MODELING OF HEAT TRANSFER IN THE SOLAR AIR MANIFOLD TRANSPIRATION TYPE

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Air solar collectors can provide moderate heating of air, followed by feeding it to a variety of dryers, heating buildings, burners heat generators. Known collector of convective and transpiration types. In the first - air flow washes impervious surface absorber is heated by solar radiation, and the second - the movement of air filtration occurs through the porous structure of the absorber. Such an absorber may be made, for example, a perforated metal sheet or metal mesh layers. It is also possible to use porous textiles (fabrics or nonwoven fabrics).

In transpiration collectors radiant heat flux transported deep into the thermal conductivity of the porous absorber and is transmitted through the air volumetric heat transfer. This allows you to significantly intensify the process of heating thanks to a highly developed heat exchange surface.

The purpose of research - development of a mathematical model of transpiration air manifold with textile absorber and the calculation of its thermal characteristics under different external conditions.

Materials and methods of research. Heat transfer between the interpenetrating fluids in porous absorber air manifold considered in the stationary one-dimensional approximation. Accepted assumptions about the isotropy of the thermal conductivity of the material of the absorber and the independence of its thermal properties as well as properties of the air temperature. Then the heat exchange process can be described by the following system of differential equations

$$\begin{cases} \lambda_1 \dfrac{d^2 t_1}{dx^2} - \alpha_v (t_1 - t_2) = 0; \\ \rho_2 c_{p2} w \dfrac{dt_2}{dx} = \lambda_2 \dfrac{d^2 t_2}{dx^2} + \alpha_v (t_1 - t_2) \end{cases} \tag{1}$$

where λ - coefficient of thermal conductivity, W / (mK); ρ - density, kg / m^3; αv - volumetric heat transfer coefficient, W / (m^3K); W_{ed} - isobaric heat capacity, J / (kgK); t - temperature, K; w - the average air velocity in microchannels, m / s, due to the speed of filtration wf expression, where P - porosity absorber x - coordinate across the porous layer; the subscripts 1 and 2 refer to the porous matrix and the air, respectively.

System (1) is solved numerically; boundary conditions (the density of heat flux and temperature) were set on top of the exposed surface of the absorber, and then calculated temperature distribution media thickness of the porous layer depending on the speed of the air filtering and heating capacity and efficiency of the collector.

Model calculations were performed for the prototype transpiration air manifold with the following design features: body made of PVC Profile (dimensions 1430x 695x85 mm); clear coat - cellular polycarbonate sheet thickness of 4 mm; absorber - non-woven fabric (1360x620x5 mm) of polyester fibers, tightly stretched inside the body and painted black.

The results of research. Calculations were carried out for the "counter" option when fluxes of heat and air in the absorber opposite.

Specific heat output and efficiency of transpiration collector "counterflow" version were 1-1,5 % higher than in the "continuous-flow". However, this difference is within the computational error and can not be considered further.

Analyzed the influence of the thermal conductivity of the porous absorber on the efficiency of heating the air. To do this, we calculated the temperature fields in filtering the air in the absorber of brass mesh. In this case, the specific modes of heat generation in the reservoir was raised to 4,5-5,4 %, and the temperature was close to the absorber field uniform. Due to the increase in the average temperature difference between the porous matrix and moving through it, the air grew and transmitted heat flux.

Mathematical modeling has confirmed the relatively high efficiency of the air solar collector transpiration type absorber with textile. Calculations hydraulic resistances absorber porosity of 0,6 showed that the drop in pressure in the air filtration velocity of 0,1 m /s at 18 Pa. Under these conditions, the power required for driving the fan, not exceed 2,5 watts.