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HELIOPHYSICS AND ALTERNATIVE ENERGY SOURCES

THE EFFICIENCY OF SOLAR DRYERS

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Abstract. This paper presents ways to improve the efficiency of solar dryers: the efficiency of heated air due to the heat storage capacity of the solar collector, natural convection of the heated air duct and the method of positioning pallets in the drying cabinet for uniform flow of heated agricultural pallets.

Keywords: solar collector, heated air duct, convection, heated air turbulization, pallets.

In the world, scientific research is underway aimed at creating power systems using solar low-grade installations in heat supply systems, taking into account the optimization of heat and mass transfer processes necessary for the development of operating, technological and design parameters, monitoring and control schemes that ensure the continuity of thermal processes. The issues of improving and developing new modern designs of solar installations, as well as increasing the efficiency of air heating collectors, natural convection and turbulization of the coolant flow are relevant today.

Solar collectors are mainly used in hot water supply systems and in air heating systems that provide natural convection and turbulization of heated air [1,2,3].

Requirements for the technical characteristics of solar collectors for hot water supply are: - average daily productivity in liters with the temperature of the received water, °C; - plant productivity, kcal/day; - maximum hot water temperature of the unit, °C; - working area and weight of the solar collector, m², kg.

The heat-absorbing material of the solar collector, made in the form of a thin cellular metal panel and not having sufficient bulk density [4], a low-power solar collector with an adsorber made of activated carbon or thin metal foil [2] and a solar collector made of drain metal shavings [3] do not provide high efficiency of heat absorption and achievement of the difference in the density of the heated air and the environment, since the value of absorbed solar energy is directly proportional to the specific heat capacity and mass of the collector

\[ dQ = C_\mu \mu m dT. \]

In [2, 3] there are practically no processes of natural convection and turbulization of heated air.

Below is the design of a distributed type solar drying plant, which makes it possible to increase the efficiency of the heated air due to the heat storage capacity of the solar collector, natural convection of the air duct and the method of uniform turbulization of the heated air in the drying cabinet.

Ways to improve the efficiency of air heating and natural convection of the incoming air.
To increase the efficiency of air heating, it is necessary to create a structural solution to ensure natural convection of cold air. To achieve natural air convection and create a greenhouse regime, it is necessary to increase the height of the air duct, the air duct must be installed above the upper part of the heat-absorbing panel - the solar collector.

Fig. 1 shows a general view of a distributed type solar dryer.

In contrast to [4], in the proposed design, the air duct (4) is located above the solar collector (1) and provides natural convection of the incoming air (7) in the gravity field with uneven heating along the height of the duct.

It should be pointed out that convection is called the transfer of heat in liquids and gases by flows of matter. Natural (free) convection occurs in the gravity field with uneven heating (heating from below) of flowing substances. The heated substance under the action of the Archimedean force $F_A = \Delta \rho g V$ ($\Delta \rho$ is the difference in the density of the heated air and the environment, $V$ is its volume, $g$ is the acceleration of gravity) moves relative to the less heated substance in the direction opposite to the direction of gravity. Convection leads to an equalization of the temperature of the substance.

With a stationary supply of heat to a substance, stationary convection flows arise in it. The intensity of convection depends on the temperature difference between the layers, thermal conductivity and viscosity of the medium.

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1 - solar collector, 2 - heat-insulating cover, 3 - solar collector housing, 4 - heated air duct, 6 - optical transparent film, 7 - air inlet, 8 - used air outlet, 9 - drying cabinet, 10 - pallets, 13 - communication pipe of the solar collector profiled sheet for filling water.

**Fig. 1. Solar Drying Plant**

The large height of the air duct (0.10 m) has a greenhouse heating mechanism, which ensures high efficiency of air heating. Low thermal conductivity of the side parts of the air heater increases the temperature of the heated air.

**Ways to improve the efficiency of solar collector heat absorption**
To increase the efficiency of heat absorption, it is necessary to increase the density and mass of the heat-absorbing panel, as well as provide for thermal insulation of the solar collector from the external environment.

Figure 2 shows a solar collector panel made of a solid blackened profiled aluminum sheet with built-in pipes, which has a solar radiation absorption capacity of 0.85 to 0.95. The size of the solar collector is 1880x1230x50 mm, eight parallel-built pipes with a diameter of 25 mm have a total displacement of 10 liters and increase the heat capacity of the heated air.

Thermal insulation of the lower part of the panel and low thermal conductivity of the side walls of the air duct increase the efficiency of heat absorption and increase the temperature of the heated air.

Ways to increase turbulization of heated air and achieve a uniform temperature distribution in the trays located in the drying cabinet

Fresh air enters the lower part of the duct located on the surface of the solar collector and is heated. Thermal insulation of the bottom of the panel and the presence of built-in water-filled aluminum pipes contribute to the heat absorption efficiency. The heated air enters the inlet of the drying cabinet. The offset arrangement of the pallets from each other at a certain distance along the floors of the drying cabinet ensures a uniform flow (turbulization) of heated air and free flow around the pallets located on different floors.

Thus, the heat-absorbing panel of the drying plant, made of a solid blackened profiled aluminum sheet with built-in pipes, provides a high heat absorption efficiency, has an absorption capacity for solar radiation from 0.89 to 0.94. Built-in pipes allow you to hold a water volume of about 10 liters and increase the heat capacity of the heated air. Thermal insulation at the bottom of the panel improves
the heat absorption efficiency. The large height of the duct located above the solar collector provides a greenhouse heating mechanism, natural air convection and high efficiency of air heating. The low thermal conductivity of the lateral parts of the air duct lowers the temperature of the heated air. The offset arrangement of the pallets from each other on the floors of the drying cabinet ensures free flow of the dried products on the pallets and a uniform flow of heated air.

References


