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Sustainable Synthesis of Green Methanol Poster

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Changing the World's Energy Future

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Sustainable Synthesis of Green Methanol

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Abstract

This project examines the technical, economic and environmental feasibility of Flexible Chemical Manufacturing to produce green methanol. It is believed that the catalytic production of fuels and chemicals will not only be technically feasible but also economically feasible, and more importantly, environmentally sustainable.

Introduction

- Green methanol is produced by the reaction of carbon dioxide (CO_2) with hydrogen (H_2).
- H_2 is obtained from water electrolysis, that is powered by low carbon energy sources such as nuclear, solar and/or wind. CO_2 is obtained from biological sources such as biomass.
- Dynamic chemical manufacturing could take full advantage of variable power costs and carbon taxes and credits to make fuels and chemicals that are economically and environmentally sustainable.

Significance

- The greater contributions of variable energy resources to the power grid have led to power price volatility (Figure 4).
- These power price volatilities could be capitalized on by operating flexible chemical manufacturing plants at full speed when prices are low and minimizing the production processes when power prices are high (Figures 2 and 3).
- More importantly, these operations can have net zero carbon emissions by capitalizing on the availability of low carbon power sources.

Results and Discussion

- Experiments were conducted in which a feed gas of CO_2 and H_2 mix was pressurized between 700 and 750 psi at 230°C in the presence of a Cu-ZnO-Al_2O_3 catalyst.
- The gas hour space velocity was varied to study the effects of the catalyst on the selectivity and yield of methanol obtained.
- It was observed that at the lowest space velocity of 1446, the highest selectivity and yield of methanol was obtained, while at the highest space velocity of 6000, the lowest selectivity and yield of methanol was obtained (Figures 5, 6 & 7).
- The catalyst operated at equilibrium at both low and high gas hour space velocities and was stable up to 100 hours of continuous operation.

Conclusion and Future Work

- The experiments produced promising and optimistic results that highlight the importance of carbon capture technologies.
- Technoeconomic analysis and life cycle assessment will be conducted to evaluate the economic and environmental feasibility of this technology.
- A journal article will be sent for peer review by the end of Fiscal Year 2022.

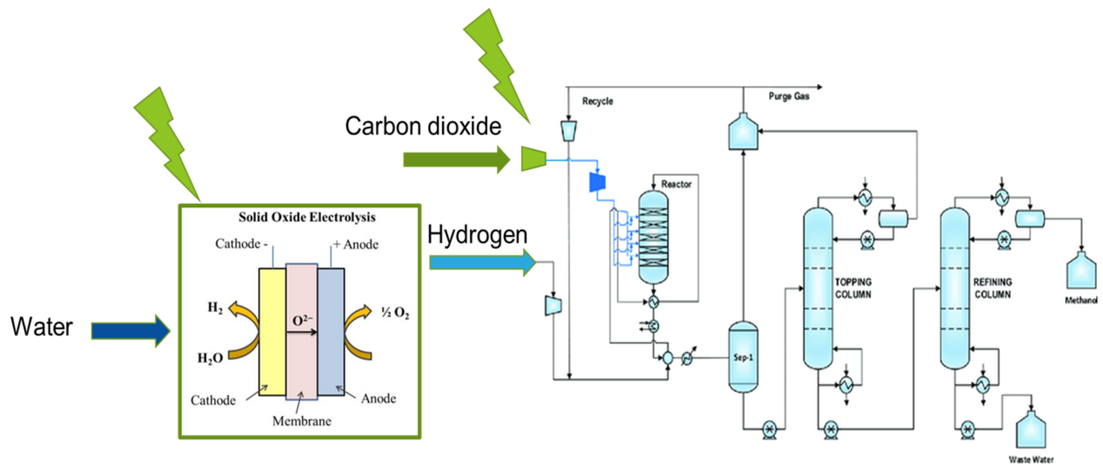

Figure 1: Flow Diagram of Industrial Setup

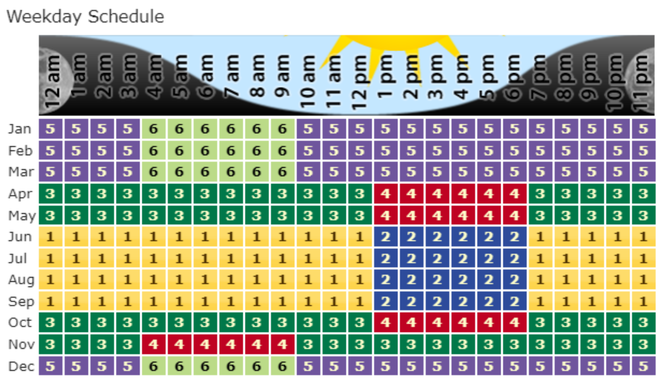

Figure 2: Rate Structure Timetable of Nashville Electric Service in 2019 [1]

