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RESEARCH OF HEAT EXCHANGE IN POULTRY WASTE IN THE PROCESS OF REGULAR THERMAL REGIME

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Abstract

The system "environment (water in an annular volume) - a thin cylindrical metal wall - the investigated liquid medium" is being studied. Heat exchange during heating and cooling of water-diluted chicken litter under conditions of forced convection is studied. Chicken droppings represent a multiphase medium, as it consists of solid particles based on a liquid medium.

It was experimentally established that there is a regular thermal regime in the experimental system: the rate of cooling) heating is constant, m = const; the heat transfer coefficient during the regular thermal regime is practically constant $\overline{\alpha_1}$ *≈ const. Processing is carried out by the method of stationary heat exchange, examining the entire period of time.*

***Key words*:** regular heat regime, chicken droppings, heat transfer coefficient.

Introduction

An unresolved stage in technology is the processing of the solid fraction of fermented bird droppings, which is a valuable organic fertilizer with a high content of nutrients and biologically active plant growth stimulants.

The use of certain methods of processing bird droppings allows you to solve the issue of its utilization, however, this is achieved at the expense of additional energy costs, irrational use of its energy and chemical potential, and an increase in the negative impact on the environment.

The purpose of the work: to investigate heat transfer in the system "water in an annular volume - a thin cylindrical wall - the investigated liquid medium".

Research results

The research is carried out on an experimental stand, which was developed at the Department of Thermal Power Engineering of the National Technical University [1-2]. These series of experiments were carried out under conditions of forced convection. The experimental setup is equipped with a removable propeller stirrer (dm = 0.058 m). The ratio of the diameters of the stirrer and the internal working capacity dm/Dvn = 0.6. V1 – external working capacity, V2 – internal working capacity. The height of the cylindrical heat exchange surface H = 0.108 m. The range of adjustment of the stirrer rotation frequency is 26...150 rpm. Experimental installation data: height of the cylindrical heat exchange surface H1 = 0.108 m; diameter of the stirrer dm = 0.058 m; the ratio of the diameters of the stirrer and the internal working cavity dm/Dv = 0.6 (Dv = 0.096 m); mass of the environment (water) – 3 kg.

From literature reference books on average temperature $\overline{\mathrm{T}}_1$ we determine the thermophysical properties of water - density ρ_1, specific heat capacity C_{p1}, thermal conductivity coefficient λ_1, thermal expansion coefficient β_1, kinematic viscosity ν_1, dynamic viscosity μ_1, Prandtl criterion Pr. We set the wall temperature of the heat exchange surface$\overline{\mathrm{T}}_{\mathrm{CT}}$ < 7-10 °C by $\overline{\mathrm{T}}_1$.

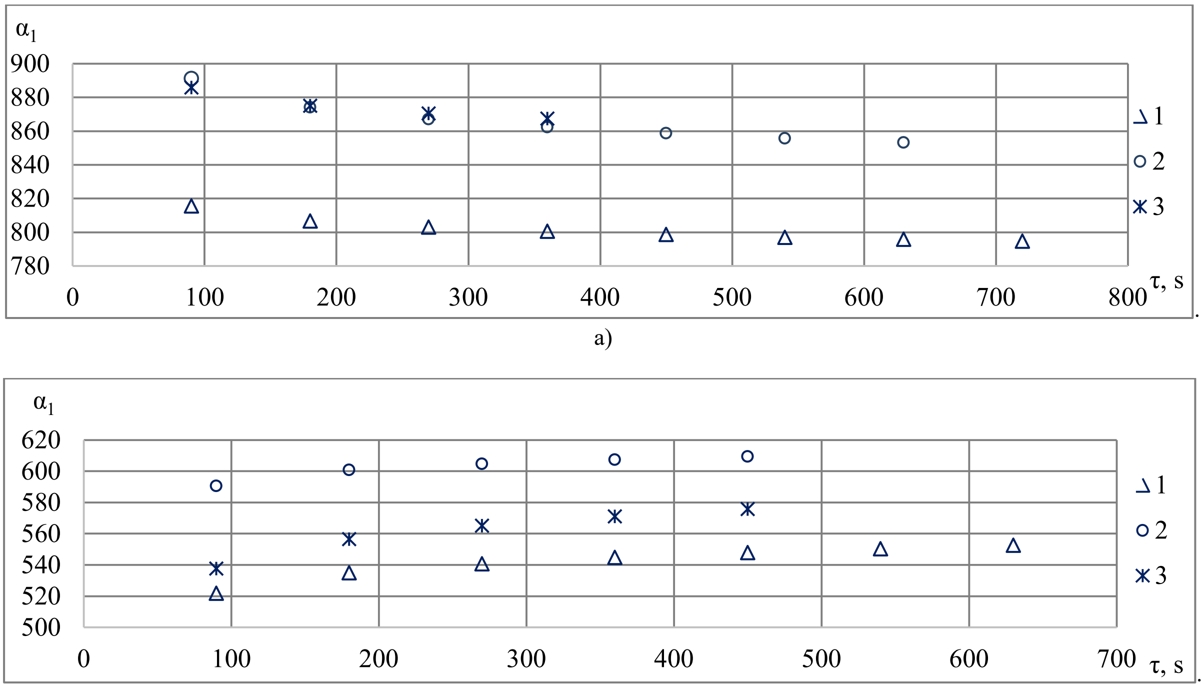
There are several basic parameters that describe the existence of a regular thermal regime in the "liquid-solid" system under the conditions of non-stationary thermal processes. One of them is the constancy of the heat transfer coefficient between the environment and the metal wall $\overline{\alpha_1}$ [3].

