CALCULATION OF TEMPERATURE FIELD IN HELIOGLASS POULTRYHOUSE FLAT WALL WATER TANK HEAT ACCUMULATOR BY ANALYTICAL AND NUMERAL METHODS

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ABSTRACT

The article describes the changes in the temperature field in the construction of a flat-walled water tank heat accumulator in a helioglass poultryhouse, analytical and numerical methods, the results of experimental research on scientific and practical basis.

Keywords: hydraulic accumulator, poultry house, flat wall, temperature field, hydrodynamic resistance.

As known, an important role in microclimate creating is played by the effective use of a heat accumulator in helioglass poultryhouse. For this purpose, a one-dimensional model equation was developed with an ideal calculation of the temperature field with a heat accumulator in a water tank. However, when solving the issue, an increase in the level of accuracy of calculating temperature fluctuations in the tank water accumulator in the time interval with a conditional limitation and a numerical method based on the C++ program will be achieved. For helioglass poultryhouse the design of the water tank-heat accumulator has been developed (Figure 1-a, b). The efficiency of the amount of heat stored in the heat accumulator is determined in accordance with the results of analytical and experimental studies and, on this basis, its coefficient of efficiency is determined in accordance with the process and method of study. Also, development of design characterizing process of thermal accumulator operation in optimal mode requires use of equations characterizing its high-efficiency process [1,2]. When calculating heat and height distribution in a water tank accumulator, the degree of efficiency of water tanks in the process of their resettlement along a flat wall and their transfer to a building where birds leave through a lower window with a hot air flow along the perimeter is determined. Also, when determining the volume values and optimal modes of hydrodynamic resistance of heat accumulators composed of water tanks, we determine the limit conditions when accumulating heat as a result of the implementation of air flow through the exhaust fan (Figure 2) due to mandatory convection

$$t_{ак} = t_ч \text{ here } \bar{x} = 0, \quad \frac{\partial t_{ак}}{\partial \bar{x}} = 0 \text{ here } \bar{x} = 1 \tag{1}$$

When solving the equation given on the boundary conditions, the Laplace integral variable method [3] was used. In accordance with formula (1), we express the boundary conditions as follows

$$\mathrm{T}_{ак} = \mathrm{T}_ч, \text{ here } \bar{x} = 0, \ \frac{\partial \mathrm{T}_{ак}}{\partial \bar{x}} = 0 \text{ here } \bar{x} = 1 \tag{2}$$

In the water tanks located in the flat wall, we express the Laplace equation, consisting of integral variables in the basis of the distribution of the temperature field in the process of acclimatization of heat

$$T = c_1 exp\left[\left(\frac{1}{2F_0} + \sqrt{\frac{1}{4F_0^2} + \frac{P + \overline{q_t}}{F_0}}\right) \cdot \bar{x}\right] + c_2 \exp\left[\left(\frac{1}{2F_0} - \sqrt{\frac{1}{4F_0^2} + \frac{P + \overline{q_t}}{F_0}}\right) \cdot \bar{x}\right]$$

(3).

Here we enter the following notations

$$K_e = \frac{1}{2F_0}; \qquad K_p = \sqrt{\frac{1}{4F_0^2} + \frac{P + \overline{q_t}}{F_0}}$$

(4).

We put the expression (4) into (3) and create the following equality

$$T = c_1 exp\left[\left(K_e - K_p\right) \cdot \bar{x}\right] + c_2 \exp\left[\left(K_e - K_p\right) \cdot \bar{x}\right] \tag{5.}$$

We enter the following system notations for integration constants from boundary conditions (2)

$$\begin{cases} T_ч = C_1 + C_2 \\ C_1 = (K_1 + K_2) exp(K_1 + K_2) + C_2 (K_e - K_p) exp(K_e - K_p) = 0 \end{cases} \tag{6}$$

