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DEVELOPMENT OF AN INNOVATIVE TECHNOLOGY-BASED SOLAR AIR HEATER

This article provides a general description of a new type of energy-efficient tubular solar air heater operating on the basis of solar energy, including from renewable energy sources. Also, in the working chamber of the solar air heater, the optimal variant of concave air ducts was used, which has the property of accelerating the heat exchange process, a mathematical model was created and solved using numerical methods.

Key words Heater, air pipeline, absorber, temperature, heat transfer.

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РАЗРАБОТКА СОЛНЕЧНОГО НАГРЕВАТЕЛЯ ВОЗДУХА НА ОСНОВЕ ИННОВАЦИОННОЙ ТЕХНОЛОГИИ

В данной статье дается общее описание нового типа энергоэффективного трубчатого солнечного воздухонагревателя, работающего на основе солнечной энергии, в рабочей камере солнечного воздухонагревателя использован оптимальный вариант вогнутых воздуховодов, обладающий свойством ускорять процесс теплообмена, создана и решена численными методами математическая модель.

Ключевые слова Нагреватель, воздухопровод, поглотитель, температура.

I. INTRODUCTION Today, many researchers and scientists are conducting scientific research on the introduction of advanced technologies and equipment that can efficiently and economically save energy and energy resources in the heat supply system.

It is known that natural resources used on an industrial scale are rapidly declining, so the use of renewable energy sources allows us to preserve natural resources and the ecological situation at the current level.[1] This article takes into account the following:

From renewable energy sources, in accordance with the climate of Uzbekistan, the sun is the most alternative, and a heat carrier has been prepared for its heat. For this purpose, the issue of creating a concentrated heat supply system based on solar collectors of an air conditioner and a solar water heater, which are carried out in various designs, is of particular relevance [2].

In the future, the use of renewable energy sources in the Republic of Uzbekistan is undoubtedly necessary to maintain energy, environmental and economic security, as well as for the sustainable development of the energy sector. For future generations, the development of renewable and alternative energy sources is a necessary condition for the conservation of natural resources and environmental protection [3-4].

II. DEVICE CHARACTERISTIC

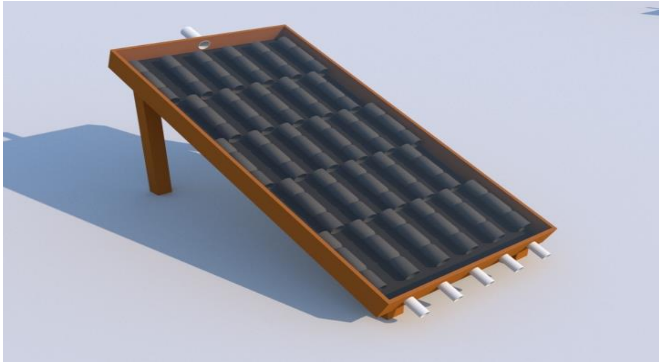

Fig.1General schematic view of a solar air heater with concave tubes

A model of a solar air heater with a concave tube with low hydraulic resistance (Fig. 1) was developed; the device has a length l = 1200 mm, width = 400 mm, height h = 62 mm. This solar air heater has metal tubes in the working chamber with a small heat capacity and concave shape and is built in a checkerboard pattern. The length of each pipe is l = 150 mm. The average duct distance is l = 60 mm. At the base of the duct, a concave shape is given in two rows, this geometric figure has a depth h = 2 mm and a width = 15 mm. The geometric shape attached to the manifold ducts is internally concave along the outer surface of the channel and vice versa. When using a solar air heater, the inlet and outlet pipes are located at d = 15 mm when using a spray gun.

II. METHOD OF THEORETICAL ANALYSIS

According to the analysis of the flow, it can be divided into a boundary layer on the channel surface and an external flow. The boundary layer plays a key role in dynamic and heat transfer processes with a washable flow body. The loss of energy is determined by the phenomena of interruption in motion and the failures arising from them.[3]

Based on the research work, the laminar boundary layer is represented as follows. [4]

$$\frac{\partial}{\partial x}(\rho V) + \frac{\partial}{\partial y}(\rho V) = 0 \tag{1}$$

$$\partial U \frac{\partial U}{\partial x} + \rho V \frac{\rho U}{\partial y} = -\frac{\partial P}{\partial x} + \mu \frac{\partial^2 U}{\partial x^2} \tag{2}$$

$$\rho U s_\rho \frac{\partial T}{\partial x} + \rho V s_\rho \frac{\partial T}{\partial y} = \lambda \frac{\partial^2 T}{\partial y^2} \tag{3}$$

$$\rho U_{\boldsymbol{\omega}} = 0, T = T_{\boldsymbol{\omega}}(y = 0) \tag{4}$$

$$U = U_\infty, T = T_\infty(y = \infty) \tag{5}$$

The following symbols are derived from these equations: ρ – the density of heat carrier (air); U, V – the longitudinal and transverse components of the velocity of the flow; U_ω, U_∞, - the flow temperature at the channel wall and at a certain distance from it; T – the flow temperature; T_ω, T_∞ - the flow temperature in and out of the channel wall; s_ρ– the specific heat capacity; λ – the heat capacity. We will re-express the equation of the law of mass compression for taking into account the effect of pressure and friction gradient on heat transfer.

