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PECULIARITIES OF MODELING HEAT PUMPS IN THE LABVIEW ENVIRONMENT

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Abstract. The research studies peculiarities of the methodology of computer modeling of the process of converting low-potential heat into a hot heat carrier in a "soil-water" heat pump. The proposed computer model consists of two components: a soil temperature model and a heat pump model, which are determined by the temperatures of the input heat flow and the heat carrier at the output of the heat pump.

Key words: low potential heat, heat pump, computer model, heat supply system.

To substantiate parameters of heat pumps, the applied software that is not in free access for publicity is normally used. The dynamic assessment of the operation modes of the heat pump installation should be reasonably based on the developed computer models. Normally, such type of models is created in the MATLAB/Simulink environment. A more informative and universal model can be built by applying LabVIEW environment of the National Instruments production, which has convenient interface of a researching user with the adequate functions of visualization, formation and accumulation of databases, etc.

The most common type of heat pump is the pump of “soil-water” type which is the most effective. To develop a computer model of such type of heat pump, it is actually necessary to build two models. The first one will demonstrate the mode of taking heat from soil, and the second – the pump itself.

While calculating the energy potential of soil at any depth, the seasonal changes of temperature should be considered. It is calculated by the formula

$$T_{soil}(z,t) = \overline{T}_{soil} + \Delta T_{air} \cdot e^{-z\sqrt{\frac{\pi}{365 \cdot a}}} \cdot \sin\left(\frac{2\pi(t-t_o)}{365} - z\sqrt{\frac{\pi}{365 \cdot a}} - \frac{\pi}{2}\right), \quad (1)$$

where $\overline{T}_{soil}$ – the annual average temperature of the soil surface (air temperature), °C; ΔT_{air} – deviation of the monthly average temperature of air in the hottest month (i.e. the month with the highest temperature) from the annual average; z – soil depth, m; t

– current day of the year; t_0 – shift of the phase of minimum temperature referring to the start of the year; a – thermal conductivity of soil in m^2/sec.

Parameters of the heat pump, which are determined by its construction and energy peculiarities, are important for organization of the total system of hybridization of a complex of power installations, in which the available resource should be reasonably used. In particular, it deals with its current thermal potential, which depends on the temperature of the primary source of heat, as well as on the necessary temperature of the heat carrier which should be supplied to the user. In that case, it is required to use technological data of the heat pump producers. Data for the heat pump of GMLW16 "air-water" type of Ochsner company were taken as an example. Particularly, the researchers determined single-parameter regression equations of the parameters of thermal potential, consumed power and the ratio of the heat pump conversion in the whole process of operation. The equations were composed for each temperature range of the heat pump operation and a consumer (temperature 35, 45, 50 and 60 ºC). The regression equations of the parameters for the output temperature of the heat carrier at the level of 45ºC were provided as an example:

- thermal potential

$$y = -3E\text{-}06x^4 - 9E\text{-}05x^3 + 0{,}0006x^2 + 0{,}2978x + 12{,}718; \qquad (2)$$

- consumed power

$$y = 1E\text{-}07x^4 + 3E\text{-}06x^3 - 0{,}0002x^2 + 0{,}0034x + 3{,}6648; \qquad (3)$$

- ratio of conversion

$$y = -1E\text{-}06x^4 - 2E\text{-}05x^3 + 0{,}0003x^2 + 0{,}0779x + 3{,}4683. \qquad (4)$$

These data are used to make time and energy characteristics of the heat pump operation. It should be controlled during operation of the system of the object power supply.

In particular, daily duration of the heat pump operation in the current period is estimated by the formula

$$\tau^i = \frac{24 P^i_{TL}}{P^i_{HP}}, \qquad (5)$$

where P^i_{TL} – current thermal load of the object, kW; P^i_{HP} – current thermal potential of the heat pump, kW.

The data of the actual and expected work of the heat pump in the current period are used to measure consumption of electric energy used for its work by the formula

$$W^i_{el} = \tau^i P^i_{el}, \qquad (6)$$

where P^i_{el} - current capacity of the heat pump consumption, kW.

The data are necessary to develop a general strategy for choosing the time mode of pump operation in the structure of the system of power supply for the object.

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A SOLAR TIMBER DRYING SYSTEM: EXPERIMENTAL PERFORMANCE AND SYSTEM MODELING

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Abstract. The technological process of wood drying in a solar dryer was studied. The modes of operation of the solar dryer with a mirror concentrator and heat accumulator, additional moisture absorption and in conditions of natural cyclicity are substantiated. The kinetic parameters of the moisture transfer processes, which reproduce the time dependences of changes in the kinetics of wood drying, the relative humidity of the incoming and outgoing air flows, were determined, and the time dependence of the humidity of the outgoing flow was simulated.

Keywords: solar energy, solar dryer, temperature-humidity fields, heat mass transfer, intensification, convective drying.

Heliothermal installations have been widely applied in the agricultural sector. For example, when drying plant raw materials, specifically timber, solar energy is actively utilized in the drying industry. A given type of dehydration is fully applicable for the region of western Polissya (forest zone) (the city of Korets, Rivne oblast, Ukraine), the structural-technological circuit of the solar dryer with a heat accumulator and a flat mirror concentrator is shown in Fig. 1.

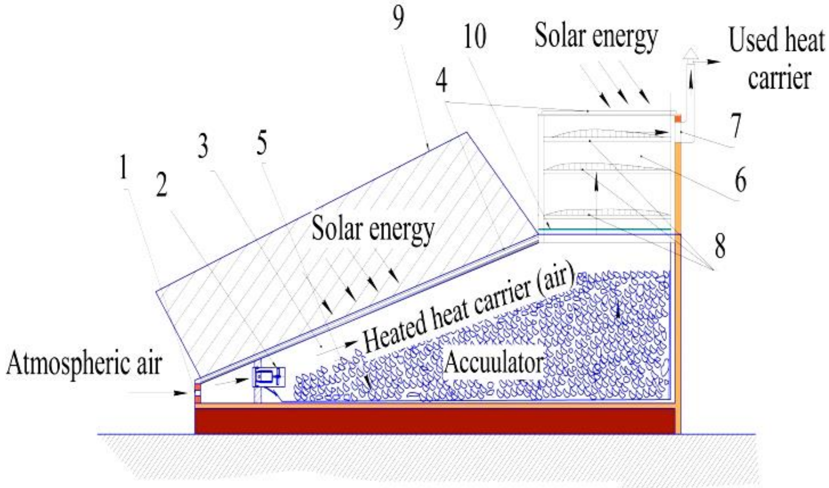

Fig. 1. Structural-technological circuit of the solar dryer with a heat accumulator and a flat mirror concentrator: 1 – inlet channel; 2 – fan; 3 – air duct; 4 – air collector; 5 – heat-accumulating material (gravel-based); 6 – drying chamber; 7 – return channel; 8 – sieves; 9 – flat mirror concentrator; 10 – valve

Timber drying in a solar dryer over 24 hours is characterized by a periodic irregularity in the arrival of a solar energy flux. Heat-mass exchange characteristics