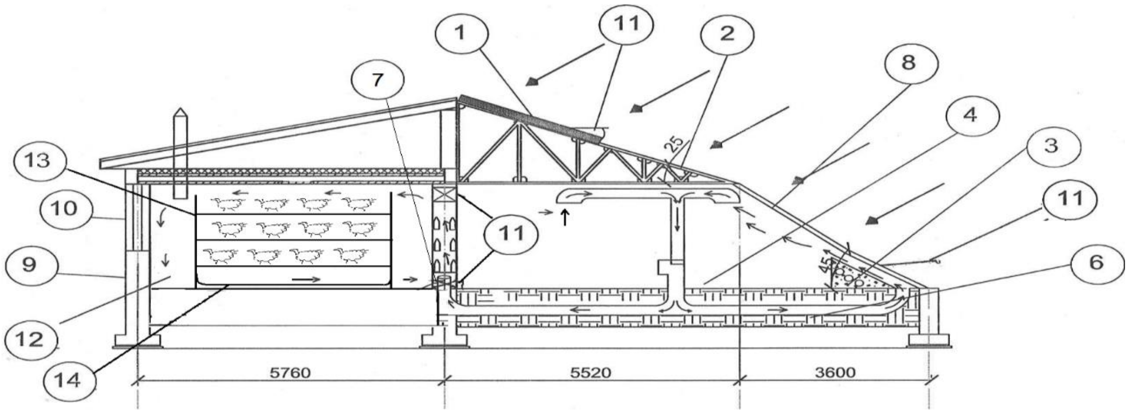

Figure 2. Diagram of the cross-section of the solar poultry house in farm and entrepreneurial farms, combined with the walls of collector batteries. Solar photographic battery. 2. The additional surface for daylight penetration; 3. Heat exchanger for heating with additional hot water from the bioenergy device; 4. Soil heat accumulator; 5. Thermal accumulator of flat wall with plastic bottles filled with water; 6. Cylindrical pipes with a diameter of 0.2 meters, made of pan; 7. An air circulation fan; 8. The fundamental thin surface for daylight penetration; 9. Flat wall made from heat keeper composite material (with cane interlaying). 10-11. Ventilation window; 12. Helioglass poultryhouse. 13. Racks for poultry care in helioglass poultryhouse.14. Washing device for poultry plant waste.

The fan diagram given in the figure 3 is water fan with automatic air temperature control by ventilation circulating through a steam heat accumulator with a flat wall of the automated helioglass poultryhouse.

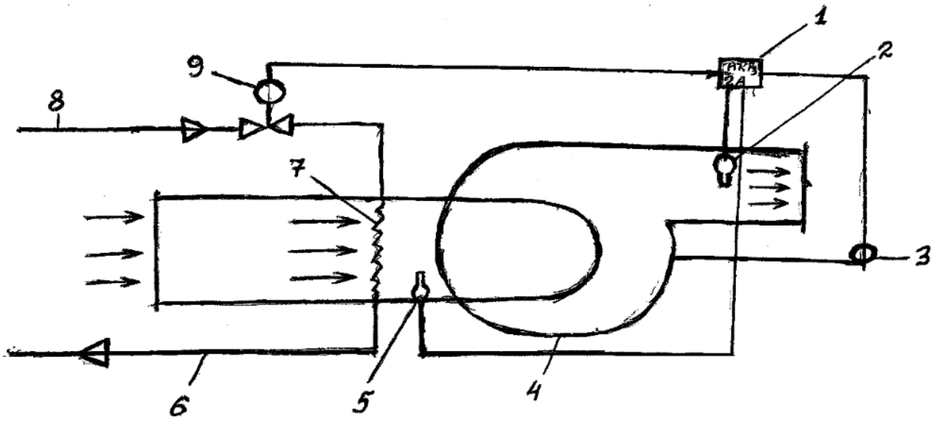

Figure 3. Controlled ABTZ-2A fan circuit with automatic electronic unit for maintaining air temperature in helioglass poultryhouse in normal mode. 1- electronic unit; 2 warm air temperature sensor; 3- a fan electric motor; 4 - fan;5- a device providing a warm flow rate of air moving through a hot accumulator with a water flat wall;6- electric current conductor, which converts into solar photobattery; 7- additional electric

