

DRYING AND BURNING OF NICKEL HYDROCARBONATE

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ANNOTATION

The article describes the process of heat treatment - drying and roasting of finely dispersed nickel bicarbonate in a contact drum apparatus with a rapidly rotating rotor. A drying curve and a drying rate curve obtained experimentally are given. On the basis of general ideas about drying and its laws, the physical picture of the process is considered according to the stages occurring in the drying unit.

Keywords: Nickel hydrogen carbonate, drying kinetics, drying rate curve, fine material, contact drying.

INTRODUCTION

Heat treatment of finely dispersed materials with particles less than 50 microns in size by the convective method of heat supply is not rationally, since there is a significant entrainment of particles of the processed material by the flow of the drying agent and the required dust collection equipment is cumbersome and ineffective, as a result of which environmental pollution occurs. In addition, the amount of supplied heat in such devices is usually limited due to convective heat transfer, but also an insufficiently developed heat supply surface.

Promising for drying fine materials is the use of continuously operating devices of the contact type with active hydrodynamic modes that exclude these phenomena, for example, contact drum dryers with a rapidly rotating rotor [1]. The applied contact dryers "Венулет", although they give a significant effect due to the transition from convective heat exchange to contact heat exchange, they have a significant drawback due to the slowly rotating mixing device. As a result, the inner heat transfer surface of the drum is not fully utilized.

RESEARCH OBJECT AND METHOD

In the proposed design of the apparatus, heat is supplied directly from the heated wall of the drum to the layer of finely dispersed material, which excludes entrainment of particles, since there is no flow of heat-transferring drying agent. In addition, rapidly rotating blades create a uniform thin (several millimeters) layer of dispersed material over the entire inner surface of the heat supply, and intensive mixing and movement of the material relative to the drum wall should provide sufficiently large heat transfer coefficients between the wall and the material layer.

In this work, we studied the kinetics of drying and roasting of nickel bicarbonate and heat transfer from a hot surface to a finely dispersed material.

The studies were carried out in an apparatus representing a fixed, horizontal, heated drum, inside which a rotating rotor with blades is located (Fig. 1). When the rotor rotates, the blades entrain the material, and the resulting centrifugal force throws the material to the periphery of the apparatus, where a moving layer is formed in contact with the heated inner wall of the drum. Heat treatment of the material takes place in a given layer, the thickness of which, and hence the residence time of the material in it, is determined by the size of the gap. Heat was supplied to the material from condensation of water vapor through the drum wall, which made it possible to control the heating temperature.

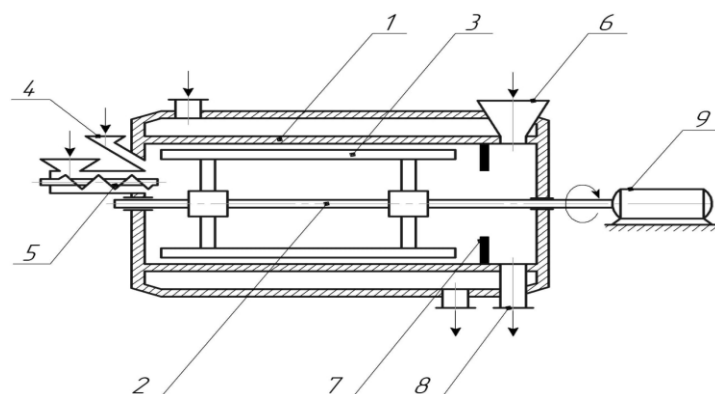


Fig. 1. Schematic of the experimental setup. 1-building; 2-rotor; 3-scapula; 4-connector; 5- feeder; 6-duct secondary steam; 7- discharge threshold; 8 - the output of the dried product; 9-electric motor.

Secondary steam with a small amount of non-condensable gases is removed from the apparatus in countercurrent to the movement of the material to be dried through the gap near the shaft and condensed in the heat exchanger. Therefore, losses and pollution of the environment were excluded. The angular speed of rotation of the rotor was stabilized by a regulating electric drive.

