*Environmental Engineering and Management Journal*

*March/April 2008, Vol.7, No.2, 167-169*
*http://omicron.ch.tuiasi.ro/EEMJ/*

*"Gh. Asachi" Technical University of Iasi, Romania*

## *Book Review*

# LOGISTIC OPTIMIZATION OF CHEMICAL PRODUCTION PROCESSES

Sebastian Engell (Ed.)

WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany
ISBN 978-3-527-30830-9, 2008, XIV+284 pages

The book "Logistic Optimization of Chemical Production Processes" is managed by the Editor Sebastian Engell, who is a professor of chemical and biochemical engineering at Technical University of Dortmund (Germany), and who also gained a deep experience in process dynamics, operations and optimization. In 2006 Sebastian Engell was appointed Fellow of the International Federation of Automatic Control. His current areas of research are advanced control of chemical and biochemical processes, hybrid systems, design of logic controllers and production scheduling on the process industries.

In the demand-driven operation of chemical, biochemical and pharmaceutical production plants, the efficient use of the available resources is of crucial importance to the economic performance of today's chemical companies. In this respect, the present book addresses the logistic optimization of chemical production processes both from a practical and from academic standpoint. Likewise, this book reviews the main problems in supply-chain optimization, the description of the methods and tools currently used in industry, logistic simulation, campaign planning under uncertainty, up to heuristics- and optimization-based production planning and scheduling, and recently proposed advanced optimization algorithms and their integration in ERP systems. The book is structured in four parts and twelve chapters that were written by 23 authors-contributors under the coordination of general Editor. All the chapters discuss real-world applications or case studies that are derived from real industrial problems. The authors represent the industrial users of tools for logistic optimization, the developers and vendors of such tools and software systems and academic researchers in a balanced fashion.

The Editor's intention was to provide an up-to-date survey of the field and at the same time a reference book than can be taken as the basis of courses on operation of chemical and biochemical plants.

The first part of the book has an introductory role and includes only the Chapter 1.

Chapter 1 "*Supply Chain and Supply Chain Management*" written by *Mario Stobbe*, sets the stage by giving an introduction into supply chains, supply-chain modeling and supply-chain management in the chemical industry.

The second part of the book comprises the Chapters 2-3 that are devoted to logistics simulation in chemical industry.

Chapter 2 "*Logistics Simulation in the Chemical Industry*" (*by Markus Schulz* and *Sven Spieckermann*) deals with logistic simulation as a tool for logistic optimization in chemical industry. Also the authors of this Chapter give an overview of the potential applications of simulation and the organization of simulation projects.

Chapter 3 "*Logistics Simulation of Pipeless Plants*" (*by Andreas Liefeldt*) describes a simulator for a type of plant that has even more operational flexibility than traditional multiproduct batch plants, pipeless plants. The simulator includes a heuristic scheduling algorithm and supports both the planning and the operation of such plants.

The third part of the book includes the Chapters 4-6 and is dedicated to industrial solutions for complex scheduling and supply-chain management problems.

Chapter 4 "*Planning Large Supply Chain Scenarios with Quant-based Combinatorial Optimization*" (*by Christoph Plapp, Dirk Surholt and Dietmar Syring*) presents a tool for the solution of

large supply-chain optimization problems that combines optimization and heuristics to successfully solve problems that are currently beyond the scope of rigorous optimization. This chapter focuses on a new approach that allows for the comprehensive planning and optimization of a multi-stage production processes – the quant-based combinatorial optimization. Also, a distinction is drawn between classical approaches such as Linear Programming (LP) and the quant-based combinatorial approach.

Chapter 5 "*Scheduling and Optimization of a Copper Production Process*" (*by Iiro Harjunkoski, Marco Fahl and Hans Werner Borchers*) outlines the application of state-of-the art optimization technology to a copper production process which is quite a complex due to the many process interdependencies. This makes it very difficult to foresee the overall consequences of a local decision. Therefore the application approached in this chapter can serve as an example of how adaptation to the needs of the real problem and careful engineering can bridge the gap between academic algorithms and practical applications and give benefits in real industrial applications.

