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Research Article

DRYING TONKODISPERSE MATERIALS IN AN UNSUCCESSED ROTARY-DRUMING MACHINE

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ABSTRACT

In the article ecologically clean drying of fine dispersed materials chemical and allied industries are considered. The equipment design and technology of drying fine-dispersed materials had been prepared.

KEYWORDS

Contact drying, finely dispersed materials, rotary-drum apparatus.

INTRODUCTION

Drying of wet particulate materials is usually carried out in convective bed dryers. If it is necessary to dry wet fine materials having a particle size of 5-50 microns. This drying method is not always effective. The reason for this is that part of the product is carried away by the exhaust gases and pollutes the environment. As a result, it becomes necessary to clean the secondary air [1-

3]. This method requires rather bulky equipment for dust collection, since several stages of cleaning are required. Convective drying is especially undesirable for small-tonnage industries with a wide range of products, in some cases having environmentally harmful components, the loss of which affects the environmental situation, especially when drying toxic materials [4-7].

In such cases, it is necessary to use contactless dryers of the contact type, for example, rotary drum dryers. This type of dryer has been developed in a number of countries, but as far as we know, they are not widely used in industry [6-9].

Based on the above conclusions, it is advisable to investigate the process of drying aggressive, environmentally harmful finely dispersed materials in apparatuses of this type, since it became necessary to use them in production.

Studies were carried out with a number of finely dispersed materials (less than 20 μm) - for deep drying (up to 0.01%) of phenyl C2 (powder press), for drying highly moist activated carbon paste and other finely dispersed materials. The device is a fixed horizontal heated drum (D=180 mm, L=300 mm), inside which is a rotating rotor with blades. When the rotor rotates with blades, the material is thrown to the periphery, where a moving mixed layer is formed, which is in contact with the heated wall. Drying of the material takes place in a layer, the maximum thickness of which, and hence the residence time of the particles in the apparatus, is determined by the size of the gap between the body and the blades (the layer thickness may be less).¬

The required heat flux was maintained constant or regulated, if necessary, to maintain a constant wall temperature by a voltage regulator. Secondary steam with a small amount of non-condensable gases was removed from the apparatus along its axis and condensed in the heat exchanger, therefore, product losses and environmental pollution were excluded [5-8].

The drying kinetics was studied in batch and continuous processes (material samples were taken periodically). The temperature of the material in the layer was measured, as well as the temperature of the inner surface of the drum wall. On the basis of experiments, kinetic curves of changes in humidity and temperature of the dried material in a batch process at different numbers of rotor revolutions were obtained. Analysis of the data showed that with an increase in the speed of rotation of the rotor, the intensity of drying increases, and the temperature of the material by the end of the process approaches the temperature of the heating surface. The influence of the number of revolutions on the heat transfer coefficient was also studied at different initial moisture content of the material. With an increase in the initial humidity, the heat transfer coefficient increases significantly and reaches high values - about 500W/m2K, but decreases significantly with decreasing humidity (less than 200 W/m2K). It seemed interesting to reveal the change in the heat transfer coefficient along the perimeter of the drum. The experiments were carried out with dry material and the local values of the heat transfer coefficient were measured with a thermistor sensor. The heat transfer coefficient was measured at 8 points along the inner perimeter of the drum. Experimental data showed that at low rotor speeds, the heat transfer coefficient is low, which is explained by poor mixing of the layer, and in the upper part of the drum particles are separated, since at these rotor speeds the centrifugal forces are small compared to gravitational forces. Because of this, the profile of the heat transfer coefficient is uneven around the perimeter of the drum. With a further increase in the angular velocity of the rotor, the heat transfer coefficient increases, as the mixing of particles improves and the number of their contacts with the hot surface increases, the centrifugal forces also increase. With an increase in the angular velocity of the rotor, the ratio of centrifugal force to gravity increases rapidly. This leads to a uniform distribution of the material in the gap along its perimeter and, as a result, an increase in the contact heat exchange surface due to the use of the upper part of the drum with an increase in the angular velocity of the rotor and to equalize the local heat transfer coefficients.

An analysis of studies on heat and mass transfer processes occurring during drying in rotary dryers shows that, based on existing studies of the drying process, it is impossible to take into account all the characteristic features and changes in the kinetics of such a process.

A more complete model would be that would take into account the change in the material temperature in each of the stages of drying, the equilibrium between the wet material, the additional heat input from energy dissipation due to the rapid movement of the dispersed material and the heated structural elements of the drum, as well as the effect of longitudinal mixing of the dispersed material.

On the basis of general ideas about drying and its laws, the physical picture of the process by stages occurring in the drying plant is considered, the developed mathematical models are described and their solution is given. The development of a mathematical model is based on the known laws of conservation of energy and mass of matter, provisions from the theory of drying and the laws of equilibrium between the material and the drying agent.

The period of removal of free moisture is characterized by the fact that evaporation proceeds according to the laws of the transformation of free liquid into vapor. During this period, the drying process is determined mainly by the rate of heat supply from the heated wall to the material being dried.

One of the most important parameters that determine the drying mode is the wall temperature. In a continuous drying process, the wall temperature along the length of the dryer changes due to heat transfer to the evaporation of the liquid, to heating the material and rotor blades.

The calculation of the period of removal of bound moisture differs from the calculation of the period of removal of free moisture in that the surface temperature of the material rises, it is necessary to calculate using the modified relationship between the wall and the material being dried.

As a result of thermal contact of the material with hot walls and rotor blades, a layer of dried material appears, the thickness of which gradually increases. And in the dried state, the dispersed material in terms of heat-conducting properties is not so far from the properties of heat-insulating materials. This is due to the fact that the main resistance to heat transfer is concentrated in the zone of the material in contact with the heat-releasing surface. The processes taking place in this zone essentially depend on the Lykov criterion. With its small values, the liquid will not have time to be supplied from the inner layers of the material to the contact surface, a layer of dry material will appear separating the contact surface and the evaporation surface. The temperature of this layer on the contact surface is the same as the temperature of the heated wall,

CONCLUSION

The results of the research were used by us in the design and testing of a pilot plant, in particular for fine material with a capacity of 100 kg of moisture per hour. The dimensions of the pilot plant were 450 mm in diameter and 1500 mm in length. For phenylone C2, the overall dimensions of the pilot plant are identical to those of the laboratory plant.

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