

CoPro: Optimum operation of an evaporator network in viscose fiber production

Project:

Improved energy and resource efficiency by better coordination of production in the process industries



COORDINATED PRODUCTION FOR BETTER RESOURCE

The goal of the CoPro project was to develop and to demonstrate methods and tools for process monitoring and optimal dynamic planning, scheduling and control of plants, industrial sites and clusters under dynamic market conditions, to provide decision support to operators and managers and to progress to automated closed-loop solutions to achieve an optimally energy and resource efficient production.

CoPro brought together 17 partners from 8 EU countries, including 5 industrial end users and 6 technology providing SMEs. The project developed solutions for the **plant-wide optimisation of large plants, for balancing production and consumption in industrial parks for industrial symbiosis**, and addressed **power plant scheduling** and **demand-side response**. It further developed online data analytics for **anomaly detection**, and **decision support** for plant operators and managers. The solutions can be integrated into the IT infrastructure of the plants via an **integration platform** that supports the connection to different IT systems. CoPro developed **model libraries**

for the efficient development of advanced optimisation-based solutions and techniques and software for **hybrid modelling** and **model management**.

The developments of CoPro were motivated by and applied to challenging use cases from different sectors of the process industries:

- (Petro-)chemical production;
- Cellulose fiber production;
- Production, formulation and packaging of consumer goods;
- Sterilisation and packaging of food.

CoPro demonstrated that significant savings of energy and resources are possible by using advanced technologies for monitoring, decision support, optimisation, and planning and scheduling.

The CoPro partners

Industrial end users and use case providers



Universities



Universidad de Valladolid



Sector:

Chemicals

Summary:

The Problem

- Recovery of the spinbath is the process with the highest energy demand in viscose production.
- An evaporator network with 29 different evaporators is used for the reconcentration of the solution in different product cycles.
- The efficiency of the evaporators depends on the type, volume flow rate, temperature and fouling effects.

The Solution

- A decision-support system (DSS) for the assignment of evaporators to different product cycles was developed in a cooperation of Lenzing AG and TU Dortmund.
- The optimum operating strategy is visualised for the operator who can accepted or reject it.
- The optimum operating strategy is determined at regular intervals and the responsible person is provided with information about the possible savings.

Theme:

Plant-wide monitoring - SPIRE02-2016

Keywords:

Load allocation, evaporator capacity, linear regression, modelling, mixed integer optimisation

Type:

Case study

Resources

Link:

Technology Short Description: Optimum operation of an evaporator network viscose fiber production



Product Cycle	Evaporators									Ev	
A											
B											
C											
D											
E											
F											
G											

The problem

The solution

Optimum operation of an evaporator network in viscose fiber production

The problem

The reconcentration of the spinbath: a complex and energy-intensive task

During the spinning process, water is introduced into the spinbath liquid due to chemical reactions. For the evaporation of the water from different product cycles, Lenzing AG uses a large network of 29 different evaporators. They vary in capacity, connectivity and energy efficiency. Furthermore, the energy efficiency of the evaporators changes over time due to fouling effects and varying operating conditions. By the choice of the best configuration of the evaporators for a given load and fouling state of the evaporators, significant amounts of energy can be saved. The task of the selection of the evaporators was previously handled by the operators based on their skills and experience.

The solution

Coordination of the evaporator network

As a support tool for the operator of the evaporator network a real time decision support system (DSS) was developed and installed in the control room of the plant within CoPro. The following steps are performed in the optimisation procedure before the result is shown via the human machine interface (HMI) of the DSS:

- Determine the parameters of the mathematical models of the evaporators
- Read process data from the OSI PI system
- Solve the optimisation problem
- Show the solution on the HMI

The optimisation algorithm is based on simple mathematical models of the evaporators. The operating behaviour of an evaporator can be described by the evaporator capacity, the specific steam consumption and the absolute steam consumption. The independent variables are the volumetric flow rate of the product cycle, the spinbath temperature, and the condenser temperature. 6 parameters are required for each evaporator model which can be obtained from measurement data by the use of a linear regression algorithm. For the determination of the model parameters, a graphical user interface was developed in a

