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BIOLOGICAL HYDROGEN METHANATION: DOES THIS CONCEPT HAVE THE POWER TO STABILIZE THE EUROPEAN ELECTRICITY GRIDS?

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The expansion of electricity generation from wind power and photovoltaics is essential to reduce greenhouse gas emissions in the energy sector. At the same time, the expansion of these intermittent power generation plants poses major challenges for the operators of power grids to ensure grid stability. One way of using and storing excess electrical energy is the production of hydrogen by electrolysis. But Europe does not yet have the necessary technical infrastructure for hydrogen either. A promising technology for the conversion of hydrogen and carbon dioxide to methane for the purpose of energy storage and biogas upgrading is biological hydrogen methanation (BHM) by using methanogenic archaea. Independent of the reactor concept used, BHM offers the advantage of being very tolerant of impurities in the product gas. Additionally, BHM is very flexible in terms of load changes and can be switched from stand-still to full load within hours, although it is based on a biological conversion by living organisms. BHM is also characterized by its high conversion efficiency. Due to their advantageous design, trickle bed reactors (TBR) are increasingly gaining attention for BHM-technologies today and recent studies intend to improve reactor performance. TBRs have the advantage of very high phase contact surfaces, which increases the gas-liquid mass transfer and thus the productivity of the entire system. To further improve the gas-liquid mass transfer and thus the performance, test series in TBRs with different operating pressures and temperatures had been investigated. Rising temperatures increase the metabolic activity of methanogenic microorganisms, thus leading to higher reactor specific methane formation rates (MFR). In order to quantify the potential for improved performance, experiments with four different operating temperatures ranging from 40 to 55 °C were carried out. Methane content increased from 88.29±2.12 vol % at 40 °C to 94.99±0.81 vol % at 55 °C with a stable biological process. Furthermore, a reactor specific methane formation rate (MFR) of up to 8.85±0.45 m3 m−3 d−1 was achieved. It could be shown that the microorganisms were able to adapt to higher temperatures within hours. The tests showed that TBR performance with regard to BHM can be significantly increased by increasing the operating temperature. Overall, TBR systems for BHM showed an extremely high process stability and reliability. In the future, surplus electric energy can be used for the production of Hydrogen via electrolysis. By the subsequent conversion of the hydrogen together with CO_2 from biogas to methane, a chemical energy carrier is formed which can be injected the gas grid. Due to the large storage capacity of the natural gas grid, BHM offers the possibility to store and distribute surplus electric energy all over Europe

Biography

Lukas Illi is a Doctoral Student at the State Institute of Agricultural Engineering and Bioenergy, University of Hohenheim since 2016. His current research is in the field of process development for the use of biological methanation in two-stage biogas production mainly focusing on microbial populations. He has completed his Master's degree in Biobased Products and Bioenergy from the University of Hohenheim and the topic of his thesis was Kinetics of biogas production of selected intermediates in anaerobic filters. His recent publications were published in *Environmental Technology and Bioresource Technology* in the fields of anaerobic filters for demand-orientated energy supply and biological hydrogen methanation (review).

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