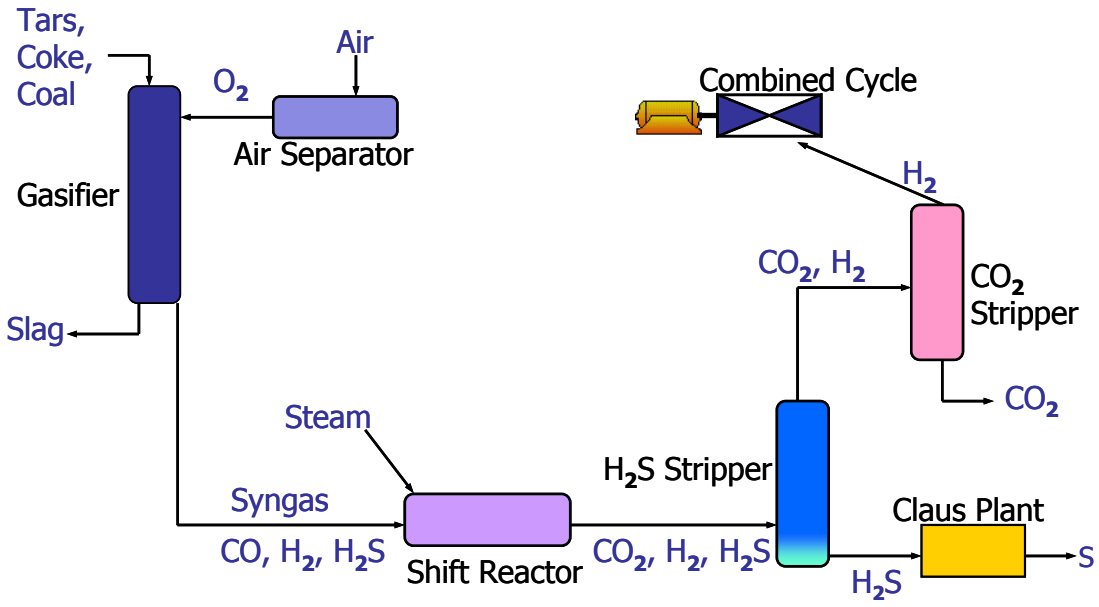
How an IGCC Plant Works

The following describes how a gasifier can be integrated with a combined cycle power plant to capture carbon dioxide. IGCC stands for integrated gasification combined cycle.



The latest gasifier designs are called entrained flow gasifiers because they entrain the fuel in the flow of hot gases passing through the gasifier. Any fuel containing carbon and hydrogen can be gasified. Tars, coke, coal, biomass, municipal solid wastes, etc. have been used as feedstock for gasifiers. Fuel can be pumped into the gasifier as a slurry or lockhoppers can be used to supply dry fuel. The fuel is mixed with oxygen in the gasifier. The oxygen is supplied by cooling and compressing the oxygen to form a liquid which is separated from nitrogen in the air separator. Oxygen is used so the syngas is not diluted with nitrogen and so less syngas needs to be processed to capture the CO_2. The oxygen is used to partially oxidize the fuel to form a syngas composed mostly of carbon monoxide, carbon dioxide, water, hydrogen and hydrogen sulphide.

The gasifer operates at about 1,500C to melt the ash in the coal. This ash forms droplets which drop into a vat of water at the bottom of the gasifier. This material is removed as a solid slag. Gasifiers operate at pressures ranging from 600 to 1,000 psi. These high pressures reduce the size of the vessel involved. The syngas exiting the gasifier is cooled so it can be cleaned. Some processes use heat exchangers to raise steam to reduce the temperature of the syngas. Other processes spray water into the syngas to cool it.

Carbon monoxide is difficult to separate out of the cooled syngas. Therefore it is mixed with steam and passed over a catalyst in the shift reactor. The carbon

monoxide is converted to carbon dioxide and additional hydrogen is produced as well.

The syngas is then passed through a liquid adsorbent in the H_2S stripper, which at high pressure, adsorbs hydrogen sulphide (H_2S). When the pressure of the liquid is reduced in a second vessel, the H_2S is liberated and sent to a Claus plant. In the Claus plant the H_2S is converted into sulphur. The remaining syngas is mixed with a liquid adsorbent in the CO_2 stripper under high pressure. Carbon dioxide is adsorbed into the liquid. When the pressure of the liquid is reduced in a second vessel, carbon dioxide is liberated. Once the CO_2 is dried it can be compressed for storage. Most IGCC plants are designed to capture about 90% of the CO_2 produced. The remaining gas consists mostly of hydrogen. It is sent to a gas turbine in a combined cycle power plant to produce power. A significant amount of the power created in the process is used internally.

Unfortunately very few turbines have been configured to operate on high concentrations of hydrogen. Standard dry low NOx burners cannot be used in turbines fired on hydrogen. Therefore nitrogen from the air separation process is sent to the gas turbine to suppress the formation of NOx.

There are gasification plants which capture carbon dioxide and some which produce power. However there are no gasification plants which produce power and capture carbon dioxide.

For more information on IGCC plants please see the following sources.