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DEVELOPMENT OF AN EXPERIMENTAL UNIT FOR STUDYING THE PROCESS OF SURFACE MOISTURE REMOVAL BY HIGH-SPEED GAS FLOW IN APPARATUSES WITH PERFORATED ARC-SHAPED ELEMENTS

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Abstract: The paper presents the development of an experimental setup to study the process of removing surface moisture from bulk material particles using high-speed gas flow in apparatuses with perforated arc-shaped elements. The main parameters influencing the efficiency of the process, such as gas flow velocity, gas flow rate through perforated surfaces and concentration of solid particles, are described. The proposed plant design allows to adjust these parameters, which provides deep dewatering of materials, including polyethylene, polypropylene and SAN pellets, achieving moisture content as low as 0.01%. Experimental results demonstrate the possibility of eliminating thermal drying, which reduces energy consumption and costs.

Keywords: mechanical dehydration, high-speed gas flow, perforated surfaces, experimental setup, polydisperse materials, energy saving, material moisture content.

One of the most common processes of chemical technology is drying. This process is widely used in the production of mineral salts, polymeric materials, dyes, etc.

One of the main disadvantages of the drying process is very high energy consumption. Heat in the drying process is spent on heating the material, on overcoming the bonding of moisture with the material and on evaporation of moisture. Reduction of specific fuel consumption for drying is an actual task. It is also known about other methods of dehydration of materials. If the initial material contains a large amount of moisture, then a significant part of it tends to remove mechanically without the use of heat. This method is many times cheaper than drying. As a rule, the mechanical method of dehydration is carried out in two stages. At the first stage the main mass of moisture is removed in various designs of thickeners (separators), and at the second stage with the help of filters or centrifuges and only after that the material is sent for drying.

There are several scientific works [1-3], where theoretical and experimental studies on deep dehydration of polydisperse materials by impacting them with high-speed low-temperature air flow are considered. However, these studies do not solve a number of problems that arise in the implementation of this method. The main problems arising at realisation of the mentioned method of removal of surface moisture are creation of high-speed difference between gas and solid phase, and also separation of phases after interaction. As a consequence, the proposed method has not yet been realised in practice.

Taking into account the revealed disadvantages we have developed new effective designs for deep dehydration of polydisperse materials [4].

In our developed dehydrating apparatuses, the reduction of surface moisture of particles is influenced by a number of parameters:

- gas flow velocity in the channel - a parameter that provides the necessary difference between the velocities of gas and particles for disruption of surface moisture;

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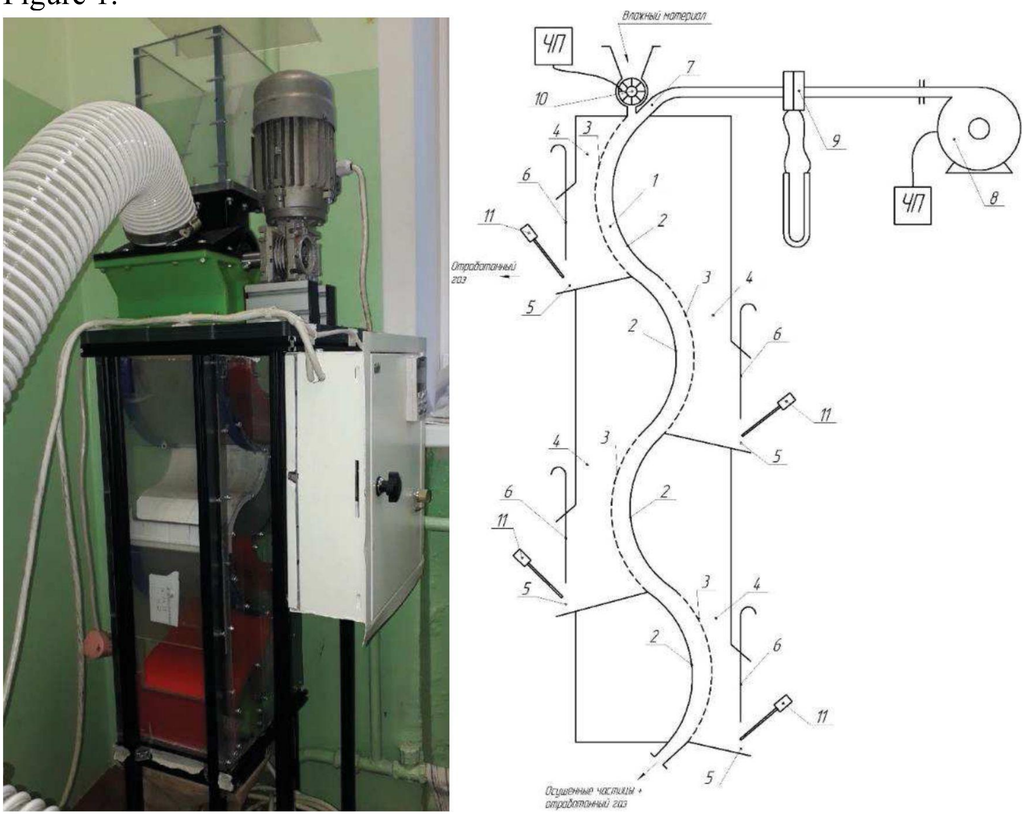
- velocity of the gas medium flow through the holes of the perforated surface of the channel - parameter, provides timely removal of the separated moisture from the working zone;
- concentration of solid particles in the gas flow - parameter, determines the hydrodynamic picture of multiphase system movement in the channel and productivity of the drying apparatus.

