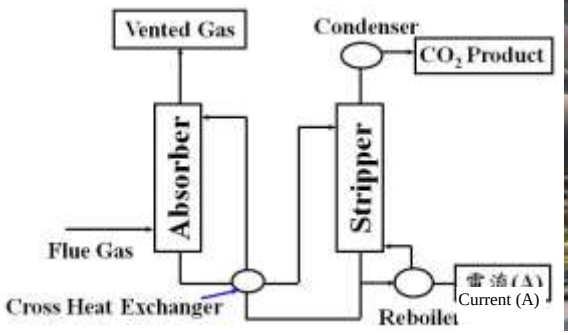
R & D Achievements on Carbon Capture and Storage in CSC, Taiwan

■ Carbon Capture Technology for Flue Gas

A self-designed carbon capture pilot plant has been constructed and tested in China Steel Company (CSC). This pilot plant based on chemical absorption is the first CO_2 capture pilot plant in Taiwan and was set up beside the #3 BF hot stove in CSC. The CO_2 capture process consists of an absorber, a stripper and heat exchangers. The BF hot stove gas was chosen to perform the CO_2 capture experiments. Currently, the feed gas from the #3 BF hot stove is put into contact with a lean solvent in an absorber unit. Gas with a reduced CO_2 content is emitted from the top of the absorption tower, while the rich solvent, loaded with CO_2, remains at the bottom of the tower from where it is then heated in a cross heat exchanger before being sent to the stripper for CO_2 stripping from the solvent. The CO_2 is released at the top of the stripper while the lean solvent is recycled back to the absorber. A current recorder was installed in the pilot plant to store input energy for calculating the reboiler duty. The pilot plant can capture 100 kg CO_2/day with CO_2 removal efficiency higher than 90%.



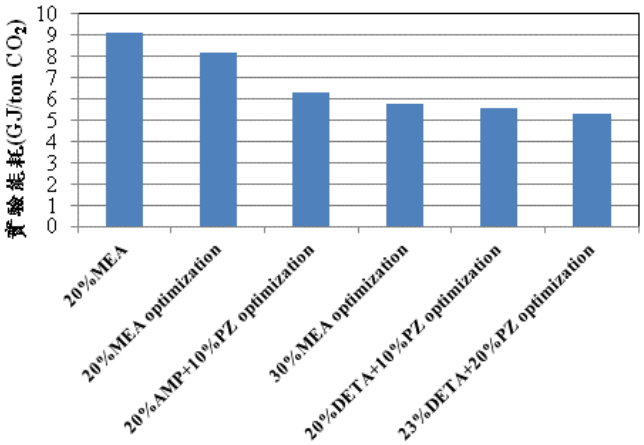
■ Chemical Absorption for Carbon Capture with Low Energy Consumption

The objective of this study was to develop low energy technology for CO_2 capture. Amine-based solvents and ammonia based solvents have been chosen as promising chemical solvents for CO_2 capture in CSC.

For amine-based solvents, several absorbents, comprising 20%AMP+10%PZ solution, 20%DETA+10%PZ solution, 23%DETA+20%PZ solution, 20% MEA, and 30% MEA solutions, were chosen to investigate their CO_2 capture properties and to search for the optimal operating parameters to reduce the regeneration energy of CO_2

capture. The experimental results show that the reboiler duty decreases with the increase of MEA concentration and that the optimal reboiler duty exists at a certain flow rate. The optimal reboiler duty for 20% MEA and 30% MEA are 8.2 and 5.8 GJ/ton CO_2, respectively. In addition, the experimental results demonstrated that the blending of different amines is effective for reducing reboiler duty. At the present stage, the optimal reboiler duty can be reduced to 5.3 GJ/ton CO_2 by using 23%DETA+10%PZ solution as the absorbent at a solvent flow rate of 100 kg/hr. Moreover, the solvent content in exhaust gas has been investigated. For 30%MEA, the content measured in exhaust gas of absorber was 145 ppm and the content in desorber was below 4.63 ppm.

The characteristics of varied ammonia-based solvents, including an ammonia-rich aqueous solvent from existing coal-chemical plant, have been investigated in pilot tests. The results show that regarding the CO_2 capture rate, ammonia is comparable to MEA under room temperature. The ammonia slip problem caused by high volatility of NH_3 has been the main theme to study. Aiming at reducing the extent of NH_3 slip, several innovative methods have been developed and verified its effect at the above-mentioned pilot.



■ Future Work

The mission of carbon capture research and development in China Steel is to ensure “capture ready” technologically. To achieve this target, we will continue to understand techno-economical aspects, obtain engineering design capabilities and accumulate operating technique of CO2 capture-related process.

Since ammonia-based capture process offers a unique opportunity of integrating carbon capture with existing steel plant. We will conduct experiments in the demo platform with hot stove flue gas. A conceptual design with PFD and material balances will be developed, and capture cost will be estimated. To achieve efficient capture, waste heat of existing process must be properly utilized.