



Some Strategies for Synthetic Fuel Production from Exhaust Emission of a Tea Factory

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Abstract

In this study, some CO₂ strategies are developed for synthetic fuel production from exhaust gas emissions by using green hydrogen by means of renewable energy sources. In this regards, renewable energy integrated CO₂ capture process, green hydrogen production and storage issues are considered. For this purpose, solar hydrogen energy integrated CO₂ capture system is designed for a tea factory. The developed system consists of five subunits which are Solar PV System, PEM Electrolyser System, Catalytic Reactor for methanol production, CO₂ Capture System and Direct Methanol Fuel Cell System (DMFC). By using this system, it will be possible to produce synthetic fuel such as methanol or formic acid by collecting CO₂ from exhaust emission of tea factory and green hydrogen from solar PV electrolyser under catalyser effect. It is considered that the system developed in this study and the proposed strategies will make significant contributions to different industrial enterprises.

Keywords: Green Hydrogen, Methanol, CO₂, Solar Energy, Tea Factory, Exhaust Emission.

I. Introduction

Methanol has become increasingly important to carry hydrogen owing to its economic advantage and high storage density. Thanks to these properties, the demand for methanol in the world is increasing day by day. In addition to these, methanol synthesis is considered a very promising strategy to reduce greenhouse gas emissions. Because, carbon monoxide (CO) and carbon dioxide (CO₂), which cause greenhouse effect are used for methanol synthesis. Lim et al. (2021). For continuously production of methanol, some processes such as steam reforming of natural gas, gasification of coal, biogas and biomass are used. Striūgas et al. (2020) and Ravikumar et al. (2020)

Various technologies have been developed for CO₂ capture in fossil fuel power plants and factories. In general, pre-combustion, post-combustion and oxy-fuel combustion CO₂ capture technologies are used to capture CO₂ in fossil fuel power plants. However, these CO₂ capture technologies reduce power plant efficiency by about 9-13%. As a result of this, fuel consumption increases and therefore the cost of electricity generation also increases. Soltanieh et al. (2012). In addition to these methods, the conversion of CO₂ gas, known as the carbon capture technique, into valuable products such as methanol is one of the most promising technologies. In this method, the captured CO₂ gas is sent to the methanol synthesis unit with green hydrogen and converted to methanol by catalytic reaction. Soltanieh et al. (2012).

Under these consideration, a green hydrogen assisted CO₂ capture system was developed for a tea factory in this study.

II. Main Consideration

In this study, the green hydrogen integrated CO₂ capture system for a tea factory is designed. The schematic illustration of the proposed green hydrogen based CO₂ capture system illustrated in Fig. 1.

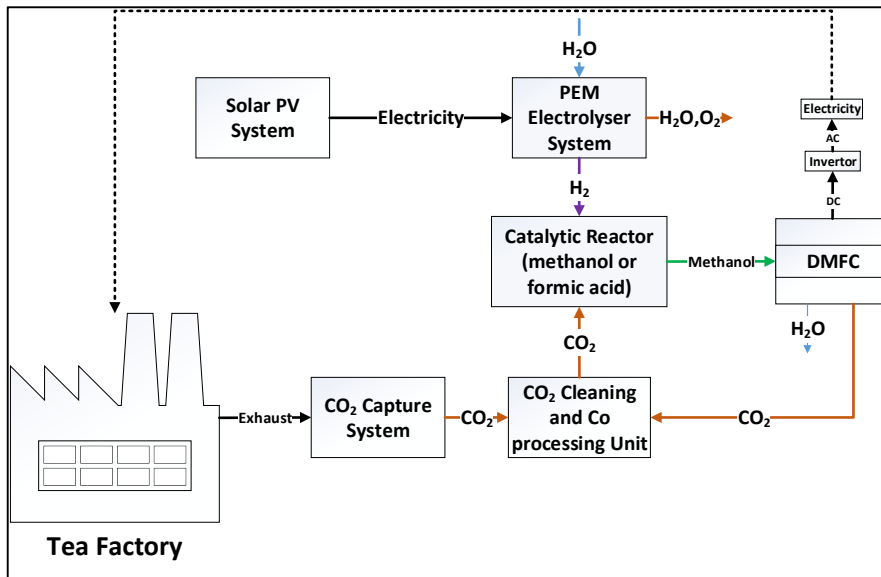
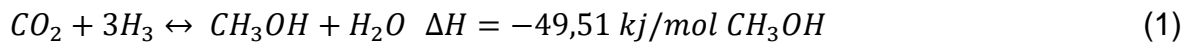


Fig. 1. Schematic illustration of green methanol production for a tea factory.

The chemical reaction that takes place in the catalytic reactor for methanol production is presented as below (Soltanieh et al., 2012).



III. Results and Discussion

The system developed for tea factory can provide the flowing advantages as described qualitatively in Fig. 2 illustrating the variation of global warming effect, environmental impact and climate change impact on the right side and environmental sustainability ratio, methanol production on the left side as a function of CO₂ capture potential.

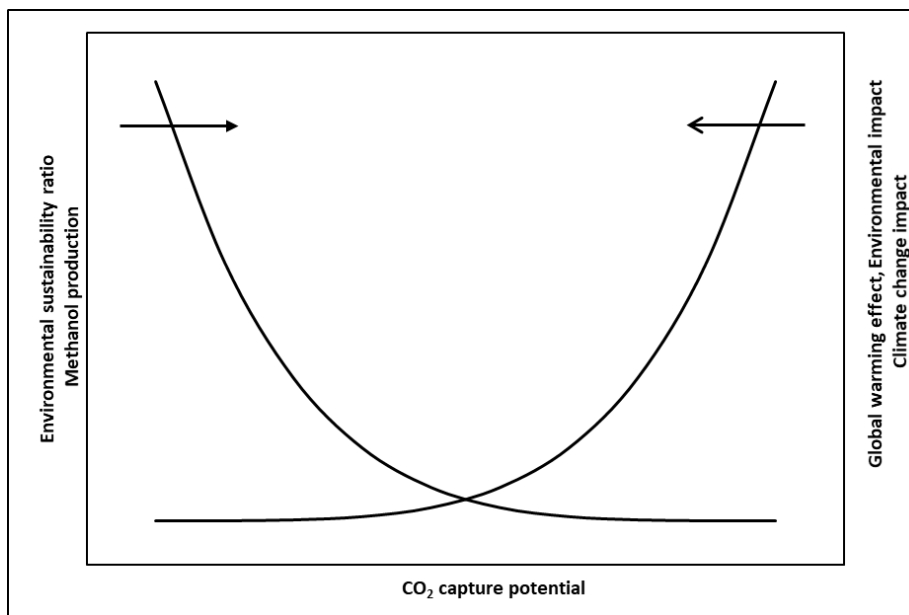


Fig.2. Qualitative evaluation of a tea factory with carbon capture and green methanol production system in terms of global warming potential, climate change effect, environmental impact and environmental sustainability ratio.

IV. Conclusion

Within the scope of this study, CO₂ capture, green hydrogen, methanol and power production, which are the main outputs of this system considered, will provide many advantages in terms of the flowing strategies:

- Carbon capture technology can be used to minimize the CO₂ emission of the tea factory. This results to decrease the carbon penalties in the tea factory.
- Green methanol can be produced by using CO₂ obtained from exhaust emissions from tea factory and green hydrogen obtained by using solar PV integrated electrolyser and the methanol produced can be used to meet some of the fuel needs of the factory. This reduces global warming potential, climate change effect and environmental pollution.

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