CoPro: Optimisation of the production and procurement of technical gases

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

COORDINATED PR
FOR BETTER RESOUR

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.

Sector:

Cement

Chemicals

Steel

Summary:

The Problem

- At the ChemPark in Dormagen, Covestro operates several networks for technical gases, which connect Covestro’s internal consumers as well as external clients with the internal production.
- Due to changes in plant operation, the demand within the networks can change several times per day.
- Contracts with multiple suppliers are in place. These contracts are tiered and coupled. The optimal procurement of the gases is a complex task.

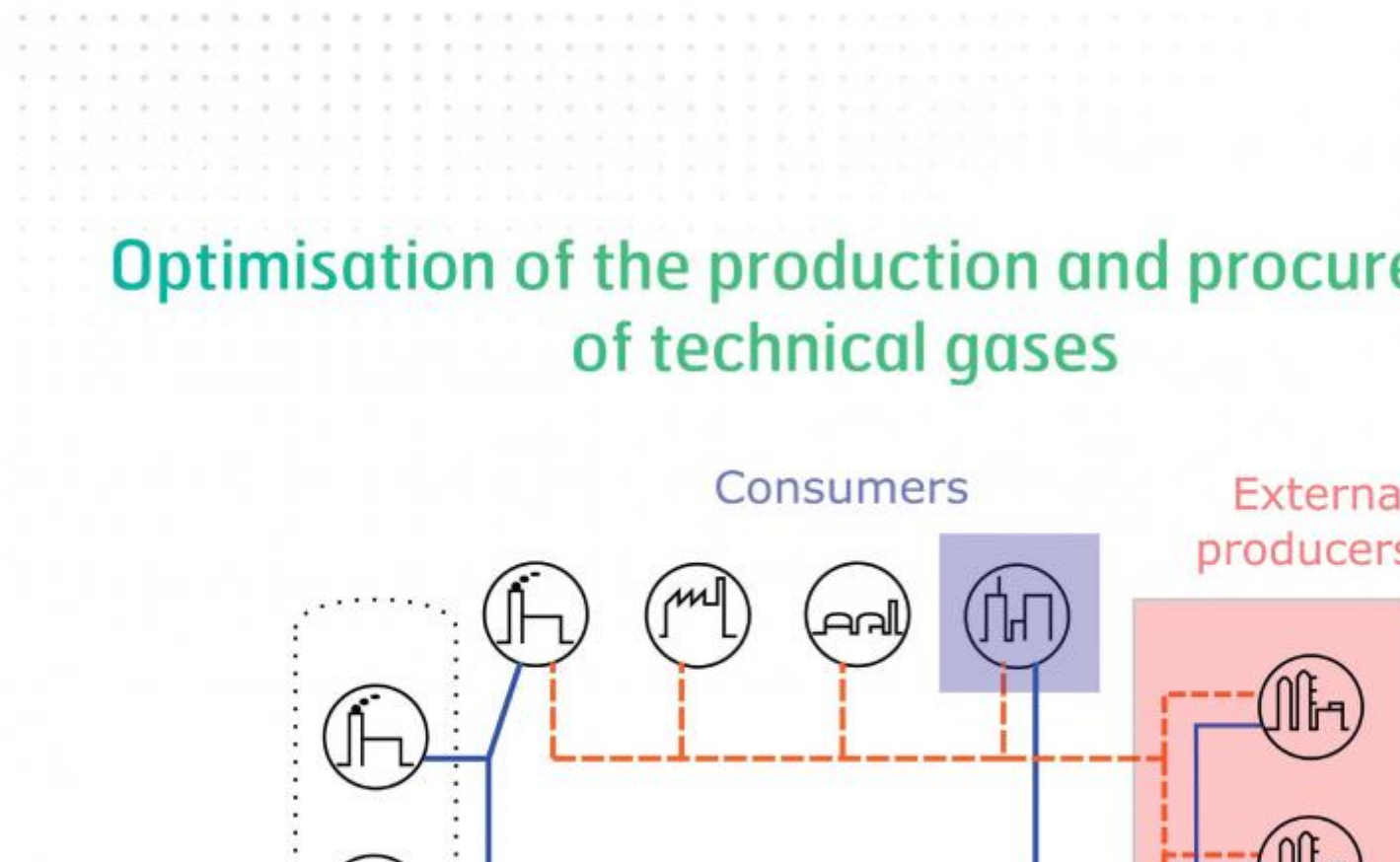
The Solution

- An advisory tool for the optimisation of purchases involving contracts with tiered structures and coupling between different raw materials was developed in a cooperation of Covestro and TU Dortmund.
- The best possible solutions are presented to the operators and hints on how to resolve conflicts that result from unfore-seen situations are provided.
- Supply orders can be generated automatically.

