EFFICIENT BATCH SCHEDULING FOR A PETRO-CHEMICAL BLENDING PLANT WITH A SHARED PIPELINE NETWORK

Alessandro Hill*  
Trijntje Cornelissens  
Kenneth Sörensen  
Department of Engineering Management  
University of Antwerp  
Belgium

[alessandro.hill,trijntje.cornelissens,kenneth.sorensen]@uantwerpen.be

1. The Application
Production Process & Resources

- Component integration
- Simplified, effective model
- Minimization of the blending tank volume utilization
- Maximization of the blending technology
- Storage tanks
- Single-product tanks (SPTs)
- Single-order tanks (SOTs)

Shared Pipeline Network
- Complies with all tank interconnections
- Not all pumping operations can be performed in parallel
- Pumping paths and component tanks need to be selected, once a BOM is chosen

2. The Model
Objectives
- Minimization of the tardiness
- Maximization of the blending tank volume utilization
- Minimization of the component costs
- Minimization of the blending tank volume cleaning
- Minimization of the lead time
- Balance of the filling units usage

Scheduling Decisions
- BOM, component pumping sequence and tanks, pumping paths, blending tank, storage tank, filling unit operations start & end times

Constraints
- Dedication: blending tank, storage tank and filling unit dedication has to be compatible with the order product
- Storage tank dwell: minimum and maximum dwell times
- Resource usage: except for the SPTs, no concurrent resource utilization
- Zero-wait policy in blending tanks
- Earliest start and latest end times
- Down times and shift breaks: lunch breaks; maintenance; 1-2-3 shift plan

Scheduling Scenarios
- Plant layout: tanks, pipelines and processing units
- Plant configuration: dedication, processing speeds, manifold connections, production policies
- Order set
- Product portfolio

3. The Heuristic
Search Strategy
- Priority rule: cost, time
- Look ahead by estimating tank durations
- Order on blending and storage or filling up Component Pumping
- Backtrack if no suitable resource available

4. Scenario Studies
More than 140 tanks and units, 300 pipelines; avg. order volume 150m³; avg. blender capacity 30m³; over 600 products grouped in 6 product families.
- Compute operational schedules for horizons up to 365 days
- Simulate to answer various what-if-questions on identity bottlenecks
- Decision support for capacity planning and plant configuration

5. Computational Performance
Run Time & Iterations
- 1 year data in 1-3 hours
- Order and parametrization-dependent (e.g. shifts, min/max early/lates)
- Efficient enough to be used as a subprocedure in high-level models

References
B. A. Hill, T. Cornelissens, K. Sörensen, Production planning and design of a petrochemical blending plant with a shared pipeline network: a comparison of deterministic and stochastic methods, Computers & Chemical Engineering 30 (5), 776-785
E. Kondili, C. A. Floudas, X. Lin, Continuous optimization in chemical engineering: history, current status and the way forward, Computers & Chemical Engineering 30 (6), 786-806

Highlights
- Model integrates many practically relevant features in a chemical blending plant
- Optimizing material flows in a complex shared pipeline network
- Simple, effective and customizable heuristic
- Decision support for scheduling short term operations as well as long term planning

Functional testing performed by Trijntje Cornelissens and Kenneth Sörensen.

Acknowledgements
- Thanks to Floor Verbiest for her engagement verifying and validating the scheduling system.