THE EXPERIMENTAL INVESTIGATIONS OF THE PROCESS OF DRYING FUEL CHIPS FROM WOOD WASTE IN A FIXED LAYER

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Abstract. In Ukraine, wood production remains one of the priority sectors of the national economy. The total area of forests is 10.4 million hectares [1-3]. The advantages of biomass as a fuel are its renewable nature, low ash content, low emissions, and the preservation of the balance of carbon dioxide in the atmosphere [4]. Energy products of biomass processing can be used in common energy installations, for example, as a traditional fuel.

Keywords: *organic waste, biomass, utilization, forestry, drying plants, engineering calculation.*

Introduction. Depending on the nature of use, forests are divided into industrial and non-industrial purposes. Industrial forests are necessary for obtaining commercial wood. This wood, due to its size and quality, is suitable for industrial processing, and is also used as a log. Sanitary logging and industrial logging take place in them, and then its restoration is mandatory.

In non-industrial forests, only sanitary logging is carried out, selectively, only to improve the condition and species composition of trees. In Ukraine, the non-industrial forest fund makes up to 57% of the entire forest fund [2]. Depending on their use, such forest areas are divided into field protection, water protection, protected, anti-slide, recreational and green zones in and around cities [5].

Wood waste is generated at all stages: growth, harvesting and processing. At the stages of sanitary cleaning and harvesting, waste is formed in the form of branches, bark, under brush, branches, tops, roots, chips, and in total make up about 21% of the entire mass of wood. During the processing of wood into lumber, waste is formed in the form of offcuts, shavings, pieces, scraps, shavings and make up 35-40% of the mass of processed materials.

Mainly, traditional methods of drying are used using, for example, drum dryers [6], one of the disadvantages of which is high specific heat consumption for evaporation (up to 5000 kJ/kg of evaporated moisture).

The purpose of the study is to experimentally determine the time required for the dehydration of fuel wood chips during drying in a fixed bed, depending on the temperature and speed of the heat carrier and the possible productivity of the designed latest energy-saving modular drying units.

Materials and methods. To conduct a series of experimental studies on the process of drying fuel wood chips in a fixed bed, the research material was first prepared. Trees of various species located on the territory of the ITTF of the National Academy of Sciences of the National Academy of Sciences were used as it.

Chopped sprouts 1.5 to 2.5 m long and 0.5 to 2.5 cm thick were used as raw materials. Fuel chips was harvested immediately before the start of the experiments with the help of a woodchipper. The approximate content is 80-90% wood, 20-10% – green leaves.

For the experimental study of the process of convection drying of fuel wood chips, the existing experimental stand was used at the first stage and the method of conducting the experiment was developed fig 1.

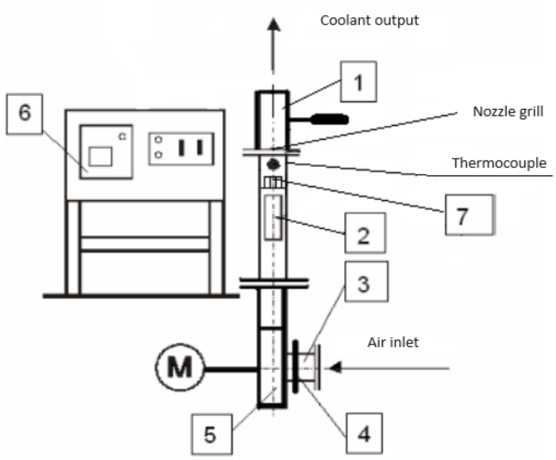

Fig. 1. Scheme of the experimental stand for researching the kinetics of the drying process: 1 – a special nozzle drying chamber; 2 – air heaters; 3 – inlet pipe; 4 – damper; 5 – centrifugal fan; 6 – control panel; 7 – distribution and shielding device.

