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KINETICS OF THE PROCESS OF ENERGY WILLOW DRYING

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In the conditions of energy crisis, research of processes of drying of power wood as a renewable energy source is an actual and timely task. To obtain solid biofuels, fast-growing energy plants such as willow, poplar, aspen, alder, spruce, pine, oak, etc. are used [1, 2]. During the production of biofuels from energy wood, it is necessary to evenly grind and dry the raw material, the residual humidity of which should be less than 10%. All stages of production are energy-intensive, especially the drying stage, which accounts for up to 70% of total energy consumption. This affects the energy efficiency of production and the cost of final products.

High-temperature and low-temperature regimes are used in energy wood drying processes [3, 4]. Under conditions of low-temperature drying, in contrast to high-temperature drying, there are no exothermic processes and reactions of decomposition of combustible components of raw materials and, consequently, harmful emissions into the air.

When developing thermal-moisture drying regimes, it is necessary to ensure the increase of energy efficiency of the process and high calorific value of the generated fuel.

Aim: intensification of the process of dehydration of energy plants, determination of rational parameters of the drying agent and dehydration conditions.

Objects, equipment and research methods. Energy willow was used as an object of dehydration. Drying was carried out until the material reached a residual moisture content of W^c = 5...6%. The study of the kinetics of the dehydration process laws was carried out on an experimental drying stand, which was equipped with modern devices for automation, control and information processing.

The results of investigations. Studies on the effect of drying agent temperature on the kinetics of moisture exchange have shown that increasing the temperature from 80 °C to 100 °C enhances heat and mass transfer and reduces the process duration to 25%, (fig. 1).

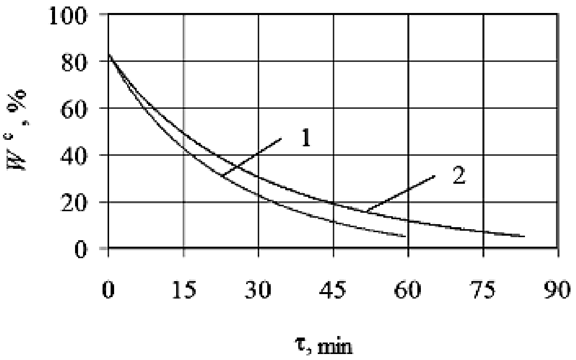

Fig. 1. The effect of drying temperature on the kinetics of drying willow,
V = 1.5 m/s, d = 10 g/kg of dry air, g = 4 kg/m^2:
1 – t = 100 °C, 2 – t = 80 °C [5, 6]

Increasing the specific load has a positive effect on the productivity of the drying plant and increases the amount of processed raw materials. The total duration of dehydration from the minimum load to the maximum increases by 3.5 times, (fig. 2). It should be noted that increasing the specific load of the material reduces the drying rate, mainly only at the initial stage of the process. As a result of shrinkage of the material, as it dehydrates, the height and density of the layer are reduced and the material is more easily penetrated by the coolant, the process speed is accelerated.

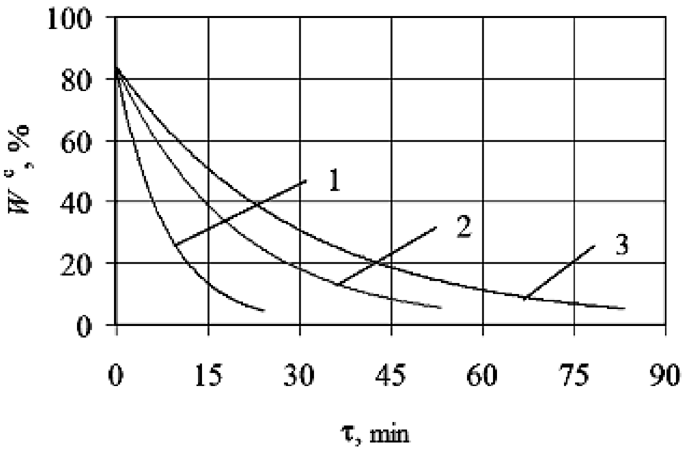

Fig. 2. The effect of specific load on the kinetics of drying willow,
***V* = 1.5 m/s, *d* = 10 g/kg of dry air, *t* = 80 °C:**
1 – *g* = 0.77 kg/m^2, 2 – *g* = 2.3 kg/m^2, 3 – *g* = 4 kg/m^2 [5, 6]

The paper notes that a significant parameter of the impact on the kinetics of drying and increase the efficiency of the process is the method of grinding raw material. During the experiments, the willow was crushed into uniform in size and geometric shape of the part as follows (Fig. 3):

- by combining abrasion and impact on samples of size L = 20…30 mm (a);
- grinding by cutting into samples of size L = 20…30 mm (b);
- cutting into cylinders L = 10…15 mm (c).

a) b) c)

Fig. 3. The photos of samples by size and geometric shape [5]

The most intensive mode corresponds to the method of grinding willow by combining abrasion and impact (fig. 4). With this method of grinding, the drying time is reduced from 15% to 25% compared to those considered.

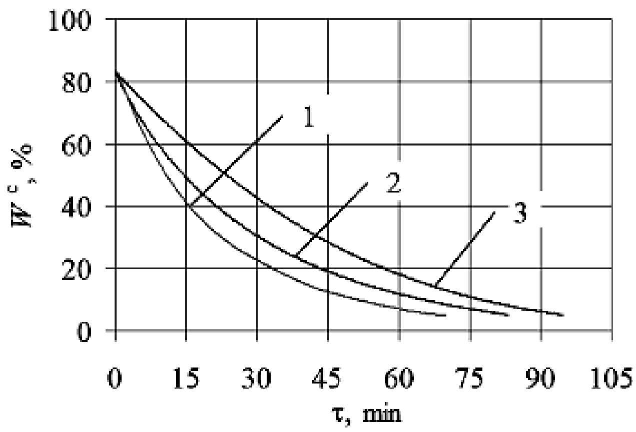

Fig. 4. The influence method of grinding of willow on wood drying kinetics
V = 1.5 m/s, d = 10 g/kg of dry air, t = 80 °C, g = 4 kg/m^2 [5, 6]:
1 – by combining abrasion and impact, 2 – grinding by cutting,
3 – cutting into cylinders

Conclusions:

According to the results of theoretical and experimental studies of the kinetics of moisture exchange in the mode of low-temperature dehydration of energy willow, the following has been established:

- the influence of the temperature of the drying agent;
- the influence of the method of grinding energy willow;
- the effect of specific load on the drying surface of the installation.

The established conditions and parameters of low-temperature drying provide intensification and efficiency of the process and obtaining dried energy willow with low and evenly distributed residual moisture. The results of experimental researches are applied to belt-type dryers. Given the shortage and rising cost of traditional energy resources, the direction of development of solid biofuel production technology is promising and appropriate [1, 5, 6].

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