CONVERSION OF CARBON DIOXIDE TO C1 AND C2 BIOFUELS USING BIOELECTROCHEMICAL SYSTEMS

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Abstract

Energy is essential component of our society to support day-to-day activities like powering home appliances, lightning, transportation, heating/cooling etc. The global energy consumption was around 520 quadrillion BTUs (British thermal units) in 2010 and is expected to increase by 56% to 820 quadrillion BTU by 2040. At present, 78% of our global energy consumption comes from non-renewable resources like coal, petroleum, natural gas and that only 19% of the present energy comes from renewable energy sources [1]. Energy crisis and pollution are biggest problems the world is facing today. Since the fossil fuels are depleting day by day and fossil fuels create pollution. Diminishing reserves and rapidly increasing energy consumption clearly suggest that we must act urgently and decisively to develop clean, sustainable, affordable and renewable energy sources. Hence waste which is biodegradable and renewable can be used and can make energy and reduces dependence on fossil fuels and pollution.

Around 2.2-4.4*10^{18} joules of energy (corresponding to 70-140 GW electricity) can be generated from waste produced by the whole 7 billion population of the world if proper Waste to energy (WTE) strategies are employed [2]. A number of technologies are available for WTE such as incineration, anaerobic digestion, pyrolysis and gasification, Bio-electrochemical systems etc.

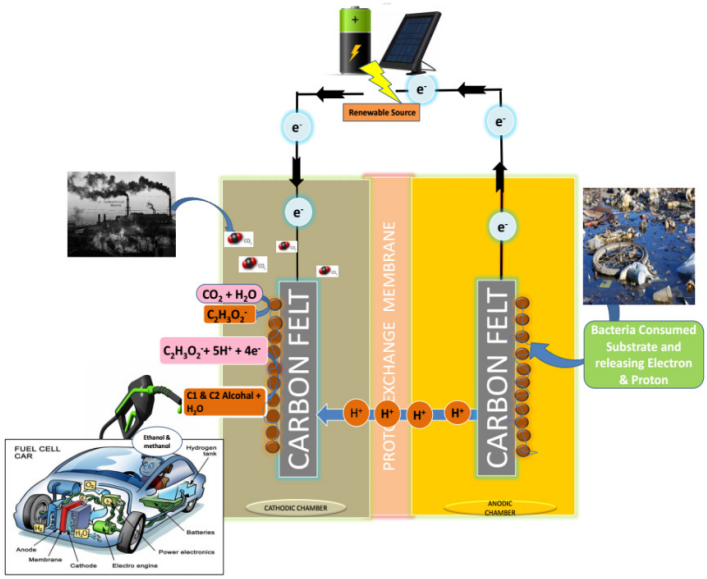
Microbial electrolysis cell is a rapidly growing bioelectrochemical system (BES), wherein an electrochemical process takes place under the influence of biological catalyst to generate energy by utilizing a wide range of substrates. MECs are unique systems capable of converting the chemical energy of organic waste including low-strength wastewaters and lignocellulosic biomass into electricity or hydrogen or other value added products (biofuels) [3,4]. Various designs of MECs are possible including single and dual chambered systems. The performance of these systems is controlled by various factors e.g. pH, temperature, catalyst loading, solution conductivity, amount of substrate etc.

In the present work, a dual chambered MEC has been constructed with a working volume of 100 mL. Carbon felt was used as electrodes and the two chambers were separated by proton exchange membrane. Glucose was added in to the anodic chamber in order to support microbial growth while carbon dioxide was bubbled in to the cathodic chamber. The hydrogen ions thus produced during the degradation were transferred through the membrane to cathodic chamber wherein they combine with carbon dioxide to form methanol and ethanol.

$$CO_2 + H^+ + e^- \longrightarrow CH_3OH$$

$$2CO_2 + H^+ + e^- \longrightarrow C_2H_5OH$$

The volume of the biofuels thus produced was measured using GC with FID detector. The microbial communities were characterized by molecular biology techniques (PCR, qPCR etc). Thus it can be concluded that the carbon foot prints can be reduced and can be efficiently converted in a bio electrochemical system to produce biofuels. Thus it can alleviate global warming and global energy crisis.



Recent Publications

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Biography

Dr Khan did his Masters in Industrial Chemistry and PhD in Chemistry (Environmental Chemistry-Waste Water Bioremediation) from AMU Aligarh in the year 2007 and 2011 respectively. Later, he was awarded with the prestigious Erasmus Mundus Fellowship by the European Union to work at the prestigious University College of London (UCL) as post-doctoral fellow (PDF). He remained there till late 2012 and later joined the department of Biochemical Engineering and Biotechnology, IIT Delhi as Project Scientist under the DST Fast Track Young Scientist Scheme. He has also been awarded the Dr DS Kothari post-doctoral fellowship by the University Grants Commission, Government of India. He joined the department of Chemistry, AMU Aligarh in early 2014. He has also been awarded Junior and Senior Research Fellowship by UGC during his doctoral studies.

His main area of interest is the bioremediation of organic compounds along with energy recovery in the form of electricity or methane using Microbial Fuel Cell Technology (MFCT). MFCT offers excellent removal efficiency along with electrical energy generation.

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