Title:	Biogas Upgradation Through CO2 Conversion Into Acetic Acid via Microbial Electrosynthesis
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Abstract:	Biogas is one of the promising futuristic renewable energy sources with enormous market potential. However, the presence of CO2 lowers down the calorific value of biogas. Hence, various biogas upgradation technologies are under intense investigation to increase the methane content to the desired level. This study reports on enhancing methane content in biogas through CO2 sequestration into acetic acid via microbial electrosynthesis (MES) process. The previously enriched mixed chemolithoautotrophic microbial culture dominated by Acetobacterium spp. used CO2 present in the biogas as the sole carbon source. After establishing a stable performing biocathode at a fixed cathodic potential of −1 V (vs. Ag/AgCl) through batch mode operation, biogas was fed continuously at different feed rates, viz., 0.5, 0.3, and 0.2 ml/min to the cathode chamber. The highest feed rate of 0.5 ml/min was least effective both for methane content increment (from 61 ± 3% to 86 ± 2%) and acetic acid titer (1.5 ± 0.5 g/L; 0.107 ± 0.02 g/L/d.). In comparison, the lowest flow rate of 0.2 ml/min was the most effective for the intended process (methane upgradation from 62 ± 7% to 93 ± 3% and acetic acid titer 3.4 ± 0.6 g/L produced at 0.24 ± 0.04 g/L/d rate). Both acetic acid bioproduction and biogas upgradation occurred best at an Ecell of 3.3 ± 0.35 V at the low feed rate. A maximum of 84 ± 7%, 57 ± 10% and 29 ± 2% coulombic, carbon and energetic efficiencies, respectively, were achieved in acetic acid. Cyclic voltammograms of biocathodes revealed the decrease in hydrogen evolution potential and increased bioelectrocatalysis, thereby suggesting the contribution of microbes in the process. Acetobacterium, which is known for CO2 fixation, was found to be the dominant microbial genus in biogas fed reactors. The demonstrated approach not only offers the advantage of obtaining two products, one in the bulk phase and the other in the off-gas, it also validates the applicability of the bioelectrochemical biogas upgradation technology.
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