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FLOW AND TEMPERATURE CONTROL IN HEATING PIPES WHEN THE AIR PUMP IS TURNED OFF AND WHEN IT IS TURNED ON

Norkulova K.T., Matyokubova P.M., Jumaev B.M., Mamatkulov M.M.

Annotation

The article discusses the control of flow and temperature in the heating tubes when it is turned off and the air pump is turned on. Submitted; Scheme of controlled heating of the air pump; a diagram of an elementary small section through which energy is received by a tube in an elementary short time; Circuit for adjusting the flow rate; graphs of the operating modes of the installation when heated by sunlight; asymmetry graphs of artificial heating; graphs of processes under load on a slice of pumpkin. As a result, in a first approximation, the process of controlling the flow and temperature in the heating tubes is described.

Key words: Heating tubes, flow rate, sunbeams, air pump, drying chamber, dynamometer.

Let the tube of radius R be heated by a constant external source. When the temperature rises, the outer surface of the tube, due to the thermal conductivity of the tube wall, thermal energy is transferred to the mass of the gas stream inside the tube. This energy is mainly used for raising the temperature and for mechanical work. This mechanical work is the lifting of less dense air masses against the directions of gravity, a well-known law.

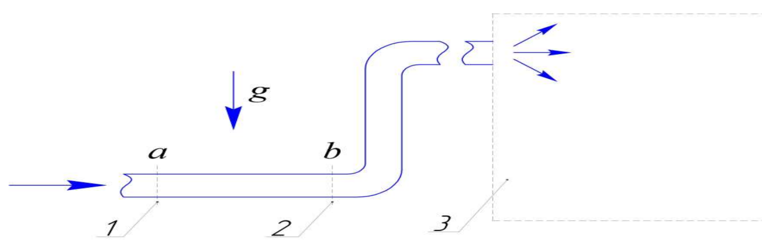

Fig. 1. Scheme of uncontrolled (free) heating of an air pump

1- Air inlet; 2 - Air outlet; 3 - Drying chamber.

Consider the process in the interval [a, b].

The energy reception by the tube in an elementary small area in an elementary short time has the form.

$$Q_1 = \partial\left(T^{\text{in}} - T^{out}\right)2\pi R dx d\tau \tag{1}$$

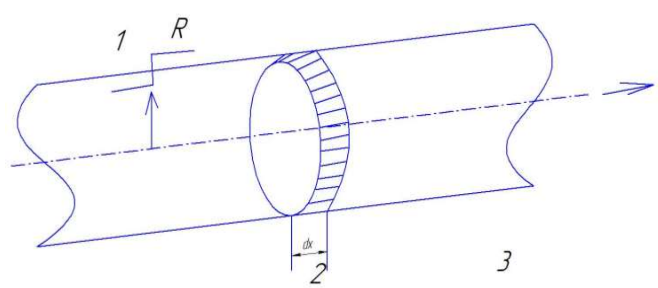

Fig. 2. The circuit is elementary of a small section through which energy is received by the tube in an elementary short time.

1 - Tube radius; 2 - Elementary disk; 3 - Heat transfer surface.

This elementary disk moves with a stream of air.

The internal air is heated in accordance with its thermophysical data..

$$Q_2 = C\rho dv d\tau = C\rho\pi R^2 dx dt^\circ \quad (2)$$

C- Heat capacity of air

Heating energy is also spent on mechanical work

$$dA = Fdx = Sc^2\left[\rho_0\left(1+\frac{\tilde{\rho}}{\rho_0}\right)-\tilde{\rho}\right]dx = Sc^2\tilde{\rho}dx \quad (3)$$

$$dA = \pi R^2 c^2 \tilde{\rho} dx \quad (4)$$

$$\Delta\rho = \rho_0(1+\alpha\Delta t^\circ) - \rho_0 = \rho_0\alpha\Delta t^\circ \quad (5)$$

α- thermal expansion coefficient

ρ_0- density to indignation

$\Delta t^\circ \rightarrow dt^\circ$- heating i.e. elementary temperature rise

$$\Delta A = \pi R^2 c^2 \rho_0 \alpha \Delta t \Delta x, \quad (6)$$

where c is the speed of sound for a given air

For an elementary site in the interval xϵ [a, b],

We can write the equation - the first law of thermodynamics:

$$dQ_1 = dQ_2 + dA \quad (7)$$

Or

$$2\partial(T_1 - T_2)dx d\tau = c\rho R dx dt^\circ + v^2 \rho R dx dt g, \quad (8)$$