Nickel bicarbonate, with which the experiments were carried out, is a finely dispersed paste with a moisture content of 32-35%. The processes of drying and decarbonation of nickel bicarbonate and obtaining nickel oxide is one of the stages of hydrometallurgical production of nickel. The obtained derivatograms of the initial product showed that the drying process takes place at a temperature of 1000 C, and the decarbonization process at a temperature of 280-3200 C. Therefore, the study of the drying and decarbonization processes was carried out in two stages.

To determine the main regularities of the drying and decarbonization processes, an experimental study was carried out to determine the kinetics of the moisture removal process and the degree of decarbonization (in a batch mode). The change in the moisture content of the material and the degree of decarbonization over time were monitored by sampling. The moisture content of the samples was determined by the gravimetric method, and the degree of decarbonization was determined by taking derivatograms. Simultaneously, the temperature of the material in the layer and the temperature of the inner surface of the drum were measured using a potentiometer.

Figure 2 shows the kinetic curves of changes in the moisture content of the material being dried at different rotor speeds. It can be seen from the curves that the process takes place in pronounced 2 periods.

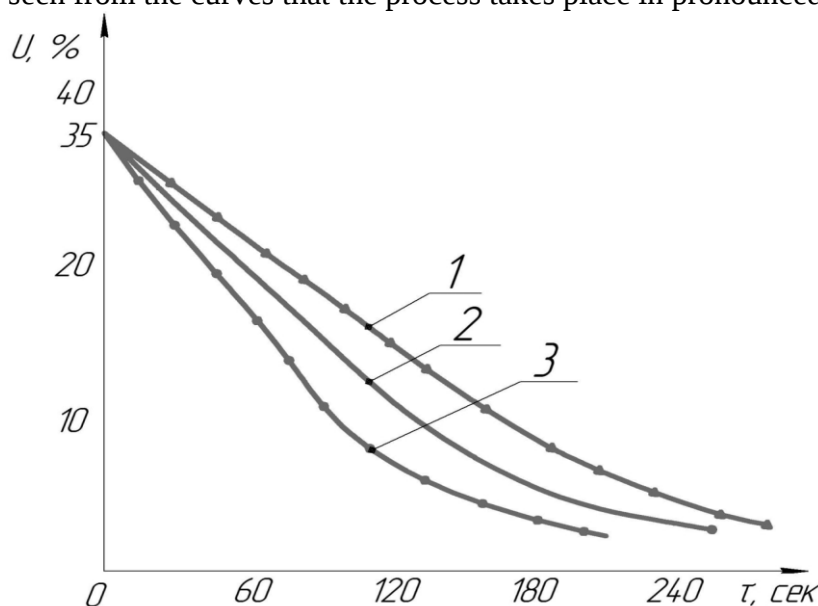


Fig. 2. Kinetic curves of changes in the moisture content of the dried material at different speeds of the rotor.
1- $n = 400$ rpm; 2- $n = 600$ rpm; 3- $n = 800$ rpm.

In the first period, the evaporation rate is high and it is limited by underwater heat. It can be concluded that in the first period there is a "squeezing" of moisture under the action of centrifugal force from the material on the wall of the drum and its evaporation at the wall. The amount of "surviving" moisture depends on the angular speed of rotation. Evaporation of moisture occurs at a constant rate and the temperature of the material is equal to the temperature of the wet bulb. This is the drying period at a constant rate when surface moisture of the material is removed. When the moisture content reaches 8-10%, the drying speed decreases and the second drying period begins. The temperature of the material starts to rise.

