JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue

JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)

An International Scholarly Open Access, Peer-reviewed, Refereed Journal

BIOCHAR PRODUCTION FOR MICROBIAL FUEL CELL ELECTRODE

Pratima Gajbhiye[1], K S Maan[1],Nishu Malik[1], Omer Faruqe[1], Hussein Khuzema Rajabali[1]

[1]Department of Chemical Engineering, School of Chemical Engineering and Physical Sciences, Lovely Professional University-Phagwara, Punjab

Abstract: The objective of the study was to prepare biochar for an electrode in Microbial fuel cell (MFC). Biochar was prepared from peanut shells by two steps slow pyrolysis process. The peanut shells used for making biochar had a yield of 16%. Electrodes fabricated were successfully tried in the Microbial Fuel Cell.

IndexTerms **– biochar, electrode, microbial fuel cell.**

I. INTRODUCTION

Biochar is a solid carbonaceous product produced by the combustion of biomass under a limited or no oxygen environment [1,2]. Production of Biochar dates back thousands of years. It was then prepared in underground pits and trenches by smoldering biomass [3,4]. Nowadays, a wide array of methods like pyrolysis [5], gasification [6], hydrothermal carbonization [7,8], flash carbonization [9], and torrefaction [10,11] are available for making biochar. Of all the above-mentioned methods, pyrolysis is mostly used for making Biochar. Thermal decomposition of organic matter in oxygen-free conditions at 300-900°C is termed pyrolysis [12].

Biochar could be the tool to address some of the most pressing problems of our time like food insecurity, water pollution from agrochemicals, soil degradation, and climate change. There is a reason to believe that biochar could store gigatons of carbon sequestered by biomass. The process of making biochar is carbon neutral and pyrolysis of biomass produces bio-oil and syngas as well which could be put to further use after suitable treatment [13].

Biochar and biochar-based materials have found applications in a variety of fields like soil remediation [14,15], wastewater treatment [16,17], climate change mitigation [18,19], and energy storage and conversion [20,21]. The microbial fuel cell is novel bio-electrochemical technology that can generate electricity by bio-degradation of organic components present in wastewater [22]. In classic dual-chamber MFCs at the anode compartment part, bacteria colonized on the electrode surface act as living biocatalysts that transfer biomass/nutrients into carbon dioxide, electrons, and protons.

The protons travel through the proton exchange membrane (PEM) to the cathodic compartment, where the oxygen reduction takes place thus requiring an effective ORR catalyst at the electrodes [23]. One of the major bottlenecks in up-scaling MFC technology is its cost and the cost of MFC to a large extent is determined by the anode material [24]. The present work focuses on the production and characterization of biochar for application in Microbial fuel cells.

II. MATERIALS

A stainless steel 304 reactor was fabricated as per the dimensions mentioned in Figure 1. The reactor has a length of 200mm and has outer diameter of 510 m. Peanuts were purchased from the local market for shells.

1. MATERIAL AND METHODS

Peanuts were obtained from the local market and nuts were removed to use shells for making biochar, Polyvinyl alcohol (PVA) was derived from Loba Chemie.

1.1 Biochar preparation

Biochar was prepared from peanut shells by pyrolysis at 800 °C for two hours as well for removal of volatile content under a nitrogen environment.

1.2 Electrode preparation

Stainless steel was used as a scaffold for the electrode. Polyvinyl alcohol (PVA) was used as a binder. PVA and de-ionized water solution was stirred at a hot plate magnetic stirrer for few hours at 80°C and then biochar powder was added. The resulting paste was coated on 8.15 cm^2.

