REZULTATI ISTRAŽIVANJA NA SPREJ SUŠARI

RESULTS OF RESEARCH ON SPRAY DRYER

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Sprej sušare se veoma često primenjuje u hemijskoj i prehrambeno - prerađivačkoj industriji. Ova metoda sušenja podrazumeva suspenziju sa sadržajem oko (30 do 40) % praškaste materije. Period sušenja u većini slučajeva je samo nekoliko sekundi. Sredstvo za sušenje je topli vazduh. U radu su prikazana eksperimentalna i teorijska ispitivanja sprej sušare skrobne suspenzije sa 30% i 40% suve materije. Prenos toplote se ostvaruje konvekcijom, zahvaljujući principu sušenja zasnovanom na direktnom kontaktu zagrejanog vazduha i vlažnog materijala. Tokom tog procesa dolazi do intenzivne razmene toplote i mase. Na osnovu rezultata istraživanja dati su modeli sušenja – temperaturna kriva sušenja, kriva brzine sušenja i temperaturna kriva vlažnog materijala.

Ključne reči: *sprej sušara, skrob, modeli sušenja, vlažnost materijala, temperatura sušenja*

The spray dryer is very often applied in chemical and food - processing industries. This drying method includes suspension - spraying with the contents about (30 to 40) % of powdery matter. The drying period in most cases is only several seconds. The drying agent is the warm air. The paper presents experimental and theoretical investigations of spray drying of starch suspension with 30% and 40% dry matter. Heat transfer is accomplished through convection, thanks to the principle of drying based on direct contact between the heated air and moist material. During that process, intensive heat and mass exchange take place. Based on the research results, drying models are given - drying temperature curve, drying speed curve and temperature curve of wet material.

Key words: *spray dryer, starch, models of drying, material moisture, drying temperature*

1 Introduction

Different suspension of certain products reacts with uneven drying, which depends on the properties of the material that is dried. It is very difficult to recommend a unique technique of the spray driers. In comparison with other systems, spray drying requires a relatively small storage space. Service and maintenance are very simple and is performed with little labor. These advantages, as well as economical heat transfer provides the optimal cost of the final dried product. Drying time in most cases only a few seconds, and can successfully dry heat sensitive products such as vitamins, chemical and food products and others, who better to submit a high temperature in a short period of time, but lower temperatures for a longer period of time [1 - 3].

For substances such as suspension of various powdery materials with (30 to 40) % of dry matter, spray drying kilns is quality solution to the problem of drying. There have been many attempts at formulating a mathematical description of spray drying since the 1950s. In spray drying there are many phenomena which are difficult to represent in the form of a mathematical model. For many years polydispersity of spray, entrainment effects, or problems of internal heat and mass transfer in the disperse phase have been inadequately considered in such models. According to [4 - 6], the solution of the spray drying model is also presented, taking into account the axial and tangential distribution of air velocities.

Drying systems based on the principle of heat transfer by convection, such as spray driers and pneumatic dryer have been treated in the literature [7 - 14]. There is still a considerable demand for simple models which can be used to optimize the process, to minimize its costs, and to evaluate product quality [11].

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2 Experimental apparatus and details

The paper presents the results of experimental research when drying a 30 - 40 % mass solution of starch and water, on a spray dryer. Spraying is mono dispersive and it is assumed that the temperature and humidity are evenly distributed in the cross section of the spray.

Starch suspensions are prepared by adding an appropriate amount of dry matter corn starch, with a particle size of 2 to 20 μm (99%) and a single particle fraction sizes below 1 μm (1%), in distilled water.

Figure 1, shows a schematic of the experimental equipment of spray dryer in which the experiments took place. In Table 1, is given the basic characteristics of the spray dryer.

