PRESS RELEASE

23 November 2022

Converting carbon dioxide into useful chemicals thanks to biotechnology

To reach climate targets, industries need to accelerate the transition towards a low-carbon, resource efficiency and circular economy. Carbon Capture and Utilization (CCU) is a crucial set of technologies that helps decarbonise hard-to-abate industries and move away from fossil fuels[1]. The European research project VIVALDI embraces circularity by developing solutions to capture and convert the carbon dioxide emissions of bio-based industries into chemicals. In this way, the industry's greenhouse gas emissions will not only decrease, but the CO_2 can also be used as a new and sustainable feedstock, which can re-enter the production process flowchart of biorefineries.

Carbon dioxide capture

Luleå University of Technology (LTU) is among the 16 partners of the VIVALDI consortium. Within this project, the Biochemical Process Engineering research group leads the task dedicated to CO_2 purification with the aim to develop a tailor-made post-treatment methodology for each of the different CO_2 streams of VIVALDI's industry partners.

Sampling activities started this summer, when Io Antonopoulou, a researcher in Biochemical Process Engineering at LTU, lead the collection of on-site off-gas streams from the VIVALDI partner SunPine, a biorefinery in northern Sweden. From the roof of SunPine's industrial plant in Piteå, flue gas was collected from the chimney pipe with the help of hoses. The collected flue gas, which consists of carbon dioxide and other substances, was packed under high pressure in large gas bottles thanks to the expertise of Krajete GmbH. The gas bottles with compressed gas were then transported to the lab at LTU. There, Io Antonopoulou and her research team have since worked to produce a clean carbon dioxide gas, which will be sent to the project partners for further processing into chemicals.

"*Instead of relying solely on chemicals that absorb carbon dioxide, our research team captures carbon dioxide using an enzyme called carbonic anhydrase. It is an extremely fast enzyme that can be used alone or combined with other more well-known capture techniques*", says Io Antonopoulou.

[1] https://www.ipcc.ch/report/sixth-assessment-report-working-group-3/

The innovation behind the concept

The concept's innovation is that the enzyme acts as a biocatalyst and accelerates the conversion of carbon dioxide to bicarbonate (a water-soluble form of carbon dioxide) so that the absorption step goes very fast. An important advantage of having carbon dioxide in the form of water-soluble bicarbonate is that less energy is required for the subsequent desorption step. This makes the concept much less energy-intensive, up to 25-30 per cent compared to conventional methods.

"*We believe that the role of carbonic anhydrase as a catalyst in carbon capture will increase enormously in the coming years*", says Io Antonopoulou.

One of the major challenges of conventional carbon capture is precisely the high cost. Carbon dioxide capture from flue gas includes an absorption step where carbon dioxide is "bound" inside a liquid, an absorbent. Then, the carbon-rich absorbent is heated in a desorption step, which releases "pure" carbon dioxide which is further compressed. Desorption and compression require considerable energy. In addition, transporting compressed carbon dioxide for use or storage is also very expensive. The techniques Io Antonopoulou's research team uses are more sustainable and cost-effective.

Luleå University of Technology's role in the VIVALDI project

The task for the Biochemical Process Engineering group in the VIVALDI project is to treat and enrich biogenic industrial emissions using a technology that combines enzymatic CO_2 capture and amine scrubbing and to provide highly pure CO_2 compressed gas to partners for utilisation. The partners will use the CO_2 stream for producing high-added value organic acids with an important role in various industries, such as the food industry.

Together with Io Antonopoulou, the researchers Paul Christakopoulos, Ayanne De Oliveira Maciel and Ulrika Rova complete the team of the Luleå University of Technology involved in the project.

Contact person	Io Antonopoulou, Assistant Professor in Biochemical Process Engineering
Partner organisation	Luleå University of Technology
Mobile number	+46 70 64 37 179 (mobile), +46 920 49 34 53 (landline)
E-mail address	io.antonopoulou@ltu.se

The VIVALDI project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000441.