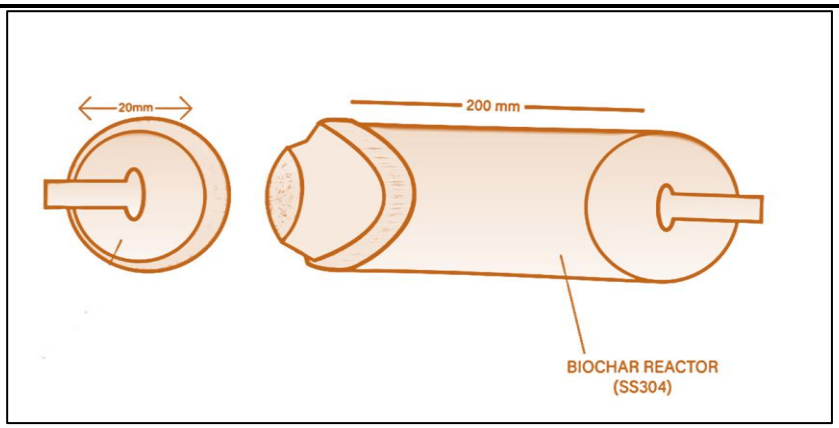

Fig 1. Stainless steel reactor

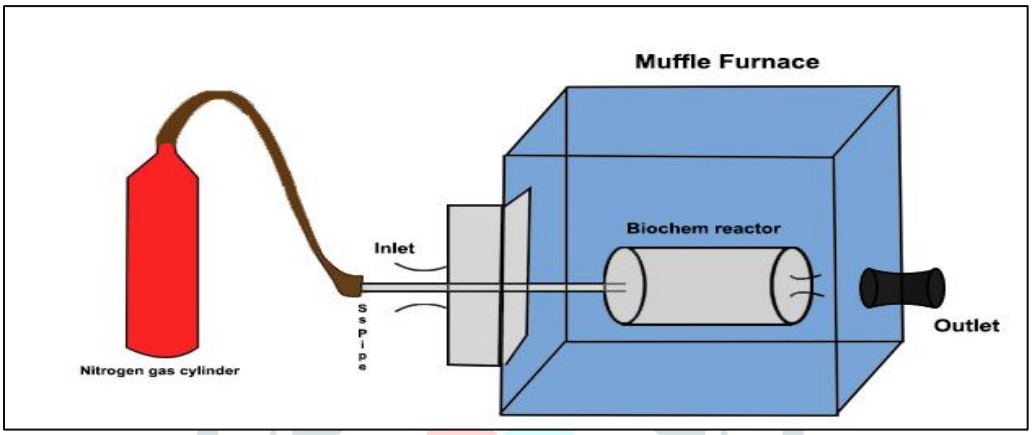

Fig:2 Setup for biochar preparation

Fig:3 Biochar preparation

Fig:4 Prepared electrode

III. RESULTS AND DISCUSSION

The biochar electrodes were fabricated using peanut shells. The yield of the biochar was found to be 16%. The electrodes were tried on in a Microbial fuel cell and found to work satisfactorily.

IV. CONCLUSION

The electrodes were fabricated in the designed SS make reactor and successfully tried in the Microbial Fuel cell.

REFERENCES

1. Dennehy, Conor, et al. "Greenhouse gas emissions from different pig manure management techniques: a critical analysis." Frontiers of Environmental Science & Engineering 11.3 (2017): 11.

2. Lin, Qi, et al. "The speciation, leachability and bioaccessibility of Cu and Zn in animal manure-derived biochar: effect of feedstock and pyrolysis temperature." Frontiers of Environmental Science & Engineering 11.3 (2017): 5

3. Solomon, Dawit, et al. "Molecular signature and sources of biochemical recalcitrance of organic C in Amazonian Dark Earths." Geochimica et cosmochimica Acta 71.9 (2007): 2285-2298.

4. Lehmann, Johannes. "Bio-energy in the black." Frontiers in Ecology and the Environment 5.7 (2007): 381-387.

5. Shafaghat, Hoda, Pouya Sirous Rezaei, and Wan Mohd Ashri Wan Daud. "Catalytic hydrodeoxygenation of simulated phenolic bio-oil to cycloalkanes and aromatic hydrocarbons over bifunctional metal/acid catalysts of Ni/HBeta, Fe/HBeta and NiFe/HBeta." Journal of industrial and engineering chemistry 35 (2016): 268-276.

