Methanation Note.pdf

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SYM Project

TECHNICAL NOTE — CH₄ ELECTRO PRODUCTION

CO₂ Methanation has been achieved by GSYF/ISEL team in the framework of SYM Project, using a catalyst reactor coupled to the SynGas electrolyzer built by GSYF. The catalyst has been produced by GSYF / ISEL team with IST technical assistance, using Nickel Acetate supported in Calcium Oxide and Alumina. A tubular reactor (25 cm length and inner Ø 0.5 cm) filled with 2 cm³ of catalyst has been used. Heating was achieved involving the reactor by a controlled ceramic resistance.

The next table presents experimental results obtained at 100°C, 150°C and 200°C (temperature measured at external wall of catalytic reactor) and atmospheric pressure.

<table>
<thead>
<tr>
<th>Electrolyzer</th>
<th>Catalytic reactor</th>
</tr>
</thead>
<tbody>
<tr>
<td>G.Fₗₒw (L/h)</td>
<td>T (°C)</td>
</tr>
<tr>
<td>55.2</td>
<td>100.0</td>
</tr>
<tr>
<td>55.2</td>
<td>150.0</td>
</tr>
<tr>
<td>55.2</td>
<td>200.0</td>
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</table>

Gas composition determined by GC analysis performed at LNEG

Main highlights:

• Methanation was achieved at a temperature of 150°C or higher. At this temperature CH₄ counts for 14.6% of gas output; the conversion efficiency is around 37%, with 83% selectivity towards CH₄. The flow is reduced to 50% from input value. These results agree with stoichiometric calculations.
• At 200°C the selectivity towards CH₄ decreases with CO₂ reduction to CO. CH₄ reduces to 7.6% of gas output, with CO accounting for 6.4%.
• Oxygen becomes residual. Our working hypothesis is that O₂ it is consumed through Ni oxidation at the lower stage of the catalyst reactor.
• Although the gas composition from electrolyzer does not comply with stoichiometric balance for methanation process (4:1 between H₂:CO₂), methanation is effective. Excess CO₂ can be, later on, mixed with an additional hydrogen source for a second methanation stage.

Next steps:

• To test the methane's catalysts supplied by FEUP and IST and proceed with comparative evaluation of their efficiency and selectivity at several temperatures;
• To test Fe powder to eliminate O₂ through oxidation, to preserve the Ni in the catalyst;
• To test methanol catalyst provided by FEUP under SYM project.

With these results, that prove the feasibility of GreenSynFuel technology to produce renewable hydrocarbons from electricity and Carbon (graphite), SYM project can be considered successfully closed. A SynGas mixture (consisting of H₂ and CO₂ with small amounts of CO and residual O₂) is obtained from a patented electrolyzer developed by GSYF. A 1kW industrial prototype electrolyzer has been already tested with success. The SynGas feeds a catalytic reactor to produce methane or other hydrocarbons.

The SYM project has been performed by a consortium of two Portuguese SME (GSYF and ACR Energy- a PV company) in partnership with several Research Centers (ISEL, LNEG, ISQ and FEUP) and has been financing supported by COMPETE (SYM project-contract nº 38940).
The scale-up of the technology to 1 MW plants to produce up to 300 ton of CO₂/year is now being designed by GSYF. New applications to Horizon 2020 and COMPETE 2020 are being prepared to financing the build-up of pilot plants for field tests.

Technology markets are huge markets namely Rural Electrification, Renewable Electricity Storage, Grid Management and Synthetic Fuels for mobility. All of these segments are looking for new competitive solutions to support Paris Conference new energy paradigm, based on Renewable Energies and Low Carbon fuels. GreenSynFuel Technology can be a relevant contribution to this global worldwide objective.

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