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.

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 unforeseen situations are provided. Supply orders can be generated automatically.

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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 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, the information is stored in order to increase transparency and facilitate traceability. Different solutions can be added to a prospective purchase planning repository, from which the order documents can be generated automatically.

The engineering interface enables the responsible engineers to easily manage and adapt the models of the suppliers, the contract structures, and the prices without modifying the underlying code. It is protected by access control, such that this information is not openly available.

The structured and modular approach makes the different components of the tool largely independent of each other. Thus, the tool can easily be adapted to other problems of a similar structure, e.g. at other sites.

The summary

New efficiency in the production and procurement of technical gases

The new gas network management and procurement tool makes the work of the operators much easier. Through automation and consistency checks, errors are avoided. The knowledge of the expert operators has been preserved, allowing also users with less expertise to perform the procurement of the technical gases efficiently and thus to focus more on other tasks. First analyses show that on top of the gains in efficiency, the tool improves the quality of the procurement decisions leading to significant savings.

Further information

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