

Application of Biogas in Chemical Energy and Liquid Fuel Production

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I. Introduction

Biogas has been identified as a renewable fuel with significant potential due to feedstock availability. It is produced rurally via anaerobic digesters after which it is transformed to a useful form of energy. Then, it is transported to the point of end use via road rail or gas grid. Particularly in Northern Ireland there is a high demand on liquid fuel as most households do not rely on gas grids and use oil as their main heating fuel.

II. Aim

The aim of the project is to investigate the applications of biogas in chemical energy and liquid fuel productions specifically via Fischer-Tropsch Synthesis (FTS) reaction. FT process is proven operational on an industrial level at elevated pressures which does not match the small scale biogas plants that are implemented in Northern Ireland. Thus, small scale FTS at atmospheric pressure is more suitable under those circumstances. Liquid fuel production by FTS seem promising since FT fuels have high energy content (Table1) and thus can ensure maximum energy recovery.

Table 1: *Energy densities of different fuels

Fuel type	Energy Density (MJ/L)
Diesel/Fuel oil	35.8
CNG (compressed natural gas at 250 bar)	9
LNG (liquefied natural gas at -160°C)	22

III. Experimental

The lab scale experimental setup consists of 30 cm quartz fixed bed reactor (6mm internal diameter), heated in a furnace with a continuous synthesized syngas flow configuration (Fig 1). A farm-scale prototype (Fig 2) would comprise of a single tube through which biogas is reformed to syngas (CO,H₂) which is later converted to liquid fuels via FTS.

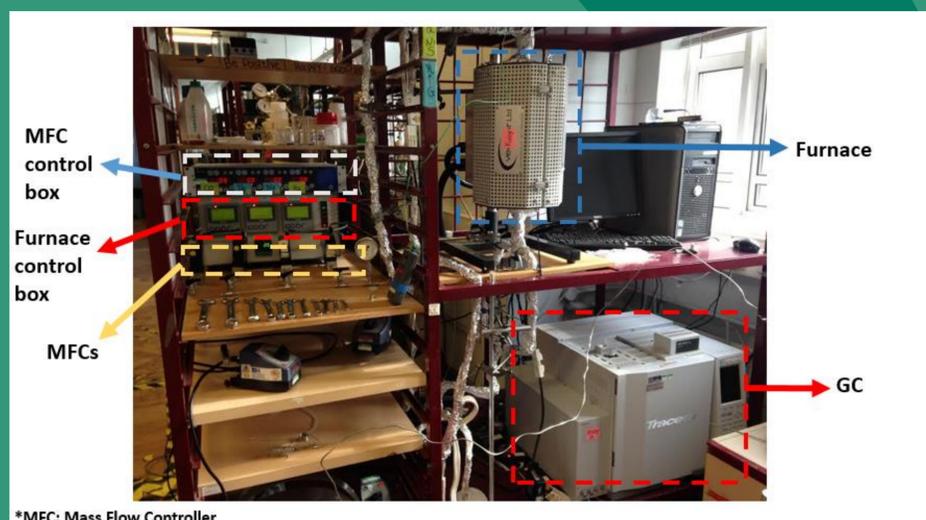


Figure 1: Laboratory testing rig

IV. Results (using commercial catalyst)

- Maximum CO conversion 35% in 1 hour (Fig 3)
- Methane is major product from 1 hour to 21 hours
- General trend: methane production decrease over time
- After 44 hours, higher hydrocarbons (C5+) become major product (Fig 3)
- Interesting regime, 44 hour induction period to reach the selectivity product distribution for FT (Fig 3)
- Run experiments for a longer period of time~1,2 weeks to explore liquid fuel product selectivity

