'Hidden heroes' of e-fuels production

By Anthony Wright on Jun 21, 2024 | 0 NEWS | METHANOL & E-FUELS

Produced by combining hydrogen with carbon dioxide (CO_2), electrofuels, or e-fuels, are rapidly becoming a key contender in decarbonising the transport sector, particularly in areas where electrification is challenging.

They can be used in internal combustion engines, providing a clean alternative to conventional fossil fuels. In the broadest sense, the term e-fuel includes electrolytic green hydrogen and one of its derivatives, green ammonia. But what of the lesser-known e-fuel technologies?

"I want to draw attention to some of the 'hidden heroes' of electrofuels production," said Stephen Harrison, founder of sbh4 Consulting during **gas**world's 'E-Fuels and Synthetic Fuels' webinar. "Technologies that are likely to play a major role, but that do not seem to get the same attention as electrolysis."

One such technology is direct air capture (DAC), where chemical reactions are used to pull carbon dioxide (CO_2) out of air. When air moves over these chemicals, they react with and trap CO_2, while allowing other components of air to pass through.

"DAC is likely to be required to capture CO_2 in remote locations where wind and solar conditions are ideal to make low-cost green power but where point source CO_2 emissions may not be available," explained Harrison.

Bringing liquid CO_2 to remote locations is possible, but adds to the cost. "DAC consumes power, which will also be required for electrolysis and can generate CO_2 at the electrofuels site, so it may be an economical solution."

Despite its potential, there are some concerns around the purity of CO_2 from DAC. Most DAC systems generate CO_2 with a high proportion of nitrogen, although purification methods do exist.

Another 'hidden hero' is CO_2 liquefaction – a technology harnessed by hundreds of liquefiers operating worldwide across a wealth of industries.

"For example, at breweries where biogenic CO_2 is produced during fermentation the CO_2 is captured, liquefied for storage and distribution to restaurants and bars to dispense beer and soft drinks," explained Harrison.

A large amount of CO_2 is also produced during fermentation of maize and other crops for bioethanol and the upgrading of biogas to biomethane. The industrial gas sector captures and liquefies this CO_2 for entry into the commercial supply chain, where it can be transported to e-fuels plants to produce methanol and jet fuel.

A third 'hidden hero' relates to three key refining processes used to convert Fischer

Tropsch (FT) hydrocarbons into jet fuel: isomerisation, hydrocracking and hydrotreating.

FT synthesis produces a mix of linear hydrocarbons of different lengths. Some of these paraffins are too short for diesel or kerosene, while others are too long.

“The long, heavy waxy molecules can be hydrocracked to make smaller chain hydrocarbons that are required for diesel and kerosene,” explained Harrison. “Hydrogen is added to the waxes in the presence of a catalyst to achieve this.”

When exposed to the very cold temperatures present during high altitude flight, a mixture of linear hydrocarbons can freeze, making isomerisation a key priority.

“Isomerisation converts the long straight paraffins to branched chains which look like Christmas trees. These molecules remain liquid at colder temperatures.”

The last of the three refining processes, hydrotreating, involves hydrogen being reacted with alcohols and esters that may form during FT, yielding water.

Harrison’s final ‘hidden hero’ is methanol synthesis – a process used daily in plants all around the world. It involves converting syngas – a mix of carbon monoxide, hydrogen and CO2 – into methanol using a catalyst at high temperatures and pressures.

Fuel-forming technologies

Also speaking on the webinar, Prasanna Kannan, Commercial Director at Zero Petroleum, which makes petroleum from air (recycled carbon) and water, said, “We opened our first plant last year, an engineering plant in Bicester, UK, and we are raising capital to hopefully build our first commercial facility in the next few years.”

The 10,000-square-foot facility in Bicester Heritage was selected in part for its historical significance in aviation and motorsports, and close to Oxford University.

Its plant contains equipment for all three separate processes used to create the fuel: DAC, electrolysis to create green hydrogen and Zero’s proprietary FT technology, DirectFT, which provides a ‘uniquely powerful’ platform for the synthesis of fuels.

“We have a unique technology that allows us to produce all types of fuel on a 100% drop-in basis,” explained Kannan.

A similar technology was started up by Infinium, a spin out from liquid fuels technology leader Greyrock Energy.

Liz Myers, Global Vice President of Business Development at Infinium, explained, “We have a direct fuel production pathway that is an alternative to FT that allows us to directly produce transportation fuels on-site, without the need for third party hydrocracking or refining.”

The trio were united in their outlook for e-fuels. Harrison said, “Let’s believe – that would be my message. Let’s learn the technologies, scale up and make the costs come down, and break this chicken-and-egg cycle.”

Kannan targeted policy as a key driver of sustainable fuels, “Ultimately we’re trying to decarbonise and it would be great if policy looked at carbon intensity. That would make it better in terms of innovations and technologies.”

Stressing the need to focus on ‘now’, Myers added, “E-fuels are here today. There’s a lot of talk about it being a 2030 solution but we’re starting to scale up, it’s at a precipice for growth and an exciting place to be.”

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gasworld’s ‘E-fuels and Synthetic Fuels’ webinar took place on 21st June 2024 and is available to watch on demand at www.gasworld.tv.