The oxygen-consuming cathode consumes up to 30 per cent less electricity than conventional processes.
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Chemical industry supports load management 23.05.2018

Adapting chlorine production to the electricity supply

The chemical industry is the second largest consumer of electricity within German industry. Using the example of energy-intensive chlorine-alkali electrolysis, scientists are now investigating to what extent this process can contribute to managing loads in the power grid. To achieve this the production needs to be adapted to the intermittent electricity supply.

As the second largest consumer of electricity in the industrial sector, the chemical industry offers considerable potential for balancing out fluctuations in the supply and consumption. It has both large positive and negative demand response capacities. To investigate how to make the power consumption of the chemical industry more flexible, the researchers have selected the energy-intensive production of chlorine. In the electrochemical process of chlorine-alkali electrolysis, chlorine gas is produced from common salt (and water). The production of this basic chemical, which is also important for plastics production, currently accounts for around 2.5 per cent of the German electricity consumption.

Load flexibilisation of electrochemical processes in industry

In cooperation with industrial partners, researchers from the TU Berlin are determining and economically evaluating the load management and flexibility potential of current and future electrochemical processes in the chemical industry. They want to prove that operation adapted to an intermittent electricity provision from renewable energies is technically and economically feasible in electrochemical processes.

The interdisciplinary joint project, which is entitled "ChemEFlex – Analysing the feasibility for increasing the load flexibility of electrochemical processes in industry", is headed by Professor George Tsatsaronis from the Department of Energy Engineering and Environmental Protection at the TU Berlin. In addition to the Energy Engineering and Environmental Protection department, the Process Dynamics and Operations, Technical Chemistry/Multiphase Reaction Technology and Technical Chemistry/Electrocatalysis Materials groups at the TU are also involved. Covestro Deutschland AG, Mitsubishi Hitachi Power Systems Europe GmbH and VESTOLIT GmbH are participating in the research project as industrial partners.

Previously continuously operated chemical plants to be operated flexibly in accordance with loads

"Until now these electrochemical processes have been operated constantly. However, we want to investigate whether it is both technically possible and economically viable to link the production process to energy price fluctuations. This means that the process is shut down when less electrical energy is fed into the grid and is then started up again when there is surplus electricity, says project coordinator Franziska Klaucke from the TU's

Department of Energy Engineering and Environmental Protection.

The researchers are investigating chlorine-alkali electrolysis (CAE) and alternative electrochemical processes to determine if flexible operation is technically feasible. They are investigating how electrodes and membranes in the electrolysis system react to shutdown and start-up processes and whether increased wear or even permanent damage can be expected. For the process they are developing a flexible control system that takes into account the boundary conditions of the electricity market and the technical restrictions. Alternative processes such as the production of hydrogen peroxide, which is important as a bleaching and disinfecting agent, will then also be investigated to see if flexible operation is feasible.

Storage and buffer solutions with batteries and methanol plant

The innovations are being tested at the industrial partner Covestro, which operates CAE systems at four sites in Germany. These run continuously under full load. The chemical processes are closely interlinked, currently without storable intermediates. Energy or chlorine storage is therefore required in order to buffer fluctuations in the chlorine production. The project is investigating how the flexibility of CAE systems can be enhanced by battery storage and hydrogen utilisation technologies. This is especially concerned with converting hydrogen and carbon dioxide into methanol.

It is not just in the chemical industry that research is being conducted into the potential for improving load management in the electricity grid. The Phi-factory, which is located on the campus of the TU Darmstadt, is also focussing on coupling production processes with the requirements of the electricity grid. This factory of the future works flexibly and networks the machines and buildings in energy terms. It is not only very energy efficient but also helps to stabilise the electrical supply network. The factory utilises a high proportion of renewable energies and helps to smooth fluctuations in the electricity supply. BINE Information Service has presented the Phi-factory and its concept.

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