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BioH_2 and bioCH_4 production using an integrated bioelectrochemical and anaerobic digestion reactor from poplar and cow manure wastes

•[1*]A. Faruk Kilicaslan, [1] Ibrahim Dincer and [2] Ali Khalvati

•[1] Clean Energy Research Laboratory (CERL), Faculty of Engineering and Applied Science, Ontario Tech. University, 2000 Simcoe Street North, Oshawa, Ontario L1G 0C5, Canada
•[2] Viona Consulting INC., Agro-Environmental Innovation and Technology, Research and Development Company, Thornhill, Ontario L3T 0C6, Canada

*E-mail: ahmet.kilicaslan@ontariotechu.net

I. Abstract

The release of greenhouse gases from fossil fuels has brought about environmental concerns that have transformed industrial business planning and led to the development of state-of-the-art equipment for green bioenergy generation. Microbial electrolytic cells (MEC) have drawn a lot of interest in this context as a practical, innovative, and environmentally friendly method. This study investigated the production of biohydrogen (bioH2) from an energetic poplar and cow manure mixture in a membrane-less single-cell microbial electrolysis cell (MEC) and biomethane (bioCH4) production in an anaerobic digestion cell. The MEC system was performed with 1.0 V. The highest bioH2 production rate was measured as a 1.797 mg/L and it was obtained at the end of the first day. The maximum bioCH4 production was obtained at the end of the first five days with 0.72 L.

II. Experimental Set-up and Procedure

All experimental runs were performed in the single-cell membrane-less MEC system and anerobic digestion cell, which are constructed by using a glass material (Fig. 1). The aluminum plates are used as an anode and cathode electrodes. The membranless microbial electrolses cell and anerobic digester were 600 mL of cow manure, 4500 mL acid-treated energetic poplar as a biomass source and 225 mL mineral oil. Copper wire connected to electrodes was used to link the MEC to the voltage delivered from an adjustable DC power supply.

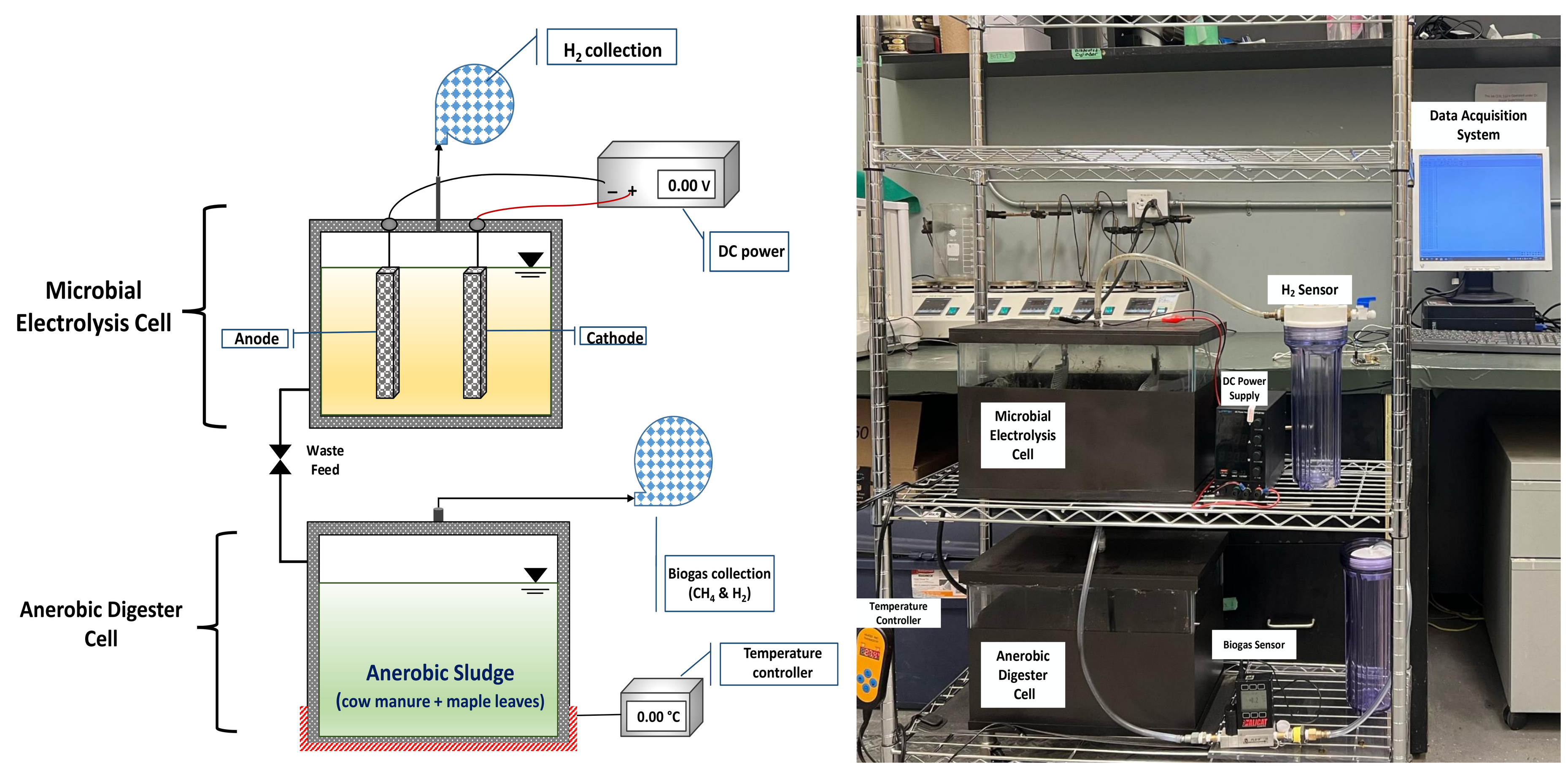

Fig. 1: Schematic diagram and experimental set-up for microbial electrolysis cell and anerobic digester cell.

