CCS from refinery emissions: CO_2 purity must be analysed and controlled

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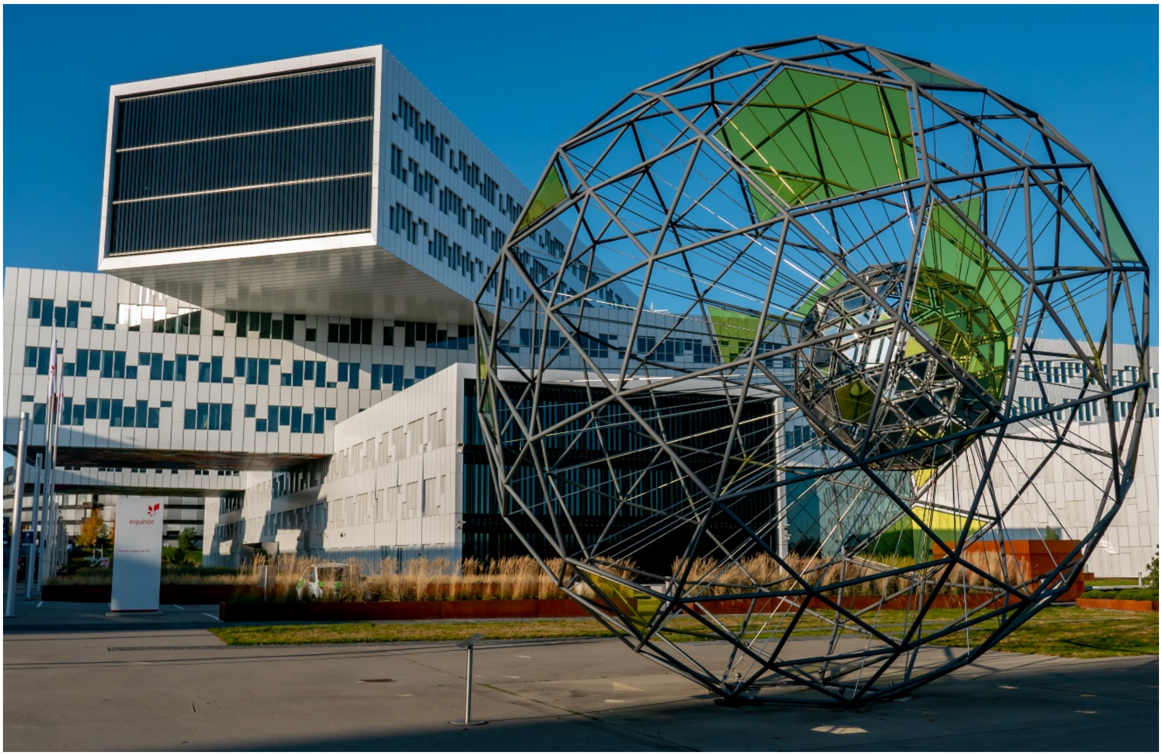
One of the most promising measures to decarbonise refinery operations is carbon capture and storage (CCS) from existing combustion processes, such as process heaters and steam plants. CCS recovers carbon dioxide (CO_2) and injects it deep into the ground for long term storage. Thereby reducing CO_2 emissions to our atmosphere to slow down climate change. Many refiners will rely on CCS to achieve CO_2 emissions reductions targets set for 2030 and 2050.

The UK has spearheaded extraction of fossil fuel reserves from the North Sea for many years. The country is also planning CCS schemes which return CO_2 to underground storage locations in sectors of the North Sea. For example, the Fergus gas terminal at Peterhead in Scotland would be integral to the Acorn project, which is slated for this decade. In this project, the flow direction of the existing natural gas pipeline would be reversed to pump carbon dioxide from onshore sources, such as Ineos's Grangemouth refinery, out to the gas fields under the North Sea.

In Norway, the local oil and gas major Equinor is playing a key role in the existing Northern Lights project which is collecting CO_2 from cement production and other heavy industries in the Oslo Fjord. Specially designed sea-going tankers transport liquefied carbon dioxide to offshore gas processing plants where the CO_2 is compressed to high pressure and injected underground. In future, it is proposed that the CO_2 collection network will be expanded to include a wide range of sources from Norway and potentially other nations.

At present there are no common standards to define the minimum quality of CO_2 that should be used in CCS projects. When we use CO_2 to freeze food or carbonate beverages the need for using a

