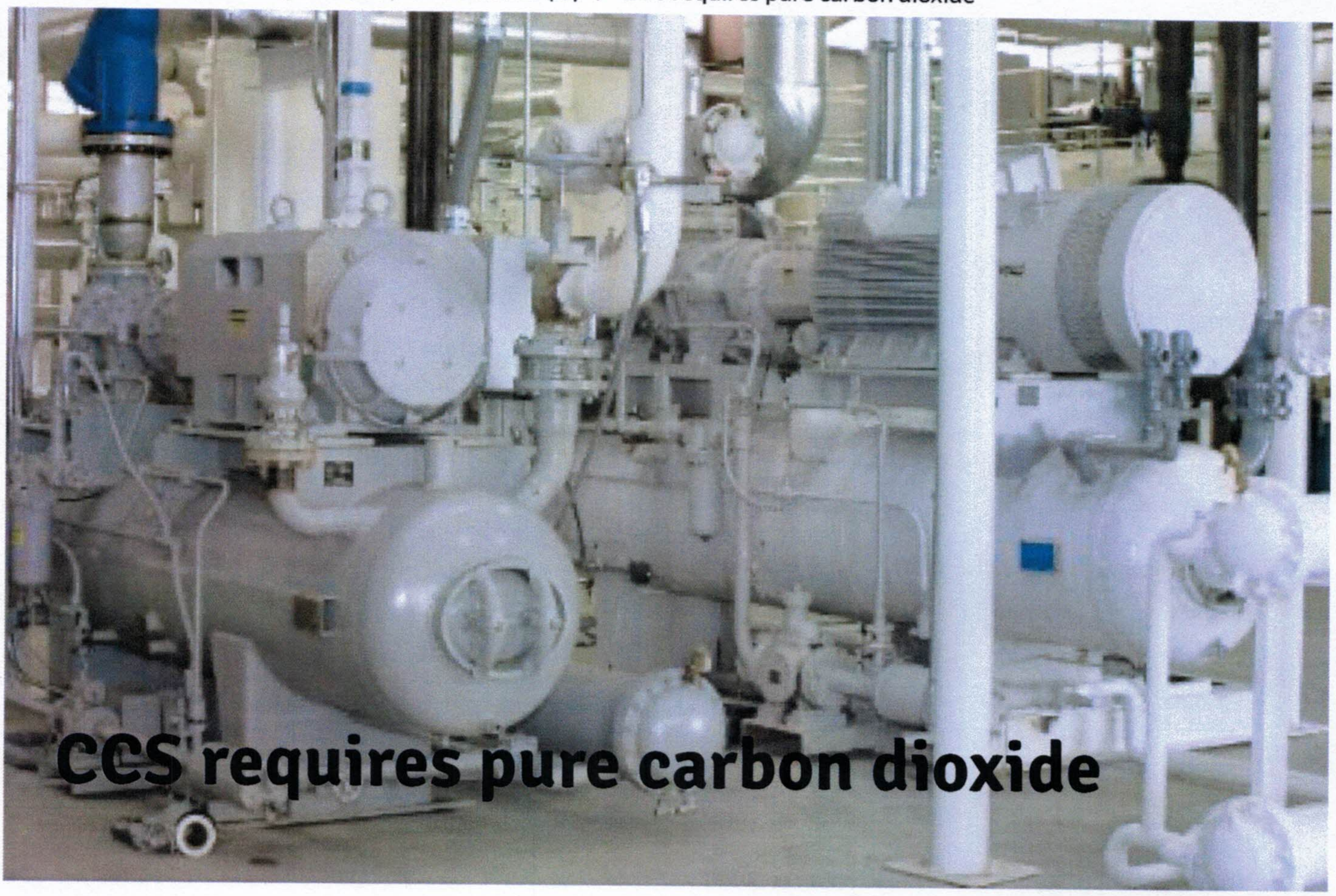

CCS requires pure carbon dioxide

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Carbon capture and storage (CCS) recovers carbon dioxide (CO_2) from industrial processes and injects it deep into the ground for long-term storage. We can thereby reduce CO_2 emissions to our atmosphere and slow down climate change. The EU Green Deal will partly rely on CCS to achieve net-zero CO_2 emissions by 2050.