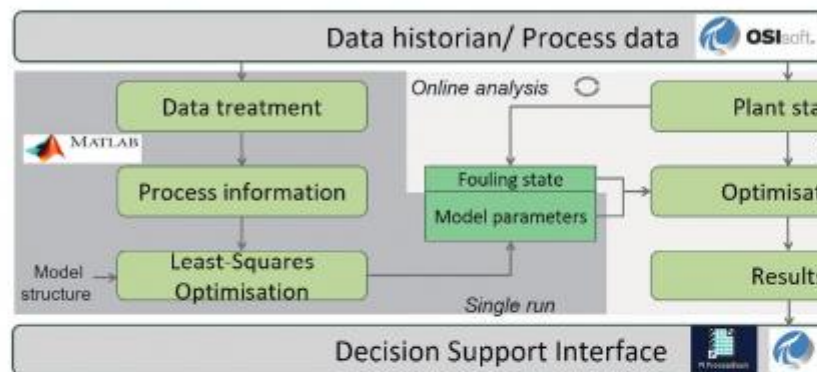


Fig. 1: Modelling and network optimisation

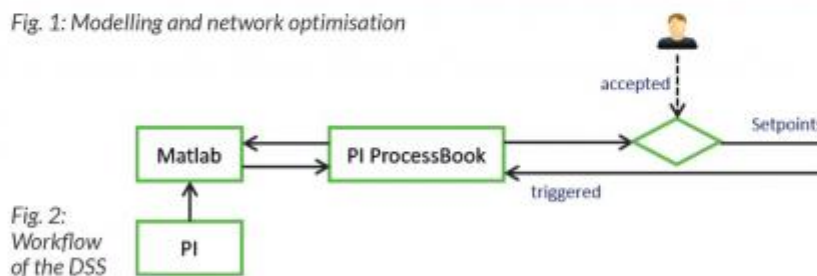


Fig. 2: Workflow of the DSS

cooperation of Lenzing AG and TU Dortmund to simplify this time-consuming task.

The DSS uses four different software systems. The PI system contains the measurement data, MATLAB is used to set up and solve the optimisation problem, the PI ProcessBook realises the HMI which is used by the operator and the DCS is used for the control of the individual components in the production lines. The MATLAB optimisation is automatically triggered via the PI ProcessBook if certain conditions in a product cycle change (e.g. a change of the overall evaporation capacity). For the calculation of the optimum operating conditions of the evaporator network, constraints (e.g. the available evaporators) have to be considered which are available via the PI system. The result of the optimisation is displayed to the operator via a HMI in the PI ProcessBook. The operator has the possibility to check if the results are feasible and, if so, to accept them. Then the new set points for every evaporator in the cycles are automatically written to the distributed control system (DCS). (Fig. 1, 2)

To optimise the energy efficiency of the evaporator network, the total absolute steam consumption is minimised while fulfilling the evaporation capacity demand of each product cycle. The degrees of freedom are the set points of each evaporator and the

allocation of the evaporators over the cycles, which introduces interdependencies. For a fast solution for large networks, absolute steam consumption is modelled as a linear or quadratic function of the evaporation capacity.

Tests with the DSS during the operation of the evaporator network showed savings of up to 2 % depending on the operating condition.

The summary

Improved operator performance and energy savings

The Lenzing AG site, located in Austria, is a reference factory in the world for producing man-made viscose fibers. These advanced fibers are used in technical applications. In the production of energy intensive viscose fibers, the recovery of the spinbath liquid in the processes with the highest energy efficiency is essential. To ensure an energy efficient spinning process, a real time decision support system (DSS) for the operator of the evaporator network was developed and installed in the control system of the plant. The results showed a relevant potential for energy savings, especially at high capacity conditions of the evaporator network.

The developers



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