Abstract

CSIRO is developing a process concept that integrates a forward osmosis desalination with an amine-based CO₂-capture process, with the aim of providing useable water for a power plant with CO₂-capture. The concept involves the replacement of the lean absorption liquid cooler in an amine-based CO₂-capture process by a forward osmosis (FO) membrane unit. In an FO operation, water is selectively transferred through a permeable membrane from a solution of low osmotic pressure (the cooling water) to a solution of high osmotic pressure (the amine solution). The FO operation might utilise a saline water source such as seawater or from an aquifer that is unsuitable for direct use. As the solutions used for CO₂-capture are usually aqueous solutions with a higher concentration than seawater there will be a driving force for transfer of water from its source to the absorption liquid. The water can be recovered from the solution at no additional heat input to the CO₂-capture process in the top of the desorber as shown in Figure 1. The wet CO₂-product leaving the desorber is supplied to a condenser or other heat exchanger with the condensate removed from the absorption liquid loop.
Previous laboratory work has resulted in the identification of suitable FO membranes that lend themselves for use in this process\textsuperscript{ii}. This analysis included an evaluation of 6 different amine solutions using a sodium chloride solution representing seawater concentrations resulting in the determination of water flux and reverse amine flux under relevant conditions. These results have been used for the design of an experimental FO rig that can treat the complete absorption liquid flow of the Delta Electricity PCC pilot plant at Vales Point power station in New South Wales, Australia.

This work presented here will provide results of trials with the FO rig integrated with the PCC pilot plant. Figure 2 shows the FO rig delivered on site of the power plant where it has been connected to post-combustion CO\textsubscript{2} capture pilot plant.

Two experimental campaigns have been carried out: the first one using an amine-based solution, the second one using an amino-acid salt-based solution. In both cases potassium carbonate was added to the solution for increased water flux and minimisation of amine losses as indicated in our laboratory work. The results that will be presented and discussed here entail:

- Design basis for the integrated FO process
- Water production rate and water quality from the process
- Amine losses to the salt water
- Salt transfer to the amine solution
- Effectiveness of the membrane process for heat exchange

The presentation will also discuss the potential for application of this desalination process in power plants with integrated CO\textsubscript{2} capture.
Figure 2: Forward osmosis rig delivered at Vales Point power station.

Keywords: Carbon capture; amines, amino-acids, water; forward osmosis, desalination

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i Water production through CO$_2$ capture in coal-fired power plants, Paul Feron, Ramesh Thiruvenkatachari, Ashleigh Cousins, Energy Science and Engineering 2017; 5(5): 244–256

ii Seawater desalination with an amine-based CO$_2$-capture process, Paul Feron, Ramesh Thiruvenkatachari, Sanger Huang, Jun-Seok Bae, Ashleigh Cousins, Debra Fernandes, Anne Tibbett, poster presentation at GHGT15, Abu Dhabi,