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Written Submission to the Energy and Climate Change Select Committee on Carbon Capture and Storage

Submission from the Government Chemist

As Government Chemist, I am responsible under certain Acts of Parliament for providing independent analytical measurement and expert opinion to help avoid or resolve the disputes over scientific data which arise from time to time between local authorities and the businesses that they regulate. My public remit also covers wider advice to UK government and other affected parties on the role of analytical measurement in effective policy, standards and regulations.

This submission covers the potential analytical measurement issues which need to be considered for carbon dioxide (CO_2) streams intended for geological storage. There is a wide range of potential contaminants and other trace compounds in these CO_2 streams, arising from different sources of CO_2. These constituents/components are capable of promoting different physico-chemical effects during introduction to, and storage in geological reservoirs.

Although the major risks associated with carbon capture and storage (CCS) are from leakage of the stored CO_2, and accidents arising from the injection of CO_2 under pressure into the geological storage site, there may be other risks arising from the nature and concentration of contaminants in the CO_2 stream, although these have been much less widely reported or studied. The technology applied to CCS is relatively young, and the volume of information relating to measurements of contaminants in CO_2 streams and problems arising from these contaminants is limited. There have been limited developments on CCS in the United Kingdom.

Sources of Contaminants in CO_2 streams

The identity and quantity of contaminants in CO_2 streams destined for geological storage depends on the source of the CO_2. Different industrial processes give rise to a different contaminant profile.

The majority of current and projected applications of CCS technology relate to emissions from power stations which burn fossil fuels. Other industrial processes which could be considered amenable to CCS technology include:

- Cement and Lime production
- Fermentation to produce ethanol
- Iron and steel production
- Ammonia production
- Hydrogen production

The contaminants which can be found in CO_2 streams from these sources include:

- Water
- Oxides of Nitrogen (NOx)

- Oxides of Sulfur (SOx)
- Methane (CH_4) and other short-chain hydrocarbons
- Hydrogen sulphide (H_2S)
- Argon
- Nitrogen
- Carbon Monoxide (CO)
- Oxygen
- Chlorine
- Ammonia (NH_3) and volatile amines
- Toxic metals (Hg, As, Se)

Effects of Contamination

CCS technology therefore needs to guard against levels of one or more of these contaminants which could adversely affect the integrity of the storage site or the relevant transport infrastructure (corrosion and impact on fluid characteristics), which do not pose a significant risk to the environment and human health, and do not breach applicable UK or EU legislation. This would normally be achieved by clean-up of the CO_2 stream prior to injection into geological storage.

For example, the presence of water in the CO_2 stream at an elevated level can produce acidic conditions CO_2 which could cause corrosion of the pipe through which the stream is travelling. A limit of 500 ppm water has been recommended as postulated in the Dynamis project (EU 6th Framework Project, 019672).

Hydrogen sulphide (H_2S) can also present problems in storage, particularly in acidic conditions, even mildly acidic conditions. In such situations, iron can be removed as iron sulfide from rocks, which may influence the integrity of the storage area.

Contaminants in CO_2 streams can also have an effect on the physico-chemical properties of the stream, including density, viscosity and interfacial tension. Variations in these properties can affect the interaction between the CO_2 stream and the reservoir boundaries.

The exact identity and concentration of impurities in CO_2 streams is dependent on the individual emission source. Compositions vary both within generic source types, and can be affected by factors such as the fuel or other process material, the process and the processing plant. Therefore, although the type of facility producing the emission can indicate the generic composition of the stream, and the likely impurities, only analysis of the stream can give the detailed information necessary to fully understand the potential effects on the integrity of the storage.

Carbon capture and sequestration is in its relative infancy, and few projects have been undertaken to capture and store carbon dioxide in geological storage. A number of contaminants have been identified which can be found in these streams, depending on their source. The potential problems which undesirable levels of these contaminants, particularly water, can cause are also well understood.

There does not appear to be any specific analytical methods recommended for determining these impurities in CO_2 streams, although chromatographic methods for separating and measuring gaseous impurities can be used, and absorption of trace metal impurities for subsequent determination by techniques such as ICP-MS and ICP-OES, or direct determination in flowing gas streams, are also feasible.

Thank you for this opportunity to contribute.

Yours sincerely

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