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A Mini Review on Risk and Potential of Biogas Fed Solid Oxide Fuel Cell

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ABSTRACT

Solid oxide fuel cell (SOFC) can reduce the carbon footprint due to their flexibility of fuel usage by using hydrogen and light hydrocarbon as fuel to convert the chemical to electrical energy. This has made the SOFC an interesting device for renewable applications. SOFC which is able to convert the biogas produces from the water treatment plant directly to electrical energy is a reliable renewable energy application. The performance of SOFC itself can be greatly influenced by the characteristics of the biogas. This is caused by the impurities of the biogas that would degrade the internal reforming aspect of SOFC. Mainly on the anode side degradation due to the formation of carbon, sulfur poisoning, and mechanical instability. The commonly found biogas impurities from the wastewater treatment plant are Siloxanes. The compound is coming from sewage sludge digestion which is the common compound in household cleaning products and cosmetics. The presence of Siloxanes in internal reforming SOFC would lead to the formation of SiO_2 which degrade the anode layer and consequently reduces the power generation of SOFC. Hydrogen sulfide and ammonia were also present in the biogas fed from the wastewater treatment plant. These contaminations also showed degradation in the SOFC of the anode. Thus, this work will discuss the contamination compound and its effect on SOFC.

Keywords: Solid oxide fuel cell; biogas; contamination; degradation

INTRODUCTION

Global energy consumption is increasing tremendously with the increase of the human population per capita (Du & Xia 2018). Energy in the form of electrical has become part of life's necessity. The conventional way of providing electrical energy is through fossil fuel-based energy by burning coal and natural gas due to their availability and abundance. In recent years, global warming has reached an alarming state where the carbon emission of energy conversion through fossil fuel has increased the world greenhouse gas (GHG). It has caused harm to the environment and human life. A change in energy production is required to reduce the GHG effect whereas renewable energy could produce or convert energy to electrical energy by reducing the GHG effect(Viju & Kerr 2013; How et al. 2019; Nevzorova & Kutcherov 2019).

Waste management is one of the major issues faced around the world. Improper handling of waste would add effect to the GHG. Breakdown of waste in an improper manner would produce carbon dioxide which is released into the environment and indirectly causes environmental pollution (Thiruselvi et al. 2021). In Malaysia, waste can be categorized into two types which are solid and liquid waste. The solid waste could come from agricultural waste such as wood, coconut, paddy, palm oil and sugarcane, animal waste, and urban solid waste. On the other hand, the major contribution of liquid waste is sludge and wastewater from living. Improper handling of waste would lead to diseases and causes a major threat to humanity. Thus, converting the waste to renewable energy through biogas production could improve the GHG and reduce the creation of diseases in humankind (Yang et al. 2021). The solid and liquid waste would go through microbiological fermentation for biogas production. The biogas produced would consist of methane and carbon dioxide in a certain proportion depending on the types of waste (Hanafiah et al. 2016; Aziz, Hanafiah & Gheewala 2019). Methane which is a compound of hydrogen and carbon could be converted to electrical energy by an energy converter.

In recent years, renewable energy demand was increasing due to the awakening call by the nature on the GHG effect. Multiple natural disasters have shown the effect of GHG on environmental and human living. Biogas that was produced from waste could be converted to electrical energy by the fuel cell. Fuel cell an energy converter has shown efficiency in converting chemical energy to electrical energy. Moreover, the fuel cell is a renewable energy converter that produces almost zero carbon emissions. There were multiple types of fuel cells such as proton exchange membrane fuel