Table 1. Basic characteristics of spray dryer

Name	Units	Dimensions
Diameter chamber spray dryer	mm	5000
Total chamber height	mm	5500
Fan	m^3h^{-1}	9750 - 15400
Heater	kW	160
Cyclone diameter	mm	1400

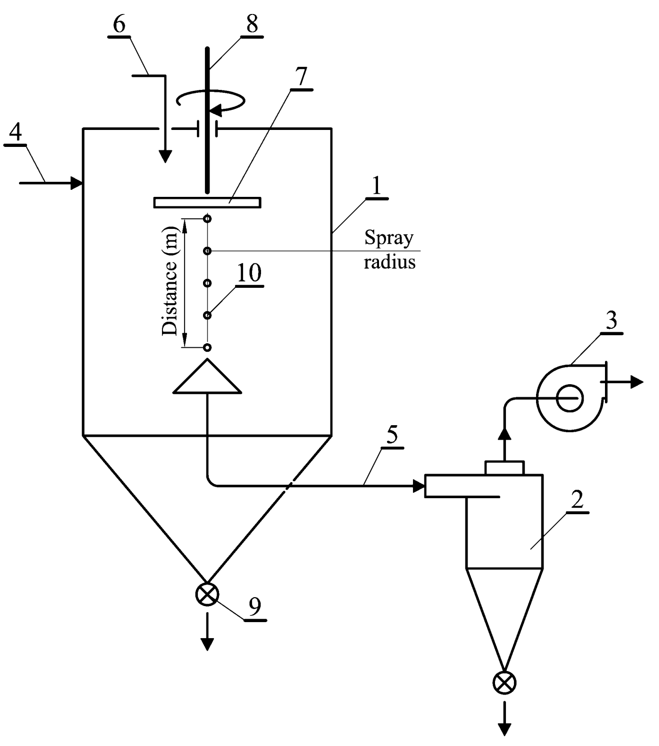

Figure 1. Schematic of the experimental plant spray dryer: 1-chamber spray dryer, 2-cyclone, 3-fan, 4- hot air inlet, 5-air outlet, 6-supply of material, 7- swirler (atomizer), 8-drive axle, 9 – rotary feeder, 10 - measuring points

Transport of hot air is performed by means of a fan (3) can be regulated in the range (9750-15400) m^3h^{-1}. Warm air - heater (4), can be regulated in the range (130 to 160) kW. The material is drying leads through the entrance (6). Material for drying empties into the atomizer (7). Axle (8), given by electric propulsion.

Atomizer (7) rotates a large number of rpm n = 3800 min^{-1}, and thus made dispersal of the liquid solution in small droplets. Aerosols are obtained on a 320 mm diameter rotating disk with blades. Spray speed is 63.5 ms^{-1}.

In contact with hot air drying is done dispersed droplets and is carried out intensive exchange of heat and mass. Air flow to the fan (3), can be regulated, so that can be achieved in the drying air velocity V = (0.14 to 0.21) ms^{-1}. Dried material using a rotary feeder (9), transported as a finished product. Air with dust particles are drains with piping (5), the cyclone (2). The cyclone (2), the complete separation, after which they are using fans (3), performed taking the air in the atmosphere.

3 Experimental results and discussion

Experimental investigations of water evaporation were carried out for two feed rates (157, 204 kg h^{-1}), two values of air temperature (150, 180 ºC). An example of the temperature change obtained at a feed rate of 157, 204 kg h^{-1} is shown in Figure 2.

Experimental studies show the character of uniform distribution of particles depending on the distance to the atomizer in all experimental series. Changes in air and material temperature in the cross section of the dispersed material are negligible, which has been experimentally confirmed.

The absence of an air temperature gradient in the spray cross-section can be explained by the design of the experimental set-ap and by process parameters. The air velocity profile in the tunnel of dryer is flat and the turbulence is low. In the study carried out by [15, 16] was observed, and obtained similar results.

The suspension of particles did not come into contact with the walls of the spray dryer, which was in accordance with the experimental observations (in all experimental tests, no wetting of the wall of the spray dryer was reported).

In Figure 2, the dependence is given changes in the temperature of air, as a function of the distance from the atomizer for the same feed rate and air flow velocity. A drop in the air temperature as a function of the distance to the atomizer is observed. Similar profiles of particular functions were obtained in many studies [17 - 19].

Experimental results shown in Figure 3, illustrate changes in the evaporation rate along the tunnel of dryer for different temperatures of air.

