse with carbon dioxide, kg/m²hours; τ_p - the time of additional feeding plants with carbon dioxide during the sunny days of the day (in the process of photosynthesis), hours.

The daily need of the greenhouse for carbon dioxide with the help of the following expression P, greenhouse comparative size c_γ (depending on (the ratio of the greenhouse volume to its surface), it can be obtained as follows: $c_\gamma = 2{,}5$ -P=0,02 kg/(m²hours) $c_\gamma = 3{,}5$ - P=0,028 kg/(m²hours), $c_\gamma = 4{,}5$ - P=0,036 kg/(m²hours). For the applicable greenhouses in our conditions, it turns out that $c_\gamma \approx 4$ is P=0,036 kg/(m²hours) [12,13].

We calculate the air exchange between the livestock building and the greenhouse. We determine the amount of carbon dioxide (CO_2) in the air exchange process. The amount of CO_2 m=300 *kg* divided by one cattle with an average weight of c=106 *l/hours*=0,106 *m³/hours*. Allowed CO_2 ingredients in the building for cattle c_1=2 *l/m³*.

The concentration of CO_2 in the composition of hot air is c_2=3 *l/m³*. By putting these values into the formula, we determine the hourly air flow rate (m³/hours) [14]:

$$L_{CO_2} = \frac{c \cdot n}{(c_2 - c_1)} = \frac{106 \cdot 40}{(3-2)} 4240 \ \frac{m^3}{hours}, \qquad (2)$$

where c=106 *l/hours* - the amount of CO_2, separated from one herd; n-the number of cattle.

During the performance of livestock buildings, harmful substances are constantly released into the atmosphere through the air. The exhaust of ventilation has nutrients for plants and is a secondary energy resource with a high energy potential, which, usually, irreplaceable, disappears, worsens the environmental situation when it spreads to the environment. Therefore, measures for the use of secondary energy resources in hothouses are considered necessary [15].

If we connect livestock buildings and greenhouses with modernized production technologies and technical means, it is possible to cut the output of harmful substances into the atmosphere as well as the unreasonable loss of heat energy.

(1) by equating the expression to (2) taking into account the density of the air, we decide the greatest area of the greenhouse in the feeding of plants with CO_2, separated from the cattle by the following formula [16]:

$$F_{gr} = \frac{L_{CO_2} \cdot \rho \cdot \tau_{CO_2}}{1{,}25 \cdot P \cdot \tau_p} = \frac{c \cdot n \cdot \rho \cdot \tau_{CO_2}}{1{,}25 \cdot P \cdot \tau_p \cdot (c_2 \cdot c_1)}, m^2 \quad (3)$$

where: τ_{CO_2} - the time of decomposition of the amount of carbon dioxide from cattle, hours; ρ - air density, kg/m^3; In calculations τ_{CO_2} =τ_p=10 hours τ_{CO2} can be considered.

Taking note of the above, we consider the area of the greenhouse when circulating the carbon dioxide air coming out of the building intended for the maintenance of 40 head cattle through the greenhouse as follows [17]:

$$F_{gr} = \frac{0{,}106 \cdot 40 \cdot 1{,}97 \cdot 10}{1{,}25 \cdot 0{,}032 \cdot 10 \cdot (3 - 2)} \approx 209\ m^2$$

Hence, taking into account the need for an average area of 6 m^2 for one head of livestock, the building area for 40 head of cattle is 240 m^2, while the carbon dioxide that separates from the cattle is a source of nutrients for plants in the greenhouse, and the area of 209 m^2 completely covers the need for carbon dioxide [15,18].

To cut the number of harmful gases contained in the air when creating a microclimate in ordinary livestock buildings, it is necessary to ventilate it with external air. As a result, a large amount of heat loss simultaneously leads to a deterioration of the environmental situation. We will have found solutions to these problems if we carry out this air exchange with a greenhouse built side by side with a livestock building.

