Carbon Capture and Storage Schemes

by ***Ir. Zaki bin Anhar***

COAL has always been perceived as a dirty fuel and is associated with thick black smoke. However, the abundant supply and the relatively lower price of coal have made it a major energy contributor throughout the world.

In recent years, several efforts have been introduced to reduce particulates, SO_x and NO_x emission from coal-fired power generation plants, for example, by introducing flue gas desulphurisation unit, Clean Coal Technology, etc. This has in some ways improved the image of coal-fired power plants. However, there is still one more obstacle for coal fired units.

Coal fired plants generate a higher amount of CO_2 as compared to other types of plants due to the higher carbon content of coal. For comparison, a 750MW coal power plant (at 40% efficiency) will typically emit approximately 822g CO_2/kWh. This is almost double the CO_2 emission of a gas-fired Combined Cycle Gas Turbine of similar size.

The present challenge is to aggressively reduce CO_2 emissions while continuing to utilise coal for power generation (because of its abundant supply). To achieve this objective, current studies are mainly focused on improving plant efficiency (*i.e.* to reduce coal consumption) and in improving the viability of Carbon Capture and Storage Schemes (CCS). In essence, CCS is to capture CO_2 emitted from the plant and store it somewhere.

There are two main options for carbon capture which is pre-combustion and post combustion. Pre-combustion capture removes carbon from the fuel before combustion. For coal, this can be achieved through the upcoming Integrated Coal Gasification Combined Cycle plants. Coal is gasified to produce syngas, which consists of carbon monoxide and hydrogen. Syngas is treated to remove CO_2, while the hydrogen is fired in a Combined Cycle Gas Turbine plant. This option is still very much in the preliminary stage, partly due to limitations of firing hydrogen in gas turbines.

Post-combustion carbon capture is generally tricky, since the percentage of CO_2 in flue gas is small. The flue gas has to be cooled and passed through chemical compounds which absorb CO_2, and this requires a significant percentage to be effective. Several methods had since been studied to increase the CO_2 percentage which, among others, include flue gas recirculation (flue gas is routed back to the furnace) and oxy-firing (supplying pure oxygen for combustion reduces the amount of air fed to the furnace, thus increasing the concentration of CO_2 in flue gas).

After capture, the pure CO_2 has to be dehydrated and compressed to a dense phase, usually at pressures above 80 bar. This fluid-like dense CO_2 can then be pumped to an underground storage which is suitable to contain the CO_2 with a leakage of less than 1% in 100 years. Among potentially suitable sites are:

- Depleted oil reservoirs
- Underground aquifers
- Used for enhanced oil recovery in active oil reservoirs
- Unminable coal seams

It is obvious that the handling of CO_2 from coal combustion is difficult and costly. However, as the cost of natural gas increases, and more regulations are introduced to penalise the producers of CO_2, this cost may be justified in the near future. It is important that the industry, at the very least, start to consider the available options and plan for staged implementation. ■

Circulating in cyberspace ...

Words to ponder

"Don't worry about avoiding temptation. As you grow older, it will avoid you."
- ***Winston Churchill***

"By the time a man is wise enough to watch his step, he's too old to go anywhere."
- ***Billy Crystal***

"I have never hated a man enough to give his diamonds back."
- ***Zsa Zsa Gabor***