Why store CO$_2$ in depleted oil and gas fields?

Of the various options for storing CO$_2$ underground, the use of depleted oil and gas fields has a number of attractions. In particular, these fields are known to have held gases and liquids for millions of years, their geology is known and there is substantial capacity available. Indeed, thousands of oil and gas fields are approaching the end of their economic lives. Such depleted fields provide the opportunity for storing CO$_2$.

How is CO$_2$ stored in oil fields?

Only a proportion of the oil in a field can be recovered using standard extraction techniques. Injecting CO$_2$ can enhance oil recovery (EOR), a technique already well established in the oil industry. After injection, a fraction of the CO$_2$ remains in the field, so this technique can also be used for storing CO$_2$. Especially for fields approaching the end of their useful working life, the extra income generated could offset the cost of CO$_2$ injection.

When CO$_2$ is injected into an oilfield it may mix with the crude oil, causing it to swell and thereby reduce its viscosity. This also helps to maintain or increase the pressure in the reservoir. The combination of these processes allows more of the crude oil to flow to the production wells.

In other situations the CO$_2$ is not soluble in the oil. Here, injection of CO$_2$ raises the pressure in the reservoir, helping to sweep the oil towards the production well.

Up to half of the injected CO$_2$ is stored in the immobile oil remaining in the reservoir at the end of production. The rest is collected from the production well and re-circulated. Globally, 130 Gtonne$^\dagger$ of CO$_2$ could be stored as a result of CO$_2$-EOR operations. The cost of capturing the CO$_2$, transporting it 300 km and storing it has been estimated to be between $30-50/tonne CO$_2$ avoided.

CO$_2$-EOR is commercially proven. It is used extensively in the USA, where 74 projects are now operating, injecting some 33 million tonnes of CO$_2$ annually. Although most of this CO$_2$ comes from natural sources, about 3 million tonnes per year is from natural gas processing plant, from ammonia production and other man-made sources. So some storage of CO$_2$ is already taking place. A limited amount of CO$_2$ is used for EOR projects in other countries.

$^\dagger$ 1 Gtonne is 10$^9$ tonne
How is CO$_2$ stored in gas fields?

In a depleted gas field the CO$_2$ would occupy some of the void space that had previously been occupied by the natural gas. Some depleted gas fields are reused as buffer stores for natural gas production. The techniques of gas re-injection can be adapted to store CO$_2$ in these fields.

Globally, 900 Gtonne of CO$_2$ could be stored in depleted natural gas fields, substantially more than in depleted oil fields. The cost of capturing the CO$_2$, transporting it 300 km and storing it in depleted gas fields has been estimated to be between $40-60/tonne CO$_2$ avoided.

Initial investigations in the USA indicate that it may be possible to inject CO$_2$ into gas fields that are approaching the end of their productive lives and enhance gas production, without contamination of the residual gas. Further research into CO$_2$ enhanced gas production is required. If, however, it is established that the process is technically feasible, then the overall cost of CO$_2$ capture and storage could be similar to that in oil fields.

The next steps

It is important to demonstrate that storing CO$_2$ in a geological structure is both safe and environmentally acceptable. Scientific information on the CO$_2$ injected into the reservoir will come from monitoring the operation – techniques for doing this are already available.

The latest CO$_2$-EOR project to come on stream is the Weyburn field in Canada. In this project, 1.8 million tonnes of CO$_2$ per year (captured from a coal gasification plant in the USA) will be injected into an operating oil field. It is expected that CO$_2$ injection will increase production from the Weyburn field over the next 20-25 years and, in that time, store 19 million tonnes of CO$_2$.

An international research project to monitor the Weyburn field has been established. The project will provide an objective evaluation of the geological sequestration of CO$_2$ during EOR operations. It will also improve the understanding of the physical and chemical processes by which the injected CO$_2$ is sequestered. The first results from this project will be available in 2002.