THE DRYING OF POROUS GRANULAR SOLIDS

B.W.Fowler, Department of Chemical Engineering, University College of Swansea, Singleton Park, Swansea, SA2 8PP, U.K.

The drying of porous granular materials is of particular interest in pharmacy in the preparation of tablet granules.

The mechanism of drying of non-porous granules is well documented and is discussed in standard texts on chemical engineering, such as Coulson and Richardson (1968). Much less attention has been given to porous materials and the objective of this work was to investigate the mechanism of drying of porous granular solids for comparison with the capillary theory applied to the drying of non-porous granules. In addition, the effect of temperature gradients on the moisture distributions within the solid were of interest.

To eliminate variations in the preparation of granules, an inert porous granule (pumice) was used, which could be repeatedly re-wetted and dried. The granules were in the size range 700 - 1700 μm, had an internal porosity of 46 per cent and a voidage between the granules of 50 per cent, giving a total porosity of 73 per cent. As a result of these properties, the critical moisture content was approximately 37 per cent (dry basis).

Experimental determination of drying rates produced curves for the falling rate period that could be expressed in dimensionless form as in Fig. 1, showing the usual falling rate periods, but an additional brief constant rate period.

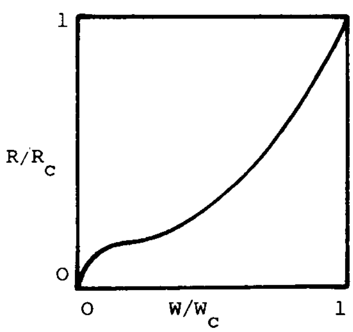

Fig. 1 Dimensionless drying curves - porous granules.

R = rate of drying
R_c = rate of drying in constant rate period
W = moisture content
W_c = critical moisture content

Determination of moisture distributions showed that the mechanism of drying was consistent with the capillary theory of drying (Pearse, Oliver and Newitt, 1949) and that the shape of the curve resulted from the high internal porosity, the second constant rate period commencing when the granules in the lowest layer were no longer saturated. In addition, it was found that the drying could depart from accepted theory since the mechanism of vapour movement to the surface during the falling rate period could occur by flow as the result of a pressure gradient rather than by vapour diffusion.

Comparison of the moisture and temperature distributions during the course of drying suggested a coupled effect and a mathematical model was evolved. This used partial differential equations coupled in the form of the Onsager equations employed to correlate heat and mass fluxes in the thermodynamics of irreversible processes.

Numerical solution by computer of finite difference forms of the equations showed satisfactory agreement with the experimental results and indicate that the method may be used to predict drying rates and distributions of temperature and moisture during the drying of porous granular solids.

Coulson, J.M. and Richardson, J.F. (1968). 'Chemical Engineering', Vol. 2, 2nd edn., London, Pergamon.
Pearse, J.F., Oliver, T.R. and Newitt, D.M. (1949). Trans. Instn. Chem. Engrs., 27, 1.