The bioH2 gas and bioCH4 were collected in an external cylindrical container, which includes an MQ-8 hydrogen sensor, and monitored during the experiments.

III. Results and discussions

This study examined the effects of the days on hydrogen and methane production in MEC and anerobic digestion sytems respectively. Hydrogen was produced in MEC system and methane was produced in anerobic digestion cell. The MEC system was worked under 1.0V applied voltages. This experiment was continued for 10 consecutive days and daily hydrogen and methane production were measured. The highest hydrogen production was measured at the end of the first day with 1.797 mg/L. The hydrogen production rate was kept decreaed continuously and the lowest hydrogen production was measured at the end of the ten days with 0.071 mg/L.

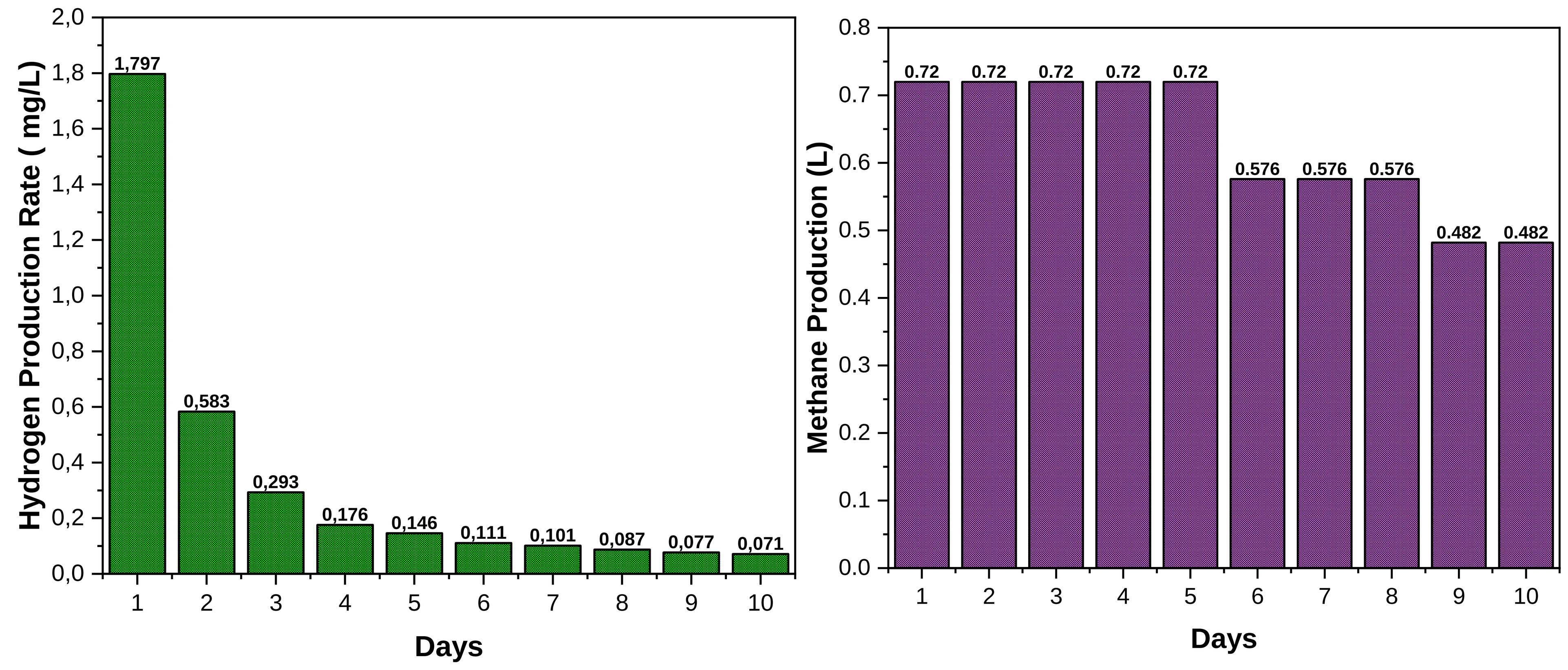

Fig. 2: Hydrogen production rate in microbial electrolysis cell (a) and methane production rate in anerobic digester cell (b)

At the end of the ten days, organic sludge in the MEC system was carried to an anaerobic digestion cell with the help of the pump to the methane production process. The anaerobic digestion cell was heated from an external heater to obtain the optimum temperature for methane production. The methane production was changed for the first five days. The maximum methane production value was measured as 0.72 L. However, minimum methane production was measured at the end of the ten days with 0,482 L as expected. The main reason for continuous drops for both hydrogen and methane production is day after day, the decrease in the number of beneficial microorganisms.

In this paper, the membrane-less single-cell MEC and anaerobic digestion processes were performed for both sustainable bioH2 production and bioCH4 production. In the MEC system, aluminum electrodes are used and 1.0 V applied to the system. The maximum bioH2 and bioCH4 production were obtained at the end of the first day as 1.757 mg/L and 0.72 L respectively. After the first day, gas production rates decreased because of the death of the microorganism. This study aims to ensure continuous bioH2 and bioCH4 production by feeding the system externally.

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