Preface

Batch chemical processes are widely used in the production of fine chemicals, pharmaceutical products, polymers, and many other materials. Moreover, the flexibility of batch processes has become an attractive feature because of the actual turbulence of markets, characterized by a rapidly changing demand.

Batch processes are often nonisothermal and characterized by nonlinear dynamics, whose effects are further emphasized by intrinsically unsteady operating conditions. Hence, methodological and technological problems related to batch chemical reactors are often very challenging and require contributions from different disciplines (chemistry, chemical engineering, control engineering, measurement, and sensing).

A number of issues need to be resolved when dealing with batch reactors in industrial applications, ranging from design and planning of the plant to scheduling, optimization, and performance achievement of batch operations. Performance is usually specified in terms of productivity of the plant, safety of operations, and quality of final products. In order to meet such requirements, several problems need to be addressed:

- modeling the reactor and the process
- identification of the parameters in the mathematical models
- control of the state variables characterizing the process; and
- early diagnosis of failures and faults accommodation.

This book is aimed at tackling the above problems from a joint academic and industrial perspective. Namely, advanced solutions (i.e., based on recent research results) to the four fundamental problems of modeling, identification, control, and fault diagnosis are developed in detail in seven chapters.

In each chapter, a general overview of foundational concepts is given, together with a review of classical and recent literature related to the various topics covered. In detail, the first chapter provides a comprehensive introduction to the main topics of the book, whereas the last chapter presents some suggestions for future research activity in this field.

The second chapter presents an introduction to modeling techniques of batch chemical reactors, with a particular emphasis on chemical kinetics. The third chapter provides a general introduction to the problem of identification of mathematical models; the general methodologies are reviewed and developed in a form suitable for identifying kinetic models of chemical reactions taking place in batch reactors. In the fourth chapter, the mathematical modeling is extended to consider the thermal stability of batch reactors, thus providing a bridge towards the problems discussed in the following two chapters.

In the fifth chapter, a general overview of temperature control for batch reactors is presented; the focus is on model-based control approaches, with a special emphasis on adaptive control techniques. Finally, the sixth chapter provides the reader with an overview of the fundamental problems of fault diagnosis for dynamical systems, with a special emphasis on model-based techniques (i.e., based on the so-called *analytical redundancy* approach) for nonlinear systems; then, a model-based approach to fault diagnosis for chemical batch reactors is derived in detail, where both sensors and actuators failures are taken into account.

In order to provide a unitary treatment of the different topics and to give a firm link to the underlying practical applications, a common case study is developed through the course of the book. Namely, a batch process of industrial interest, i.e., the phenol-formaldehyde reaction for the production of phenolic resins, is adopted to test the modeling, identification, control, and diagnosis approaches developed in the book. In this way, a *roadmap* for the development of control and diagnosis systems is provided, ranging from the early phases of the process setting to the design of an effective control and diagnosis system.

In conclusion, the aim of the book is twofold:

- to bring to the attention of process engineers industrially feasible model-based solutions to control and diagnosis problems for chemical batch reactors, where such solutions in industrial contexts are often considered not feasible; and
- to disseminate recent results on nonlinear model-based control and diagnosis among researchers in the field of chemical engineering and process control, so as to stimulate further advances in the industrial applications of such approaches.

Hence, the book is directed to both industrial practitioners and academic researchers, although it is also suitable for adoption in advanced post-graduate level courses focused on process control, control applications, and nonlinear control.

Potenza

Fabrizio Caccavale, Mario Iamarino
Francesco Pierri, Vincenzo Tufano

Springer

http://www.springer.com/978-0-85729-194-3

Control and Monitoring of Chemical Batch Reactors
Caccavale, F.; Iamarino, M.; Pierri, F.; Tufano, V.
2011, XVII, 186 p., Hardcover
ISBN: 978-0-85729-194-3