The experimental results were processed in the form of the dependence of the heat transfer coefficient from the heated wall to the material layer on the material moisture according to the formula:

$$\alpha = Q / F * \Delta t_{av} \quad (1)$$

The amount of heat Q supplied to the material during the drying process was determined by the balance:

$$Q = Gc (du / d\tau) * r + Gc (Cc + CB * U) dt / d\tau \quad (2)$$

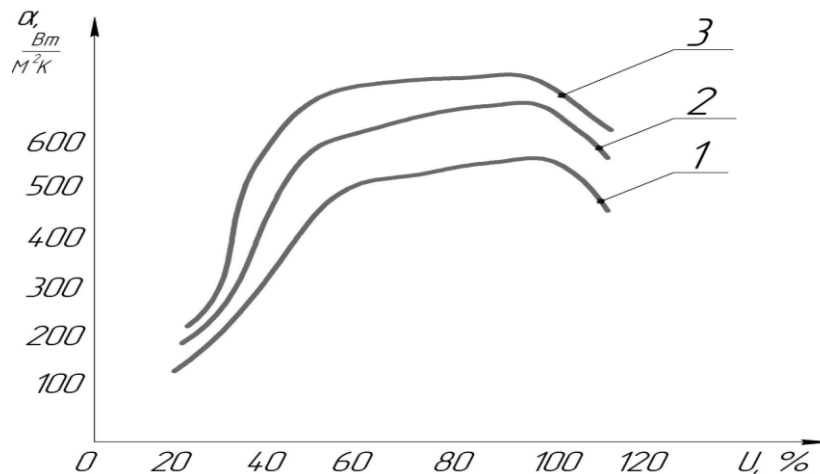


Fig. 3. Dependence of the heat transfer coefficient on the moisture content of the material.

1 - $n = 400$ rpm; 2 - $n = 600$ rpm; 3 - $n = 800$ rpm.

Figure 3 shows the dependence of the heat transfer coefficient on the moisture content of the material, from which it can be seen that three periods of the process should be distinguished: in the first period, the heat transfer coefficient is relatively high, since evaporation of the "squeezed out" moisture occurs and heat transfer is limited by the thermal resistance of the drum wall. In the second period, the coefficient α remains approximately constant. Under these conditions, normal contact of the layer with the wall is maintained, and heat transfer depends only on the intensity of this contact. At a moisture content of 8-10%, surface moisture is largely removed and the contact of the material with the surface deteriorates. The upper surface of the particles becomes dry and the moisture front deepens, the temperature of the particle surface heats up.

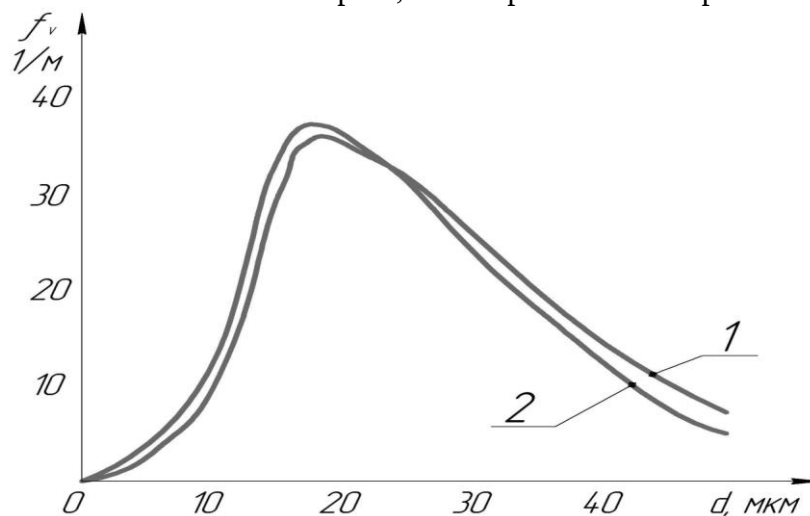


Fig.4 Analysis of the dispersed composition of the product. 1- before heat treatment in the apparatus, 2- after heat treatment in the apparatus.

Figure 4 shows the analysis of the dispersed composition of the product before and after heat treatment in the apparatus, carried out on an FS-112 phase composition analyzer. From the data obtained, it can be seen that the dispersed composition of the experimental and control samples coincides, therefore, it can be concluded that the abrasion of the product during the drying and decarbonization process does not occur in this apparatus.

CONCLUSION

According to the results of the study, it can be concluded that it is possible to jointly produce the process of drying and decarbonization of nickel bicarbonate in one apparatus with contact heat.

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