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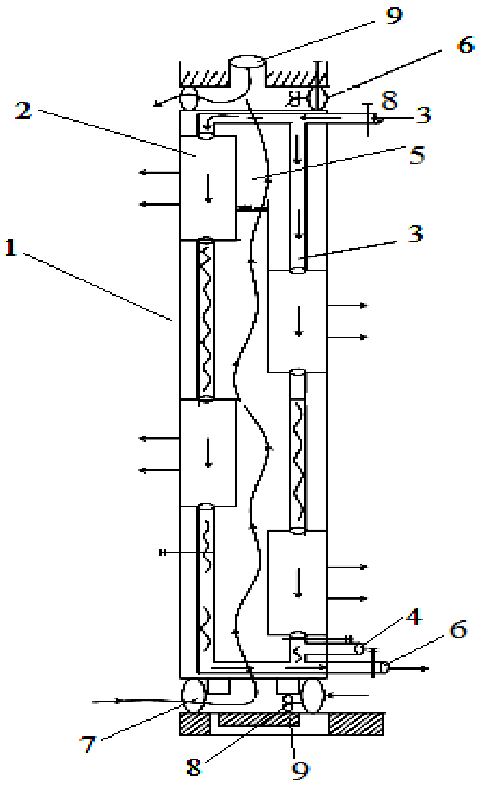
heating unit; 8- an electrical conductor transmitted to the device from the solar photobattery; 9- automatic device starting mechanism.



1^b-figure. Diagram of heat accumulator with flat tank wall. 1- heat accumulator with flat tank wall; 2- total 16 water tanks and each tank consists of 20L and 320L water tanks; 3- suction fan; 4- air flow control device; 5- air flow moving pipeline; 6- device for air flow control, which passes into helioglasshouse; 7- control device designed for ventilation of poultryhouse; 8- suction fan for fresh and low-temperature air in the helioglasshouse; 9- base.

(6) тенгламалар системасини C_1 ва C_2 га ечамиз We solve system of equations (6) comparatively C_1 and C_2.

$$\left.\begin{aligned} C_1 &= -T_\Gamma \frac{(K_e - K_p)exp(-K_p)}{(K_e + K_p)exp(K_e + K_p) - (K_e - K_p)exp(K_e - K_p)} \\ C_2 &= T_\Gamma \frac{(K_e - K_p)exp(K_p)}{(K_e - K_p)exp(K_p) - (K_e - K_p)exp(-K_p)} \end{aligned}\right\} \quad (7)$$

In this case, the temperature change in heat accumulators consisting of flat walls of waterproof tanks is determined by the following equation.

$$T = T_\Gamma exp\left[(K_1)\bar{x}\right] \frac{[(K_e - K_p)exp(-K_p)(1-\bar{x})] + (K + K_p)exp[K_p(1-\bar{x})]}{(K_e + K_p)exp(K_p) - (K_e - K_p)exp(-K_p)} \quad (8)$$

Or $$T_a = T_r exp(K_1\bar{x}) \frac{K_e ch[K_p(i-\bar{x})] + K_p sh[K_p(1-\bar{x})]}{K_e ch(K_p) + (K_p)sh(K_p)}$$

(9)

The figure and cover of the formula (9) express an infinite polynomial p. So, applying the formula Winter C.D [4] to this formula, the actual temperature area of the battery was found in tanks with a flat wall.

$$t_{ak} = A + \sum_{n=1}^{x} \frac{B(P_n)}{P_n \cdot C^1(P_n)} \cdot e^{p_n x} \tag{10}$$

Here, $A = \lim_{p\to 0} T, B(P_n) -$ is grub of the image p_n in formula (10) and characterizes the essence of the equation.

$C^1(P_n)$ is the root of formula (10) and it optimizes the value of the equation.

Equality $$A = \frac{k_1 ch[1-\bar{x}] + k_2 sh[k_2(1-\bar{x})]}{k_1 ch(k_2 + k_2 sh)(k_2)} \tag{11}$$

was defined directly from the equations (4) and (9).

