CO_2 Capture in Power Generation

Technology that has been used in the oil industry for many years could be used to capture CO_2 from power plant. This information sheet describes the technology, its current use and the potential for improvement.

Why capture CO_2 from power plant?

Modern power plant operate at high efficiency generating electricity reliably and at low cost. Use of CO_2 capture technology with such a plant would reduce CO_2 emissions by more than 80% whilst still providing reliable and relatively low cost power.

How would CO_2 be captured?

Solvent absorption technology has been used for many years in the oil industry to remove CO_2 from mixtures of gases. There are several installations where CO_2 is captured from the flue gases of power plants; these are used to supply CO_2 to the food industry and other industrial users. This process is based on a reversible chemical reaction between CO_2 and a solvent, typically an amine compound.

Thus the technology to 'decarbonise' electricity generation is already available. It could be done using either pre- or post-combustion techniques.

What is post-combustion capture?

This method could be used on the flue gas stream of any fossil fuel-fired power station and would capture most of the CO_2 in the flue gas. However, due to the large amount of flue gases to be processed, the equipment would be very large. Such plants would have a large demand for steam, reducing the overall generation efficiency.

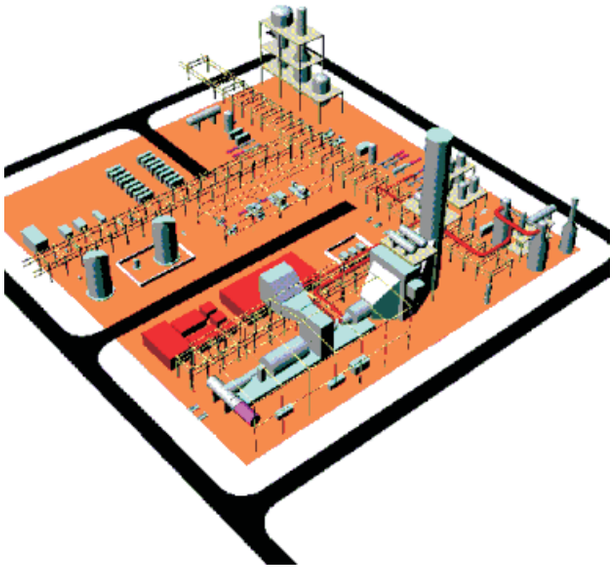
Developments in post-combustion capture of CO_2 are focussed on cost reduction by improved energy efficiency, better liquid-gas contacting and improved solvents. Two recent developments are the use of sterically-hindered amine solvents, and a combination of membrane technology and solvent absorption.

CO_2 capture at AES' Warrior Run power station (Cumberland, USA). The captured CO_2 is supplied to the food industry

What is pre-combustion decarbonisation?

A major part of the chemical industry is based on producing "synthesis gas", which is a mixture of hydrogen and carbon monoxide. This technology could be adapted for power generation, improving the conditions for capture by separating the CO_2 before combustion.

The carbon monoxide (CO) in the synthesis gas can be converted to CO_2 very easily, which is then captured using a solvent. A hydrogen-rich fuel is produced which can be burnt in a gas turbine with minimal CO_2 emissions.



Vision of a pre-combustion decarbonisation plant (Courtesy of Foster Wheeler)

Combustion of a hydrogen-rich fuel in a gas turbine is not yet standard practice but it is believed that any problems could be readily overcome. Other developments in pre-combustion decarbonisation are aimed at reducing the cost of producing synthesis gas.

Other ways of capturing CO_2

There are a number of other processes for capturing CO_2. Membranes are being developed which may be used on their own or in combination with solvents. Oxyfuel combustion, in which the fossil fuel is burnt in oxygen, may be favoured in some applications. This produces water and CO_2 which can be readily separated. Cryogenic cooling of the gas is another way of separating CO_2 if its concentration is high.

What would CO_2 capture cost?

The penalties for capturing CO_2 would be similar for pre-combustion decarbonisation and post-combustion CO_2 capture. The cost of electricity is increased by at least 1.5 US cents/kWh and the process efficiency is reduced by about 10 to 15 percentage points. The cost of avoiding CO_2 emissions is $30-50/tonne for capturing CO_2.To this, must be added the cost of transmission and storing of CO_2 (which is relatively small).

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