Real Time Optimization For Freeze Drying Process

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Abstract
Freeze drying process involves the following three stages: freezing, primary drying and secondary drying.
A theoretical model was developed and solved in order to describe quantitatively the dynamic behavior of the primary and secondary drying stages. The solution procedure involves the discretization of the equations by orthogonal collocation in the axial direction and the integration with respect to time by an algorithm based on the Runge-Kutta method. For the validation procedure, the results of the solution model were compared with real values (pilot plant for skimmed milk and industrial plant for soluble coffee). The model allows extensive of simulations to be made, so that it is possible to observe which are the design and operating variables that more significantly impact the system behavior. Furthermore, the intention was to simulate the process aiming high quality dried product with the minimum time process.
The results show that the proposed model presents better predictions than the existing mathematical model, since a more detailed process description is provided.
The next step was to implement the optimization algorithm. For the freeze drying optimization solution, the option was to use an algorithm based on the non linear programming routine developed by Schittkowsky (1985). This routine solves general problems of non linear programming and it was adapted quite well to the proposed mathematical model. The optimization of the freeze-dryer process showed real benefits by decreasing the process time and the amount of residual water.

Keywords: Freeze-drying, Dynamic Process, Mathematical Model, Optimization.

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