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Electricity generation and industrial wastewater treatment using microbial fuel cell

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ABSTRACT

Due to the rapid increase in population and industry sectors, the consumption of energy from fossil fuels is increasing rapidly, as a result, carbon emissions have increased, which negatively affects the environment. Currently, the electrical energy plants in Kuwait serve around 70,085 M.kWh and this is expected to increase in the future, which will increase the strain on the budget of the Kuwaiti government [1]. Most of the energy consumption was concentrated in the water and electricity sector, oil sector, transportation sector, and household sector. Furthermore, the industrial sector is another important sector that consumes a significant amount of energy on a daily basis [2]. In Kuwait, there are now more than 18 industrial areas and most of these industries are located mainly in Shuaiba, Mina Abdullah and Mina Al-Ahmadi. Those areas mainly contain the following industries: refineries, dairy factories, detergents factories, and soft drinks factories. Kuwait Environmental Protection Authority (KEPA) has divided industrial wastewater into two main categories: industrial wastewaters that meet KEPA's standards and can be treated off-site at municipal wastewater treatment plants, and industrial wastewaters that do not meet KEPA's standards and can be treated on-site or at special treatment plants. Thus, it is important to find an effective and sustainable way to treat industrial wastewater on-site and then transfer it to the treatment plant. Generally, wastewater contains a huge amount of energy, approximately 3–10 times more energy than the energy required for treating wastewater [3]. Each gram (g) of chemical oxygen demand (COD) contains 14.7 kJ, which means that there is a massive amount of energy in wastewater [3]. Using conventional wastewater treatment processes are expensive and consume huge amounts of energy, especially with the restrictive regulations prior to discharge where most of the energy is used for aeration and recirculation. Microbial fuel cells (MFCs) are bio-electrochemical devices that utilize electrochemically active bacteria (The microorganisms that are capable of exocellular electron transfer) as catalysts to convert the chemical energy of organic substrate into electricity [4]. MFCs are able to recover energy by degrading organic and inorganic matter in wastewater and produce less sludge. MFC offers a promising waste-

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water treatment technology with great environmental friendly benefits, such as a source of energy, wastewater treatment process, biosensor system, and low carbon emission process [4]. MFCs have many advantages, such as being easy to handle, not being toxic, the ability to extract 90% of electrons from organic compounds, and self-sustaining systems. MFC produces around 0.5 to 0.8 V working voltage (0.02 – 0.07 kWh/kg-COD), which considers low for real applications but very efficient in wastewater treatment. The generated energy is a function of wastewater type, COD concentration, MFC design, and the selected design materials. In addition, the generated electricity can be promoted by connecting many individual MFCs in parallel, series, or hybrid stacks.

Keywords: Microbial fuel cell; Industrial wastewater; Electricity; Sustainability; Treatment