C2FUEL

NEWSLETTER

Carbon Captured Fuel and Energy Carriers for an Intensified Steel Off-Gases based Electricity Generation in a Smarter Industrial Ecosystem.

Edito by the coordinator

C2FUEL aims at developing energy-efficient, economically and environmentally viable CO_2 conversion technologies into high added value chemical energy carriers, dimethyl ether and formic acid. The first one is a promising synthetic equivalent of diesel, able to be use for heavy-duty mobility while the second one is an hydrogen carrier with tremendous advantages amongst its ease to be stored and transported, its gravimetric density and its ability to produce back hydrogen at high pressure. One of the CO_2 conversion routes developed within C2FUEL will be demonstrated on DK6 combined cycle power plant through an integrated pilot including a CO_2 capture and conditioning unit, a solid oxide electrolysis for green hydrogen production and a catalytic section for the conversion of CO_2 and H_2 into fuels.

Despite a highly challenging sanitary context, major results have been generated during the first 16 months of the project for each unitary brick to be included in the final demonstration pilot. The design of the CO_2 capture unit is on-going supported by various lab experiments and simulations study. Solid oxide electrolysis cells and stacks have been manufactured for exhaustive characterization and the design of the system is almost finished. First membranes for DME production have been manufactured and characterized and a catalyst screening is underway. In the same way, a catalyst screening have been performed for CO_2 electroreduction into formic acid as well as the selection of the best operating conditions. Finally, the final uses of the fuels produced to be performed during the last phase of the project is well on track: formic acid will be used in a dedicated genset to be installed within Dunkirk Harbor for clean electricity generation while DME will be tested on a real internal combustion engines to assess its potential as a fuel for heavy-duty mobility.

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Progress towards...

CO_2 capture and conditioning

The design of carbon capture unit dedicated to CO_2 extraction from blast furnace flue gases is currently under progress (CNRS and ENGIE). This design and conception process is supported by dust filtration experiments, solvents inventory and selection, membrane contactor tests on synthetic gas mixtures and design of a mini absorption / regeneration unit to be installed on site at DK6. A series of simulations is simultaneoulsy carried out by CNRS in order to achieve the final design of the carbon capture pilot, based on the CCU specifications (flowrate, purity, trace compounds).

Figure 1 : Dust exposure tests on membrane contactor (CNRS)

Solid oxide electrolysis

A set of SOEC unit cells and stacks have been manufactured by Elcogen for detailed characterization to be performed in DTU facilities. The unit cell testing have started and is currently supporting system optimization at DTU. In addition, detailed thermo-mechanical-electrochemical modelling by DTU are currently allowing optimization of system operation. Finally, Elcogen has finished a conceptual design of the SOEC pilot system to be integrated into DK6 power plant.

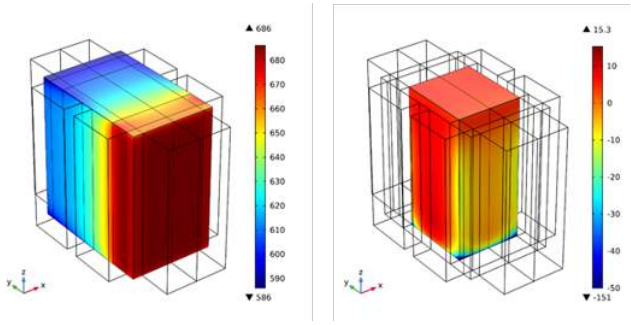

Figure 3 : CFD modelling and simulations of SOEC stacks

Figure 2 : SOEC stacks manufactured

Figure 4 : 3D view of C2FUEL SOEC pilot

Progress towards...

DME production

In TU/e, some students are collaborating with the research team, helping in getting interesting results for the development of efficient membrane reactors for DME production: (i) Gaia Basile is testing membranes developed by Tecnalia for water/methanol permeation, (ii) Deniz Etit has designed the first route for the separation section for the DME direct synthesis, (iii) Alessandro Gazzola is designing the conventional process and the membrane reactor based one in order to compare the performances, (iv) Danny Helwegen has implemented a model from literature to study the effect of operating conditions on the capillary condensation phenomenon

