Plastic membrane to bring down the cost of CO_2 capture

The large absorption towers of many power stations present just one cost challenge for carbon dioxide capture. Joe Gough

Coal-fired power stations are acknowledged as the single largest contributor to Australia's carbon dioxide emissions. PhD student, Julianna Franco, has developed a cost-effective CO_2 capture system based on the use of inexpensive plastic.

While environmentalists would like to see such power stations phased out sooner rather than later, governments and industry groups are allocating significant funding to the development of 'clean coal' technology that captures CO_2 from power station flue gases. Coal, it seems, will be around for a while.

One of the barriers to commercial implementation of 'clean coal' technology across Australia is cost. Proposed CO_2 capture systems overseas are based on the use of large absorption towers – a 400 MW power plant might require a 7 m high by 20 m wide structure – or expensive membrane materials such as Teflon, used in pilot-scale CO_2 capture systems.

University of Melbourne doctoral student, Julianna Franco, has developed a CO_2 capture system that replaces Teflon by using polypropylene (plastic).

In this membrane gas absorption (MGA) system, the porous plastic acts as a semipermeable barrier, allowing CO_2 gas on one side to come into direct contact with an aqueous solvent on the other, without the gas or liquid dispersing into each other.

MGAs are commonly used to remove gases from, or dissolve them into, water. For an MGA to be effective, however, the membrane must be water-repellent on one side to prevent the water from passing through the pores into the gaseous side of the membrane.

According to Franco's supervisor, Professor Geoff Stevens, past research on the use of polypropylene as a membrane for CO_2 capture concluded that it was unsuitable for MGA use. The plastic's pores were observed to 'wet' in the presence of the aqueous solvent used to absorb CO_2 from the gaseous phase, allowing the two phases to mix.

However, Franco has now modified the surface properties of the polypropylene to make it as water-repellent as Teflon.

This allows the CO_2 to selectively pass through the membrane and be absorbed on the other side by a widely available solvent (20–30% methylethanolamine dissolved in water).

The membrane can be deployed in the form of hollow fibre units that provide an order of magnitude more surface area than those available in conventional CO_2 capture columns.

'MGA units can separate carbon dioxide using three to four times less space than processing towers, making carbon dioxide capture more efficient and economical,' says Franco.

Franco's research follows on from earlier research that resulted in the construction of a pilot-scale membrane gas absorption plant – incorporating Teflon as the membrane material – for separation of CO_2 from natural gas at Kårstø, Norway.

Australia, too, has natural gas reserves with high CO_2 levels, such as those at the Gorgon gas field on the north-west coast of Australia. According to Stevens, a polypropylene MGA system would make new natural gas fields with high CO_2 content more economically – and environmentally – viable.

Global interest in this research is demonstrated by the list of universities collaborating with the University of Melbourne: Canada's Regina University, the University of Trondheim, Twente University in the Netherlands, and the University of Texas.

However, it's still early days. Stevens says the polypropylene carbon capture system is due to be tested next year at a pilot plant that will process 25 tonnes of CO_2 per day.

The pilot plant is being built at Hazelwood, one of Victoria's oldest – and its most greenhouse-polluting – brown coal-fired power stations. The trial is being funded by the Australian and Victorian Governments.

Depending on the outcome of that trial – in particular, how the economics of this technology stack up against competing technologies – the most optimistic date for the full deployment of commercial-scale carbon dioxide capture systems in Australia is 2015, although other sources put the date at 2020.

● **Mary-Lou Considine**