We calculate the least area of the greenhouse, where the air temperature in the livestock building is $t_{lives.}$=26,8 ^{0}C according to the figure when there is an air exchange through the greenhouse. First of all, we draw up the heat balance of the greenhouse[13,15]:

$$Q_{gr.b} + Q_{inf} - Q_{rad} - Q_{ven} = 0 \quad (4)$$

where, $Q_{gr.b}$- Heat lost through greenhouse barriers, W; Q_{inf}- Heat lost by infiltration, W; Q_{rad} - the heat that flows into the greenhouse through solar radiation, Vt; Q_{ven}- heat brought from the livestock building through ventilation, W.

The heat lost by infiltration, as it is seen in the literature, is equal to 10-11 % of the heat lost by the greenhouse barrier, usually, this lost heat can be written in the following form [17,18].

$Q_{gr.b} + Q_{inf} = k \cdot F_{gr} \cdot (t_{gr} - t_{out}) \cdot K_b \cdot K_{inf}$ (5)

where, k - it is the heat transfer coefficient of the greenhouse bed, which is equal to 5,8 for a two-layer film, W/(m^2/^{0}C); F_{gr}-greenhouse area, m^2; K_b - it is a barrier coefficient, for greenhouses of semi-cylindrical shape $K_b = 1{,}4$; K_{inf} - become infiltration coefficient, K_{inf} =1,11; t_{gr}, t_{out} - greenhouse and outdoor temperatures, respectively, ^0C.

We calculate the heat absorbed into the greenhouse by solar radiation by the following formula [19,20]:

$Q_{rad} = q_{rad} \cdot \alpha_n \cdot k_a \cdot F_{gr}$ (6)

where, q_{rad} - average for the region, which is seen as solar radiation falling on the surface of the earth during the day $q_{rad} = 200\, W/m^2$ equal to; $\alpha_n \cdot k_a$ - the conduction and absorption coefficients of the greenhouse clear coating, respectively, can be obtained in calculations $\alpha_n \cdot k_a = 0{,}8$ [13,16].

(5), (6) putting expressions (4) into expression, we can write the heat balance of the greenhouse as follows:

$k \cdot F_{gr} \cdot (t_{in} - t_{out}) \cdot K_b \cdot K_{inf} - q_{rad} \cdot \alpha_a \cdot k_a \cdot F_{gr} - L \cdot \rho \cdot c \cdot \left(t_{lives} - t_{gr}\right) = 0$ (7)

(7) from the expression we find the least area of the greenhouse according to the value found by the graph in figure t_{out}=-6 ^{0}C, the air temperature in the greenhouse, and the temperature in the livestock building t_{in}=18 ^{0}C:

$F_{grQ} = \frac{L \cdot \rho \cdot c \cdot (t_{lives} - t_{gr})}{k \cdot (t_{in} - t_{out}) \cdot K_b \cdot K_{inf} - q_{rad} \cdot \alpha_a \cdot k_a}$, (8)

(8) we calculate the expression with attention to the above values:

$$F_{grQ} = \frac{1{,}18 \cdot 1{,}293 \cdot 1005 \cdot (26{,}8 - 18)}{5{,}8 \cdot \left(18 - (-6)\right) \cdot 1{,}4 \cdot 1{,}11 - 200 \cdot 0{,}8 \cdot 0{,}8} \approx 153\, m^2$$

This means that by utilizing the greenhouse from the free flow of heat separated from the livestock, as well as from the calculation of the Daily solar charge, the greenhouse with an average working area of 153 m^2 can fully compensate for the heat load. By calculating the average value of the surfaces found in the greenhouse from the calculation of carbon dioxide and the need for heat, we calculate the equal area of the greenhouse:

$$F_{gr.} = \frac{F_{grCO_2} + F_{gr.Q}}{2} = \frac{209 + 153}{2} = 181\, m^2 \approx 180\, m^2$$

In summary, if the working area of the building where 40 head cattle are stored is 240 m^2, if we place a greenhouse through a wall with the south side of this building, then by circulating the free heat and CO_2 gases separated from the cattle, we can fully give the greenhouse with a useful area of 180 m^2, taking into account that.

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