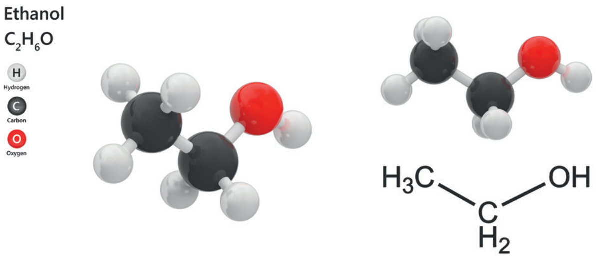
BIO-ETHANOL FOR SAF

Fermentation of maize to ethanol is common in North America. Carbon dioxide (CO2) can readily be captured from the fermentation broth and purified for industrial applications such as food freezing and beverage carbonation. Ethanol can be blended with petroleum derived gasoline to improve the sustainability of automotive transportation fuels.



Ethanol can be converted to jet fuel

Ethanol can also be converted to the paraffinic fraction of synthetic aviation fuel (SAF) through the ethanol to JET (ETJ) or alcohol to JET (ATJ) pathway (JET is the term used to describe aviation kerosene). The chemistry of the ETJ conversion relies initially on dehydration to strip water out of multiple ethanol molecules followed by oligomerisation, which is a controlled amount of polymerisation.

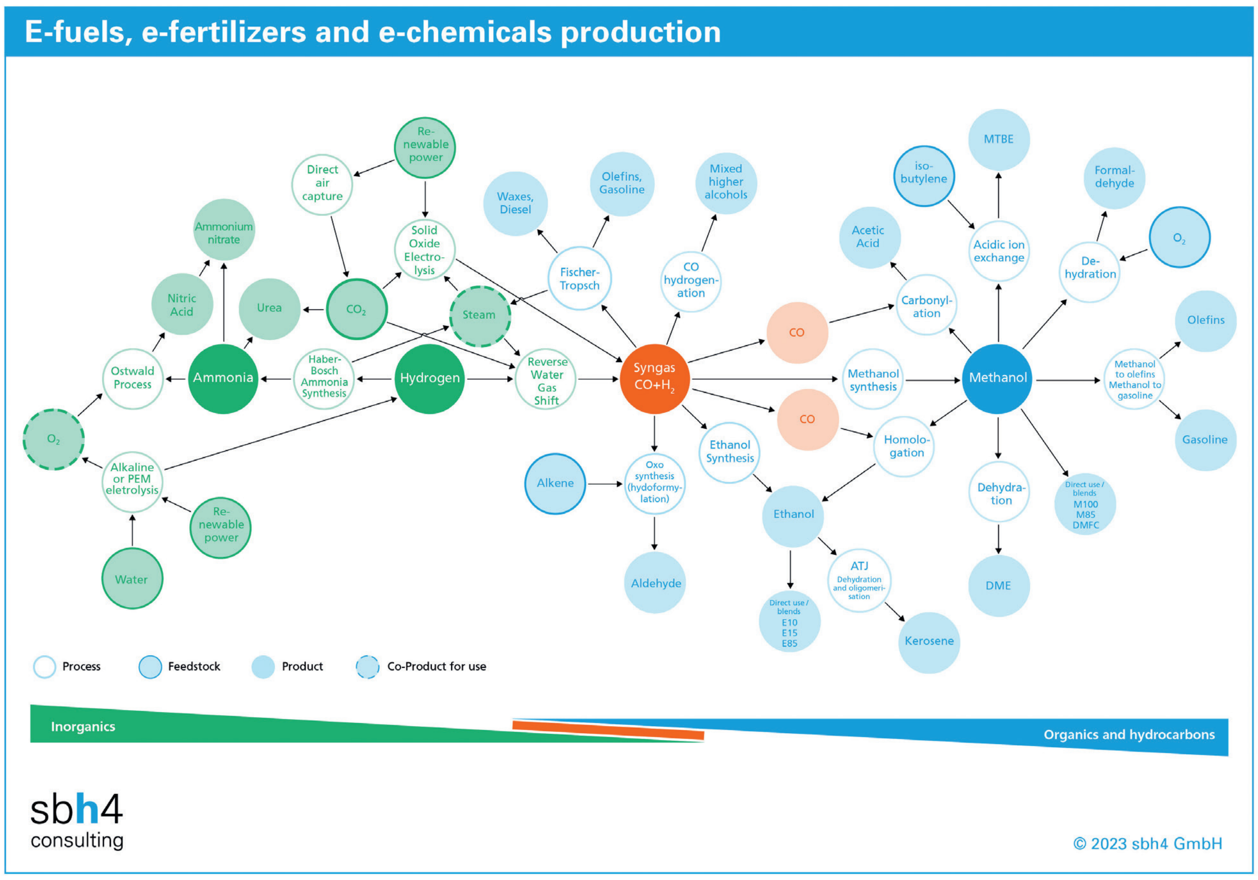
The properties of JET from refined petroleum products and JET that contains SAF are stated in relevant ASTM specifications. A key aspect is the maximum allowable fraction of aromatic compounds in JET containing SAF is capped at around 25% by the ASTM 7566-22a.

