Results & Discussions
Chapter-5

CHAPTER 5

5.1 A comparative study of a microbial fuel cell with two different proton exchange membranes for the production of electricity from wastewater

A preliminary experiment was conducted to check the efficacy of MFC for the production of electricity. In this experiment, we had checked only voltage production and current generation and measured the internal resistance of MFC for different membranes. MFC was operated at room temperature (25±5 °C) inoculated with mixed culture using sewage wastewater as substrate and glucose as an additional substrate for faster growth and maintenance of culture.

5.1.1 Experiment design

In the present study, electricity generation with wastewater as substrate was investigated in a two-compartment MFC with two different combinations of electrodes and membrane. Two proton exchange membranes namely nafion and agar salt bridge and aluminum as the electrode was used in the MFC1. Mixed bacterial culture was used as inoculum. In the experiment, wastewater along with 5% glucose (as a carbon source) was used as feed for the growth of bacteria.

5.1.2 Result & Discussions

- **MFC operation**

Experiments were carried out using Nafion and Agar salt bridge as membranes. Before starting the experiment a blank run was performed to check the error produced by the system. In the blank run, both chambers were filled with distilled water, and the setup was operated for 7 days. A potential drop of 0.02V was shown by the voltmeter at 1000

Ω resistance. In further experiments, the resistance of 1000 Ω was kept constant for comparative study. Inoculation of the anaerobic chamber was done with mixed bacterial culture obtained from the sewage treatment plant. On the 7th day, a glucose solution was added. The voltage and current generated from MFC were monitored continuously. With the addition of glucose, the voltage rose sharply to 0.5 V till the 9th day for Nafion and thereafter it decreased. Again on the 11th day glucose was added to check the effect on the voltage output of MFC. But even after the addition of glucose, voltage decreased continuously. inside MFC. Slowly the voltage in the MFC decreased to 0 V and then again glucose solution was added to explore the revival of MFC but a very small rise in the voltage was observed after the 20th day. This phenomenon may be attributed to the decay of microorganisms. Here, we had observed that continuous increases in the substrate will not increase voltage production inside MFC. We need to replace the whole medium with fresh inoculum at an intermittent time to maintain stable voltage production.

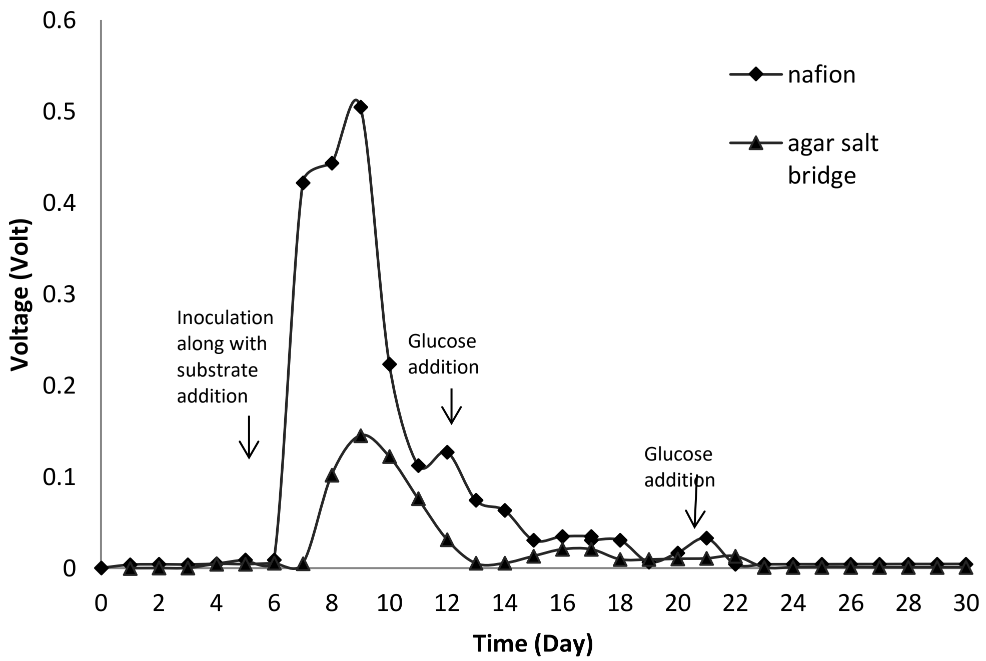

Figure 5.1 Comparison of voltage produced by Nafion as separator and agar salt bridge as a separator.