One of the most promising routes to take the next steps on the road to full decarbonisation is CCS from existing combustion processes, such as refinery process heaters and steam plants. CCS is an integral part of these schemes to ensure that they produce blue hydrogen and play a role in sustainable decarbonisation.

For sure, when we use CO_2 to freeze food or carbonate beverages, the need for using a high purity gas is abundantly clear. But with the basic idea of pumping CO_2 underground, why would 'purity' ever come into question? There are equally compelling, but different reasons that CO_2 purity is also a critical issue when it is pumped underground in CCS. However, at present there is no common standard to define the quality of CO_2 that should be used in CCS projects.

Leveraging healthcare and hydrogen purity standards

In patient healthcare, as has been highlighted by the many thousands of respiratory treatment cases caused by COVID-19 worldwide, oxygen is used as a medical therapy. It is inhaled and its purity must be tightly controlled. In this medical application, there are also rigorous standards set by the main international Pharmacopeia which govern the production, identification and assay of medical oxygen. The European and US Pharmacopeia require the use of a paramagnetic oxygen gas analyser to perform the identification of oxygen and assay of oxygen purity. Toxic impurities such as carbon monoxide and carbon dioxide must also be analysed using an infrared gas analyser or tested using a gas detection tube.

The purity of hydrogen for use in fuel cell electric vehicles is also subject to an international standard: 'ISO14687:2019 Hydrogen fuel quality – product specification'. Impurities such as carbon monoxide and hydrogen sulfide are capped at levels that will guarantee the hydrogen is compatible with standard modern fuel cells and does not poison the sensitive catalysts. The examples above relate to oxygen and hydrogen. They share are a minimum purity for the gas and maximum concentrations of impurities which could be harmful to the application. So, in the consideration of a future standardised purity specification for CO_2 in CCS, there are some existing standards to leverage.

International standardisation of carbon dioxide purity for CCS is the future

A leader in international metrology for energy gases, Dr Arul Murugan, Senior Research Scientist for Energy Gases at NPL in the UK says that "when considering the purity standards for food ingredients, public health is the major concern. For CCS, public health and safety are also of concern and there are additional issues to consider. For example, in some CCS schemes, the idea is to liquify the carbon dioxide either for immediate storage or to enable its transportation by ship to an offshore platform where it will be further processed. Incondensable gases such as nitrogen or methane could reduce the efficiency of this process by increasing the required energy input. Furthermore, these gases do not behave in the same way as CO_2 when injected underground and they take up valuable storage space".

Murugan adds that "in other CCS schemes, the proposal is to compress CO_2 to a high pressure so that it can be cost effectively transported in long distance pipelines before being injected into suitable geological structures deep underground. These compressor stations and pipelines are highly valuable assets which must be protected. If there are combinations of gases in the CO_2, that can result in corrosion, such as ammonia and moisture or hydrogen sulfide and moisture they may cause irreversible damage to the pipeline or even the storage site itself. This corrosion of the CCS infrastructure would be costly to repair. Corrosion could also pose a safety risk if it went unnoticed and caused a pipeline rupture. In these cases, detection of these trace contaminants is essential to prevent problems escalating".

Process performance and gas distribution asset integrity are not the only reasons for careful analysis and control of CCS CO_2 purity. The safety of the personnel operating the CCS equipment and the general public are also of paramount importance. Murugan continues to say that "CO_2 intended for CCS may also contain trace levels of highly toxic chemicals such as mercury or hydrogen cyanide. Whilst we cannot always prevent these molecules being present at tiny levels, we can monitor their concentrations to ensure that they exist in the gas only in minute traces which would ensure that any potential CO_2 leak from the CCS processing equipment or storage site does not pose a health risk. With all these considerations in mind, my team at NPL are starting to develop the analytical methods and traceable reference materials required for performing these important purity analyses".

The UK, the Netherlands and Norway have spearheaded the extraction of fossil fuel reserves from the North Sea for many years. These countries have previously drilled in the North Sea to extract oil and gas. Beyond these traditional oil and gas nations, many other countries in Europe will also need to participate in CCS schemes and many will need to export their CO_2. So, the trade in CO_2 for CCS will inevitably become international. This is a key driver for the development of an international standard for CCS CO_2 purity to ensure a harmonised approach and consistent levels of safety. The confirmation of a standard will also lock in parameters that players in the CCS industry can design around to ensure optimal performance of their equipment, thereby securing the path forward to investment.

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