On the other hand, volatile aromatics are required to be blended with the heavier paraffinic olefins that are produced by the ETJ process so that the mixture can meet the specified distillation curve. The distillation curve is prescribed as the amount of JET recovered at various distillation temperatures.

The maize crop, along with other plants absorbs CO2 during photosynthesis. Plants use carbon from CO2 to make carbohydrates and, starches to build their leaves and structure. Bacteria can also consume CO2 and carbon monoxide (CO) to produce valuable chemicals such as ethanol.

LanzaTech utilises anaerobic acetobacter bacteria in a fermenter to convert CO rich feed gases, such as syngas, to ethanol and a range of biochemicals. Subsequently, the complimentary LanzaJet process can be used to convert the bioethanol to SAF in their proprietary 'Ethanol to Jet' or ETJ process which converts the ethanol to ethylene, through dehydration then oligomerises the ethylene to paraffinic olefins.

The ideal feedstocks for the LanzaTech fermenter are CO-rich. CO2 rich streams can potentially be utilised in combination with hydrogen. But a high CO content in the feed to the bioreactor, or fermenter, reduces the green hydrogen feed requirement. Syngas derived from waste or biomass gasification is generally CO-rich and is a good feedstock for the LanzaTech process.



E-fuels, e-fertilizers and e-chemicals production

Iron and steel making also yields CO-rich flue gases which are ideal feedstocks to the LanzaTech process. Blast furnace gas (BFG) contains 20% CO and converter gas (also known as basic oxygen furnace gas or BOFG) contains 60% CO. Utilisation of BFG and BOFG in the LanzaTech process can generate valuable bioethanol.

LanzaTech's process was demonstrated at pilot-scale in 2008 using flue gases from the BlueScope Steel mill in Glenbrook, NZ. Since then, LanzaTech has successfully deployed its technology at two 300 tonne per annum demonstration facilities at Baosteel Shanghai and Shougang Steel Caofeidian in China. These LanzaTech fermenters are fed with a range of iron and steel making off gases including BOFG, BFG, and coke oven gas (COG).

Jet airliner refuelling

The term CCT or 'Carbon Capture and Transformation' has been used to describe the LanzaTech fermentation process. Whilst it is highly effective at transforming carbon monoxide to ethanol, the LanzaTech process has more in common with carbon utilisation than CO2 sequestration.

LanzaTech operates the Freedom Pines Biorefinery in Soperton, Georgia which uses bio fermenters to generate ethanol and other chemicals. The LanzaJet ethanol to jet SAF production process will soon also be implemented at that location to utilise captured carbon to make fuels that can substitute aviation kerosene, a fossil fuel distilled from crude oil.

Life Cycle Analysis (LCA) of the LanzaTech process shows that the holistic CO2 emissions reduction is primarily due to the substitution of fossil fuels with SAF derived from ethanol recovered from the fermentation broth.

Also integral to the LanzaTech LCA is consideration of whether the feedstock, such as iron and steel making flue gases are flared, or utilised. If they are flared, their recovery and conversion to ethanol is a significant environmental benefit.

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