Where do we have: $\frac{dt^\circ}{d\tau} = 2\partial\frac{T^{out}-T^{in}}{R(c\rho+c^2\rho\alpha g)}$ (9)

Given that dx=udτ, из (8) we have:

$$\frac{dt^\circ}{dx} = \frac{1}{\rho u R} * \frac{\partial(int - T^{out})}{c + c^2\alpha g} \quad (10)$$

Where is the I-hydrodynamic gas flow rate

For distance L, we look for the amount of heating:

$$t^\circ = \frac{1}{\rho u R} * \frac{\partial(T^{виш} - T^{внутр})}{c + c^2\alpha g} L \quad (11)$$

So, heating by the value t°, we can write in the form:

$$t^\circ = \frac{L}{uR}\ \text{B},\ \ \text{B} = \frac{1}{\rho} * \frac{\partial(T^{виш} - T^{внутр})}{c + c^2\alpha g} \quad (12)$$

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$$2\partial c \quad B = \frac{\partial}{\rho(c+c^2\alpha g)}\left(T^{\text{виш}} - T^{\text{внутр}}\right) \tag{13}$$

Formula 11 shows that by changing the radius of the tube (we can increase the number of pipes without changing the total area), which gives the effect of an increase in gas temperature.

The artificial partition on the path of the heated gas allows you to vary the total cross-sectional area, which should be able to control the temperature

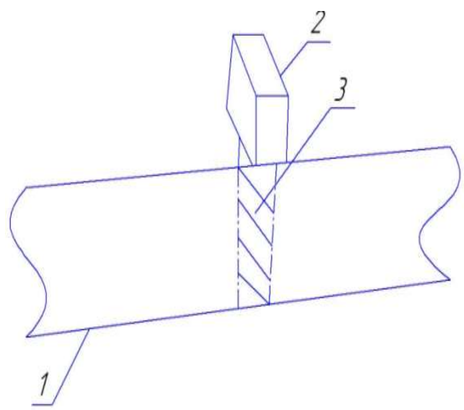

Fig. 3 Electromagnetic flow rate adjustment circuit

This design has a peculiarity - the presence of a faucet for changing the cross section of the outlet tube (Fig. 1, element 5).

Indeed, changing the position of the faucet, we can change the area of the tube at a given point. And this, in turn, increases the pressure inside (2), since the air inlet and the outlet will be different. As a result, the hydrodynamic velocity at the exit increases (5). You increase the overheating time for air particles inside the chamber, which leads to an increase in the temperature of air movement.

The laboratory chamber has a receiving air, it also has a more efficient transducer with an area of $1m^2$, with a black surface.

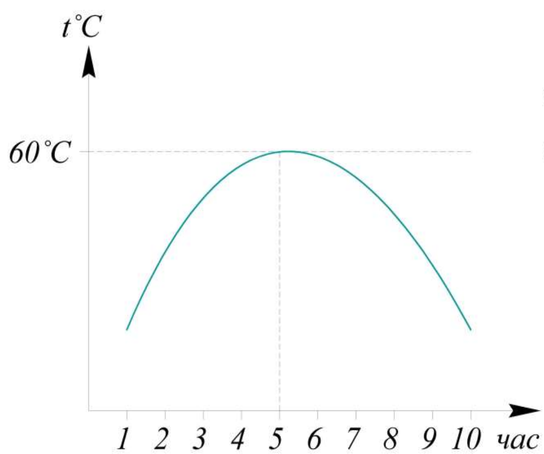

Fig.4

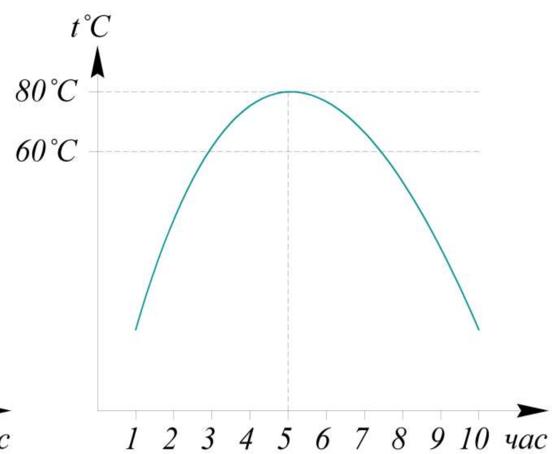

Fig.5

On (Fig. 2, 3) the operation of the installation is shown during heating by solar rays, i.e. the gas temperature after heating, at the outlet of FIG. 1, element 5.

