Kinetics of Polymer Dispersion Drying dy the Conduction Method

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***Abstract* – The effects of conduction heating at the drying surface temperatures ranging from 50° to 90°C for thin layer conduction drying of polymer dispersion were studied.**

Results show that polymer dispersion at 52 percent initial moisture contants dried initially under constant rate period for a very short time and then dried under falling rate period.

The empirical drying equations, developed before for the above drying conditions can be used to predict the drying time with fairly good accuracy.

Keywords – contact drying, drying rate, drying time, drying kinetics, polymer dispersion

I. Introduction

The drying of materials is often the final operation in a manufacturing process and the drying operation often follows evaporation, filtration and crystallisation.

Heat transfer and mass transfer are critical aspects in drying processes. Heat is transferred to the product to evaporate liquid, and mass is transferred as a vapor into the surrounding gas. The drying rate is determined by the set of factors that affect heat and mass transfer.

The conduction method is of considerable interest for the understanding drying kinetyc. According to this method, the total drying time of a thin film material form (50-150 μm) can be calculated.

II. Materials and methods

Typically convection approach to define the drying kinetic can be used. The mass transfer at atmospheric pressure can be modeled using Crank's model [1].

Another approach can be used for conductive drying. A conduction dryer experiment is made on a metal-walled, heat-jacked arrangement that is either stationary or rotating. Accoding to this conditions removal of vaporized water is independent of the heating medium. It depend from heat surfase temperature and more other factors such as structure and material properties, heat transfer, operation pressure. The polymethylmethacrylate-polystyrene water dispersion was investigated under contact drying conditions. The physical properties of the polymer dispersion are given in Table 1.

TABLE 1

THE PHYSICAL PROPERTIES OF THE DISPERSION

Solid phase content	47-48%
Particle size	0.2-0.4 μm
Viscosity at 25^{0}C	200 – 500 mPa·s
Density of dispersion	1108 kg / m^3
Film formation	93 ^{0}C
Sintering temperature	104 ^{0}C

III. Results and discussions

The surface temperature was 50, 75, and 92°C. The diagram in Fig. 1 shows that the process consists of two periods.

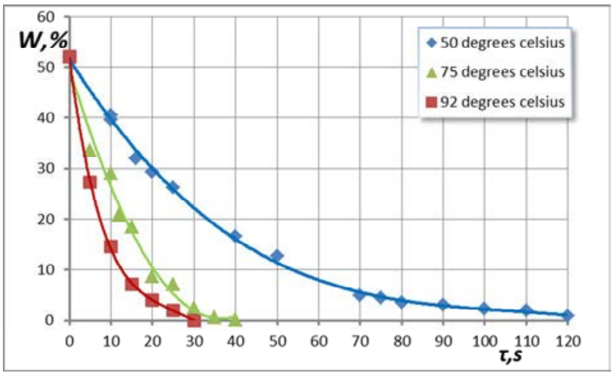

Fig. 1 The polymer dispertion drying curve

The instantaneous moisture content during the first period of drying can be determined from the equation:

$$W = W_i - Nt_1 \quad (1)$$

where W_i is the initial moisture content, %; N the rate of drying in the first period, %/sec; and τ, the drying time, sec.

The moisture content in the second falling rate period can be determined from the equation:

$$W - W_E = (W_{cr_1} - W_e)\exp(-2{,}3X_1Nt_2) \quad (2)$$

where τ_2 is the time elapsed from the start of the second period, sec; X- the relative coefficient of drying, 1/% and W_e the equilibrium moisture content, %.

According Eqs. (1)-(3) taken into account gave the following equation of the total drying time:

$$t_{total} = \frac{1}{N}(W_i - W_{cr_1} + \frac{1}{X_1}\lg\frac{W_{cr_1} - W_e}{W_u - W_e}) \quad (3)$$

where W_u is the ultimate moisture content. [2]

Conclusion

The rate of water loss during contact drying of polymer dispertion was directly related to the temperature.

The process time to attain a We water loss can be predicted using the proposed model when the model parameters are known.

The rate of drying in the first period N and relative coefficient of drying X obtained from the experimet data ranged from 0.038 to 0.141 s^{-1} and from 0.023 to 0.06, to temperature ranged from 50 to 90 °C, respectively.

References

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