Biomethane production generates biogenic CO_2

Why stored carbon needs a purity standard

By Stephen B. Harrison, sbh4 consulting

Industrial carbon management – ICM, for short – is the range of technologies to capture, transport, use and store carbon dioxide emissions from industrial and energy production facilities, as well as to remove CO_2 from the atmosphere. Today it is recognised as an imperative to mitigate climate change. At the heart of this work is carbon capture, transportation and storage – let's call it CCTS for short. The concept is to recover CO_2 from industrial process gas emissions and inject that captured CO_2 deep into the ground for long-term storage.

This work will be essential to mitigate CO_2 emissions from industrial processes such as cement making, steelmaking and thermal power generation. There are several projects underway to capture CO_2 from ammonia plants, steam methane reformers, and new-build auto thermal reformers. CCTS is an integral part of these schemes to ensure that they produce blue ammonia or hydrogen.

However, at present there is no common standard to define the quality of CO_2 that should be used in CCTS projects. In the absence of a standard, many operators refer to the Northern Lights project and its CO_2 purity standard. That flagship project has, in essence, filled the vacuum for now.

Cross-border transfers

Denmark, the Netherlands, Norway and the UK have spearheaded the extraction of fossil fuel reserves from the North Sea for many years. They are also at the forefront of developing subsurface geological CO_2 storage sites.

Some of the CCTS schemes in these countries will remain national in the years ahead. In the UK, two CCTS schemes are proposed for the Irish Sea, off the west coast of England. HyNet North West will decarbonise England's Liverpool Bay industrial cluster, including blue hydrogen production at the Essar refinery. The Peak Cluster focuses on capturing, transporting and storing CO_2 from lime and cement making in the Peak District in England.

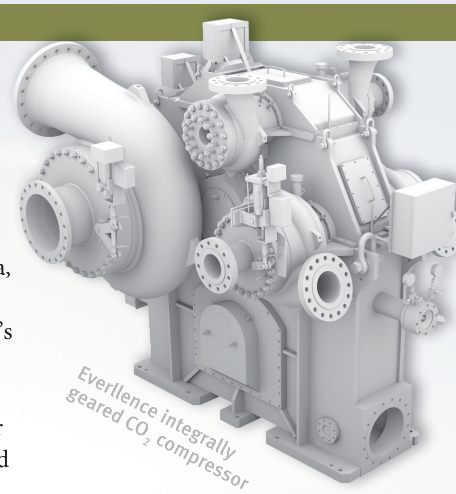
In many other CCTS schemes, waste CO_2 will be captured in one country and transported across borders to the storage location. In the case of Norway and the UK, these are not just national borders but also represent a movement of CO_2 into or out of the EU.

Many nations in Europe will need to participate in cross-border CCTS schemes because their country does not have the appropriate geological profile to store CO_2. It means that the future of CCTS will require an international and regional approach. This should also act ais a key driver for the development of standards for CO_2 purity for storage, in order to ensure a harmonised approach.

Yara Sluiskil and Northern Lights

What is the source for Northern Lights? Fertiliser and industrial business Yara operates an ammonia and fertiliser plant at Sluiskil in the Netherlands. It is already a major source of merchant liquid CO_2 for commercial applications. From 2026, an additional 800,000 tonnes per year of CO_2 emissions will be liquefied, transported by ship and stored underground as part of the Northern Lights scheme.

At Sluiskil, Yara will have 15,000 tonnes of liquid CO_2 storage. This will be transferred to a fleet of two ships, each capable of carrying 7,500 tonnes of CO_2. Each week, both of these ships will be loaded at Sluiskil and make the round trip to the offshore storage facility in the Norwegian sector of the North Sea.



Everllence integrally geared CO_2 compressor

SMR is an easy win

Another source of CO_2 for storage derives from the steam methane reformers used to produce hydrogen for ammonia.

The ammonia production must capture CO_2 from the process gas, and since it is captured for process reasons already, the capital and energy costs involved are already accounted for. CO_2 drying, purification and liquefaction are the only incremental costs when capturing CO_2 from an ammonia plant.

Competition for biogenic CO_2

CO_2 for storage can also come from biogenic sources. Storage of biogenic CO_2 results in negative CO_2 emissions because plants remove CO_2 from the air and this is then permanently stored. One of the main sources of biogenic CO_2 is the upgrading of biogas to biomethane.

In Denmark, the biogas sector is highly consolidated, with several large plants dominating production. The implication is that CO_2 capture on these large biomethane facilities is cost-effective. INEOS Energy has capitalised on this opportunity. It will aggregate liquefied biogenic CO_2 in Denmark and transport it by ship to the Greensand Future CO_2 storage site west of Esbjerg. This is a depleted oil field in the Danish sector of the North Sea which is being repurposed for carbon storage.

