GAS ANALYSIS FOR CCS – FOCUS ON AUSTRALIA

Hydrogen has recently received the essential worldwide recognition required for decarbonisation to combat climate change resulted from greenhouse gas emissions. We will soon see a similarly high level of recognition for the complementary role that carbon capture and storage (CCS) can play.

There are 26 operating CCS schemes worldwide. Many are related to enhanced oil recovery in the United States and Canada. Several more exist in Europe and the APAC region. In the next decade, this number is likely to increase ten-fold to become 300 schemes or more.

It is becoming clear that CCS will have a central role to play in securing the mid-century target of 'net-zero' carbon dioxide emissions to which many nations aspire.

As the torchbearer for CCS in the APAC region, Australia, home to the Global CCS Institute, has long been a pioneer of the technology. Operating from Barrow Island off the western coast of Australia, the Gorgon CCS scheme is one of the world's largest. It has a nameplate capacity to capture and store 4 million tonnes of carbon dioxide (CO_2) each year and is linked to the production of liquefied natural gas (LNG) from the Gorgon and Jansz-Io gas fields. The distribution of LNG via ocean-going tankers to Asia export markets must take place in the absence of CO_2. The CCS project separates the CO_2 from the methane and injects it underground for permanent storage. The methane is liquefied and loaded onto ships as LNG.

Challenges and Opportunities

CCS presents challenges and opportunities to industrial gases companies. Process equipment required to operate CCS schemes, such as gas separation systems. High-pressure gas compression trains and distribution pipelines will need to be constructed and operated as new projects are confirmed. These technologies are in the sweet spot of industrial gases expertise and are potential business opportunities.

On the other hand, through the operation of steam methane reformers (SMRs) and gasification plants to produce syngas and hydrogen, industrial gases companies face a challenge to decarbonise. As they look upstream in the value chain, they will also see that much of the power consumed by their ASUs to perform the cryogenic separation of air into oxygen, nitrogen, and argon is derived from fossil fuel combustion with significant CO_2 emissions. That power generation will also need to decarbonise, perhaps through the application of CCS or with a transition to renewable energies.

Decarbonisation of Hydrogen Exports

The Hydrogen Energy Supply Chain (HESC) project will demonstrate the viability of ocean shipments of liquid hydrogen from Australia to Japan. It will open the door to full-scale energy exports of low-carbon hydrogen.

At this early stage of the project, hydrogen gas is produced from the gasification of brown coal at a pilot plant in the Latrobe Valley in the Australian state of Victoria. Gasification involves reacting coal with oxygen at a high temperature to produce Syngas which contains, carbon dioxide, carbon monoxide, and hydrogen. This gas mixture is further purified to yield the desired hydrogen. The result is a high purity, low-cost hydrogen gas that can be cryogenically cooled to form liquid hydrogen for efficient long-distance transportation.

The 'brown' hydrogen produced in this gasification process is generated from coal. For every tonne of hydrogen produced on this pilot reactor, 12 tonnes of CO_2 are produced. When

Copyright ABB - Process Gas Chromatograph for pipeline gas monitoring

Gas pipeline flow and purity monitoring station

the HESC pilot project is complete, a full-scale gasification plant incorporating CCS will be used to make the hydrogen production process more sustainable. Hydrogen produced from coal combined with CCS is sometimes referred to as 'purple' hydrogen, a close relative of 'blue' hydrogen produced on a steam methane reformer (SMR) fitted with CCS.

CCS from Steam Methane Reforming

The production of ammonia, as part of the urea fertilizer value chain, is the largest consumer of hydrogen, accounting for approximately 50% of the world's hydrogen demand. These plants use SMR for hydrogen production. SMRs are also used on crude oil refineries and methanol plants to produce hydrogen.

The most compatible CO_2 capture technology for the SMR off-gases is a system that involves absorbing CO_2 in an amine-based chemical and then heating the amine in the second stripping tower to yield a high purity CO_2 gas stream. The gases emitted to the atmosphere from the absorber contain only circa 10% of the CO_2 that would be emitted without CCS.

In many countries, emissions of the three main greenhouse gases (CO_2, methane, and nitrous oxide) are reported to environmental authorities to ensure that the integrated SMR and CCS facilities are operating within its consent levels. Stephen Gibbons, Global Market Manager, Continuous Gas Analysers at ABBs Measurement & Analytics Division, states that "these IR- and UV-active gases can be measured on Uras26 and Limas21 continuous gas analyser modules which can be incorporated into our Advance Optima system".

The impact of carbon dioxide purity

In CCS schemes, the distribution process compresses CO_2 so that it can be transported in long-distance pipelines before being injected into suitable geological structures deep underground. These are highly valuable assets that must be protected. One of the most important criteria is the amount of moisture permitted in the pipeline. Water combined with CO_2 produces carbolic acid that would corrode the grades of steel used to construct gas pipelines.

Inert and incondensable gases such as argon, nitrogen, or methane increase the power demand of the gas compression process. Furthermore, they do not shrink in the same way as CO_2 when compressed and take up disproportionately large amounts of valuable storage space.

The safety of the public is also of paramount importance. CO_2 intended for CCS may contain trace levels of toxic chemicals such as CO, NO_x, or SO_x. Operators can monitor their concentrations to ensure that any potential CO_2 leak does not pose a health and safety risk.

Gibson Island Ammonia, Urea and CO_2 Carbon Capture and purification plant, Brisbane Australia

ABB's Gibbons points out that "many of the chemicals that must be monitored in carbon capture and storage are the same ones that are present in the environmental emissions monitoring application and our UV or IR based gas analyser technologies or the broad-spectrum ACF5000 FTIR can play vital roles in CCS gas purity analysis. With an installed base of many thousands of continuous emissions monitoring gas analysers worldwide we are confident that end-users will find highly reliable solutions for their CCS gas analysis requirements from our range of continuous gas analysers."

A need for custody-transfer and accurate gas metering

Most existing CCS schemes are point to point, meaning that one carbon capture location, such as an ammonia plant SMR, is connected to one underground geological CO_2 storage location. This simple model will transition to more complex 'hub and cluster' schemes where CO_2 will be captured from several plants and fed into a feeder network connected to a long-distance transmission pipeline that will mirror the existing natural gas pipeline grids.

A leading example of this concept is CarbonNet. It aims to establish a commercial-scale CCS network in Victoria, Australia. The network will deliver CO_2 captured from a range of industries based in Victoria's Latrobe Valley as the future commercial phase of the HESC project and existing fertilizer plants. The main CO_2 transmission pipeline will be more than 100 km long, with a 10 km offshore leg extending into the Bass Strait. CarbonNet has the potential to capture five million tonnes of CO_2 per year, giving it a similar scale to the Gorgon CCS project off the coast of Western Australia.

One of the implications of this network concept is the change of CO_2 ownership as it flows from the feeder pipelines to the main transmission pipeline. It is likely to be invoiced based on accurate metering of the CO_2 flow. Furthermore, the CO_2 gas purity will need to be confirmed before it can enter the highly valuable transmission infrastructure.

"These concepts replicate current natural gas distribution grid operations where regular gas analysis and flow metering also take place" says Gibbons. "This requires extremely accurate CO_2 flow measurement and gas purity analysis. ABB process GCs, such as those in the NGC 8200 series, have been used for fiscal monitoring and custody transfer in natural gas pipelines for many years and they can be applied to CCS applications."

Author Contact Details

Stephen B. Harrison. sbh4 GmbH • Kranzlstraße 21, 82538 Geretsried, Germany • Tel: +49 (0)8171 24 64 954 • Email: sbh@sbh4.de • **Web: www.sbh4.de**