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Energy Saving Equipment for Crushed Materials Drying

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Abstract

Wooden and agricultural waste which has the high humidity having negative impact on the quality of the ready-made products is often used as a filler in the composite materials production. At the same time, a decrease in moist indicators of vegetable raw materials with the known methods is a rather energy-intensive action. In this regard, the development of the energy saving drying technologies and equipment is one of the most important problems of modern production.

The convective vacuum drying installation of dish-shaped type based on the technology of convective drying at the stationary lowered pressure is presented in this article. The feature of this drying installation is the existence of the multistage punched plates, the diameter of perforation of which varies depending on device height starting from 15 mm in the top part of the camera down to 2 mm in the lower part. That allows drying up different fractions of the crushed material evenly. During experiments it has been revealed that the greatest efficiency of process is reached with a pressure of 50-60 kPa, the temperature of the drying agent of 84-87 ^{0}C and the speed of its movement of 6-7 m/s. Besides, this technology of drying allows for the lower power costs associated with the process due to the reduction of heat losses due to the absence of high temperature regimes and decreased duration of the process.

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*Keywords:*wood, drying, vacuum, efficiency, energy saving.

1. Introduction

Currently one of the main ways of obtaining materials with desired properties is the creation of compositions based on known widely used in practice substances (mineral binders, polymers) and different fillers of natural and synthetic origin (sand, waste wood and agricultural wastes).

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Various wood wastes (low-grade wood, timber, wood chips, machine chips) [1-3] and agricultural wastes (cotton stalks, rice straw, flax fire) are used for the production of wood-filled composite materials – cement wood, cement-shaving boards, wood-polymer composites and chipboard [4].

In this case wood and vegetable raw materials processed into wood chips and shavings have high humidity (60-100%) as a rule. At the same time the moisture content of fibrous filler before the production of the composite material should be in the range of 2-6% [5]. Moreover, the enterprises for the production of chipboard dry wood filler to 1-3% regardless of its destination in recent years [6,7].

With the purpose of intensification of the process the drying is usually carried out at high temperatures (temperature of the drying agent in the initial period can be up to 250°C [8]), that not only increases a fire risk, but explosion hazard of production.

In this regard, the study of the processes of drying of shredded wood and plant materials under reduced pressure is important, because the application of vacuum technology allows intensifying the process at temperature 100°C [9].

However, the implementation of vacuum methods had substantial difficulties in heat supplying. Known methods of heat supply in the vacuum, such as microwave energy and contact methods are expensive and do not allow achieving uniform water content of all dried material [10-12]. Therefore, the methods of convective heat supply are the most promising in the field of vacuum drying of wood.

In this regard, the method of convective drying of materials in a stationary reduced pressure can be chosen. The main technological difference of this method is that drying occurs at a constant heat supply by convection in the rarefied environment that allows using lower temperature regimes, which lead to a significant reduction of energy costs for drying.

2. Materials and methods

In this regard, studies on convective drying of crushed wood raw material if the stationary reduced pressure have been conducted.

Mine equipment for drying with a vertical circulation of the coolant was created for experimental studies. Fig. 1 presents a functional diagram of the equipment.

Complex for drying of crushed material consists of a supply system of wet raw material 1, the drying chamber 2, the system of pumping air 3, the circulation system of the drying agent 4 and the line of unloading of the dried raw material 5. The supply system of wet raw material 1 consists of the loading hopper 6, the dosing unit 7, the vacuum valves 8 and 9 and the transmitting hermetic bunker 10. The drying chamber 2 contains a set of perforate declined shelves 11 within creasing from the top down diameters of holes, but with a constant sum of areas of holes in a variety of inclined shelves to ensure uniform flow of the drying agent. The shelves are fixed to the internal frame of the drying chamber with the possibility of creating of vibrating and heating layer and are driven by means of drive 12. To lock the residual pressure in the drying chamber 2 a manometer 13 is provided. The system of pumping air 3 consists of a capacitor 14, valves 15 and 16, the vacuum pump 17. Circulation system of the drying agent 4 consists of the pipeline in which the fan 18 and the heater 19 are installed. Line of discharge of the dried material consists of the vacuum valves 20 and 21, and the intermediate sealed hopper 22.

Complex for drying of wet fibrous crushed materials operates as follows. The wet raw material enters the transmitting sealed hopper 10 through the hopper 6 when the vacuum gate 8 is opened. The number of submitted raw material is regulated by means of the dosing unit 7.

After the supply of certain portions of the dried raw material in transmitting sealed hopper 10, the vacuum shutter 8 is closed. The vacuum valves 9, 20 and 21 and valves 15 and 16 are closed. At the same time the heating of the drying chamber 2 starts by the fan 18 and heater 19 which creates the circulation of the drying agent through the perforated sloping shelves 11. Next the vacuum shutter 9 is opened. The wet raw material is supplied on the perforated top shelf. The stage of lowering the pressure in the drying chamber 2 begins. The working residual value of pressure is determined according to the experiment plan. The process of pumping air is carried out by opening the valve 16, by supplying of heat carrier to the condenser 14 and by switching on the vacuum pump 17.

The movement of the drying agent and the wet raw material is carried out in the same direction from top to bottom in the drying chamber 2, and there is a constant separation of the crushed material determining the time of