Chapter 6 "*Stochastic Tools in Supply Chain Management*" authored by *Rudolf Metz* is focused on stochastic tools for handling the randomness of demands in the planning of production campaigns. The stochastic tools used here differ considerably from those used in other fields of application, e.g., the investigation of measurements of physical data. In the first theoretical part of this chapter the author starts with random demand and end with conditional random service which is the basic quantity that should be used to decide how much of a product one should produce in a given period of time. Likewise, the Chapter 6 discuses the optimal planning of the production, illustrates the theory by a few examples of the results applied to case studies as well as outlines the implementation of the optimization in the software-tool BayAPS-PP and its integration in the software systems doing the daily business.

The Part IV of the book includes the Chapters 7-10 and is focused on optimization being designed to provide an introduction to the state-of-the-art in optimization technology from an academic standpoint.

Chapter 7 "*Engineered Mixed-Integer Programming in Chemical Batch Scheduling*" is authored by *Guido Sand*. In this chapter, a real-world case study is used to demonstrate how to develop and to solve a specific short-term scheduling problem. Also, the engineered MINLP-model with its binary and continuous variables, its nonlinear and linear constraints and its objective is developed and discussed. The solution of the MINLP-model and MILP-model by various standard solvers is compared and with respect to the solution quality and the computational effort. In the final section, some general conclusions on the application of engineered mixed-integer programming in chemical batch process scheduling are drawn.

Chapter 8 "*MILP Optimization Models for Short-term Scheduling of Batch Processes*" (*by Carlos A. Mendez, Ignacio E. Grossmann, Iiro Harjunkoski and Merco Fahl*) discusses the choice of linear mixed-integer optimization models for the same task, in particular the key issue of the modeling of time that has been the focus of scientific discussion for many ears now. The objective of this chapter was to provide a comprehensive review of the state-of-art of short-term batch scheduling. In addition, a classification for scheduling problems of batch processes, as well as of the features that characterize the optimization models for scheduling is presented. The significant information is given concerning the representative MILP optimization approaches for general network and sequential batch plants, focusing on discrete and continuous-time models. Computational results on a specific case study for a general network are also presented in order to compare the performance of several methods, particularly discrete- and continuous-time models.

Chapter 9 "*Uncertainty Conscious Scheduling by Two-Stage Stochastic Optimization*" (*by Jochen Till, Guido Sand and Sebastian Engell*) shows the benefit of using a stochastic model in a moving horizon based real-time scheduler. Also, here it is discussed the algorithmic issues in solving the resulting large stochastic optimization problems and a new hybrid evolutionary algorithmic approach is presented.

Chapter 10 "*Scheduling Based on Reach-ability Analysis of Timed Automata*" (*by Sebastian Panek, Olaf Stursberg and Sebastian Engell*) introduces a completely different approach to the modeling and solution of scheduling problems. This approach is based upon timed automata that were introduced in computer science in the past decade. The formulation of the models can be done in a modular way and solved using tools from computer science for reachability analysis.

The last part of the book (i.e. Part V) comprises the Chapters 11-12 and discusses the integration of the solution of operational planning and scheduling problems into the mid and long-term material and resource planning performed by ERP (enterprise resource planning) systems.

Chapter 11 "*Integrated Short and Midterm Scheduling of Chemical Production Processes – A Case Study*" (*by Mathias Göbelt, Thomas Kasper and Christopher Sürie*) is devoted to demonstrated how a case study can be solved using state-of-the-art advanced planning software from SAP. Therefore, the concept of advanced planning systems is introduced first. Also, the particular attention is highlighted for model building in discrete manufacturing. The solution of the case study presented is then explained, focusing first on how to model the business requirements within the software and second on how to solve these models.

Chapter 12 "*Integration of Scheduling with ERP Systems*" wrote by *Winfried Jaenicke* and *Robert Seeger* uses the terminology of the market leader in business software (SAP AG).

Likewise, the authors of this chapter bring to discussion the integration of scheduling algorithms with ERP systems and highlight the role of humans and organization in the planning and scheduling process.

It should be mentioned here that general Editor tried to achieve in this collection of contributions a balance between the end users of tools and methods in the chemical industry, the tool developers and academic researches which have to advance into new areas of logistic optimization of chemical production processes.

This book could be very useful to specialists in the realm of optimization, chemical engineering, software developing for industry and researchers who works in process control and plant design.

In its approach of state-of –the-art topics of logistic optimization the book is of significant value.

Each chapter contains an up-to-date well documented list of references and many chapters bring into discussions the case studies.

The book is written in very modern way and contains many illustrations which make the text more useful for specialists in process control.

***Matei Macoveanu***
***Corneliu Cojocaru***
*Department of Environmental Engineering and Management*
*Technical University of Iasi*