As ammonia plants have been closing down in Europe due to high natural gas prices, industrial gases operating companies have turned more attention to CO_2 from biogas plants. Prices for this biogenic CO_2 will be set by the highest bidder and this is likely to be the voluntary carbon market, which relies on permanent storage of biogenic CO_2 to deliver its aims.

So Industrial gases distributors may be advised to identify fossil CO_2 sources to ensure CO_2 availability and cost competitiveness for applications in welding, pH control, food chilling and beverage carbonation applications. As with storage applications, in the food and beverage sector CO_2 purity is paramount, so biogenic is suitable for CCTS.

Other options are challenging

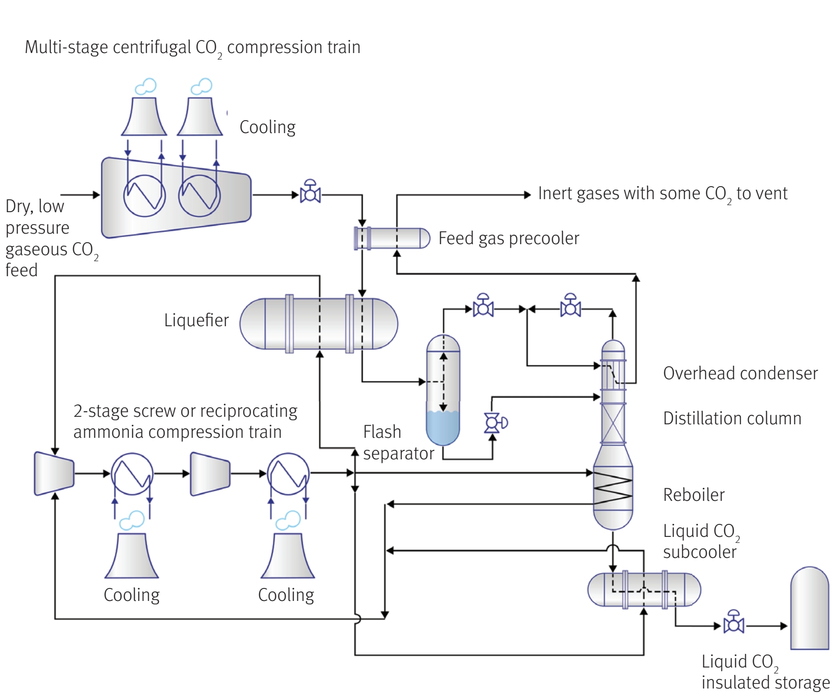
In addition to process emissions of CO_2 from biogas, the petrochemical sector and fertiliser production, there are many other industries that yield CO_2.

Cement making, iron and steelmaking and power generation from coal are three notable examples. However, the mix and concentration of impurities in each of these flue gas streams differs, and that is something that must be addressed.

To ensure that CCTS is cost-effective and scalable, CO_2 emissions from these industries will likely be aggregated into shared infrastructure. Pipelines, ships, trains and geological storage sites will be operated to serve a mix of emitters. The implication is that when the CO_2 is blended it must be compatible with the grades of steel being used in the common infrastructure and any associated environmental and safety concerns. It is something that just has to happen.

There are other impurity risks, too. In some CCTS schemes, CO_2 will be liquefied to enable its transportation by ship to an offshore platform where it will be injected into the CO_2 reservoir. Non-condensable gases such as nitrogen or methane increase the required energy input during CO_2 compression and liquefaction. Furthermore, these gases do not behave in the same way as CO_2 when injected underground at high pressure and they take up disproportionately large amounts of valuable space in the storage site. ▸

CO_2 liquefier with ammonia refrigeration cycle



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Some captured CO_2 will also be routed to utilisation for e-fuels production. E-methanol and eSAF (sustainable aviation fuel) are built from green hydrogen and CO_2. In the processes that synthesise methanol and SAF inert gases such as nitrogen accumulate in the reactor recycle streams. When these inert gases are vented, valuable feedstock and product is vented with them. Therefore, the CO_2 purity requirement for these emerging CO_2 utilisation applications is very high.

Work to do

In short, there is work to do when it comes to CO_2 and the purity needed for storage, and some of it starts with standards.

International confirmation of standard CO_2 temperature and pressure condition would lock in parameters that players in the CCTS value chain could design around, for example. That is one starting point that will start to shape this important emerging industry that is crucial to limiting global heating. gw


INERATEC ERA ONE e-fuels plant at Frankfurt


CO2 pipelines and storage tanks at the Northern Lights terminal

Northern Pioneer at the Northern Lights terminal in Norway