Here $k_2 = \sqrt{\frac{1}{4F_0^2} + \frac{q_{ucc}}{F_0}}$

Dividing into equal parts, we introduce a new variable

$$\mu = i\sqrt{\frac{1}{4F_0^2} + \frac{p + q_{ucc}}{F_0}} = ik_p \tag{12}$$

$$p = (\mu^2 \cdot F_0 + \frac{1}{4F_0^2}) - \bar{q}_{ucc} \tag{13}$$

Also, taking into account the following symbols

$$chk_p = \cos(ik_p), shk_p = i\sin(k_p) \tag{14}$$

we determine the value of temperature change in water tank accumulator::

$$T = T_r \exp[(-k_1)\bar{x}] \cdot \frac{k_1 \cos[\mu(1-\bar{x})] - \mu \sin[\mu(1-\bar{x})]}{k_1 \cos\mu - \mu \sin\mu} \tag{15}$$

The roots of this equation will be determined through the following equations:

$$k_1 \cos\mu - \mu\sin\mu \tag{16}$$

or

$$\frac{k_1}{\mu} = tg\,\mu \tag{16^1}$$

This equation is known from the nostationary theory of thermal conductivity [2], the roots of which are graphized. Therefore, we define the value of equation (9) on P

$$C^1(k+1)\frac{sh\sqrt{\frac{1}{4F_0^2}+\frac{p+q_{ucc}}{F_0}}}{2F_0\sqrt{\frac{1}{4F_0^2}+\frac{p+q_{ucc}}{F_0}}}+\frac{ch\sqrt{\frac{1}{4F_0^2}+\frac{p+q_{ucc}}{F_0}}}{2F_0} \qquad (17)$$

By entering the signs of formula (12) in this equation, we get the following equality

$$C^1=\frac{k_1+1}{2F_0}\cdot\frac{\sin\mu}{\mu}\cdot\frac{\cos\mu}{F_0} \qquad (18)$$

and by means of equations (15) and (18) temperature change t_{ak} in the water thermal accumulator of the solar greenhouse

$$t_{ak}=t_r^1\exp(k_1\overline{x})\left\{\frac{k_1ch\left[k_2(1-\overline{x})+k_2sh\left[k_2(1-\overline{x})\right]\right]}{k_1ch(k_2)+k_2sh(k_2)}+\sum_{n=1}^{\infty}\frac{k_1\cos\left[\mu_n(1-\overline{x})-\mu_n\cdot\sin\left[\mu_n(1-\overline{x})\right]\right]}{\left[\frac{k_1+1}{2F_0}\cdot\frac{\sin\mu}{\mu}\cdot\frac{\cos\mu}{F_0}\right]\left[\mu_n^2F_0+\frac{1}{4F_0}-\overline{q}_{ucc}\right]}\right\}\times$$

$$\times\exp\left\{\left[\mu_n^2F_0+\frac{1}{4F_0}-\overline{q}_{ucc}\right]\tau\right\} \qquad (19).$$

A hot water battery can be obtained provided that the temperature fluctuations in the upper and lower parts are similar. t_{ak} is the network change of the water temperature in the tank battery and it depends on the change of the temperature in the upper and lower part of the battery and is determined by the equation:

$$t_{ak}=\Delta t_{\text{в}}\left\{\frac{sh(\frac{\overline{x}}{2F_0})}{sh(\frac{1}{2F_0})}+\sum_{n=1}^{\infty}\frac{2\mu_n\sin(\mu_n\cdot\overline{x})}{\mu_n^2+\frac{1}{4F_0^2}\cdot\cos\mu_n}\right\}\times$$

$$\times\exp\left[-\left(\mu_n^2F_0+\frac{1}{4F_0}\right)\overline{\vartheta}\right]\cdot\exp\left[\frac{1}{2F_0}(\overline{x}-1)\right]+ \qquad (20);$$

$$+\Delta t_n\left\{\frac{sh(\frac{\overline{x}-1}{2F_0})}{sh(\frac{1}{2F_0})}+\sum_{n=1}^{\infty}\frac{2\mu_n\sin[\mu_n(1-\overline{x})]}{(\mu_n^2+\frac{1}{4F_0^2})\cdot\cos\mu_n}\times\right.$$

$$\left.\times\exp[-(\mu_n^2F_0+\frac{1}{4F_0})\cdot\tau\right\}\exp\left[\frac{1}{2F_0}\overline{x}\right]$$

here $\Delta t_{\text{в}}$ is temperature change at the top of the battery with water;

