Chemical Products on a Renewable Basis

The KIT Develops a New Process for Industrial Manufacture of Platform Chemical 5-HMF – Production Has Started at AVA Biochem Facility

At this facility, AVA Biochem produces 5-(hydroxymethyl)furfural from biomass. The compound can serve as a precursor for various materials. (Photo: AVA Biochem)

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A breakthrough in the use of renewable raw materials in chemical production has been achieved by Karlsruhe Institute of Technology (KIT) and its industrial partner AVA Biochem: In January this year, a facility at AVA Biochem in Muttenz (Switzerland) has started production of 5-(hydroxymethyl)furfural. The KIT has developed an innovative hydrothermal method to obtain the organic compound from biomass. Being a platform chemical, 5-HMF can serve as a precursor for various materials.

Today, the chemical industry mainly uses fossil raw materials such as crude oil and natural gas. From these materials, so-called intermediates or platform chemicals serving as precursors for various industrial products such as plastics or substances for coatings, paints, and varnishes are manufactured. However, in view of today's limited resources, the climate change, and our quest for sustainable development, the interest in renewable raw materials that can replace crude oil increases. The platform chemical 5-(hydroxymethyl)furfural (5-HMF) plays a key role in the change from a crude-oil-based to biomass-based chemistry.

5-HMF is an organic compound that forms during thermal decomposition of carbohydrates and can thus be detected in many heat-treated foods such as milk, fruit juice, honey or coffee. Heating sugar in a pan, we can, for example, smell the compound as the sugar caramelizes. 5-HMF can be obtained from vegetable biomass and can serve in the future as a precursor for different innovative materials, in particular for polymers with specific properties. According to the U.S. Department of Energy, 5-HMF is one of the ten most important platform chemicals. It is, however, a challenge to manufacture the compound on an industrial scale. Karlsruhe Institute of Technology and the Swiss AVA Biochem BSL AG now achieved a significant scientific-technical breakthrough: In January this year, the facility “Biochem 1” operated by AVA Biochem in Muttenz near Basel started commercial operation for industrial manufacture of 5-HMF. The manufacturing method was developed by researchers from KIT.

Cooperation with AVA Biochem is part of comprehensive KIT activities for manufacture of chemical energy carriers as well as intermediates from biomass with emphasis on so-called hydrothermal methods i.e. reactions in water at increased temperatures. “The hydrothermal methods can be well integrated in different process chains for which biomass is used as raw material,” explains Professor Jörg Sauer, head of KIT’s Institute of Catalysis Research and Technology (IKFT). “On the one hand, biomass with a high water content which, for example, is a by-product of food production, serves as raw material. On the other hand, the hydrothermal technology can be combined very well with biotechnological conversion processes.

Within 18 months, the researchers at KIT developed a 5-(hydroxymethyl)furfural laboratory production process that can be implemented in the industry. Hydrothermal carbonization i.e., a method which at high temperatures and increased pressure converts biomass in a closed system in aqueous suspension into biochar, served as a basis. Unlike hydrothermal carbonization, the new process, however, is operated so that the formation of solid materials from biomass is avoided. The fragments from the biomass are converted into chemical components, for example for plastics manufacture.

“Within the short time of only 18 months, our team had to develop a solution to be scaled up from the laboratory to an industrial scale,” says Professor Andrea Kruse from KIT. “Thanks to our more than twenty years’ experience in hydrothermal processes, we have succeeded in mastering this great challenge.” Together with engineers

from AVA Biochem, the KIT researchers, parallel to the laboratory experiments, started at an early stage to work on Scale-up to the production scale. Already since 2010, KIT and AVA-CO2, the holding company of AVA Biochem, had researched into hydrothermal carbonization and put it to industrial application. This was also to the benefit of the development of the new method. “The close cooperation between researchers and plant engineers has enabled a rapid industrialization. We are several years ahead of the market,” sums up Jan Vyskocil, CEO at AVA Biochem.

In parallel to current production, the teams at KIT and AVA Biochem now optimize the process. Both the spectrum of usable biomasses and the achievable yields have much development potential and open up additional opportunities. A joint patent was taken out on the developed method. There is lively interest now already from different industries. Orders from customers have already been received.

About AVA Biochem

AVA Biochem manufactures the superior platform chemical 5-(hydroxymethyl)furfural from biomass and delivers it to customers from the industry and research worldwide. The raw materials used in manufacture do not compete with food production. The objective of AVA Biochem is to become market leader in 5-HMF production through application of the innovative production process. The company is a subsidiary of AVA-CO2 Schweiz AG located in Zug, Switzerland. In Muttenz, AVA Biochem operates the worldwide first 5-HMF production plant based on hydrothermal carbonization.

Karlsruhe Institute of Technology (KIT) is a public corporation according to the legislation of the state of Baden-Württemberg. It fulfills the mission of a university and the mission of a national research center of the Helmholtz Association. Research activities focus on energy, the natural and built environment as well as on society and technology and cover the whole range extending from fundamental aspects to application. With about 9000 employees, including nearly 6000 staff members in the science and education sector, and 24000 students, KIT is one of the biggest research and education institutions in Europe. Work of KIT is based on the knowledge triangle of research, teaching, and innovation.

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