Tiny 'cages' could trap carbon dioxide and help stop climate change

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A natural physical process has been identified that could play a key role in secure sub-seabed storage of carbon dioxide produced by fossil-fuelled power stations.

A team of researchers at the Centre for Gas Hydrate Research, at Heriot-Watt University is investigating how, in some conditions, seawater and carbon dioxide could combine into ice-like compounds in which the water molecules form cavities that act as cages, trapping the carbon dioxide molecules.

In the unlikely event of carbon dioxide starting to leak into the sea from an under-seabed disposal site (e.g. a depleted North Sea oil or gas reservoir), this process could add a second line of defence preventing its escape.

This is because, as the carbon dioxide comes into contact with the seawater in the pores of seafloor sediments above it, the compounds (called carbon dioxide hydrates) would form. This would create a secondary seal, blocking sediment pores and cracks, and slowing or preventing leakage of the carbon dioxide.

Professor Bahman Tohidi is leading the project. "We want to identify the type of seabed locations where sediment, temperature and pressure are conducive to the formation of carbon dioxide hydrates," he says. "This data can then be used to help identify the securest locations for carbon dioxide storage and can aid in the development of methods for monitoring potential CO_2 leakage. In the future, it may even be possible to manipulate the system to promote CO_2 hydrate formation, extending the number of maximum-security sites that are available."

Combining engineering expertise with computer modelling and geology skills, the research team is examining exactly how and where hydrates form, and establishing the optimum conditions that enable this process to take place. Their work includes the use of an experimental facility to simulate conditions in different sub-seabed environments with different types of sediment, and to observe hydrate formation when carbon dioxide is introduced. They have also developed tiny 2-dimensional 'sediment micromodels' (layers of glass etched with acid to simulate sediments) to help explore how hydrate crystals grow at pore scale in seafloor sediments.

Carbon dioxide emissions from fossil-fuelled power stations are a major contributor to climate change. With fossil fuels predicted to remain essential to world energy supplies for several decades, finding alternatives to releasing these emissions into the atmosphere is an urgent priority. Capturing them and then storing them long-term in stable geological formations under the sea is one promising option.

As well as helping to offset the environmental impact of fossil-fuelled power generation, carbon capture and storage is seen as a key 'bridging' technology that could help the emergence of a hydrogen energy economy, which may eventually replace today's largely carbon-based energy system. This is because, although hydrogen is expected to be produced in the long term from carbon-free renewable energy sources (e.g. via hydrolysis), in the shorter term it will probably be produced mainly from fossil fuels, generating carbon dioxide as part of the production process. Professor Tohidi stresses that carbon storage is only a short to medium-term solution. He says: "It should not be considered a limitless option but rather a stop-gap means to facilitate a smooth transition from fossil fuels to clean energy resources."

As well as contributing to climate change, carbon dioxide could pose a serious threat to marine life if it escaped from sub-seabed storage in significant quantities.

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