A series of experimental studies on convection drying of fuel chips was carried out on a laboratory stand called "Fluidized bed drying stand" with the following thermotechnical parameters: the temperature at the entrance to the working chamber varied from 130°C to 180°C; the speed of the coolant at the entrance to the working chamber is 0.3 - 1.2 m/s; the thickness of the material layer is 100 mm; diameter of the working chamber – 135 mm; the volume of the batch of material under investigation is 0.0014m^3; the range of initial moisture content of the material under study (fuel chips) is from 46% to 55%; chips fuel contained 10-20% of chopped leaves by volume.

The methodology for conducting experimental research was as follows: we determined the initial moisture content of the material; we weighed a special nozzle drying chamber without material (1.84 kg); we poured experimental material (prepared fuel wood chips) weighing 0.3 kg into a special nozzle drying chamber; we put a special nozzle drying chamber on a laboratory stand for the drying process of fuel chips at the set parameters of the temperature and speed of the heat carrier; after certain time intervals, we turned the special nozzle drying chamber with fuel chips by 180 degrees. We measure the change in the mass of the material during the drying process on the scales and continue the drying process until the change in the mass of the material under study does not change after certain time intervals.

At the end of the experiment, we determine the final moisture content of the material under investigation with the help of a drying cabinet.

Results and discussion. Table 1 shows the expected design number of zones of the dryer depending on its performance at different temperature indicators of the coolant.

The research was carried out under the following parameters: temperature at the entrance to the chamber – from 130 to 180°C; the speed of movement of the coolant was 1.1 m/s. Fuel wood chips contained 10-20% leaves by volume.

The mass of the studied material was equal to 0.3 kg.

Table 1. Change in the moisture content of the fuel wood chips in the dryer blocks.

№	G, kg/h	v, m/s	W, %	τ, min	t, °C	Number of drying zones					
						1	2	3	4	5	6
1	500	1,1	47	13	130	15	6				
					150	13	4				
					180	10					
2	1000	1,1	47	7	130	28	17	8			
					150	27	13	6			
					180	23	8				
3	1500	1,1	47	5	130	35	26	17	12	7	
					150	34	23	15	10	5	
					180	29	17	8			
4	2000	1,1	47	3	130	39	31	23	18	14	9
					150	37	28	20	14	9	6
					180	35	24	16	10	6	

From the analysis of Table 1, it can be seen that with an increase in the design productivity of the dryer (G) by 4 times, the maximum design length of the dryer will increase by 3 times. Design and dimensional characteristics of the dryer are as follows: width – 2 m, length of each zone – 3 m.

Conclusions. The obtained experimental data will be used in the creation of experimental stands, numerical study of the process in the working chamber of drying plants, as well as in the creation of engineering calculations of plants for the energy-efficient disposal of thermolabile organic waste.

References:

1. State Statistics Committee of Ukraine. Available at: http://www.ukrstat.gov.ua.

2. Ivanusa A. V. (2006). Osoblyvosti utvorennia, pererobky ta utylizatsii derevynnykh vidkhodiv. [Peculiarities of formation, processing and disposal of wood waste]. Derevoobrobnyk, 11, 4 – 5.

3. Shershun M. Kh. (2012). Analiz diialnosti lisohospodarskykh pidpryiemstv ta efektyvnist vykorystannia lisoresursnoho potentsialu v umovakh rozvytku ekonomichnoi kryzy. [Analysis of the activities of forestry enterprises and the effectiveness of the use of forest resource potential in the conditions of the development of the economic crisis]. Zbirnyk naukovykh prats VNAU, 4/70, 194 – 199.

4. Apostoliuk S. O. (2012). Promyslova ekolohiia: navchalnyi posibnyk. [Industrial ecology: a study guide]. Znannia, 430.

5. Oliinychuk O. I. (2009). Osoblyvosti lisohospodarskoho vyrobnytstva ta pidvyshchennia yoho efektyvnosti. [Peculiarities of forestry production and increasing its efficiency]. Aktualni problemy rozvytku ekonomiky rehionu: naukovyi zbirnyk, 2, 148 – 154.

6. Catalog of dryers. Available at: https://www.agrovektor.com.