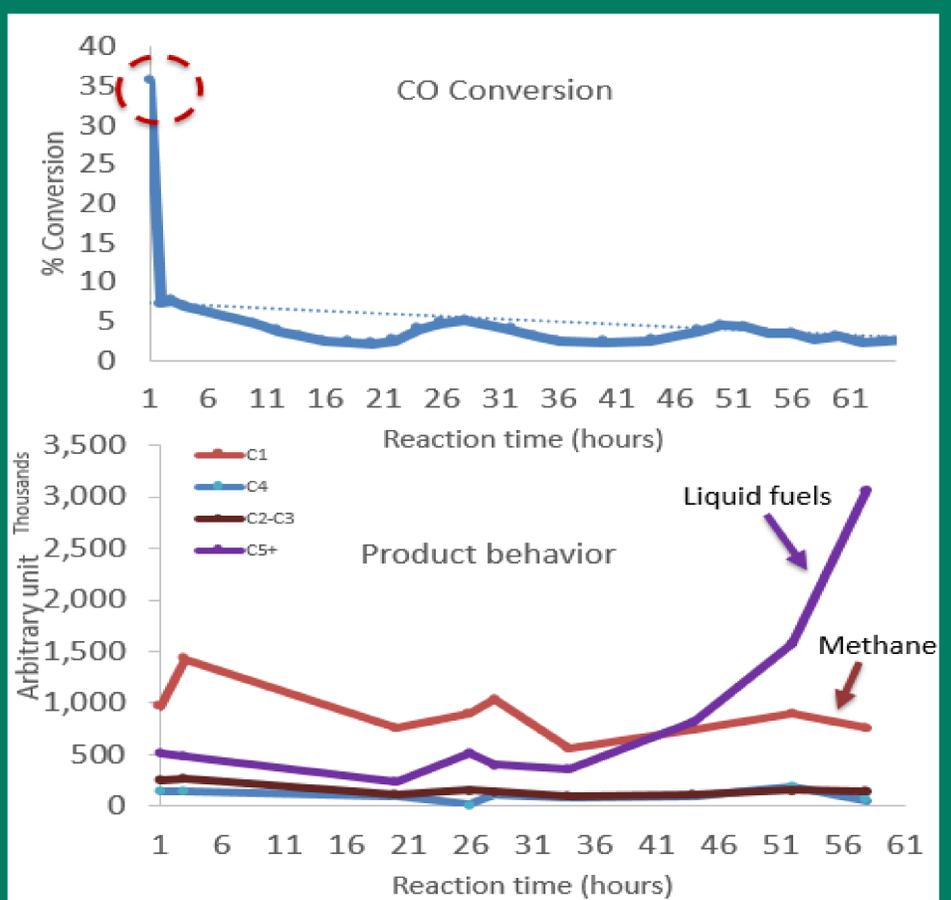


Figure 3: Testing results

V. Conclusion

Liquid fuels were produced at P=1 bar and T=210°C with a higher selectivity to C5+ than CH₄. Results indicate potential farm-scale applicability.

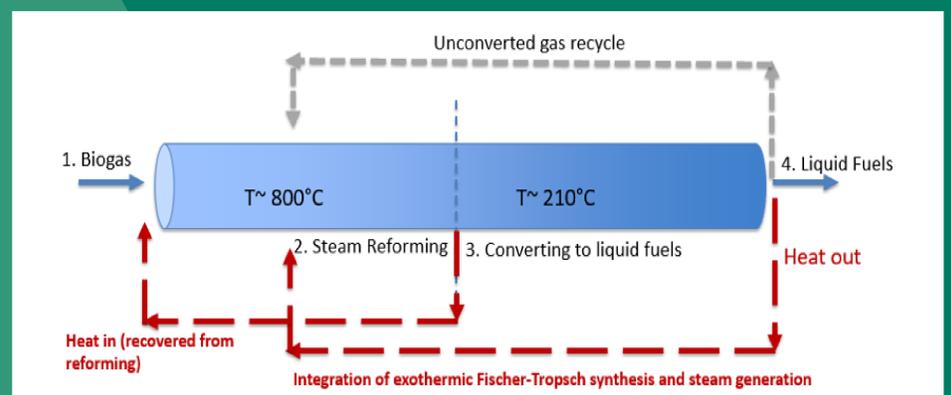


Figure 2: Single tube system

* References

"About Natural Gas | Reference Guides." *Natural Gas, Delivered by Australian Gas Networks*. 2007. Web. 2015.