

## **BOOK REVIEW**

### **Intermittent and Nonstationary Drying Technologies (CRC Press)**

*by Azharul Karim and Chung Lim Law*

Drying is a complex operation of momentum, heat and mass transfer which involves high energy consumption owing to the high moisture content of materials such as food and agricultural products. Traditionally, drying is carried out under continuous heating mode using hot air especially in convective drying. According to literatures, drying consumes large amount of energy and could account for up to 15% of all industrial energy usage. Typically, thermal efficiency is only in the range of 20-25% in industrial drying equipments. In attempts to reduce energy consumption and improve product quality, the concept of intermittent drying (ID) was introduced by drying researchers and applied in several existing drying technique such as convective drying, microwave drying, heat pump drying, infrared drying, fluidized bed drying and spouted bed drying.

*Intermittent and Nonstationary Drying Technologies: Principles and Applications* by Azharul Karim and Chung Lim Law, to my best knowledge, this is the first book that is dedicated to application of intermittent drying strategies in improving energy consumption and product quality. The aims of the editors were to provide readers with the understanding of intermittent drying (ID) in the following aspects:

- Basic principles and fundamentals of ID
- How to use ID to minimize energy consumption
- How to use ID to improve product quality
- Variants of ID dryers
- Modelling of ID and application in dryer design

This book covers several topics of intermittent and nonstationary drying with comparison to current conventional drying practices and 10 chapters are included in this book (total 244 pages).

Chapter 1 provides an overview and introduces the concept of ID including selection and classifications of intermittent dryers for both batch and continuous processes. Selected examples are included that demonstrate product quality improvement using pulsed fluidized bed drying, heat pump drying, microwave drying and swell drying. This enables industry to examine current drying facilities and identify potential application of ID in existing drying operation.

Chapter 2 to 7 are mostly dedicated to influence of process parameters on product quality during ID. Selected findings on energy consumption and savings are included briefly in Chapter 2, 4 and 7. Several product quality measurements are included such as colour, texture, shrinkage, microstructure, microbiological, browning, bioactive ingredients, various nutrients, water activity, rehydration and sensory evaluation. Selected examples of products are mostly from food and agricultural origin but few non-food products are included such as wood and clay. This demonstrates potential applications of ID not only in food but also in non-food products.

Chapter 9 presents water distribution at cellular level (plant based food materials) and its investigation using nuclear magnetic resonance (NMR), differential calorimetry (DSC), dilatometry (DTA) and bioelectrical impedance analysis (BIA). A brief implication of ID on movement of cellular water is included where it is recommended to use microwave at the final stage of ID to disrupt rapidly the cell membrane which results in faster moisture transport.

Chapter 8 and 10 are dedicated to the modelling aspects where particular emphasis is given to application of reaction engineering approach (REA) (Chapter 8) and the multiscale approach (Chapter 10) in modelling ID. This provides readers with alternative methods in modelling drying processes besides theoretical and empirical approaches.

In summary, this book provides comprehensive details of the state-of-the-art and concepts behind implementation of ID to drying processes. Therefore, it is highly recommended to readers from the chemical, pharmaceutical, food and timber industries and not limiting to engineers, technologists and researchers but also to students (both undergraduate and postgraduate). Particularly, this innovative and emerging concept can be implemented without considerable modification works on current drying facilities.

**Dr Ching Lik Hii**

Associate Professor

Food and Pharmaceutical Engineering Group

Department of Chemical and Environmental Engineering

University of Nottingham, Malaysia Campus