Applications of Discrete-Event Simulation in the Chemical Industry

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Production processes in the chemical industry are to a large extent not discrete but continuous. Hence, the application of discrete-event simulation (DES) in this field is not as widespread as in discrete manufacturing. In order to apply DES methodology to chemical production processes, continuous aspects have to be covered sufficiently. This contribution briefly introduces and discusses combined discrete-continuous simulation approaches and illustrates the potential of the methodology using three cases of a leading German chemical company from supply chain optimization to the shop floor.

14.1 Introduction

The chemical industry is to a large extent not a “typical” domain for the application of discrete-event simulation. An extensive literature review on simulation in business and manufacturing by Jahangirian et al. (2010) refers to only two out of more than 200 papers with a connotation to the chemical industry. An earlier review by Smith (2003) with a sample size of 188 papers is more or less focused on discrete manufacturing industries. Discussing simulation applications in discrete product manufacturing, batch production, and continuous production, Mehra et al. (2006) make the observation that the majority of studies relate to discrete products.

All in all, the footprint of the chemical industry in the scientific simulation literature is relatively small compared to the economic impact of the according companies which contribute more than 10% to European GDP according to Eurostat (cf. Stawinska 2009, p. 19). To a large extent, this mismatch is explained by the fact that the most common simulation technique in the manufacturing context is discrete event simulation (DES; cf. Smith 2003 and Jahangirian 2010) and DES does have some limitations when it comes to the modeling of specific process characteristics as we will discuss in Section 14.2. The approaches to overcome these limitations by combined simulation techniques and to tackle the industry specific challenges as well as the state-of-the-art in terms of tools and applications in the
field are discussed in Section 14.3. Subsequently, Section 14.4 presents some case studies. The article finishes with a short summary and some conclusions.

### 14.2 Specific Challenges in the Chemical Industry

DES is applied to approach manufacturing issues on different operational layers from supply chain down to shop floor level and in different phases of the planning process as illustrated by Fig. 14.1 and shown by the cases in this book. Considering the chemical industry, DES may basically be applied on the same operational levels (cf. Schulz and Spieckermann 2008). Depending on the operational level there are, however, more or less specific characteristics of the industry which modeling approaches need to take into account.

With respect to the analysis of supply chains, there are almost no differences between the chemical industry and other industries. On this operational layer, in almost all cases discrete processes such as scheduling orders, dispatching transports, or planning resources (warehouses, production capacity, capacity for transportation) need to be considered. Thus, DES is an appropriate means to support supply chain studies in the chemical industries as the example in subsection 14.4.1 will demonstrate.

![Supply Chain Simulation Distribution Network Simulation](image)

**Fig. 14.1** Application areas of DES

However, as soon as the processes within one plant or within a selected part of a plant are subject to a study, some specific characteristics of processes in the chemical industry have to be taken into account. Günther and Yang (2004)