ROASTING OF NICKEL HYDROCARBONATE

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Annotation

Thermal treatment of finely dispersed materials with particles smaller than 50 μm by the convective method of heat supply is notrationally, since there is a significant entrainment of particles of the processed material by the flow of the drying agent and the required dust-collecting equipment is bulky and inefficient, resulting in environmental pollution. In addition, the amount of heat input in such devices is usually limited due to convective heat transfer, but also due to an insufficiently developed heat supply surface.

Keywords: dispersed materials, drying, process, materials, quality, transferred, convective, decarbonization processes.

Introduction

Promising for drying finely dispersed materials is the use of continuously operating contact-type apparatuses with active hydrodynamic modes that exclude these phenomena, for example, contact drum dryers with a rapidly rotating rotor [1-4]. The used contact dryers "Venulet", although they give a significant effect due to the transition from convective heat exchange to contact heat exchange, they have a significant disadvantage due to the slowly rotating mixing device [5-9]. As a result, the inner heat transfer surface of the drum is not fully utilized.

Object and method of research

In the proposed design of the apparatus, heat is supplied directly from the heated drum wall to a layer of finely dispersed material, which eliminates the entrainment of particles, since there is no flow of a heat-carrying drying agent [10-19]. 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 high heat transfer coefficients between the wall and the material layer. In this work, we studied the kinetics of drying and firing of nickel bicarbonate and heat transfer from a hot surface to a finely dispersed material [20-27]. The studies were carried out in an apparatus, which is 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 that contacts the heated inner wall of the drum. Heat treatment of the material takes place in this layer, the thickness of which, and hence the residence time of the material in it, is determined by the size of the gap [28-35]. Heat was supplied to the material from the condensation of water vapor through the drum wall, which made it possible to control the heating temperature.

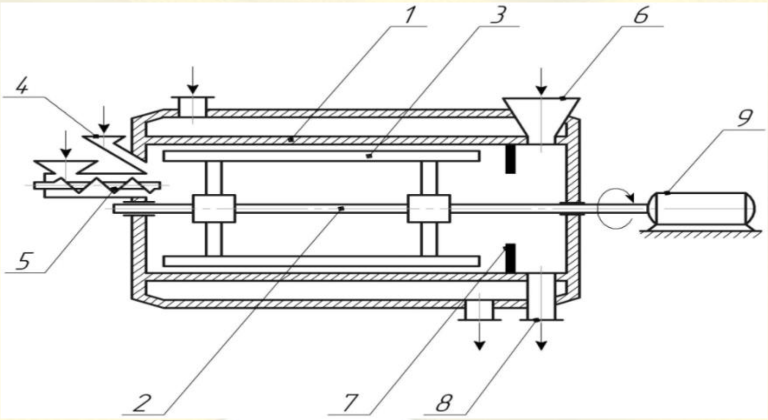

Fig.1. Scheme of the experimental setup. 1-case; 2-rotor; 3-blades; 4-fitting; 5- feeder; 6-fitting secondary steam; 7- unloading threshold; 8 - output of the dried product; 9-electric motor.

Secondary steam with a small amount of non-condensable gases is removed from the apparatus countercurrent to the movement of the dried material through a gap near the shaft and condensed in the heat exchanger. Therefore, losses and environmental pollution were excluded. The angular speed of rotation of the rotor was stabilized by a control electric drive [36-42].

Nickel bicarbonate, with which experiments were carried out, is a finely dispersed paste with a moisture content of 32-35%. The processes of drying and decarbonization 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 occurs at a temperature of 100 °C, and the decarbonization process at a temperature of 280-320 °C [43-46]. 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 periodic mode). Changes in material moisture and degree of decarbonization over time were monitored by sampling. The moisture content of the samples was determined by the weight method, and the degree of decarbonization 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 dried material at different numbers of rotor revolutions. It can be seen from the curves that the process occurs in pronounced two periods.

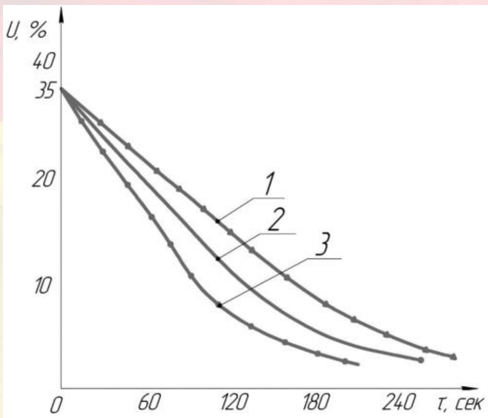

Fig.2.Kinetic curves of changes in the moisture content of the dried material at different rotor speeds. 1- n \u003d 400 rpm; 2 - n = 600 rpm; 3 - n = 800 rpm.

In the first period, the evaporation rate is high and it is limited by the underwater heat. It can be concluded that in the first period, moisture is “squeezed out” under the action of centrifugal force from the material onto the drum wall and evaporates near the wall. The amount of “survivable” moisture depends on the angular velocity 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 period of drying at a constant rate when the surface moisture of the material is removed. When a moisture content of 8-10% is reached, the drying rate decreases and the second drying period begins. The temperature of the material starts to rise. The results of the experiments were processed as a dependence of the heat transfer coefficient from the heated wall to the material layer on the moisture content of the material according to the formula:

$\alpha = Q/F * \Delta tav$ (1)

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

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

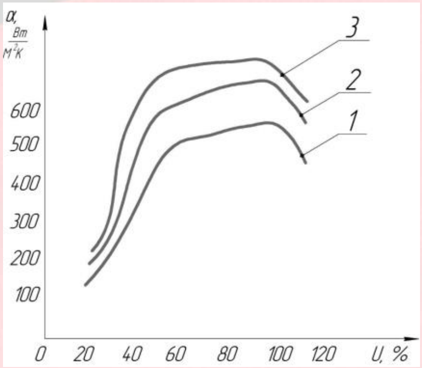

Fig.3.The dependence of the heat transfer coefficient on the moisture content of the material. n \u003d 400 rpm; 2 - n = 600 rpm; 3 - n = 800 rpm.

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, because the “squeezed out” moisture evaporates and the 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 between the layer and the wall is maintained, and heat transfer depends only on the intensity of this contact. At a moisture content of 8-10%, the 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 surface temperature of the particle heats up.

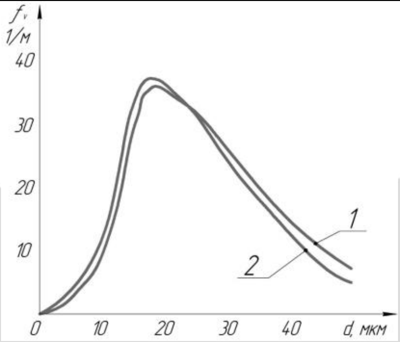

Fig.4 Analysis of the dispersed composition of the product. 1 - before heat treatment in the apparatus, 2 - after heat treatment in the apparatus.

Figure 4 shows the analysis of the disperse composition of the product before and after heat treatment in the apparatus, carried out on a phase composition analyzer FS-112. From the data obtained, it can be seen that the dispersed composition of the experimental and control samples is the same, therefore, we can conclude that the attrition of the product during drying and decarbonization does not occur in this apparatus.

Summary

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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