The maximum voltage of 0.50 V with a current density of 0.10 A/m^2 was obtained with the Nafion membrane. Another experiment was performed with an Agar salt bridge as a membrane under the same operating condition as it was in the case of nafion. From **figure 5.1**, it is evident that the voltage produced is significantly lower for the agar salt bridge. Maximum voltage for agar salt bridge was obtained after the 8^{th} day of inoculation and found to be 0.145V with a current density of 0.06 A/m^2 (**Figure 5.2**). The above result is similar to the results obtained by various researches with agar salt bridge as a membrane (Fang et al., 2017; Hernández-Flores et al., 2015).

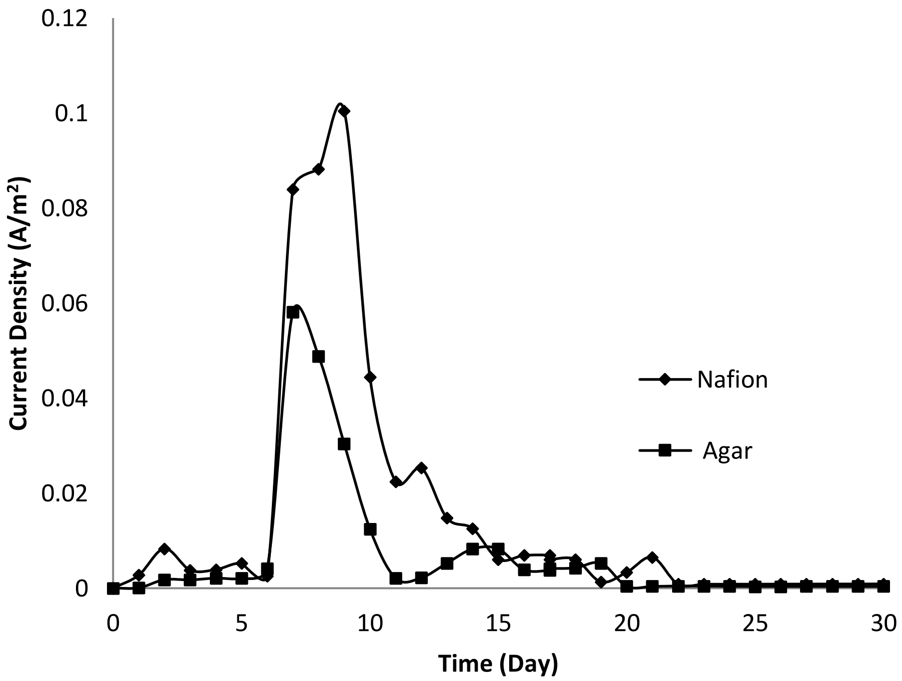

Figure 5.2 Comparison of current density produced by Nafion as separator and agar salt bridge as a separator.

The voltage profile obtained with the Nafion membrane was similar to the voltage profile obtained by the agar salt bridge. The voltage obtained with Nafion was found significantly higher than the agar salt bridge which may be due to the low resistance of Nafion for hydrogen ion transport as compared to the agar salt bridge. The difference in the results obtained in the present study as compared to other reported work may be due to various factors such as the difference in design and operating condition of MFCs etc.(Çetinkaya et al., 2015; Yee et al., 2012).

- **Polarization curve & Internal Resistance**

The polarization curve for the Nafion and agar salt bridge was plotted in **figure 5.3**. For Nafion membrane, open-circuit voltage (OCV) was found to be 0.62 V and for agar salt bridge was 0.25 V. Here Internal resistance is a combination of ohmic and charge transfer resistance and measured with polarization curve on varying resistance from 10 Ω to 1000 Ω. Internal resistance for Nafion was calculated as 871.14 Ω and for agar salt bridge was found to be 4117.11 Ω. Similar results were reported by many researchers (Daud et al., 2018; Y. S. Oon et al., 2018; Prakash et al., 2018). When the same electrode is used, the current produced during Nafion was higher than the agar salt bridge, this result also supported the phenomena of low internal resistance offered by Nafion as compared to the agar salt bridge.

