Summaries of presentations

Dr Ing. Rico Kanefke, Suez

Germany is the world champion in exports of chemical and pharmaceutical products. Although organic substances (plastics, pesticides, pharmaceutical products or special chemicals) are being produced ever more efficiently and with less waste, the carbon source is still almost exclusively oil or natural gas. The next step towards a CO_2-neutral chemical production - that is less dependent on fossil carbon sources - could be the chemical recycling of organic (but also inorganic) waste, or like I want to call it: secondary raw material sources. There are now several approaches that lead to completely different basic chemicals for chemical synthesis (e.g. naphtha, synthesis gas, CH_4, CO, CO_2). As a supplement to the Power-To-X processes, which will provide hydrogen, based on renewable energies in the future, carbon from organic waste can be an important step in the future carbon supply of the chemical industry. CO_2 for example is easy to produce and either directly needed as such or can be reduced to CO by electrocatalytic processes, for example, and is thus once again available as a universal basic material for organic chemistry. One possibility for converting hazardous and non-hazardous waste into CO_2, that is as pure as possible, is the FPO process (Flameless Pressurized Oxy-combustion) combined with an adapted waste menu. The presentation shows the situation in Germany and Saxony-Anhalt described above and the possibilities that e.g. FPO technology can offer in the future for the defossilization of chemical production.

Prof Mercedes Maroto-Valer, Herriot Watt University/IDRIC

The decarbonisation of industrial clusters is of critical importance to the UK's ambitions of cutting greenhouse gas emissions to net zero by 2050. The UK Government's Industrial Clusters mission aims to establish the world's first net-zero carbon industrial cluster by 2040 and at least one low-carbon cluster by 2030. This plan is underwritten by a £170m public investment through the Industrial Strategy Challenge Fund (ISCF). The £20m Industrial Decarbonisation Research and Innovation Centre (IDRIC) is a critical element of this funding package.

IDRIC is working with industry, academia, policymakers and other stakeholders to deliver a multidisciplinary research and innovation agenda to decarbonise the UK's largest six industrial clusters (Humberside, South Wales, Grangemouth, Teesside, North West and Southampton).

Building on her May 2020 webinar for the SCI which has led into this SCI conference series, Mercedes will give an update on progress for IDRIC including next steps, activities and opportunities. Mercedes will provide a summary of the outcomes of the IDRIC engagement process and the priorities identified for the centre.

More information about IDRIC can be found at www.idric.org

Dr Mim Rahimi, Massachusetts Institute of Technology (MIT)

Electrochemistry, a key part of the 2019 Nobel Prize in Chemistry, is emerging as a powerful tool for designing diverse CO_2 mitigation approaches, offering a unique advantage in the future, when the electrical energy is mostly generated by renewable; the carbon footprint and the cost of the electrochemical processes would be minimized. In this context, electrochemically driven processes for carbon capture and storage (CCS), as a new frontier within the electrochemistry and climate change framework that has drawn significant attention in the last few years, could be an attractive approach to either avoid further release of CO_2 by capturing it at the source point or to reduce the atmospheric CO_2 level through a direct air capture process.

In this talk, a comprehensive background on various electrochemical approaches for CCS will be discussed along with their impact, advantages, and challenges they are currently facing. In addition, an electrochemically mediated amine regeneration (EMAR) that we recently developed will be discussed and recent advancements in process developments and scale-up will be provided. The EMAR process scheme is similar to that of the state-of-the-art aminebased thermal scrubbing processes, but the high-temperature desorber (normally operating at 120°C) is replaced by an electrochemical cell that operates at moderate temperatures (e.g., 50°C) in which copper ions are electrochemically generated from a copper plate anode to drive the dissociation of amine and CO_2 toward CO_2 desorption. Once the gas is flashed off, the CO_2 lean stream is regenerated via the electrochemical plating of copper on the cathode from the copper-amine complex. The overall energetics of EMAR to desorb CO_2 captured from a flue gas stream was estimated to be between 50 and 80 kJe/molCO_2, suggesting the competitiveness of this approach with the conventional thermal processes. EMAR, as an electrochemical based technology, offers several advantages over thermally driven aminebased processes, including operation at low temperature and the ability to desorb CO_2 at moderate pressures, which minimizes the downstream compression costs for CO_2 storage. Overall, the developed EMAR could be an impactful electrochemical-based approach that could effectively mitigate CO_2 emission and climate change.

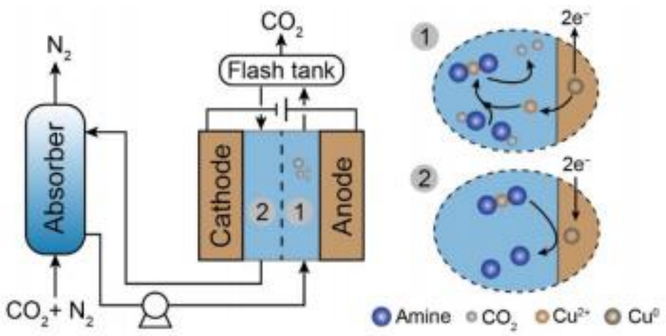

Figure 1. **Schematics of an electrochemically mediated amine regeneration (EMAR)**

developed for carbon capture from a flue gas stream. The process scheme consists of three chemical or electrochemical transitions that take place in an absorber, an anode, and a cathode.

Andy Walker , Johnson Matthey

To date, 23 countries and regions have put commitments in place to limit the impact of climate change by planning to become net zero Greenhouse Gas economies by 2050 – and the UK was the first of the major economies to codify this commitment in law. The pace of change towards net zero is really accelerating – for example, just 12 months ago, 16% of GDP derived from nations and regions with net zero commitments – this figure is now 53% and this trend will continue to get stronger and will require significant change in the behaviour of governments, industries and individuals.

There is a broad consensus emerging that net zero cannot be achieved without widespread use of clean hydrogen, particularly in hard to decarbonise sectors such as heavy transport (eg long-haul trucks), high temperature industrial processes, domestic heating, and chemical manufacture. Hydrogen will also play a key role in enabling the increased implementation of renewable energy, by providing long-term (seasonal) energy storage, to cover long periods with little sunshine or wind.

Clean hydrogen can be produced in two main ways: through the electrolysis of water using renewable electricity, and via steam (or auto-) reforming of methane with capture and subsequent storage or utilisation of the associated CO_2 (Carbon Capture, Utilisation and Storage, CCUS). Some of this captured CO_2 can be used, for example, to make fuels or chemicals.

This presentation will outline the role of hydrogen in future net zero societies, and show how the interplay between hydrogen and CO_2 can be a synergistic one, to enable decarbonisation across a range of sectors and applications.