$$\rho U_\infty, S = const \tag{6}$$

$$\rho \frac{\partial U_\infty}{\partial x} + U \frac{\partial S}{\partial y} = 0 \tag{7}$$

$$\frac{\partial U_\infty}{U_\infty \partial x}+\frac{\partial S}{S\partial x} \quad (8)$$

$$S=(a-\delta^{\circ})b \quad (9)$$

Of these formulas A and B are the height and width of the profiled channel. Given the similarity of the air channel to the diffuser-confuser, and by determining the angle of opening of the duct through U, we obtain. [5]

$$\frac{x\partial U_\infty}{U_\infty \partial x}=\frac{xdS}{SdS}=\frac{xd(a-b^*)b}{(a-b^*)bdx}=\frac{x}{(a-b^*\ )bdx}\left[\frac{da}{dx}-\frac{d\delta^*}{dx}\right] \quad (10)$$

$$a=a_0\ +xtg\gamma \quad (11)$$

$$\frac{x\partial U_\infty}{U_\infty \partial x}=\frac{xdS}{SdS}=\frac{xd(a-b^*)b}{(a-b^*)bdx}=\frac{x}{(a-b^*\ )bdx}\left[\frac{da}{dx}-\frac{d\delta^*}{dx}\right] \quad (12)$$

$$\frac{x\partial U_\infty}{U_\infty \partial x}=\frac{x}{\partial x(a-b^*)}=\frac{xtg\gamma}{a-\delta^*}) \quad (13)$$

The extrusion thickness of the boundary layer is expressed by the modifiers η of the auto-model δ:

$$\delta^*=\eta\frac{x}{\sqrt{Re}} \quad (14)$$

$$\eta\frac{x\sqrt{Re}}{x}\int_0^y(1-\frac{\rho U}{(\rho U)_\infty})dy \quad (15)$$

$$d\delta^*=\eta\frac{1}{2}\frac{1}{\sqrt{Re}} \quad (16)$$

$$\frac{dP}{dx}=-\left(\frac{xdU_\infty}{U_\infty dx}\right)=\frac{x\eta\frac{1}{2}\frac{1}{\sqrt{Re}}}{a-\eta\frac{x}{\sqrt{Re}}}=\frac{xtg\gamma}{(a-\eta)\frac{x}{\sqrt{Re}}}\frac{\frac{1}{2}\eta}{\frac{a\sqrt{Re}}{x}-\eta}\frac{tg\gamma}{\frac{a\sqrt{Re}}{x}-\eta} \quad (17)$$

Heat transfer also occurs depending on the pressure in the diffuser-confuser channels to dissolve the friction mass in the channels. [6.7.8]

According to studies, there can be three types of coolant movement in the receiving devices: continuous, pre-intermittent and intermittent. The current can be laminar and turbulent. To solve the boundary layer problem, you can use the following method. We accept the following deviations; Structural methods for solving problems of the boundary layer in a free-form profile in which the flow is stable and cannot be compressed by air without two-dimensional heat transfer of the flow are based on solving the momentum equation.

$$\frac{d\delta^{**}}{\partial x}+\frac{dV_0}{\partial x}\frac{\delta^{**}}{V_0}(2+H)=\frac{\tau_\omega}{\rho_0 V_0^2} \quad (18)$$

Here: δ ** - the thickness of impulse loss; δ* - the thickness of extrusion; v0, ρ0 - the velocity and density at the outer boundary of the boundary layer; N= δ*/ δ**; τω–the tension of wall friction. The extrusion thickness of the boundary layer with the exact profile and velocity is determined by the following expressions.

$$\delta^*\int_0^\delta(1-\frac{\rho v}{(\rho_0 v_0)})dy \quad (19)$$

- the thickness of impulse loss

$$\delta^{**}\int_0^\delta\frac{\rho v}{(\rho_0 v_0)}(1-\frac{v}{v_0})dy \quad (20)$$

Because the impulse equation has three indeterminate parameters — δ **, δ *, and τω — the problem is solved by a series of profiles and velocities related to one parameter to an equation with one unknown, according to the approximate solution method. Instead of such a parameter, the amount of φ, called the form parameter, has been proposed, which allows the development of structural methods of boundary layers on the theoretical basis of the existence of internal scales of turbulence. [9.10.11.12] The method of calculating the lost viscosity of the turbulent boundary layer is also of special importance. [13]

