Drying of particulates and heat-sensitive materials

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Conventional drying technologies are constantly undergoing revision in search of faster production rates with lower energy consumption and optimum product quality. The approaches involve development of new technologies that reduce energy consumption and the environmental impact through design of new equipment and optimization of the drying conditions. Drying of pharmaceuticals, biological and high value products, which are heat sensitive, demand special attention. When dried by convection at higher temperatures, these heat sensitive products degrade, change color and appearance and have lower content of vitamins and others nutriments.

Freeze drying is an effective method from the point of view of product quality. Freeze drying has been widely used in the industry as the structure and properties of the dried material are hardly altered during the drying process. However, the process is very expensive and lengthy due to the use of low temperatures and very low pressures. Therefore, freeze drying is economically feasible only for high value products. To avoid aforementioned drawbacks of the traditional freeze drying process, atmospheric pressure freeze-drying with adsorbent in a fluidized bed dryer has been postulated to be an attractive alternative. The advantages of both freeze drying (high product quality) and convective drying (low cost) can thus be combined in. The technical feasibility of atmospheric freeze drying has been demonstrated by a number of investigators through experiments and mathematical models. The main drawbacks of atmospheric freeze drying systems are: (a) difficult- to- control structure of the frozen products, (b) abrasion of dried product and (c) internally controlled mass transfer due to atmospheric pressure in the drying chamber. The use of vibrofluidized bed driers is a viable option mainly for particulate materials with high moisture content which exhibit problems related to water removal mechanisms with intraparticle resistance and formation of particle agglomerates.

This project is undertaken to study both experimentally and numerically the performance of vibrating bed atmospheric freeze drying processes in the presence of selective adsorbent. The main objectives of this project are as follows:

- Effect of different operating variables of the novel vibrating bed atmospheric freeze drying processes on the drying kinetics and quality (color and structure) of selective products will be studied experimentally.
- Development of a theoretical model to predict dryer performance. Effect of diameter and density of drying partices, different possible combinations of

conduction and radiation heat input and the amplitude and frequency of vibration on heat and mass transfer will be simulated.

- A numerical simulation will be carried out using Fluent to characterize the heat and mass transfer of two spheres touching steadily and periodically with and without flow of air.
- A two-dimensional model will be developed to carry out a detail investigation on the distribution of moisture and temperature inside a model composite food product at different drying time.

Selected Publication:

S.M.A. Rahman., Md. Raisul Islam, A.S. Mujumdar., A study of coupled heat and mass transfer through a composite food product during convective drying, submitted to 15th International Drying Symposium, Budapest, Hungary, August 20-23, 2006.