DATA ON THE DRYING OF THERMOSENSITIVE SUBSTANCES

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For the drying of thermosensitive substances, spray dryers were found to be effectual in many cases. In the high potential space of spray driers thermosensitive substances (e. g. enzymes, vitamin preparations) can easily be dehydrated.

The explanation for the results obtained has chiefly been sought for in the short drying time (cca 2—15 sec.) as compared with other types of driers. It has further been assumed that best penetration affects only the surface of the drops under drying, and that this outer layer provides certain protection for portions of the substance taking place in the drops. It was Kitzes [1] who first pointed out that in the course of manufacturing powdered milk the heat coagulation of the proteins of a powdered milk with smaller granules is less than that of bigger granules. The outer layer, therefore, does not offer protection against heat penetration. If we assume that in the course of spray drying, the temperature of the drying material changes similarly to that of otherwise identical drying parameters in some other hot-air drying equipments, even the short drying period would be sufficient to bring about undesirable changes caused by heat.

In the constant rate period of drying, the temperature of the drying substance is identical with the wet bulb temperature, if there is no soluble material present. According to Likov's [2] experiments, the first critical moisture content value which closes the constant rate period of drying, depends on the layer thickness of the drying material (direct proportionality), and furthermore on the circumstances of drying. In case of rigorous drying, the critical point will show itself by higher moisture contents. Likov has also established that the moisture evaporation occurs not only from the geometric surface but from the so-called evaporation zone. The depth of the evaporation zone differs considerably with each type of material. Reckoning the diameter of the sprayed drops with 60 μ, assuming already an evaporation zone of 10 μ, we come to the conclusion that 70 per cent of the total material or of the moisture quantity, respectively, will fall within this zone. Thus, in the range of the usual drop diameter the importance of the "evaporation zone"-

theory increases. In case of actual drying, the value of the wet bulb thermometer with the usual drying temperatures (100—150 C°) does not exceed the 35—45 C° values.

DLOUGHY and GAUVIN [3] have examined the mass and heat transfer in the course of Ca lignin sulfonate spraying. From the data submitted it can be established that on the rate curve taken in the tray drier, the first critical moisture content value appeared with a water content of about 70 per cent, while on the basis of values measured in the spray drier this occurred at a 25 per cent water content.

Taking into consideration the aforesaid, it seemed evident to assume that in the spray driers the drying rate curve of the drops becoming dry becomes distorted, i. e. the conclusions that can be drawn from drying rate curves taken by way of the usual technology are not pertinent in the case of spray drying.

In order to prove this, we dehydrated baker yeast in a Niro system pilot plant spray drier, the technical data of which and the influence of parameters exercised on drying have already been discussed [4]. The test material had to satisfy the following stipulations:

1. It must be thermosensitive
2. The ensued change should be measurable
3. It should be available in carrier-free form
4. No crystallization is allowed to take place (rise of temperature)
5. The value of the critical moisture content should appear at high moisture contents.

On the basis of the drying rate curve obtained from the drying curve, we have established that the constant rate period exists at about 50 per cent moisture content. According to PELC's [5] measurings, in case of pressed baker yeast, the water content outside the cells is 19—23 per cent depending on the initial moisture content of the samples. The comparison of the two data shows that the constant rate period ceases at the moment when the water departs from between the cells. During actual drying (100—150 C°) no drying curve can be made due to the unsettled character of the values obtained. To trace the temperature of drying drops throughout the process has so far not been possible.

The principle of the applied indirect drop temperature determination was the following:

The temperature of the drying liquid drops under the given conditions if the constant rate period is determined by the rate of vapour pressure caused by the soluble substance. Between the vapour pressure and temperature of the drop direct proportionality exists. If the vapour pressure above the material (equilibrium vapour pressure) is known, the drop temperature can be determined with the aid of a psychrometric diagram in the constant rate period. According to Marshall's [6] data, the results obtained through graphical method agree with that of the practice. As it can be seen in Fig. 1, the point of intersection of the adiabatic saturation line drawn across the points which are in compliance with the vapour pressure and the temperature of the drying air, and of the vapour pressure curve of the examined material, will give the temperature sought for

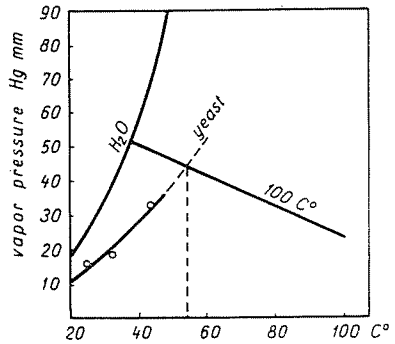

Fig. 1

Sketching the vapour pressure curve of the yeast with a moisture content of 25%, into the psychrometric diagram, in case of drying air with a temperature of 100 C°, we were able to determine the drop temperature. This proved to be 50—55 C°. Thus, even if the drying of yeast drops with a moisture content of 25% occurs in the constant rate period, we have to reckon with a drop temperature of 50—55 C°. In case of falling rate period, though the above method cannot be applied, the temperature will, by all means, be higher, i. e., after the critical point, an abrupt increase will be noticable in the temperature of the material.

The final product was dried to a moisture content of 12%, which was gathered together on cooled surface, thus excluding the heat effect caused by the metal surface that had become warm compared to that of a material dried at 100 C°. (The time difference showing itself in the motive power as compared to the original substance, is the same in both cases; the number of dead cells was 30 per cent in both cases.) In the falling rate period the raising temperature would necessarily be followed by the increase of the temperature of the material and, together with it, the decrease of activity.

The temperature of the drops could not reach the 65 C° because in that case as was already reported in details in another paper [7], the number of dead cells ought to have exceeded the above mentioned 30 per cent even within a short time.

The above data proved that in the course of spray drying of yeast up to about 12 per cent moisture content, the drying takes place in the constant rate period. The actual temperature of the dried drops fall between the value obtained with psychrometric diagram (50—55 C°), and the values 60—65 C° as established on the basis of cell decomposition. This can be possible only if up to the measured moisture content (12%) we reckon with the constant rate period.

Summary

Baker yeast was dried in an experimental spray drier, and the formation of the drying rate was examined. It was established that even in the case of yeast that is difficult to dry, the constant rate period of drying is postponed in the direction of lower moisture contents which gives an explanation for the relatively little decrease in the activity of the final product.

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