III. EXPERIMENTAL RESULTS

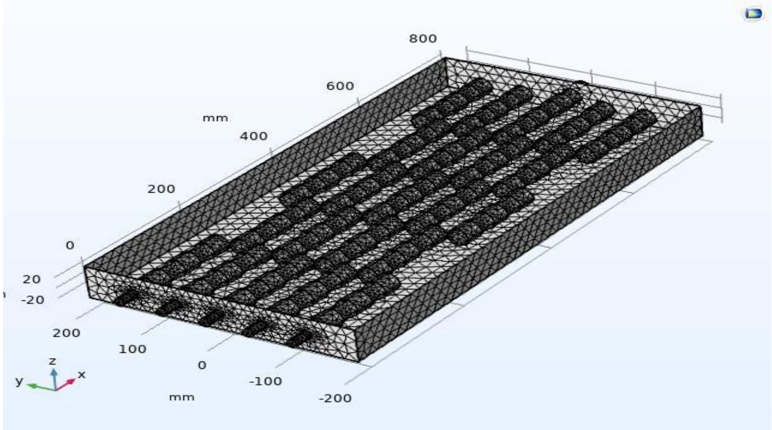

Fig 3. Separate the device into separate sets

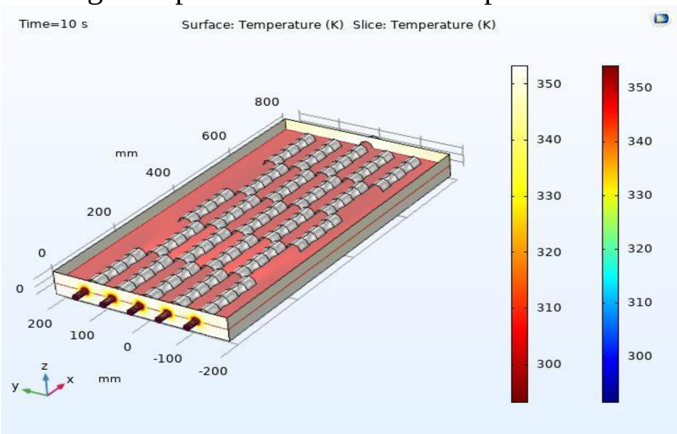

Fig 4. The process of heat dissipation from the absorber

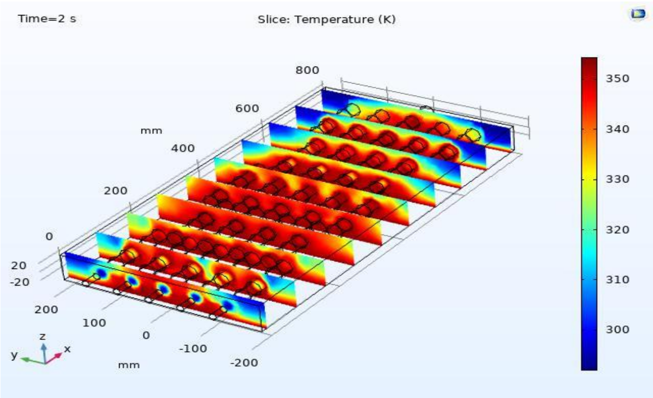

Fig 5. The process of vertical distribution of heat in the device

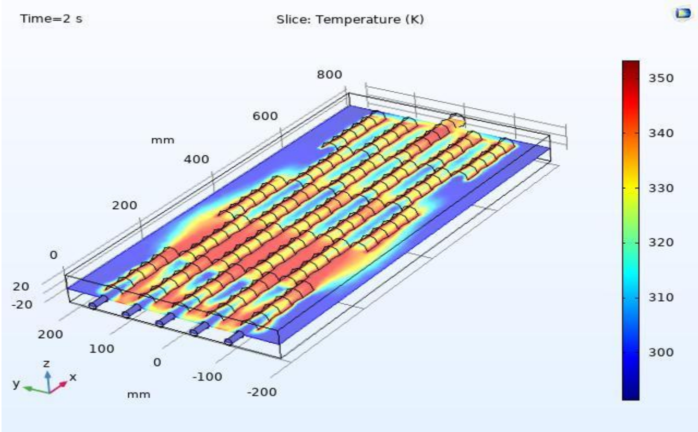

Fig 6. The process of dissipation heat horizontally

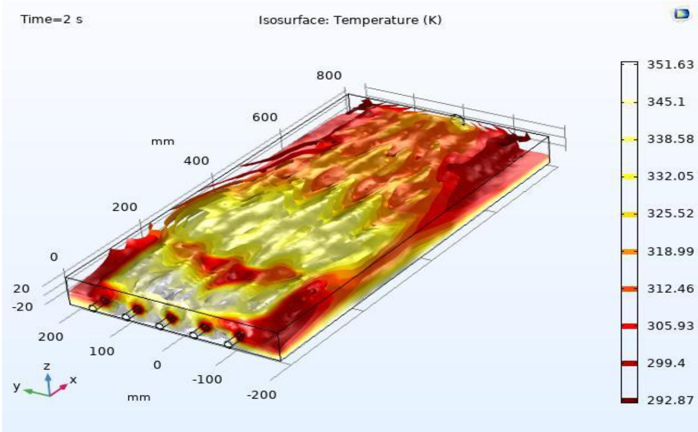

Fig 7. The process of heat dissipation of the overall surface of the device

IV.CONCLUSION

Based on the results of experimental research conducted on a solar air collector with a concave channel in the form of a triangle, developed in a new way, the development of a mathematical model of the air flow in the air channels of the collector is required.

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