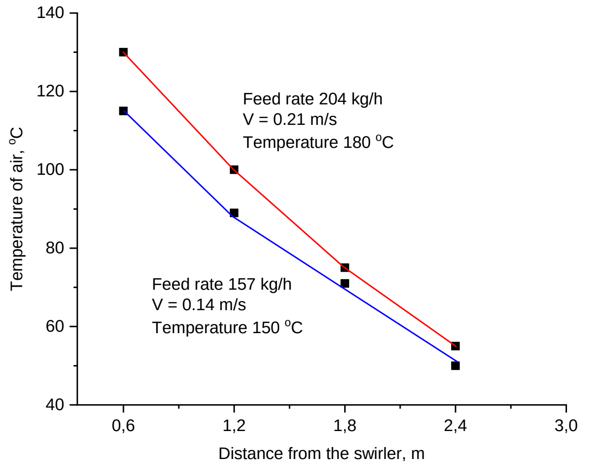

Figure 2. Temperature of air

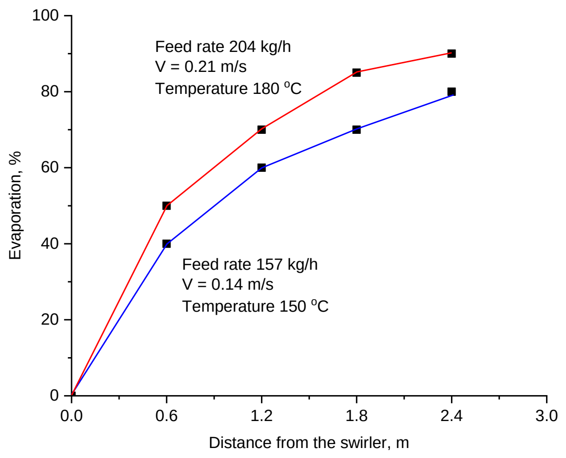

Figure 3. Evaporation at different air temperatures

Air temperature has a decisive effect on the evaporation rate. The rate of addition is the parameter that determined the rate of evaporation [20]. No significant influence of the drying agent velocity on the shape of the curves discussed was observed. As the moisture content decreases, the rate of evaporation from the surface of the dried material decreases. A drop in humidity was also observed depending on the distance to the swirler. In Figure 4, the temperature curve of the wet material is given. The change in the temperature of the material is insignificant in relation to the air temperature.

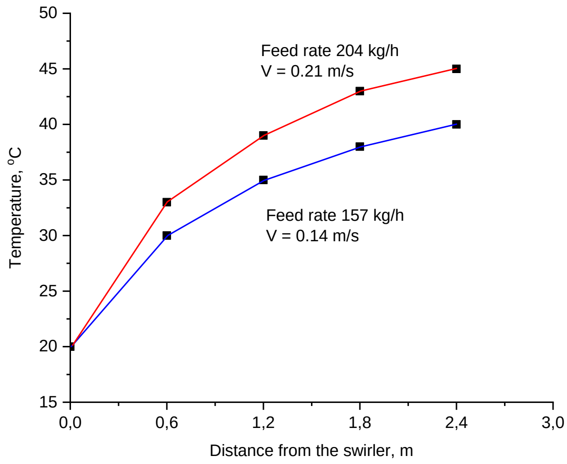

Figure 4. Temperature of material

4 Conclusion

In this paper, experimental and theoretical investigations of drying by spraying starch solution are presented. The paper presents evaporation at different temperatures, as well as drying temperature curves.

Based on the results of the research, the following was determined:

– a drop in the air temperature as a function of the distance to the atomizer is observed,
– air temperature has a decisive effect on the evaporation rate. The rate of addition is the parameter that determined the rate of evaporation,
– the change in the temperature of the material is insignificant in relation to the air temperature,
– the determined parameters of the drying regime can be considered as optimal parameters, considering that the experimental drying process obtained good quality of the dried material,
– the model presented in this paper can be used to predict many subtle phenomena that occur during spray drying, in particular at complex air flow.

The research results have practical value, because it is based on experimental data. The results of the research can serve researchers, equipment manufacturers and users of these and similar drying systems.

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