Title:	Benchtop validation of microbial electrosynthesis process for biogas upgradation through CO2 utilization
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Keywords:	microbial electrosynthesis
Issue Date:	May-2023
Publisher:	IISER Mohali
Abstract:	With fossil fuels meeting about 80% of the global energy demand, energy crisis is inevitable in the upcoming decades. Alternative sustainable as well as cost-effective sources of energy are thus increasingly being investigated. Biogas is a promising clean, renewable and carbon- neutral energy source with the potential to quench global energy demand. By using biogas as an energy source, the issue of underutilized methane emissions, a highly potent greenhouse gas, can be addressed as well. However, the high concentration of CO 2 present in biogas hinders its usage as fuel by considerably lowering its calorific value. Thus, biogas first needs to be upgraded by removing CO 2 content, which enhances its methane content and thereby its calorific value. Current biogas upgradation techniques are mostly centralised and upon completion of the process, they release the scrubbed-out CO 2 back into the atmosphere. In this context, microbial electrosynthesis, which offers CO 2 conversion rather than release,can be a promising technology for upgrading biogas. It is a microbial electrochemical technology in which microbes are used as catalysts for the reduction of CO 2 into value-added compounds. Thus by utilising the CO 2 component of biogas via microbial electrosynthesis, the methane content can be enhanced. The proof of concept of this concept has been established at the laboratory scale. As a logical continuation, my thesis work focussed on the bench-top validation of microbial electrosynthesis process for biogas upgradation and understanding the scale-up issues. A custom-made 4.3L scale parallel plate two-chambered electrochemical reactor was designed for the study. Two batches of experiments were conducted with different modes of energy supply as well as electrode material. In the first experiment, the reactor was operated in a potentiostatic mode with carbon felt as the cathode material. An increment in methane concentration from 57.5% to 75.2% was observed at an applied E cathode of -1.0V vs. Ag/AgCl. This experiment yielded 2.83g/L acetic acid along with coulombic and energetic efficiencies of 28.5% and 15.87%, respectively at E cell of 2.82V. However, the carbon felt material was found to be unstable for long-term operation due to detachment of fibres from it. In the second batch of experiments, the reactor was operated in a galvanostatic mode along with graphite plate as cathode material. The methane content in biogas was enriched from 57.5% to 78.6% in this experiment at an applied current of -0.08A. This experiment yielded acetic acid titer of 2g/L along with coulombic and energetic efficiencies of 34.9% and 18.68%, respectively at E cell of 2.51V. This experiment was better performing in terms of methane enrichment and energetic efficiency; however, further optimisation of the system need to be performed for better yields and biogas upgradation. The feed rate of biogas as well as the applied current or voltage needs to be optimised in order to make the system efficient for real world applications
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