Experimental and numerical assessment of the CO_2 absorption process in the Sotacarbo pilot platform

G. Calì, F. Ferrara, C. Frau, A. Pettinau
SOTACARBO S.p.A., c/o Grande Miniera di Serbariu, 09013, Carbonia, ITALY,
f.ferrara@sotacarbo.it

ABSTRACT

CO_2 separation technologies are of prime importance for the prevention of global warming and worldwide climate change. The separation of the CO_2 can be achieved by a variety of techniques, including membrane separation, low temperature distillation, adsorption and absorption. The chemical absorption of CO_2 into monoethanolamine (MEA) is one of the most favoured method for the capture of carbon dioxide from fossil fuel power plants. The reaction between amines and CO_2 brings some advantages such as high absorption rate of CO_2 and absorption in low pressure. Moreover, a benefit of chemical absorption into amine solution is that the chemical reaction can be reversed at higher temperatures and the MEA recycled.

In this context, Sotacarbo is studying a CO_2 absorption process, which has been tested in the pilot platform which has been recently built at the Sotacarbo Research Centre in Carbonia, Italy. The platform includes two different units, both based on fixed-bed air-blown gasifiers (Wellman-Galusha technology): a 5 MWth demonstrative plant (with a fuel capacity of 700 kg/h of coal) and a 200 kWth pilot plant (feed with 35 kg/h of coal). While the demonstrative plant has been developed for the optimization of the gasification process and for the definition of the start-up and shut-down procedures, the pilot plant has been designed to develop and optimize the whole syngas treatment line for hydrogen production and power generation. Therefore, downwards the gasification process, the pilot plant includes a syngas depulverization system, a cold and hot gas desulphurization processes, an integrated CO-shift and CO_2 absorption system, a PSA section for hydrogen purification and a syngas-feed internal combustion engine for power generation.

Regarding the CO_2 absorption process, it takes place in an innovative bubbling reactor and the absorption experiments were performed in 5 M monoethanolamine solution at 303 K.

Figure 1. CO_2 absorption reactors

This paper reports a preliminary analysis of the experimental results obtained in the CO_2 separation section. It is important to underline that, during the tests in the pilot plant, both air and a mixture of oxygen and carbon dioxide have been used as gasification agent.
As concern the process performance, the effect of the chemical reactions has been evaluate in terms of the enhancement factor, defined as the ratio between the absorption flux when reaction occurs to that which would occur if there were no reaction. Moreover, the CO_2 partial pressure and the liquid bulk concentration of all the chemical species present in the solution was calculated.

Keywords: absorption, carbon dioxide, monoethanolamine, experimental plant.

Proposed Topic: pre-combustion CO_2 capture