Establishment of regularities of influence of the listed para-metres on the process of mechanical drying of materials are the main tasks of our further researches.

To solve the set tasks we have designed and manufactured an experimental unit, shown in Figure 1.



a) b)

Figure 1 - Experimental setup for studying the process of surface moisture removal by high-speed gas flows

a) - image of the experimental setup; b) - schematic diagram of the experimental setup

The basis of the experimental unit is a four-sectional apparatus for removing surface moisture from bulk material particles. The apparatus consists of an arc-shaped channel 1 formed by two types of arc-shaped surfaces: solid 2 and perforated 3. In each section the mutual arrangement of these surfaces alternates. Behind the perforated surface 3 for each section there are chambers 4 with spigots 5 for exhaust gas with drops of removed surface moisture. Pipes 5 are equipped with shibbers 6. Shibers 6 allow to regulate the flow rate of gas passing through the holes of the perforated surface 3 in each section of the apparatus. This technical solution allows to regulate the speed of gas flow through the holes of perforated surfaces 3 for each section of the apparatus separately. The amount of air passing through the holes of the perforated surface 3 in each section was determined by measuring the air velocity in the nozzles 5 using a probe 11.

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Gas flow into the arc-shaped channel 1 through branch pipe 7 was pumped by centrifugal fan 8. The fan motor was connected to the electric network through a frequency converter, which allowed to change the speed of the centrifugal fan wheel. The possibility of adjusting the speed of rotation of the wheel of the centrifugal fan, allowed to set the required air flow rate. The very value of air flow rate was determined by means of a flow diaphragm 9 with a differential manometer. The experimental installation also provides the possibility of changing the flow rate of wet solids supply to the arc-shaped channel 1.

Adjustment of the flow rate of solid particles is achieved by changing the rotor speed of the feeder 10.

A small part of the results of the conducted experiments is presented in Figure 2.

The figure shows graphical dependences of moisture content of material W (g/g) on air flow rate V (m3/s). In experiments polyethylene granules with particle size 4 mm, polypropylene granules with particle size 3 mm, SAN granules with particle size 0,1-2 mm were used.

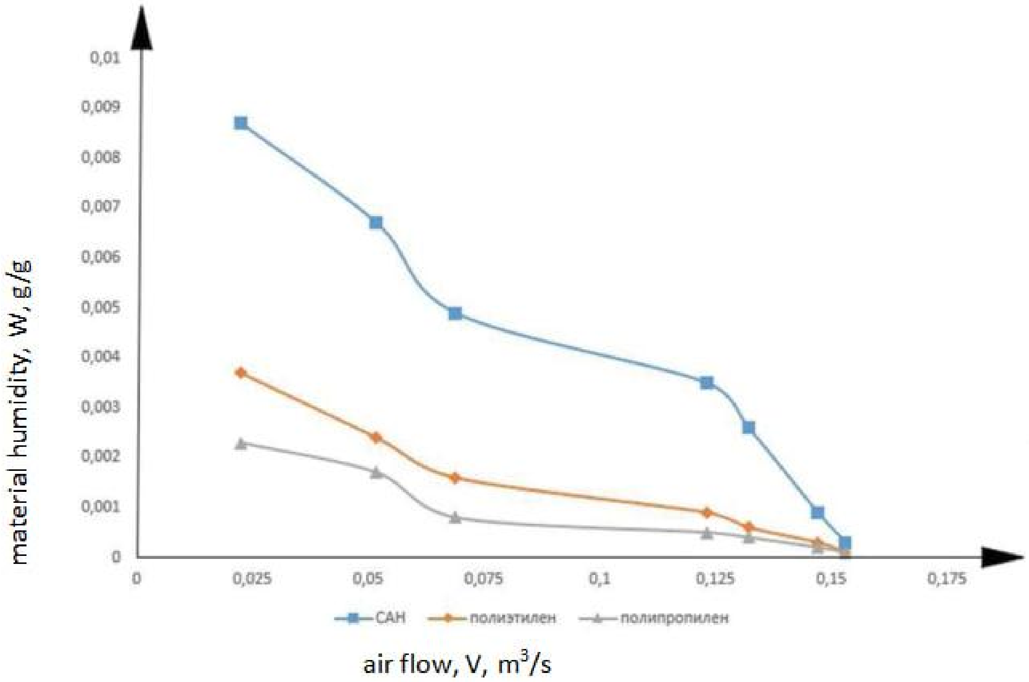

Figure 2 - Graphical dependences of material moisture content change on air flow rate

From the presented graphical dependences, it is obvious that using the developed by us designs of mechanical drying apparatuses it is possible to reach humidity of materials up to 0,01 %, and to refuse their subsequent thermal drying.

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