$\Delta t_n -$ is temperature change in the lower part of the water tank battery;

$$F_0 = \frac{a}{u \cdot н}; \quad \bar{x} = \frac{x}{н}; \quad \bar{\tau} = \frac{\tau}{\tau_0} = \frac{\tau u}{н}.$$

When calculating temperature fluctuations in a water tank battery using formula (20), it is taken into account that the height 2 m and volume $V = 320л$ of the battery.

Figure 4 shows the relative temperature change $\bar{T}$ in height in different values of the water tank battery F_0.

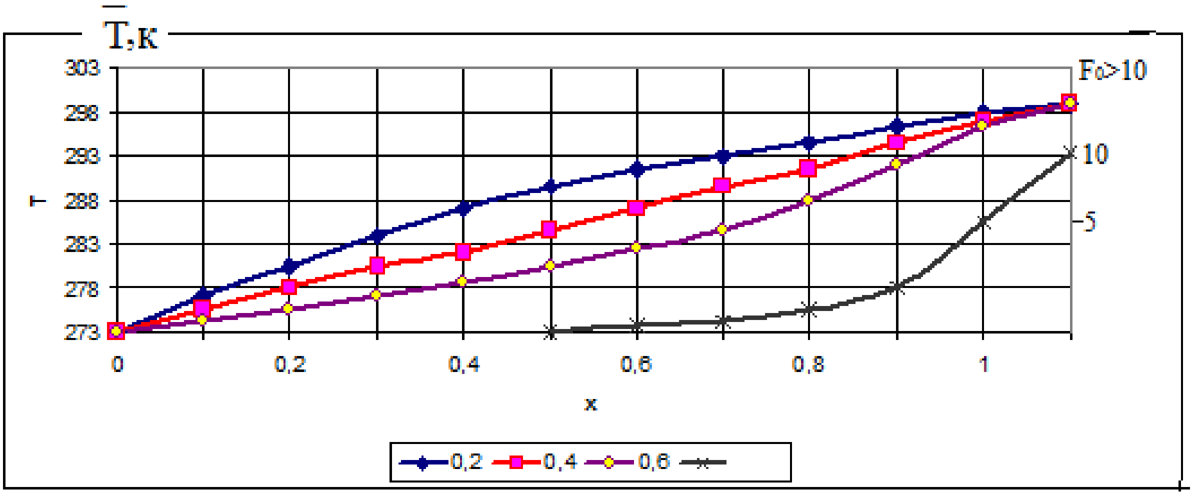


Figure 4. The change in Fourier number in different values $\bar{T}$ in the average height H of water heat accumulator F_0 with flat wall.

It can be seen from the graph that in the tank of the battery with a flat wall of the helioglass poultryhouse, the results of calculations based on the numerical method using the formula for relative temperature change (20) correspond to experimental attributes. From the conducted experiments on heating heat accumulators, consisting of tanks with a flat wall, it follows that when exposed to warm water energy circulating from an additional biogas boiler plant on cold days, the water temperature in a slow accumulator with a flat wall varies in thickness, indicated in Figure 2. Using the equations given in the citation [4,5,6], it has been found that the accumulator accumulates 22-26% of the thermal energy on a water tank basis.

Arbitrary notations:

$\bar{T}$- change of heat accumulator with water by height; $t_ч$- air temperature coming out of accumulator manifold with flat water wall; P- complex variables, τ- time; F_0 – Fourier test; x- coordinate characterizing heat flows in the width direction of the water heat accumulator; U- medium section of coolant movement through water heat accumulators; $a-$ temperature conductivity coefficient; H- height of heat accumulator with water; t_{ar}- air temperature included in the heat accumulator; $\overline{q_{uc}}$ - the average amount of heat transferred through the water heat storage tank to the poultry house.

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