Theme:
Plant-wide monitoring - SPIRE02-2016
Keywords:
Technical gases, Operator decision support, Production Optimization, Supply Optimization, Software life cycle
Type:
Case study
Software
Poster

Resources

Link:
Technology Short Description: Optimisation of the production and procurement of technical gases



Optimisation of the production and procurement of technical ga

The problem

Different contracts, different gases

At ChemPark in Dormagen, Covestro operates several networks for technical gases. They connect Covestro's internal consumers as well as external clients with the internal production. The networks

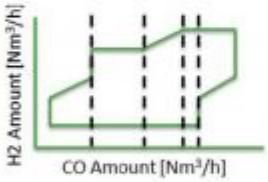


Fig. 1: Exemplary contractual offer of one external supplier for the purchase of technical gases with tiers and coupling between the gases.

are balanced by imports from external suppliers. To ensure continuity of supply and favourable conditions, contracts with multiple suppliers are in place. These contracts are tiered and coupled because in some of the processes different gases are produced in a coupled manner.

Since the circumstances change frequently due to the numerous parties involved, i.e., between one or two times on a regular day and up to twelve times in special cases, creating the supply orders for the next few hours or days under time pressure is not a trivial task. A lot of expertise is required for handling non-standard scenarios, such as low demands, shutdowns and technical limitations, e.g. due to defective equipment. In the worst case, the situation in the gas networks may lead to undesired adjustments in the production or to wasting resources.

The solution

A framework for the optimisation of purchases

Within CoPro, a framework for the optimisation of purchases involving contracts with tiered structures and coupling between different raw materials was developed in cooperation of Covestro and TU Dortmund. The solution significantly facilitates the work of the operators. Based on the demands given as inputs, the best possible solutions are presented to the operators and hints on how to resolve conflicts that result from unforeseen situations are provided if necessary. Factors that determine the results are documented. Order documents for the different suppliers are generated automatically.

The tool consists of three main components: the backend, the operator interface, and the engineering interface.

In the backend, the conditions that govern the purchase of the gases, including contractual and technical constraints, are formulated as a structured Mixed-Integer Linear Programming (MILP) problem using the Python-based PYOMO modelling language. The problem is solved using an open source state-of-the art solver that is part of the Computational Infrastructure for Operations Research suite. It finds the global optimum in less than 10 seconds. The tool is designed to work robustly such that in all scenarios, even if the problem is infeasible according to the contracts, a solution with auxiliary variables is returned. This solution can then be used by the operators to identify possible workarounds.

The graphical operator interface is designed and implemented such that it grants direct access to all relevant factors of the decision making, including the availability of the suppliers, the quantities of the gases, which supplier is responsible for the pressure control, possible options for resolving special cases, etc. If the input is consistent, the constraints and conditions specified by the user are translated automatically into the corresponding parameters of the optimisation problem. Once the solution is accepted by the operators, th stored in order to increase tr facilitate traceability. Differe be added to a prospective pu repository, from which the o can be generated automatica

The engineering interface e responsible engineers to eas and adapt the models of the the contract structures, and without modifying the under protected by access control, information is not openly ava

The structured and modular the different components of independent of each other. T can easily be adapted to othe similar structure, e.g. at othe

The summary

New efficiency in th production and proc of technical gases

The new gas network manag procurement tool makes the operators much easier. Throu and consistency checks, erro The knowledge of the expert been preserved, allowing als expertise to perform the pro technical gases efficiently an more on other tasks. First an that on top of the gains in eff improves the quality of the p decisions leading to significa

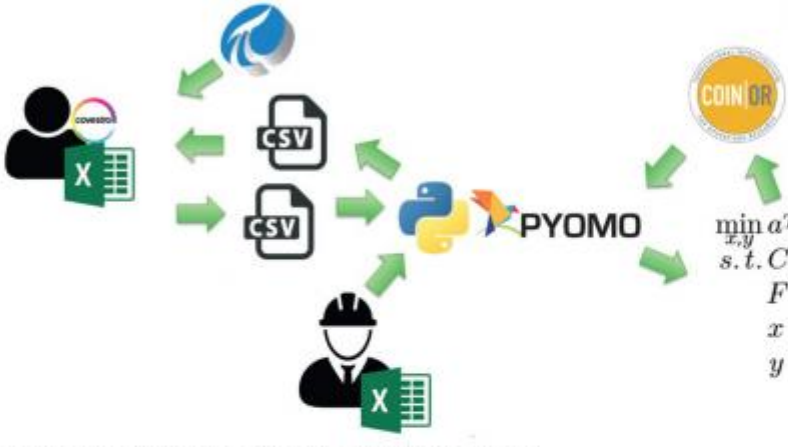


Fig. 2: Structure and information flow of the developed tool.

The developers

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