UMWELT TECHNIK BW Landesagentur für Umwelttechnik und Ressourceneffizienz

Biorefinery project KoalAplan is extracting raw materials from wastewater

Research project explores new ways of creating bio-economic value

Stuttgart. The Ministry of the Environment, Climate Protection and the Energy Sector is funding the KoalAplan project, which extends the functional scope of a wastewater treatment plant. The project, based in the Stuttgart district of Büsnau, aims at recovering raw materials from wastewater and is therefore making a positive contribution to climate neutrality, as the products obtained replace fossil raw materials and energy-intensive processes.

Scientists from the DVGW Research Centre at the Engler-Bunte Institute of the Karlsruhe Institute of Technology (KIT), the Fraunhofer Institute for Interfacial Engineering and Biotechnology, Hamburg University of Technology, the University of Stuttgart and the Clausthal University of Technology are working on a project to create new processes for wastewater treatment together with Umwelttechnik BW (UTBW), the state agency for environmental technology and resource efficiency in Baden-Württemberg. The KoalAplan project, also described as 'the Büsnau biorefinery' focuses on municipal wastewater as a source of ammonium nitrogen, hydrogen and bioplastics. The project has been launched to recover raw materials from municipal wastewater and to generate an impact towards climate neutrality.

In a conventional wastewater treatment plant, the nitrogen contained in the wastewater undergoes biological degradation. Microorganisms convert the nitrogen compounds into gaseous nitrogen, which escapes unused into the atmosphere. For the conversion process, the microorganisms require organic carbon, which is no longer available as a feedstock but is discharged as CO_2 and sewage sludge. "We are bypassing biological nitrogen removal in our project and would like to demonstrate that we can recover a large part of the organic load from wastewater," explains Professor Harald Horn, Head of Research at the Engler-Bunte-Institut.

The planned process concept consists of chemical, physical and biological process steps. A core part of the entire process is the use of micro-screens to separate the particulate organic carbon from the wastewater stream already after primary sedimentation. In the main stream process, the ammonium nitrogen is subsequently removed using ion exchangers, producing a product that can be used as a fertiliser. In the side stream process, the actual biorefinery, the filtered solids and the primary sludge are first converted into organic acids by acid hydrolysis (dark fermentation), which also produces biohydrogen and CO_2. The hydrolysate is then filtered and converted to hydrogen (and again CO_2) through microbial electrolysis. Hydrogen has many applications in the chemical industry and is considered a future energy carrier. In a feasibility study, the gas flows from microbial electrolysis and dark fermentation are utilised in a biotechnological process for the production of valuable chemicals. In the process, the carbon dioxide contained is also fixed again.

The material streams, which contain carboxylic acids among other things, are converted into polyhydroxyalkanoates (PHA), a natural biopolymer, in a fermentation process. "From waste material streams, we produce the microbial biopolymer PHA, a starting material for biodegradable packaging materials and can thus replace persistent plastics from fossil sources," says Dr.-Ing. Susanne Zibek, group leader for bioprocess technology at Fraunhofer IGB.

The new process concept is currently being tested in Stuttgart-Büsnau, at the sewage treatment plant for research and education of the University of Stuttgart. Peter Maurer, Technical Operations Manager at the plant, explains: "We are testing innovative processes for wastewater treatment. We've often worked against the odds, but usually, our efforts have been rewarded with success."

The project is also investigating what other effects the innovations will have. "A detailed life cycle assessment will show whether the process enables us to make a positive contribution to the environment and climate," emphasizes Dr Andrea Hille-Reichel, Project Manager at the Karlsruhe Institute of Technology. With the help of a climate and energy balance, the process can be compared to conventional sewage plant operation.

"We are networking local players and looking to identify potential buyers for the products produced. We are convinced of the market potential and economic viability of the process," says Dr Anette Zimmermann, Head of Environmental Technology at Umwelttechnik BW.

The KoalAplan project intends to highlight the recycling potential in wastewater treatment. The projected recovery of the products hydrogen, bioplastics and nitrogen/phosphorus fertiliser can significantly reduce resource consumption. At the same time, energy-intensive processes will be replaced and emissions reduced. The project is considered an integral part of the Ministry's strategy to build a sustainable bioeconomy in the federal state of Baden-Württemberg. Based on this strategy the state government supports the change to a raw material-efficient and cycle-oriented economy using renewable and biological resources. The project is funded by the Ministry of the Environment, Climate Protection and the Energy Sector Baden-Württemberg as part of the European Regional Development Fund funding programme "Bioeconomy - Biorefineries for the recovery of raw materials from waste and wastewater".

About Umwelttechnik Baden-Württemberg (UTBW)
Umwelttechnik Baden-Württemberg is the state agency for environmental technology and resource efficiency in Baden-Württemberg. UTBW works at the interface between politics, business and science. With core competencies in the classic environmental technology fields (waste, wastewater, exhaust air) and activities in the field of bioeconomy, UTBW supports companies on their way to a more sustainable future.

Given dwindling resources and fluctuating prices, the aim is to raise awareness for the potential of bioeconomy and efficiency strategies and to support companies with the implementation of sustainability measures. With a wide range of information services, training courses, events and the implementation of funding programmes, UTBW has been active in the federal state of Baden-Württemberg since 2012.

The state agency is state-owned but operates independently as a private limited company. The supervisory board of the state agency, which is composed of representatives of the Ministry of State, the Ministry of the Environment, Climate Protection and the Energy Sector, the Ministry of Economics, Labour and Housing and the Ministry of Science and the Arts, controls the strategic orientation and finances of the state agency.

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