(a)

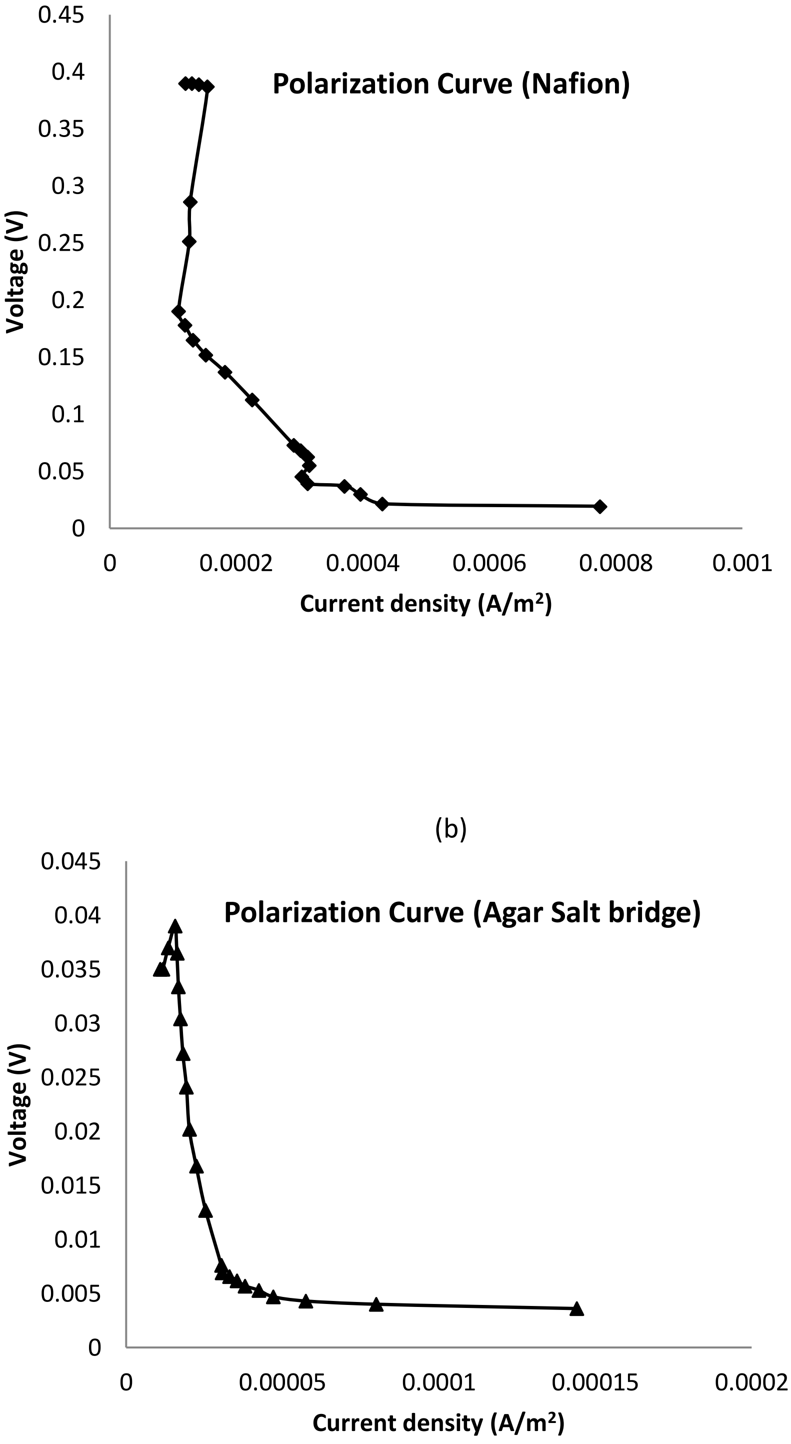

Figure 5.3 Polarization curve for Nafion and agar salt bridge as PEM

5.1.3 Concluding remarks

The study successfully demonstrated electricity production in MFC using wastewater obtained from local wastewater treatment plant as a source of the substrate as well as medium with two different membranes namely Nafion and Agar salt bridge. Agar salt bridge may be a low-cost alternative of proton exchange membrane but electricity production was found to be higher in the case of Nafion membrane than agar salt bridge membrane in the same MFC under same operating conditions which show the low resistance of Nafion as compared to agar salt bridge.