TNO Pilot Plant Description

Since early 2008, TNO has installed a 250 kg per hour CO2 capture plant at a coal-fired power plant from E.ON in Rotterdam. A sufficient flue gas stream from the coal-fired power plant is diverted to the CO_2 flue gas extraction equipment for processing. The resultant vapor exiting the extraction system's absorber and stripper are combined and returned to the power plant's flue gas stack..

Figure 1: View of the TNO pilot plant.

Flue Gas Conditioning System (SO_2 washer)

Initially, the volume of flue gas to be processed can be controlled with two modulating damper adjustable from the PC. One modulating control is mounted at the inlet to the caustic scrubber and one modulating control is mounted on the by-pass piping directly connected to the flue gas booster compressor. Each stream has a temperature and pressure compensated flow meter to allow for various flow rate selections. When the flue gas is directed to the caustic scrubber, the SO_2 will be reduced to <1.0 ppm v/v before further processing in the extraction system. The caustic scrubber includes a recirculation system with a water cooled heat exchanger to control the flue gas temperature exiting the scrubber if required. The system is controlled through a pH selector that will automatically dose caustic soda into the scrubber when required. Next, the flue gas will enter a flue gas booster compressor that provides the necessary increase in pressure required to overcome the pressure drop in the caustic scrubber, absorber tower and related piping.

Figure 2: View of the caustic scrubber.

Absorber
TNO's Absorber Tower is designed and manufactured for efficient removal of the CO_2 from the flue gas being processed. and for a removal of 250 kg CO_2 per hour (coal fired flue gas). This results in a nominal flue gas flow of 1200 Nm3/hr.

After processing in the flue gas conditioning system, the flue gas is sent to the absorber tower for CO_2 extraction. In the absorber tower, the flue gas passes through a series of four (4) packed beds designed to allow sufficient contact time for efficient absorption of the CO_2 into the test solvent absorbing solution. The balance of the flue gas, primarily nitrogen, is vented to atmosphere from the top of the absorber tower through a specialised demister section designed to minimise the loss of the recirculation solvent. Additionally, prior to the demister, the absorber vent passes through an integrally mounted water wash section where a portion of the water vapor and solvent is condensed, washed from the vent steam and returned to the system. Again, this design lowers the loss of your recirculation solvent. Based on solvent expectations, this wash section is over designed to allow for various solvent tests. The temperature and circulation rate of the wash section will be easily controlled from the PC.
The rich solution (solution rich in carbon dioxide) is then pumped from the absorber sump to the lean/rich heat exchanger, where it is heated before entering the stripper tower. Pre-heating the rich solution before the stripper tower serves two purposes:

- Minimises the heat required for the stripper duty
- Ensures maximum stripping in the top portion of the Stripper Tower.

Figure 3: View of the absorber

Desorber / Stripper
The lean solution (solution stripped of carbon dioxide) accumulates in the stripper sump and flows to the reboiler, where it is heated by auxiliary steam. The solution steam generated in the reboiler is piped to the stripper sump where it flows upward, countercurrent to the rich solution. The absorbed CO_2 is released from the rich solution, flows to the top of the stripper tower, with a packed wash section and specialized demister to minimize solvent carryover. The CO_2 then exits the stripper tower and enters the product cooler and knock-out frum, where the solvent steam is condensed and the CO_2 cooled. The resultant condensate from the product cooler/knock-out drum is returned to the system, providing the condensate for the wash trays or packed section in the Stripper. The CO_2 exiting the CO_2 product cooler is combined with the absorber vent to be returned to the power plants flue gas stack..