

POPULAR SCIENTIFIC ABSTRACT

Brian Dahl Jønson

Development of Biogas-based Power-to-Methane Technology

This thesis has been conducted within the EUDP funded project e-Fuel [Project ID 64018-0559]. The PhD has been a collaboration between University of Southern Denmark and Nature Energy A/S. The focus of this thesis has been on biological utilization of carbon dioxide (CO_2) with hydrogen (H_2) to produce methane (CH_4), known as biomethanation. The current climate and energy situation in the world, requires green solutions for fuel which can substitute fossil fuels and provide energy stability. This thesis focused on the upscaling of the biomethanation technology using trickling filters (BTFs), to investigate the larger scale potential. During the PhD laboratory reactors of 0.29L and 8L were upscaled to pilot-scale of 1000L. During laboratory scale research, a new method was developed which reduced the start-up time for at BTF from 2 months to 14 days. The successful method was confirmed with DNA-analysis and would be implemented in further research within the thesis. Another laboratory research in the thesis was the investigation of dynamic operation of biomethanation in BTFs. For this testing, new laboratory BTFs were designed and operated, which implemented the previous method for start-up, with success. The dynamic operation is needed as the energy system, and thereby the supply of H_2 , will be intermittent. A method with optimized operational parameters were developed, which proved effective for reducing the time needed to regain performance, from 280 min to 120 min. These results indicated the potential for dynamic operation for BTF in larger scales, but the method needed validation in larger scale operation. With development and operation of a pilot-scale BTF plant, containing two 1000L BTFs. This pilot-scale would be operating using the CO_2 within raw biogas, and would validate the methods developed in laboratory scales, along with performance obtained during laboratory research. The operation of this pilot-scale plant validated the start-up method and operational stability and performance. Some results from laboratory BTFs were exceeded during the pilot-scale operation. The dynamic operation of biomethanation in BTF have been successfully validated in the pilot-scale plant, but optimization of the methods is still needed. The PhD thesis have successfully developed a biogas-based power-to-methane technology, which can be implemented into an energy-production. By utilization of raw biogas, the technology proved the potential of using non-treated process gasses for carbon capture utilization, while being implemented into an intermittent energy system.