Abstract

Freeze drying is a separation process based on the sublimation phenomenon. This process has the following advantages compared to the conventional drying process: the material structure is maintained, moisture is removed at low temperature (reduced transport rates), product stability during the storage is increased, the fast transition of the moisturized product to be dehydrated minimizes several degradation reactions. Freeze drying process has not been studied well enough. In order to put it to practice, a mathematical model based on fundamental mass and energy balance equations has been developed, based on a deterministic mathematical model proposed by Liapis and Sadikoglu [Drying Technol. 15 (3–4) (1997) 791], and used to calculate the amount of removed water and amount of residual water. The proposed model contains the freeze drying equations, which are solved by the orthogonal collocation and polynomial approximation—Jacobi method. The results show that the dynamic mathematical model represents well the process and is especially well suited for real time optimization. As a case study to illustrate the model utilization in a real time optimization procedure, the freeze drying process was optimized by the method of Successive Quadratic Programming (SQP) used for solution of non-linear equations, for skimmed milk and soluble coffee. The optimization procedure showed to be an important tool to improve the process performance since lower energy consumption and hence lower cost has been achieved to obtain the product with the same quality.