SOLETAIR – Fuels and Chemicals from the Sun and Air: Experiences from the integration and test campaigns

The SOLETAIR project aims to develop and demonstrate a process for reusing CO2 from atmosphere to sustainable fuels and chemicals. The SOLETAIR concept is based on Power-to-X (PtX) production models, in which surplus renewable electricity e.g. from solar and/or wind power will be transformed into hydrogen by water electrolysis. This hydrogen reacts with CO2 in a Fischer-Tropsch synthesis unit to produce hydrocarbons that are suitable for fuels and chemicals production.

The integration of the individual system components; renewable electricity, electrolysis, CO2 capture from air and synthesis to a power storage use (PtX) is at a very premature level and requires intense research efforts to become a commodity. The main objectives of SOLETAIR is to learn how to integrate all individual components together and how the concept can be realized in a feasible way. The integrated SOLETAIR concept validation takes place in the premises of Lappeenranta University of Technology (LUT) currently.

In the SOLETAIR project, the solar field of LUT produces the renewable electricity for the hydrogen production. The 5 kW water electrolyser unit is based on a proton exchange membrane (PEM) technology by EWII Group. The unit can produce 1 Nm3/h of hydrogen at maximum 50 bar outlet pressure.

The process also utilizes atmospheric CO2. The carbon dioxide is collected by a Direct Air Capture (DAC) unit developed by VTT Technical Research Centre of Finland and Hydrocell Oy. The technology is based on cyclic temperature-vacuum-swing adsorption on solid amine sorbents. The production rate is 3.8 kg of CO2 per day.

VTT has also developed together with IneraTec GmbH a Mobile Synthesis Unit (MOBSU), which will be used in the SOLETAIR demonstration for methane, liquid fuels and solid waxes production. The MOBSU contains three reactors: rWGS for CO production (designed by VTT), CO2 methanation (VTT, test runs late 2017) and Fischer-Tropsch (FT) synthesis (IneraTec). The feed gas flow rate is 5 m3N/h and in the Fischer-Tropsch mode, the production rate is 0.5 bpd.

These three units, electrolyser, DAC and MOBSU, are all constructed inside sea containers for easy transportation. In addition to validation of the technical integration, the aim is also to have a proof-of-concept for transportable, decentralized process units that can be easily integrated into any CO2 and surplus electricity source.

The preliminary test runs with the DAC unit have resulted in gas that contains 97 vol% (dry) CO2. The first test runs with MOBSU unit at 205 °C and 30 bar(a) have resulted in a Fischer-Tropsch product with alpha-value of 0.9. Around 60% of the FT product was gasoline and diesel and 20% wax. The rest was light gaseous compounds.

The focus of this presentation is in the first experiences of integrating solar field, electrolyser, DAC and synthesis. The results of the first test runs will be presented in addition to the results of the technical validation and feasibility of the decentralized fuel production concept.