frontiers in Energy Research

EDITORIAL
published: 20 August 2018
doi: 10.3389/fenrg.2018.00078

Editorial: Carbon Dioxide Utilization

Peter Styring and Katy Armstrong*

Department of Chemical and Biological Engineering, UK Centre for Carbon Dioxide Utilization, The University of Sheffield, Sheffield, United Kingdom

Keywords: ICCDU, carbon dioxide, CCU, CDU, carbon dioxide utilization

Editorial on the Research Topic

Carbon Dioxide Utilization

The ICCDU is the foremost conference on Carbon Dioxide Utilization (CDU) on an international stage. The 14th Edition was hosted at the University of Sheffield, the first time it has been hosted by the United Kingdom. The conference was organized by the CO2Chem Network (www.co2chem.com), the largest global network in the field. When this Research Topic was conceived we were very clear that this should not be considered as a set of conference proceedings, but high quality original research papers that reflected the general flavor of the conference. Each paper has had the rigorous peer review that would be expected, as I am sure you will discover.

In the last decade there has been considerable advancement in CDU chemistry and engineering. There has been a transition from bench scale chemistry through to commercial implementation across the world. This Research Topic reflects this transition as it covers areas as diverse as carbon dioxide capture, the chemistry and laboratory scale engineering and even capture free utilization, while also addressing the commercial and social aspects of utilization across the supply chain. While the editors did not impose any barriers to the type of utilization covered, it was noticeable that the majority of papers focused in the conversion of CO_2 into fuels. This demonstrates the need to develop methodologies toward the production of low carbon fuels, particularly for mobility applications, that have superior physical and environmental properties when compared to fossil fuels.

The paper on capture of CO_2 (Reed et al.) offered a new approach to purification through a pressure swing adsorption (PSA) process, based on an ionic liquid coated on to sustainable cellulose fibers. The best materials show capacity similar to aqueous MEA solutions but with reduced costs and faster cycle kinetics. One key finding was that the best performance was achieved for 25% loading of the ionic liquid on to the low-cost cellulose, an effect of the thin film coated on to a highly textured support surface. This was evidenced in SEM studies. The process was further used to integrate the capture unit to a low temperature plasmolysis reactor (Moss et al.) to produce CO, a key constituent of syngas. Different concentrations of CO_2 in the purified flue gas were reacted by plasmolysis, and the results showed that conversion of 80% CO_2 in N_2 into CO was far more efficient than when using pure CO_2. This has potential implications in cost reduction in plasma-catalyzed processes.

In most CDU processes, catalysis is expected to play a major role. This was exemplified in the use of a copper catalyst to convert syngas to methanol in a single pass (Ahoba-Sam et al.). Methanol is not only an important transport fuel or additive, but also a key intermediate in chemicals manufacture. The role of the solvent in the low-temperature process was investigated and it was observed that the best syngas conversion was achieved using diglyme. Indeed, methanol is a key feedstock in the production of butanol, a direct gasoline drop-in fuel, using a non-catalytic process (Dowson and Styring). The novelty of the latter process is that it does not require a CO_2 capture step, instead using the product production to do a reactive capture from flue gas concentrations of CO_2 in nitrogen.

Edited and reviewed by:
Ah-Hyung Alissa Park, Columbia University, United States

****Correspondence:***
Peter Styring
p.styring@sheffield.ac.uk

Specialty section:
This article was submitted to Carbon Capture, Storage, and Utilization, a section of the journal Frontiers in Energy Research

Received: *03 July 2018*
Accepted: *20 July 2018*
Published: *20 August 2018*

Citation:
Styring P and Armstrong K (2018) Editorial: Carbon Dioxide Utilization. Front. Energy Res. 6:78. doi: 10.3389/fenrg.2018.00078

While some might say that the conversion of CO_2 back to a fuel is an energy inefficient process, it is argued that there is a need for synthetic fuels as we move toward a low carbon economy (Wilson and Styring). Synthetic fuels derived from CO_2 are not necessarily the same as those derived from fossil oil as the former have zero sulfur content. Furthermore, they produce far less particulate matter on combustion, because synthetic fuels are low in aromatic and branched hydrocarbons making them more environmentally attractive.

An interesting article from Sweden investigates how synthetic fuels can be produced electrochemically from CO_2 emitted from fossil fuel combustion and biogenic processes (Hansson et al.). This emphasizes the need for local clean energy sources and appropriate CO_2 sources when devising CDU processes. The paper concludes that electro-fuels could be produced from CO_2 but that the limiting factor is a potential supply exceeding demand in Sweden and the availability of clean energy in the country: it is proposed that by 2030 the major market could be derived from lignocellulose-based CDU.

Finally, two papers consider the techno-economic and social aspects of CDU. The first looks at what barriers there are at the present time to the implementation of CDU commercially (Kant). Public acceptance of new technologies is often key to the successful implementation. Carbon Capture and Storage (CCS) has suffered across Europe because of public opposition, to the extent that CCS is not now permitted in countries such as Germany. The second paper considers the best ways to address public concerns (Jones et al.) to present CDU as a truly environmentally-friendly technology, based on an evidential approach. The paper recognizes that research in this area is limited but offers a potential agenda for its continued study and implementation of the data.

It is gratifying to see the level of interest that this Research Topic has generated. At the time of writing this Editorial, 18 June 2018, the combined views recorded for the papers in this topic are over 26,000. Recent developments since the 2016 conference mean that the status of CDU is increasing internationally. A 2018 report from Mission Innovation, supported by the G20 governments and the European Union as a block, has recommended significant increase in funding for CO_2 utilization chemistries and technologies. A number of papers published in this Research Topic featured in the evidence presented to the panels and in the final policy document (https://www.energy.gov/sites/prod/files/2018/05/f51/Accelerating%20Breakthrough%20Innovation%20in%20Carbon%20Capture%2C%20Utilization%2C%20and%20Storage%20_0.pdf). It is becoming clear that the use of CO_2 as a chemical feedstock is becoming an integral tool in a move toward a low carbon future and a circular economy. CDU means that less fossil carbon enters the supply chain, satisfying the top level of the Lansink waste protocol. Furthermore, it also addresses issues of reuse and recycling as part of an industrial carbon cycle.

AUTHOR CONTRIBUTIONS

PS was the primary author of this Editorial paper. KA provided additional information and proof reading of the paper.

FUNDING

We acknowledge the Engineering an Physical Sciences Research Council for funding the CO2Chem Network which organised ICCDU 2016 under grant numbers (EP/K007947/1 and EP/H035702/1).

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.