Figure 5 : Reactor for catalyst activity tests

Figure 6 : Carbon membrane sent from TECNALIA to TU/e

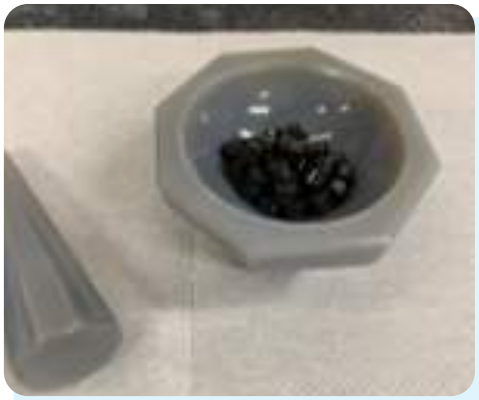

Figure 7 : Catalyst for the methanol synthesis

Formic acid production

So far, work have been done on the design and development of (electro)catalysts and reaction conditions for CO_2 conversion into formic acid to be used as fuel in other activities of the project (TUE). In addition, the technical and economical aspects of the possible processes such as heterogeneous or electrocatalysis have been assessed.

2020 Events and dissemination activities

JUNE 2020

12M GA On-line

C2FUEL project had its 12 months general assembly under a semi-virtual format. Even during these difficult times, level of commitment of the whole consortium is outstanding. Major advancements have been shared such as a nice 3D layout of the future demonstration pilot that will be installed at the DK6 power plant.

SEPTEMBER 2020

5th INEA Workshop on CCUS technologies

C2FUEL project coordinator, Camel Makhloufi, has attended on the 17-18th September the 5th INEA workshop of H2020 Carbon Capture Storage/Use (CCS/CCU) and Alternative Fuels. He introduced C2FUEL project advancements and discussed common communications and dissemination strategies with other CCUS projects representatives. It was a great opportunity to see how European Commission is supporting many outstanding CCUS initiatives as CCUS is a key topic to achieve global decarbonization goals.

AUGUST 2020

Article TheInnovator

C2FUEL project is a great example where high level academics, disruptive startups and big corporates are collaborating to pave the way towards green hydrogen for carbon capture and use in the framework of smarter industrial ecosystems in Dunkirk area. An article from the online media TheInnovator dedicated to the project has been released on the 17th of August. Link to the article : https://innovator.news/how-big-corporates-and-startups-are-teaming-on-the-hydrogen-economy-eb7cced27052

DUNKIRK

3D project

In the frame of Carbon Capture and Storage/ Utilization technologies development, Dunkirk Harbour industrial ecosystem is highly active. The 3D project aims to develop and test at an industrial relevant scale an innovative carbon capture technology based on DMX solvent. A demonstration pilot system will be installed in 2021 with a capture capacity of 0,5t/h CO_2. C2FUEL and 3D consortium are teaming up to bring to light CCUS potential and benefits for territories, especially in Dunkirk area.
Website : https://3d-ccus.com/

2021 Events and dissemination activities

FEBRUARY 2021

International Workshop on CO_2 capture and Utilization

C2FUEL and 9 others H2020 granted projects organize an international workshop on CO_2 capture and utilization with the active support of Eindhoven University of Technology. This workshop to be held on 16 and 17th February of 2021 is registration free and will gather all major stakeholders regarding innovative CCUS technologies development.

MARCH 2021

Scientific communication by TU/e at CAMURE-11 Conference

TU/e will give a speech at the CAMURE-11 conference that will be held on March 2021. This presentation will be dedicated to the "Effect of membrane properties on the direct conversion of CO_2 to dimethyl ether in a fixed bed membrane reactor".

Future work within the next months

Next months will be dedicated to the follow-up of the laboratory works in order to pave the way towards the demonstration phase planned for the last year of C2FUEL project. Different solvents and membrane contactors will be assessed for CO_2 capture from blast furnace gases while simulations study will support the design and sizing of the final CO_2 capture unit (CNRS and ENGIE). SOE cells and stacks will be exhaustively characterized and will be supported by 3D modelling while safety studies will be achieved on the SOE pilot (ELCOGEN, DTU and ENGIE). The catalyst screening for DME production will be achieved and new membranes manufactured while whole process design will be supported by modelling and simulations (TU/e and TECNALIA). Electrochemical cells optimization will be achieved for CO_2 electroreduction as well as catalyst selection (TU/e). Regarding the uses of formic acid and DME, the formic acid to power pilot system will be finalized and tested on manufacturing site (DENS) while first combustion tests with commercial DME will be performed (BTD and VOLKSWAGEN).