Storing CO_2 in Unminable Coal Seams

One way to combat climate change is to prevent the release of CO_2 to the atmosphere by storing it in geological reservoirs. This information sheet provides an overview of the storage potential of unminable coal seams.

Why store CO_2 in coal seams?

In nature, coal seams also contain gases such as methane[1]. The gas is held in pores on the surface of the coal and in fractures in the seams. If CO_2 is injected into a coal seam it displaces the methane, which can then be recovered. The CO_2 will remain stored within the seam, providing the coal is never disturbed. In addition, the sale of the methane produced could help to offset the cost of injecting the CO_2.

Potential methane recovery

Coal seams that have never been disturbed can contain considerable amounts of methane (up to 25m^3 per tonne of coal). This coal typically lies between 300 and 1 500m below the surface, with reserves of more than 4 000 billion tonnes of coal at these depths. Typically 50% of the methane in the coal can be recovered using standard techniques. The methane is usually of high purity (>90% by volume) and can be supplied more or less directly to a natural gas distribution system or used for power generation or heating.

During the last two decades, operators in the United States have successfully adapted oilfield technology to produce methane from deep coal seams. Investment of more than $4 billion has achieved an annual production (1996) of 28 million m^3 from over 6 000 coalbed methane wells. This accounts for 5% of the USA's natural gas production.

Coal bed methane test well at Sealand, Chester, UK. (Courtesy of Evergreen Resources)

Coal bed methane production takes place in other countries too.

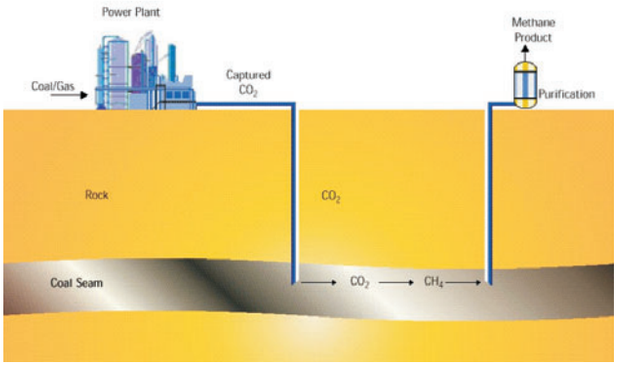
What happens when CO_2 is injected into coal seams?

CO_2 injected into coal seams is adsorbed at the expense of coal bed methane, which can then be recovered as free gas. This process, known as CO_2-enhanced coal bed methane production (CO_2-ECBM), is a potential underground storage facility as the CO_2 remains stored within the seam, providing the coal is never mined. If the CO_2 has been captured from fossil fuel combustion, this will achieve sequestration of the greenhouse gas.

Based on laboratory measurements, it is estimated that twice as much CO_2 would be stored as the methane desorbed. Early indications from actual applications suggest this ratio might be even higher. This technique is capable of recovering 90% or more of the methane in the coal seam.

As methane is a greenhouse gas, all of the gas produced must be efficiently captured and put to use, so as to ensure it does not escape to atmosphere.

1 The amount of methane in the coal varies depending on the depth of the coal and its history



Schematic diagram of the CO_2-ECBM process

How much CO_2 can be stored in coal seams?

In the most favourable coal basins it is estimated that 15 Gtonnes† of CO_2 could be stored in coal seams. In the best sites, the operating income from increased methane production would compensate for the additional costs associated with CO_2 injection. Far more CO_2 (perhaps 20 to 50 times as much) could be stored in less favourable coal basins, where costs would be higher. A key factor determining the attractiveness of a particular site is the permeability of the coal.

The cost of capturing CO_2, transporting it 300 km and storing it in the best site has been estimated to be between $30-50/tonne CO_2 avoided.

What is the status of CO_2-ECBM?

One pilot project has been underway for the past three years. Burlington Resources, together with BP, is operating a 13-well CO_2-ECBM pilot unit in the San Juan Basin in southwestern USA. Initial results show that increased methane production can be achieved by CO_2 injection. Also, no CO_2 has been found in the produced gas indicating that the CO_2 is being stored in the coal seam as predicted.

Another field test using CO_2 and CO_2/N_2 mixtures is being carried out in Alberta, Canada. This combination of CO_2 and N_2 may offer advantages over the injection of just one gas. A practical research project has been established in conjunction with the IEA Greenhouse Gas R&D Programme to enable international collaboration to support this work.

Future developments

A new project to study sequestration of CO_2 in deep unminable coal seams is under development in the USA. This project is again focused on the San Juan Basin and aims to demonstrate CO_2 sequestration in deep coal seams. The knowledge gained will be used to verify gas storage mechanisms in coal seams and to develop a means of assessing the potential for CO_2 sequestration at a site. CO_2-ECBM is also attracting interest in a number of other countries, with further work being conducted or proposed in the Netherlands, Belgium, China and Australia.

† 1 Gtonne is 10^9 tonne

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