6. Lee, Eun Hwa, et al. "Hydrodeoxygenation of guaiacol over Pt loaded zeolitic materials." Journal of Industrial and Engineering Chemistry 37 (2016): 18-21.

7. . Kambo, H., Dutta, A., 2014 Hydrothermal carbonization (HTC): an innovative process for the conversion of low quality lignocellulosic biomass to hydrochar for replacing coal. In: Proceedings of the 9th Annual Green Energy Conference (IGEC-IX), 2014 Tianjin, China, pp. 25-28.

8. Román, S., et al. "Hydrothermal carbonization as an effective way of densifying the energy content of biomass." Fuel Processing Technology 103 (2012): 78-83.

9. . Nunoura, Teppei, et al. "Studies of the flash carbonization process. 1. Propagation of the flaming pyrolysis reaction and performance of a catalytic afterburner." Industrial & engineering chemistry research 45.2 (2006): 585-599.

10. Nimlos, Mark N., et al. "Biomass torrefaction studies with a molecular beam mass spectrometer." Am. Chem. Soc. Div. Fuel Chem 48.2 (2003): 590-591

11. . Meyer, Sebastian, Bruno Glaser, and Peter Quicker. "Technical, economical, and climate-related aspects of biochar production technologies: a literature review." Environmental science & technology 45.22 (2011): 9473-9483

12. . Heidari, Aghdas, et al. "Effect of process conditions on product yield and composition of fast pyrolysis of Eucalyptus grandis in fluidized bed reactor." Journal of Industrial and Engineering Chemistry 20.4 (2014): 2594-2602.

13. Renner, Rebecca. "Rethinking biochar." (2007): 5932-5933.

14. Tang, Jingchun, et al. "Characteristics of biochar and its application in remediation of contaminated soil." Journal of bioscience and bioengineering 116.6 (2013): 653-659.

15. Sizmur, Tom, et al. "Application of biochar for soil remediation." Agricultural and environmental applications of biochar: Advances and barriers 63 (2016): 295-324.

16. Huggins, Tyler M., et al. "Granular biochar compared with activated carbon for wastewater treatment and resource recovery." Water research 94 (2016): 225-232.

17. Thompson, Kyle A., et al. "Environmental comparison of biochar and activated carbon for tertiary wastewater treatment." Environmental science & technology 50.20 (2016): 11253-11262.

18. Woolf, Dominic, et al. "Sustainable biochar to mitigate global climate change." Nature communications 1 (2010): 56.

19. Winsley, Peter. "Biochar and bioenergy production for climate change mitigation." New Zealand Science Review 64.1 (2007): 5-10.

20. Liu, Wu-Jun, Hong Jiang, and Han-Qing Yu. "Emerging applications of biochar-based materials for energy storage and conversion." Energy & Environmental Science 12.6 (2019): 1751-1779.

21. Cheng, Bin-Hai, Raymond J. Zeng, and Hong Jiang. "Recent developments of post-modification of biochar for electrochemical energy storage." Bioresource technology 246 (2017): 224-233.

22. Sumisha, A., and K. Haribabu. "Modification of graphite felt using nano polypyrrole and polythiophene for microbial fuel cell applications-a comparative study." International Journal of Hydrogen Energy 43.6 (2018): 3308-3316.

23. Li, Shuang, Chong Cheng, and Arne Thomas. "Carbon-based microbial-fuel-cell electrodes: from conductive supports to active catalysts." Advanced Materials 29.8 (2017): 1602547.

24. Slate, Anthony J., et al. "Microbial fuel cells: An overview of current technology." Renewable and sustainable energy reviews 101 (2019): 60-81.

23. Ossman, M. E., et al. "Peanut shells and talc powder for removal of hexavalent chromium from aqueous solutions." Bulgarian Chemical Communications 3.3 (2014): 629-639.

24. Apaydın-Varol, Esin, and Ayşe Eren Pütün. "Preparation and characterization of pyrolytic chars from different biomass samples." Journal of Analytical and Applied Pyrolysis 98 (2012): 29-36.