Heat transfer coefficients $\overline{\alpha_1}$ are determined by the well-known criterion equation of the stationary mode for "large volume" [4] $\overline{Nu_1} = 0{,}76 \cdot (\mathrm{Gr}_1 \cdot \mathrm{Pr}_1)_h^{0.25} \cdot \left(\frac{Pr_{\mathrm{p}}}{Pr_{\mathrm{ST}}}\right)^{0{,}25}$ in laminar conditions $10^3<(\mathrm{Gr}\cdot\mathrm{Pr_p})<10^8$. In the criterion equation: $\mathrm{Gr}_1 = (g\cdot\beta_1\cdot\overline{\Delta}\mathrm{t}\cdot H^3)/\nu_1^2$ – Grashof's criterion; g – free fall acceleration, m/s^2; β_1 – thermal expansion coefficient of water, $°C^{-1}$; $\overline{\Delta}\mathrm{t} = |\overline{\mathrm{t}_1} - \overline{\mathrm{t}_{\mathrm{ST}}}|$ – temperature pressure, $°C^{-1}$; $\overline{\mathrm{t}_1}$ – average water temperature, ºC; $\overline{\mathrm{t}_{\mathrm{ST}}}$ – average wall temperature, ºC; $\mathrm{Pr}_{\mathrm{p1}}$ – Prandtl's criterion for the average volume temperature of water; $Pr_{ст}$ – the Prandtl criterion for water at the wall temperature in the process of iterations; ν_1 – kinematic viscosity of water, m^2/s.

Heat transfer coefficients $\overline{\alpha_1}$ between water (environment) and a metallic cylindrical wall using the criterion equation [4] is determined by the formula:

$$\bar{\alpha}_1=\frac{Nu_1\cdot\lambda_1}{H}, \qquad (1)$$

Nu_1 – Nusselt's criterion; H – determining size of the internal cylindrical vessel (height), m; λ_1 – coefficient of thermal conductivity of water, W/(m·K).



a)

b)

Fig. 1. Heat transfer coefficient α1 during heating (a) and cooling (b) of chicken litter at the following revolutions of the stirrer: 1 – 33 revolutions/minute; 2 – 114 revolutions/minute; 3 – 156 revolutions/minute.

Deviation of local heat transfer coefficients $\overline{\alpha_1}$ from the average heat transfer coefficient of the entire range of studies is mainly within the limits 25%.

It was experimentally established that there is a regular thermal regime in the experimental system: the heating (cooling) rate is constant, m = const; the heat transfer coefficient during the regular thermal regime is practically constant $\overline{\alpha_1} \approx$ const, which is characteristic of a regular thermal regime in a solid body and a system of solid bodies [3].

Conclusions

1. The coefficient of heat transfer between the environment and the metal wall is determined $\overline{\alpha_1}$.
2. It was experimentally established that there is a regular thermal regime in the experimental system: the heating (cooling) rate is constant, m = const; the heat transfer coefficient during the regular thermal regime is practically constant $\overline{\alpha_1} \approx$ const, which is characteristic of a regular thermal regime in a solid body and a system of solid bodies.
3. B Deviation of local heat transfer coefficients $\overline{\alpha_1}$ from the average heat transfer coefficient of the entire range of studies is mainly within the limits 25%.

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