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Now, we will consider its characteristic during artificial heating with power. 4 kW

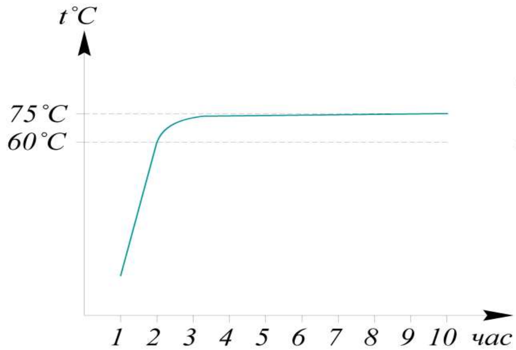

Fig.6

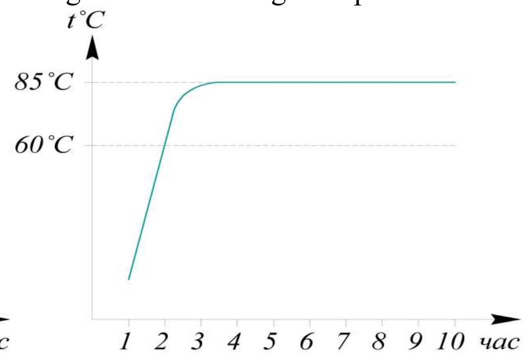

Fig.7

Note the features of the obtained graphs.

- Symmetry of solar heating during the day from $3^{\circ\circ}$ to $18^{\circ\circ}$ for both open faucet and closed.

- Asymmetry of artificial heating (Fig. 4, 5).

- Relatively low solar heating temperatures are explained by a change in the tilt of the Sun, as you change the flow of rays according to the law $\Phi = \Phi_0 \cos\frac{2\pi}{\mathrm{T}} t,$ where

$\Phi_0 -$ maximum flow, T- 24 hours. Therefore, characteristics (2) and (3) have a half-wave form.

Now we will consider the operation of this device in the presence of a load, where as the last we chose a pumpkin slice of size $(2\times 3 \times 2)cm^3$, total weight 6kg.

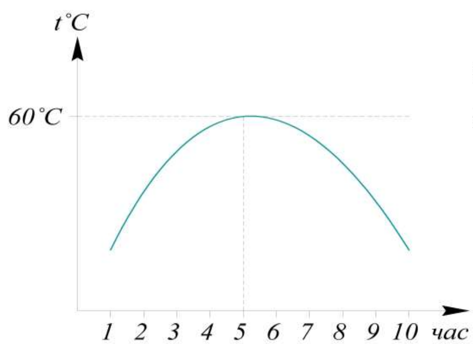

Fig.6

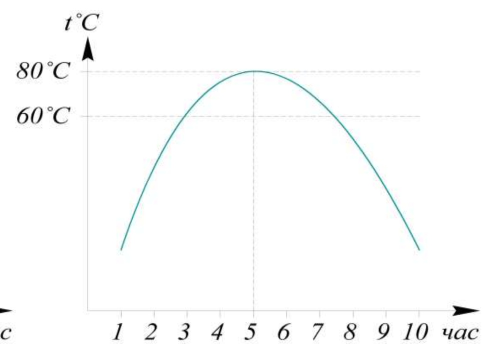

Fig.7

The processes in Fig. 6 and 7 are similar to Fig. 2 and 3 have a feature, they have higher air temperatures in the first 5 hours. Fig. (2,3,4,5) determine only the temperature. At the exit, we partially closed the tube, and therefore, due to the constancy of the heat flux in Fig. 4.5, the picture of the process becomes clear within the framework of the law of conservation of energy.

$$\begin{cases} \mathrm{M} = cmt^{\circ} = const \\ m = \rho S U \end{cases},$$

where ρ - is the density, S - is the cross-sectional area, U - is the hydrodynamic velocity, and c - is the heat capacity of air.

We showed that the drying process can be rationally controlled with the help of artificial changes in the dynamometer and number of tubes, which will preserve the quality of the dehydrated products as much as possible.

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