V. I. Mushtaev

FUNDAMENTAL THEORY OF CONVECTIVE DRYING AND REFINED METHOD OF DESIGNING DESICCATORS*

Reviewed by A. V. Lykov and P. S. Kuts

The drying of materials in a fine-dispersion state is a process widely accepted in various branches of the domestic economy. Many problems concerning the design and construction of desiccators have not yet been explored sufficiently well, however, which is the cause of some great difficulties in operating this apparatus, especially for large-scale production. There are still no reliable formulas available for determining the size of desiccators. For this reason, the textbook by V. I. Mushtaev does, to some extent, close the gap here: it is very topical and of theoretical as well as practical interest.

The textbook features 84 pp. with 32 illustrations.

A correct solution of the problem of drying a disperse material by interaction with a gas stream under continuously variable operating conditions is an extremely complex matter and the method proposed by V. I. Mushtaev represents the first attempt to solve this fundamental problem in the drying technology.

The use of thermodynamic diagrams for calculating the kinetics of desiccator processes is feasible under the following conditions: a) the entire heat which the moist material has received from the surrounding atmosphere is used up only for evaporating the moisture from the material (the Reynolds number is much smaller than unity: $N_{Re} \ll 1$); b) the thickness of the boundary layer (thermal and hydrodynamic) at the body is negligibly small, which is equivalent to assuming a uniform distribution of the temperature and the partial vapor pressure near the surface of the moist body. In the latter case, the design calculation procedure may be based on a "jump" change in temperature and partial vapor pressure near the body surface.

These assumptions and restrictions may apply to spray drying and fluidized bed drying of a fine-dispersion.

In solving this problem it is necessary to consider the process over its entire continuum and interaction between the material and the ambient medium, as well as the interaction between particles in the complex which follows certain definite statistical laws. Therefore, the author has quite correctly used methods which are widely accepted for the design of chemical apparatus and for the study of the kinetics of chemical engineering processes. He takes into consideration the motive process forces, the number of transport units, etc., guided by analogies with mass-transfer calculations pertaining to technological processes. This method yields a refined result concerning the kinetics of the drying process for the case of a fine dispersion under variable conditions in desiccators of various designs.

The author does not limit his presentation to analytical methods only, he also uses the air-humidity diagram for plotting the drying process applied to a fine dispersion in a variable-temperature gas stream. In the course of such an analysis, the author has introduced a rather substantive correction to the conventional design procedure now followed in the drying industry. The assumption is made here usually that the drying process can be represented on the air-humidity diagram by an h = const line. If the energy of the bond between moisture and the material is also taken into account, however, then such a representation is in principle incorrect. Corresponding to sorption desorption isotherms, the derivative of air enthalpy

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with respect to air humidity will not be a constant but rather a variable quantity corresponding to the characteristic function on the psychrometric chart. It stands to reason, therefore, that the relation between the enthalpy and the moisture content of a hygroscopic material will not be linear but, instead, will follow some curve which can be determined on the basis of sorption and desorption isotherms. The author uses this method and proposes a new method of plotting the drying process on the air-humidity diagram. This method accounts for the energy of the bond between moisture and the material, thus making it possible to plot the process in accordance with the true mechanism of interaction between moist material and humid air.

The proposed method of reproducing the changes in the state of the drying agent and in the state of the surface of the dried material (when it is in equilibrium with the ambient gas) on the air-humidity diagram is a new and original one that makes it possible to calculate rather reliably the kinetics of the drying process for a fine dispersion in pneumatic and in spray desiccators, with the bond energy of the moisture taken into account.

Noteworthy is also the author's analysis of the interrelation between the rate coefficients of the drying process β / a.

Based on the theoretical discussion is an illustrative example in the last part of the book, where the author shows the design of a pneumatic desiccator for fine dispersions. The calculations here are quite thorough and can be of use not only to students in their classroom and dissertation work but also to designers and engineers.

It must be said, in conclusion, that the material in this book is rather complete, well organized, and methodically presented.