From digitalisation to optimisation: Overview of the results of CoPro

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Better coordination of production means improved energy and resource efficiency.

Inefficiencies result from lack of coordination.

Individual units are already automated and operated efficiently.
CoPro technologies

• Digital
• Targeting the optimal operation of large, complex facilities
• Model-based
  - Data-based and approximate models
  - Physical models
  - Hybrid models
• Bring optimisation technology to work in real environments
• Improve energy and resource efficiency as well as plant economics
• Address the interaction with the operators
• Support the development and deployment of new digital solutions
Consortium

Industry with 5 applications covering the complete value chain

Technology providing SMEs

Universities

Dissemination and exploitation support

Research institutes
(Petro-)chemical production: Coupled processes incl. an on-site power plant and the procurement of electricity, unit switch on/off, logistics, detection of anomalies

Coordination of production and distribution of gases: Production and procurement of basic chemical gases in an integrated site

Cellulose fibre production plant: Spinbath recovery network with redundant equipment, selection and switching of equipment, planning of cleaning

Production, formulation and packaging of detergents: Production planning and scheduling, increase of throughput, investigation of new plant layouts

Sterilisation and packaging of food (fish): Batch production steps with continuous production lines, reduction of energy use in sterilization, reduction of changeover times
INEOS in Köln use case – NH₃ network optimisation

- Discrete decisions (on/off, ramp-up)
- Described by generic model elements that are connected to build large-scale models
- Connection to the IT-landscape via LeiKon’s Intexc-suite
Covestro use case – CO and H₂ network optimisation

Balancing the networks by coordinating

- Internal production
  - Considering fluctuating electricity prices
- Internal consumption
- External consumers
- Purchases from external producers
  - Minimum purchasing quantities
  - Coupled contracts with different tariffs
- Transfer of gases between sites

Improving economics and resource efficiency by reducing waste streams and demand side response
Lenzing viscose fiber production process

From the pulp to the fibers

- A network of evaporation plants (29) and plate heat exchangers (25) form the system to reconcentrate and to reheat the diluted spinbath to required setpoints.

Challenge: High energy demand (~47% of total in the spinbath reconcentration)
Decision support tool for evaporator load allocation

Workflow:
- Fully implemented and already running in the control room.
- Reduced operator workload.
- Faster reaction against production changes.
- Up to 1.9 % more efficient operation:
  - ≈ 40 t/d steam savings
  - ≈ 250.000 €/y savings

BONMIN gets an optimal solution in a few seconds
General characteristics
- Large order-driven production with high production flexibility
- **Sterilisation:** Most critical element
  - Ensures food safety & product quality
  - Energy intensive process
  - Production bottleneck

Main achievements
- Optimisation-based reactive scheduling for better plant utilisation
- Optimisation of the sterilisation process ➔ **significant energy savings** by better control and coordination with scheduling
Site-wide optimisation without sharing of sensitive data

• **Problem:**
  - Increasing the efficiency of the whole site without sharing internal data of business units or companies

• **Solution:**
  - Market-like distributed optimisation
  - Each plant is optimised individually
  - Adaptation of the prices by the coordinator (central function)
  - Mimics a micro-market

• **Enabler of Industrial Symbiosis**
CoPro developed and demonstrated
- Data-based and hybrid modelling for decision support
  - Best is combination of knowledge-based and data-based models
  - Plant-wide optimisation with discrete decisions
    - Feasible with adequate modelling depth and tailored algorithms
  - Tools for hybrid modelling and IT-integration
- Technologies were demonstrated in real environments
- Several solutions will be put into productive operation
- Commercial software tools
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- ResearchGate:
  https://www.researchgate.net/project/CoPro-Coordinated-Production-for-Better-Resource-Efficiency