Diplomarbeit / Masterarbeit

Medium-term production planning of flexible, multi-product modular continuous processes

Introduction:

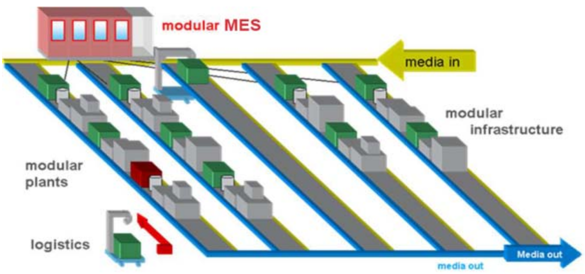

Fig. 1: Schematic view of a F3 multi-product modular plant.

Due to their high flexibility, multi-product batch plants are used in the chemical industry to produce high-valued products in small quantities, e.g. pharmaceuticals, other fine chemicals, etc. On the other hand, continuous plants dedicated to a single product can produce large quantities in a more economical fashion. To combine the benefits of both production modes, a new flexible, multi-product modular plant for continuous processes (F3 plant), see Fig. 1, is currently under development in the scope of the European research project F3 Factory [1]. The F3 plant is based on generic backbone facilities (lanes) for rapid interfacing with standardized process equipment containers (PEC), which house process equipment assemblies (PEA). The standardization of lanes, PEC's, and PEA's allows a plug-and-play style reconfiguration of the plant and makes it flexible for e.g. scale-up/-down, product changes, etc. The economic operation of such an F3 plant requires the development of an effective manufacturing execution system (MES). One generic module of the MES is the medium-term production planning to optimize the production schedule in a campaign planning fashion including the reconfiguration of the plant for different products or changes of the demand by addition (or removal) of PEC's and PEA's.

Objectives:

The objective of this thesis is to develop a MILP formulation [2, 3] to determine global optimal solutions to the medium-term production planning of the F3 plant for flexible, multi-product modular continuous processes, in a campaign planning fashion, taking into account all relevant restrictions.

The MILP formulation will be demonstrated and evaluated on a polymerization plant case study with sequence-dependent changeovers, cleaning requirements, reconfigurations, due dates, storage capacities, etc. An initial production scenario has been defined in cooperation with interested companies, but changes to the scenario to explore the behavior of the solution algorithm and to check the influence of different requirements on the result should be performed.

Steps:

a) Familiarization with existing MILP formulations for production planning of continuous production processes [2, 3], with suitable MILP solvers (e.g. GAMS/CPLEX), with the F3 plant concept, and with the polymerization case study.
b) Development and formulation of an MILP model to handle the production planning problem of an F3 plant including all relevant restrictions.
c) Definition of realistic and challenging scenarios for the polymerization case study.
d) Application of the developed MILP formulation to the scenarios of the case study using a suitable solver and experimentation with the problem parameters and the solver parameters.
e) If needed, proposal of strategies for the decomposition of the problem to increase the speed of solution.
f) Preparation of a thesis report that contains a comprehensive description of the case study and the scenarios, a description of the developed MILP formulation, and the major results of the application of the approach to the scenarios of the case study.

Literature

[1] F3 Factory (2007). Flexible, Fast and Future Production Processes. http://www.f3factory.com. EU-funded research project, contract number CP-IP 228867-2 F3 Factory.

[2] M. G. Ierapetritou, C. A. Floudas. Effective Continuous-Time Formulation for Short-term Scheduling. 2. Continuous and Semicontinuous Processes. *Industrial & Engineering Chemistry Research, Vol. 37*, 1998, pp. 4360-4374.

[3] M. A. Shaik, C. A. Floudas, J. Kallrath, H.-J. Pitz. Production Scheduling of a Large-scale Industrial Continuous Plant: Short-term and Medium-term Scheduling. *Computers and Chemical Engineering, Vol. 33*, 2009, pp. 670-686.

Requirements:

For the development of the MILP model and the tests knowledge in mathematical modeling, MILP solvers (e.g. GAMS/CPLEX), and production planning is obligatory.

Knowledge about polymerization processes is preferable but not compulsory.

Start and duration:

As soon as possible, 6 months full time

Contact:

Christian Schoppmeyer
Phone: 0231 / 755-6080, G2-509, christian.schoppmeyer@bci.tu-dortmund.de
Subanatarajan Subbiah
Phone: 0231 / 755-6080, G2-509, s.subbiah@bci.tu-dortmund.de