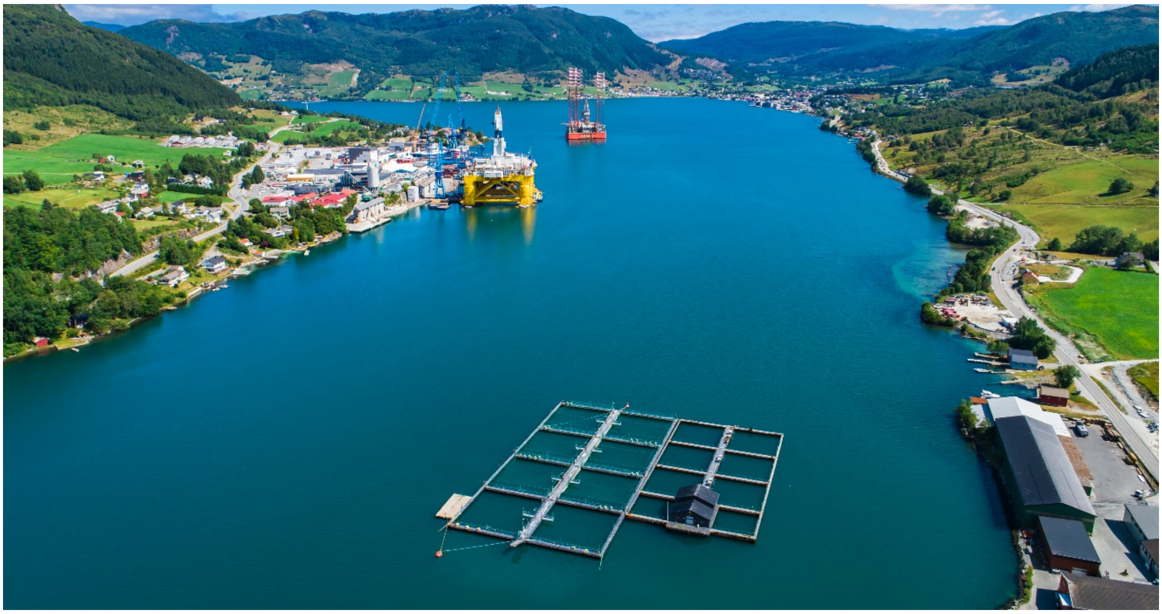
Ineos Grangemouth refinery



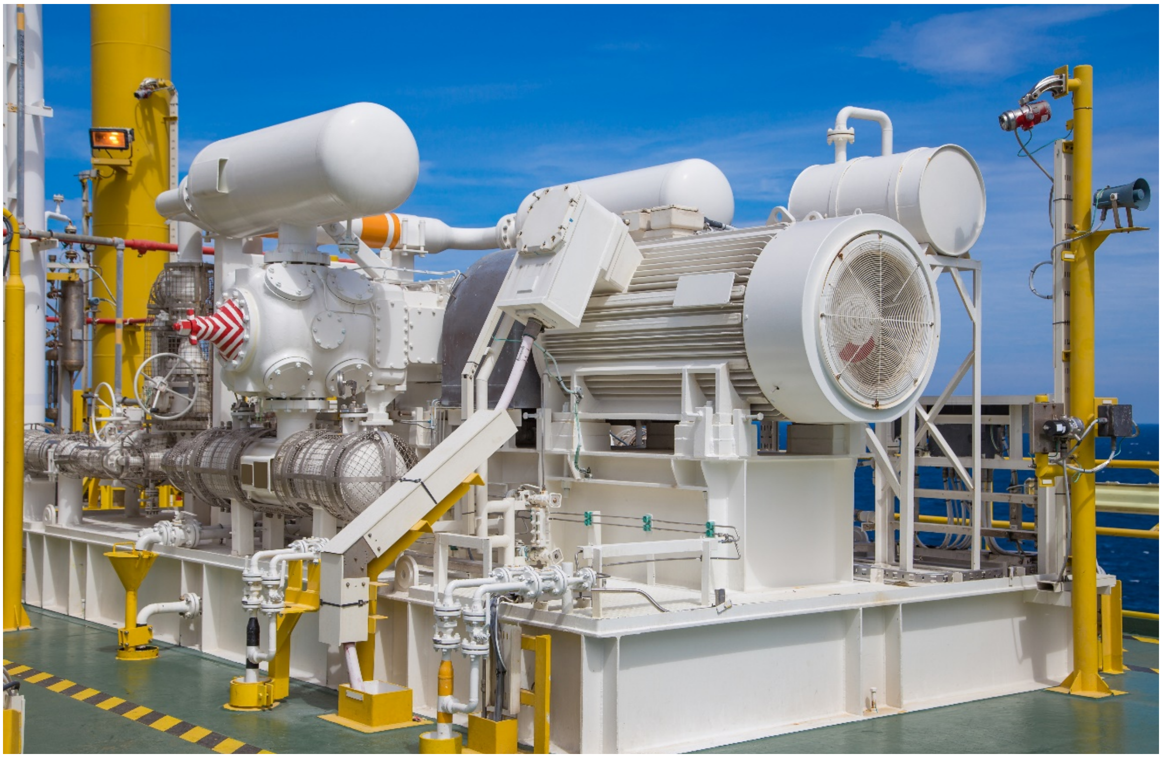
Equinor head office, Norway

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 for CCS.

The UK, 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



Oil and gas rig construction at Olen, Norway



High pressure gas compression on an offshore rig

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 and a convergence towards one or more purity standards may be required.

Careful analysis required to confirm CCS carbon dioxide purity

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 sulphide 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".

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