

## Newsletter

# COZMOS - Efficient CO<sub>2</sub> conversion over multisite Zeolite-Metal nanocatalysts to fuel and Olefins

### Word from the coordinator

by Unni Olsbye, University of Oslo

With three years in the books, the COZMOS project is progressing towards its ultimate checkpoint: Testing of the combined catalyst and reactor design at pilot plant scale. A tandem catalyst with high selectivity for propane production has been selected and is scaled-up, and a short-list of catalyst candidates with high selectivity for propene production is soon to be ranked. Pilot plant construction is on-going.

The foundation for catalyst and plant design selection is manifold, and this year I would like to highlight two pillars, advanced materials characterisation and life cycle analysis (LCA). During the third year of the project, the materials characterisation expertise of the COZMOS team was key to important strategic decisions. While I write these words, the first complete LCA of the COZMOS process, using COZMOS plant design and experimental data as input, is nearing completion. This work covers the full breadth of the project and is a joint effort of team members from five partners.

Beyond COZMOS, knowledge sharing is an important aspect of advancing CCU technologies as such. During the third year, the COZMOS team published six open-access papers in peer-review journals – a new record by our team.

As project coordinator, I am proud of the team's many achievements, and of the dedication, mutual trust and enthusiastic knowledge sharing that continues between partners at our frequent virtual meetings, large and small. The project is systematically progressing towards reaching the overall project KPIs, pointing towards a successful outcome of the COZMOS project.

### COZMOS TRL 5 pilot plant

by Pelin Deniz Akkuş, Tüpraş

Turkish Petroleum Refineries Corporation (Tüpraş), Turkey's largest industrial enterprise corporation with its four refineries and a total of 30 million tonnes annual crude oil processing capacity, will host the TRL 5 COZMOS Pilot Plant. Tüpraş recently announced its strategic transformation plan focusing on sustainable new business areas on its path to a 2050 Carbon Neutrality target. As a contribution to the company's sustainable refining business and in line with the COZMOS project objectives, the pilot plant will use representative industrial feedstocks to demonstrate the operability and performance of the COZMOS technology for conversion of CO<sub>2</sub> into the targeted C<sub>3</sub> hydrocarbons products propane and propene, to gather engineering design and performance data for the developed breakthrough catalysis technology and to enable evaluation of the target products

for commercial use and scale-up.

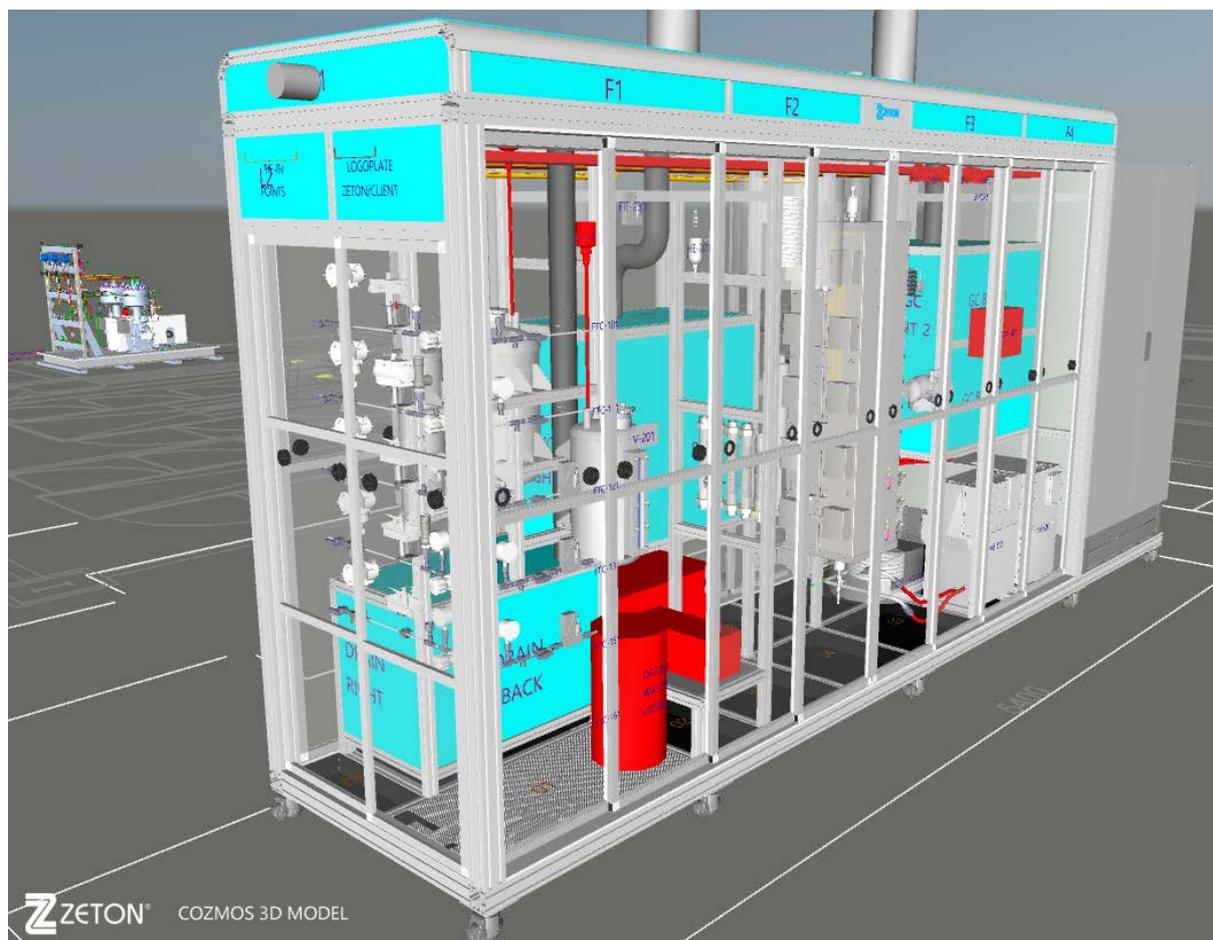
Tüpraş project teams are collaborating with Zeton B.V. from the Netherlands as the pilot plant engineering company for the design, construction and start-up of a new pilot plant for the demonstration of the developed novel catalysts. The pilot plant is designed to achieve automated 24/7 safe operation in once-through mode integrated with smoke, flame and gas detectors inside and outside the pilot plant cabinet and to operate together with a dedicated mixed gas compressor and online gas chromatograph. The pilot plant is to be monitored and controlled by a Honeywell Distributed Control System (DCS). The basic and detailed design phases and HAZOP studies of the pilot plant are completed. Currently, Zeton B.V. is continuing with the construction phase of the pilot plant. In parallel, Tüpraş project teams are also working with Zeton B.V. and Honeywell Turkey teams on the design and the implementation of the control system. Zeton B.V. is expected to deliver the pilot plant to the Tüpraş R&D Pilot Plant Building in the last quarter of 2022.

