Rock formations suitable for CCS

Oil and gas reservoirs

By definition, oil and gas reservoirs, such as those found under the North Sea, are proven natural traps of liquids and gas, and the injected CO_2 would fill the pores in the rock that were previously filled by them. Their geology has been thoroughly studied for over a hundred years, and the techniques used to manage and monitor fluids underground can easily be adapted to manage and monitor CO_2 storage sites.

In active oil and gas fields that are reaching the end of their productivity, the CO_2 can also be used to increase the proportion of oil and gas recovered from the porous rock as the injected CO_2 pushes them towards the production wells in a common process called Enhanced Oil or Gas Recovery (EOR and EGR). In other cases, the CO_2 could be injected into depleted and/or inactive oil and gas reservoirs.

A critical part of using oil and gas reservoirs is ensuring that any abandoned production wells in the area are identified and properly sealed so that there is no escape route for CO_2 – this is well understood and would form an integral part of any CO_2 storage engineering process.

Deep saline formations

Deep saline formations are very similar to oil and gas reservoirs in that they are deep, porous rocks that may contain a fluid trapped by cap-rock for many millions of years – in this case, water that is unusable because of its high salt and/or mineral content. These formations are widely found around the world and, critically, often in areas with high CO_2 emissions but with little oil and gas production. Injecting CO_2 in these formations would see the CO_2 at first added to the salty brine, eventually dissolving and finally mineralising to become part of the rock.

Deep saline formations generally are not mapped in as much detail as oil and gas reservoirs because they may occur away from oil and gas accumulations and finding and characterizing them historically has not been a fundamental part of the hydrocarbon exploration and production industry. However, their geology can be very similar and, since deep saline formations contain most of the global geologic storage capacity for CO_2, they are likely to become the most widely used type of geologic storage site in the long-term. Sophisticated monitoring techniques on current pilot projects in deep saline formations have detected no leakage since injection was started over 10 years ago. Both of these types of rock formations can be suitable for storing CO_2 securely nderground and are widespread throughout the world. Geologists have only just started to estimate the capacity of rock formations and discoveries of suitable sites are being made every day.

Even conservative estimates, however, such as in the IPCC's Special Report on Carbon Dioxide Capture and Storage, found the capacity of storage sites to be many hundreds of times greater than the annual CO_2 emissions from industrial sources like power plants and refineries and there is enough storage capacity to store our emissions for the next 200 years. Meaning that if we effectively put CO_2 deep underground into these formations, we have a way of meeting global energy needs at the same time as tackling climate change – essential if we are to move towards a low carbon energy future.

Unminable coal seams

Another potential storage medium is unminable coal. CO_2 can be injected into suitable coal seams where it will be adsorbed onto the coal, locking it up permanently provided the coal is never mined. Moreover, it preferentially displaces methane that exists in the coal Methane is already extracted from coal seams by depressurisation but this typically recovers only about 50% of the gas in place. Injection of CO_2 enables more methane to be extracted, while at the same time sequestering CO_2

Coal can adsorb about twice as much CO_2 by volume as methane, so even if the recovered methane is burned and the resulting CO_2 is reinjected, the coal bed can still provide net storage of CO_2. A substantial amount of coal bed methane is already produced in the USA and elsewhere but, so far, there is only one CO_2-enhanced coal bed methane project, the Allison Unit in New Mexico, USA. Over 100 000 tonnes of CO_2 has been injected at this unit over a three year period.

A field test of enhanced coal bed methane (ECBM) production using CO_2 and nitrogen mixtures is being carried out by the Alberta Research Council under an international project facilitated by the IEA Greenhouse Gas R&D Programme - the combined approach may offer more attractive means of recovering methane and storing CO_2.