Dynamic Flowsheet Simulation of Solids Processes

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Editor

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Springer

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ISBN 978-3-030-45167-7 ISBN 978-3-030-45168-4 (eBook)
https://doi.org/10.1007/978-3-030-45168-4

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

Processes of material and energy conversion often consist of multiple individual sub-processes that are interconnected by material, energy and information streams. The cross-links between the individual sub-processes have a significant impact on the dynamic behaviour and the stability of such processes. For the design and optimization, particularly in view of the conservation of energy and raw material resources, not only the individual components should be simulated, but also the dynamic behaviour of the whole process. This is the state of the art for fluid processes and different tools for dynamic flowsheet simulation are commercially available. In contrast, such program systems and process models which are generally applicable to a wide range of applications are missing for solids processes. This is due to the complex description of solids with their multivariate disperse properties and the associated processes for the conversion of solids.

The flowsheet modelling allows for an investigation of complex processes consisting of several interconnected apparatuses and sub-processes on longtime scales. For the solids process engineering, the multidimensionality of the properties of granular materials significantly complicates the solution of various problems, such as design or optimization of production processes. As most solids processing systems include unit operations that have a strong impact on the transient behaviour of the whole process, like conveyors or bunkers, the ability to simulate the behaviour of dynamic systems is crucial for applying flowsheet models for optimization or control purposes in the area of solids processing technology.

Available flowsheet simulation programs deal with the challenge of solids process simulation. However, none of the tools offer the option of dynamic process simulation of solids processes with the inherent description of the multidimensional distributed parameters of the granular material.

The German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) has supported a research program in the form of the Priority Program (SPP 1679) on "Dynamic simulation of interconnected solids processes (DYNSIM-FP)" from 2013 to 2020. The goal was to study the dynamics of different processes in the area of solids process engineering and to gain a better understanding of the phenomena that arise when combining various of such sub-processes into a single interconnected system. The central aim was to provide numerical tools for dynamic simulation of interconnected solids processes. For this, dynamic models of various equipment and machinery for solids processing are to be formulated and implemented. Furthermore, methods for the numerical treatment of such systems and new models for the description of solids properties shall be developed.

The research within SPP 1679 was classified into three research areas consisting of 27 research projects from universities and research institutes from Germany: (a), (b) models for the description of solids properties, (c) algorithms and process simulation. Additionally, a separate Central Project (Z-project) was established. Its goal was to develop a flowsheet modelling system, which should serve as a platform for combining the results of all these individual groups into a single framework. To allow for mostly independent model development and research, the flowsheet simulation framework must provide high flexibility, extensible libraries and stable interfaces. The resulting open-source modular modelling system Dyssol—an acronym for "**Dy**namic **s**imulation of **sol**ids processes"—offers these features through its high degree of modularity, open and standardized interfaces, efficient algorithms and a clear user interface.

This book summarizes the research results of this joint research project. The research program SPP 1679 DYNSIM-FP has been steered by a committee, where Prof. Stefan Heinrich, Hamburg, took over the coordination (spokesperson) and was supported by Prof. Arno Kwade, Braunschweig (vice-spokesperson); Prof. Heiko Briesen (vice-spokesperson), München; Prof. Wolfgang Peukert, Erlangen; Prof. Matthias Kind, Karlsruhe; and Prof. Achim Kienle, Magdeburg. We want to thank and greatly appreciate the DFG for financial support, and especially Dr.-Ing. Bernd Giernoth, Dr.-Ing. Georg Bechtold, Dr. Simon Jörres and Ms. Anja Kleefuß for their excellent coordination and continued support of the research activities. Of course, the great success of the SPP 1679 would not have been possible without the enthusiasm of all involved Ph.D. students and researchers and their excellent contributions. Numerous workshops, most held in Hamburg, were the clamp of the intensive cooperation within the several projects.

Hamburg, Germany Stefan Heinrich
February 2020

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