The COZMOS Pilot Plant, shown in a 3D layout on the next page, consists of Gas and Liquid Feed Sections, a Mixed Gas Compressor Section, a Reactor Section including a fixed bed tubular reactor, a Separator Section, a Liquid Product and Sampling Section and a Gas Product and Analysis Section.

### 1st CCU-Net symposium on CO<sub>2</sub> capture, storage and utilization

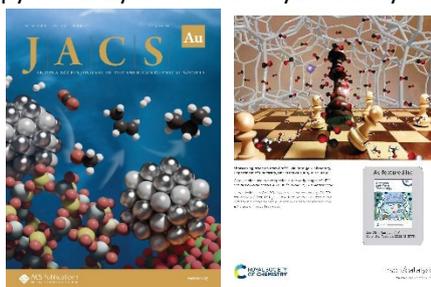
by Tomás Cordero-Lanzac, Univ. Oslo

The first CCU-Net symposium took place last December 9-12, 2021. The CCU-Net Research Mobility Program is a consortium of four Nordic universities (Technical University of Denmark, Luleå University of Technology, University of Oslo and University of Eastern Finland) involved in developing materials and technologies for CO<sub>2</sub> capture and fixation into "CO<sub>2</sub>-neutral" fuels and chemicals. In this first symposium, each of the partners presented their main research lines and recently obtained results related to CO<sub>2</sub> valorisation. New materials for CO<sub>2</sub> capture, membranes for CO<sub>2</sub> separation and strategies for CO<sub>2</sub> hydrogenation or reduction via electro- and photocatalysis were among the topics addressed. Each section of the symposium started with a keynote lecture by the PI of each university of the consortium: Prof. Andreas Kaiser (DTU), Prof. Farid Akhtar (LTU), Prof. Unni Olsbye (UiO) and Prof. Anna Lähde (UEF). Prof. Olsbye, the COZMOS project coordinator, gave a lecture on the kinetics and mechanistic insights into the CO<sub>2</sub> hydrogenation to methanol. COZMOS dissemination during the event included an oral presentation by Dr. Tomás Cordero-Lanzac (UiO) on the kinetics of tandem conversion of CO<sub>2</sub> to light hydrocarbons.



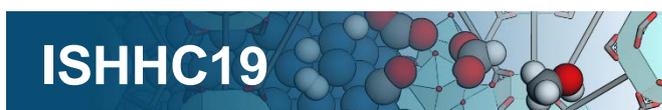
## Scientific Dissemination

The COZMOS partners continue to be very active disseminating the scientific results from the project. The project is now up to 11 publications total. 18 oral or poster presentations have been given at scientific conferences or workshops. One of the papers, "Multifunctional Catalyst Combination for the Direct Conversion of CO<sub>2</sub> to Propane", from COZMOS partners KAUST, Univ. Torino and Univ. Oslo, was featured on the volume 1, issue 10 (25 October, 2021) cover of the American Chemical Society open-access journal *JACS Au* (left). Another publication, "Catalyst sites and active species in the early stages of MTO conversion over cobalt AlPO-18 followed by IR spectroscopy" from Univ. Torino and Univ. Oslo, is part of a Themed Collection on "In situ and operando spectroscopy in catalysis" in the Royal Society of Chemistry journal *Catalysis Science & Technology* and is featured on the inside back cover (right) of volume 12, issue 9 (7 May, 2022).



The COZMOS website has links to all the open-access publications generated during the project, under the heading "Outcomes – Publications" and also under the News/Events feed. Keep an eye on our Twitter feeds, LinkedIn page and web site for announcements on the publication of more papers from the COZMOS project.

## Upcoming Events



The 19<sup>th</sup> International Symposium on Relations between Heterogeneous and Homogeneous Catalysis (ISHHC-19), which is organized by Univ. Oslo and in part by the COZMOS project, will be held as a digital event 27-30 June 2022. The theme of the conference is "Overarching Concepts in Catalysis", and there will be two sessions on CCU. Registration is still open; please visit the conference website, [here](#).

At the same time, 26-30 June 2022, the 19<sup>th</sup> International Conference on Carbon Dioxide Utilization (ICCDU-19), will be held as a hybrid event in Princeton, New Jersey, USA. The conference website is [here](#).

COZMOS Website: <https://www.spire2030.eu/cozmos>

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