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New bubble-based technique for leak detection at CCS offshore sites

Better methods are needed to monitor underwater gas leaks. A new study outlines a technique that uses sound to detect bubbles of escaped gas and could help produce more accurate measurements of gas leakage rates from carbon capture and storage (CCS) sites, pipelines and natural leakage sites.

CCS provides a means to mitigate climate change by capturing CO_2 from the atmosphere and storing it underground. In the near future, it is envisaged much of the CO_2 captured will be stored in old oil and gas fields under the seafloor. Since leaks from these sites could reduce the efficiency of CCS and have effects on marine ecosystems, for example, by acidifying the ocean – there is a need to detect and monitor leakage, as the oil and gas industry does for underwater pipelines. Monitoring of CCS storage sites is an obligation of site operators under EU CCS legislation[1]. Leakage from natural methane seeps is also relevant to climate change because methane is a far more potent greenhouse gas than carbon dioxide.

It has been known for many years that it is possible to detect gas bubbles using sound. Bubbles reflect the sound waves emitted by an active sonar device on a boat. However this technique has drawbacks for long-term monitoring of an area, since it is expensive in terms of power usage and data storage. While such active sonar would provide a useful confirmation, an alternative technology is needed for long term monitoring of large areas of the seafloor. Researchers have shown how this can be achieved using a simple underwater microphone, which continually listens for the sounds generated by the bubbles when they are first released. This passive listening device can monitor areas of the seafloor that are several km in extent, and triggers an alarm if leaks are detected, enabling confirmation and mitigation measures to be deployed. The microphones can be left on the seabed for long periods, requiring only the power derived from local sea currents. If they detect a leak, the sound can be used to count the number of bubbles and quantify the amount of gas being released.

It has been known for decades that an individual bubble will have a unique sound signature related to its size. However, the problem with this strategy is that if the gas is leaking too fast, these signatures start to interfere and overlap with each other, making it difficult to estimate the number of bubbles. In this study, the researchers describe an alternative theory for estimating gas leakage rates based on calculations that can deal with overlaps.

The researchers worked with data previously collected from three natural methane leakage sites to test their calculations. Although only tested theoretically, independent members of the oil and gas industry have confirmed that the method should be around 100 times more sensitive than current techniques for leak detection in long deep gas pipelines. This is important because without high sensitivity, very small but persistent leaks may go unnoticed for a long time, eventually releasing large volumes of gas. The results also suggest that the biggest of the three leaks they studied could be monitored from further away, up to around 700 metres for the sites studied, and the larger natural leaks which do occur at sea would be detectable at several kilometres. Most commercial pipelines or storage facilities would be at risk of higher leakage rates and so could be monitored from considerable distances.

However, the researchers say that the accuracy of the results will depend on the accuracy of the inputs, essentially, how well the physics of the underwater environment in question is modelled by those implementing the technique. Using theory alone, it is difficult to account for all the factors that might influence the results obtained at sea. Thus, certain chemicals might dampen the signals produced by bubbles. Further testing would reduce these uncertainties.

1. See : http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32009L0031:EN:NOT

Source: Leighton, T.G and White, P.R. (2011). Quantification of undersea gas leaks from carbon capture and storage facilities, from pipelines and from methane seeps, by their acoustic emissions. *Proceedings of the Royal Society A*. 3: 1170-1189.
Contact: tgl@soton.ac.uk
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