Period	Tier	Max Usage	Rate $/kWh	Adjustments $/kWh
1	1	200	0.05573	-0.001196
	2	400	0.02115	-0.001196
	3		0.01774	-0.001196
2	1		0.08064	-0.001196
3	1	200	0.05795	-0.001196
	2	400	0.02115	-0.001196
	3		0.01774	-0.001196
4	1		0.06929	-0.001196
5	1	200	0.05541	-0.001196
	2	400	0.02115	-0.001196
	3		0.01774	-0.001196
6	1		0.05541	-0.001196

Figure 3: Rate Structure Pricing of Nashville Electric Service in 2019 [1]

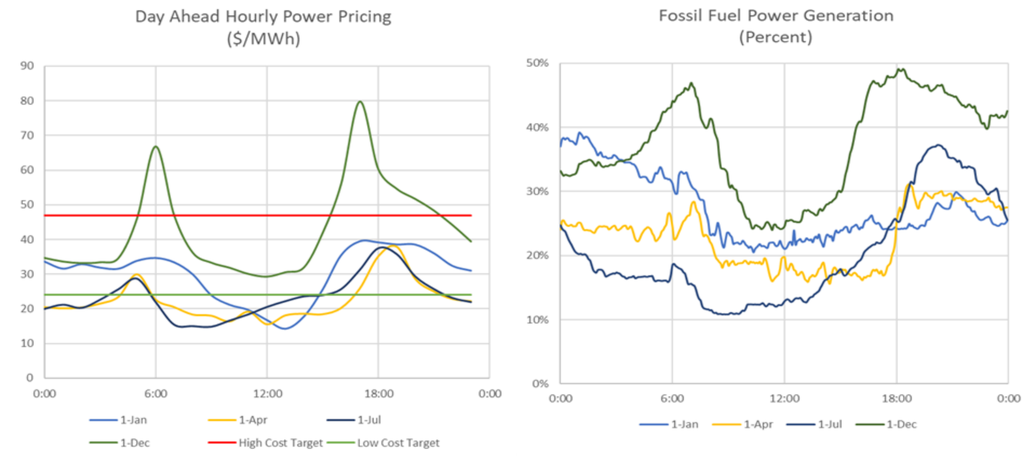

Figure 4. Variables effecting economics and carbon emissions as a function of time of day [2,3]

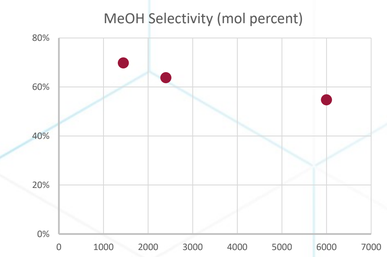

Figure 5: Methanol Selectivity as a function of Space Velocity

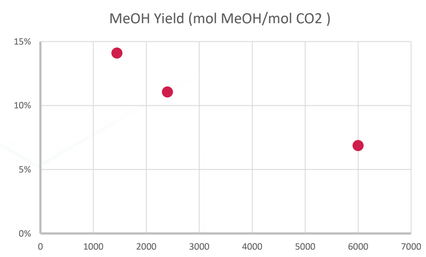

Figure 6: Methanol Yield as a function of Space Velocity

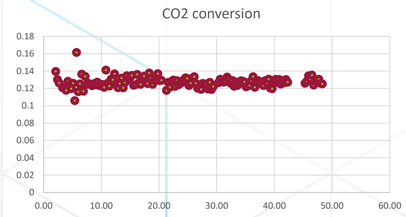

Figure 7: Carbon Dioxide Conversion as a function of time

References

1. https://openei.org/wiki/Utility_Rate_Database
2. http://oasis.caiso.com/mrioasis/logon.do
3. http://www.caiso.com/informed/Pages/ManagingOversupply.aspx.

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