# CO2CRC Capture Activities
# Otway Focus

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BUILDING A LOW EMISSIONS FUTURE

**GHGT-14**

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# Highlighted Features in capture Program

Otway Capture Project

- Our membrane and adsorbent capture technologies are being developed in our state-of-the-art Otway Capture Facility for natural gas separation under high pressure. We are also opening this facility to 3rd parties for their own use.

Membrane-solvent Contactor in a power plant in NSW

- Development of a novel, compact and hybrid carbon capture technology for coal fired power plants. It takes advantages of both membrane and solvent technologies making it compact and highly efficient.

Other Items

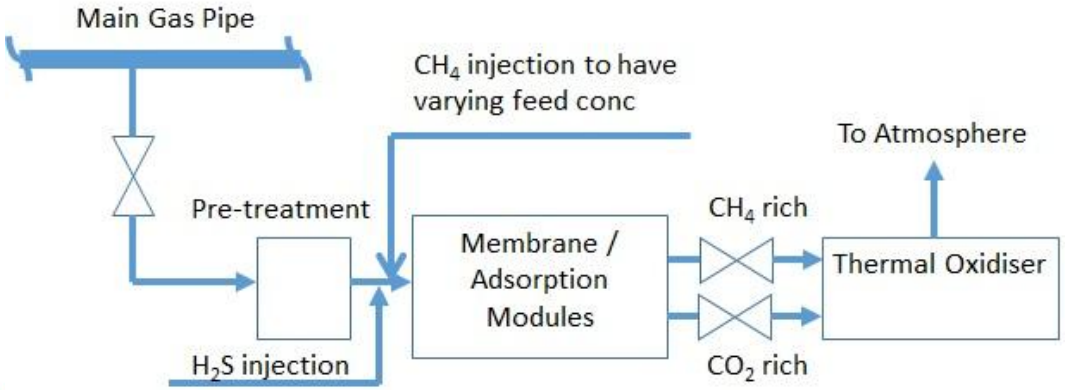
Gas Refining in HESC (Hydrogen Energy Supply Chain) in Latrobe Valley

- CO2CRC has been awarded a contract to do EPCC of the gas refining part to purify syngas to obtain pure hydrogen from brown coal via gasification route. This project, if successful, will lead to a large-scale plant where CCS will become a vital component, where CO2CRC's expertise and involvement would be expected to be valuable for the benefits of both the HESC consortium and the CCS cause.
- A visionary Capture Retrofit Study for a Latrobe Valley power plant has been completed. Technical feasibility for a complete retrofit of the whole power plant with estimated cost have been worked out.
- Asian CCS readiness study funded by ADB.
- Exploring other CCU projects, like biorefinery, conversion of $CO_2$ into products (biofuel, plastics etc.)

Otway Capture Rig’s components

# Otway Capture Rig Key Facts

*High pressure (up to 90 bar) experimental natural gas separation rig*


Gas fields with high $CO_2$ content are economically not viable using current solvent technology. The main aim of this project is to develop cost-effective, robust and compact technology for separating NG under high pressure and with high $CO_2$ content.

Project duration: 2016 – 2019

Feed: Buttress gas (~79% $CO_2$, ~19% $CH_4$ ) $CH_4$ from cylinders to obtain various $CO_2$ conc.

Rig Pressure: designed to operate up to 90 bar

Flow Rate: ~10 L/min

Capture Techn: Adsorption and Membrane

Research Lead The University of Melbourne and UNSW

Why Buttress gas: Real NG with high $CO_2$ content

Impurities: Higher hydrocarbons

$H_2S$ injection: Worse impurity in natural gas

Test Campaigns: Campaign 1: Commercial materials for benchmarking - completed

Campaign 2: New developed materials with higher separation efficiency - ongoing

Campaign 3: Long term and impurity testing

Third Party Testing The rig offers service to third party

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# Otway Capture Achievements so far

## Till Sept 2018

### Achieved

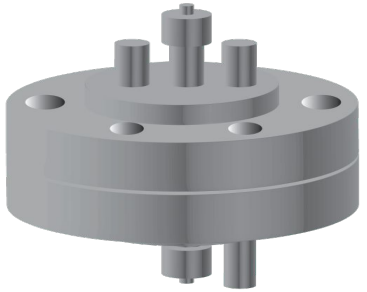
- Implemented a complex State-Of-The-Art fully automated pilot plant operating under high pressure.
- 3 diferent membrane modules and one type adsorbents have been trialled to collect bench marking data in Campaign 1
- High efficient and better tolerant advanced materials for both membranes and adsorbents have been developed and are currently undergoing trials in Campaign 2 using Buttress gas

### Lessons learned:

- Confidence in collecting vital data by operating continously 24/7
- It has given confidence in carrying out the rest of the campaigns and hence the possibility of success in the technologies to be robust and durable
- Operating the complicated skid for almost one and a half years has provided some learnings and ideas to improve operational matters

Adsorbents

Spiral wounds



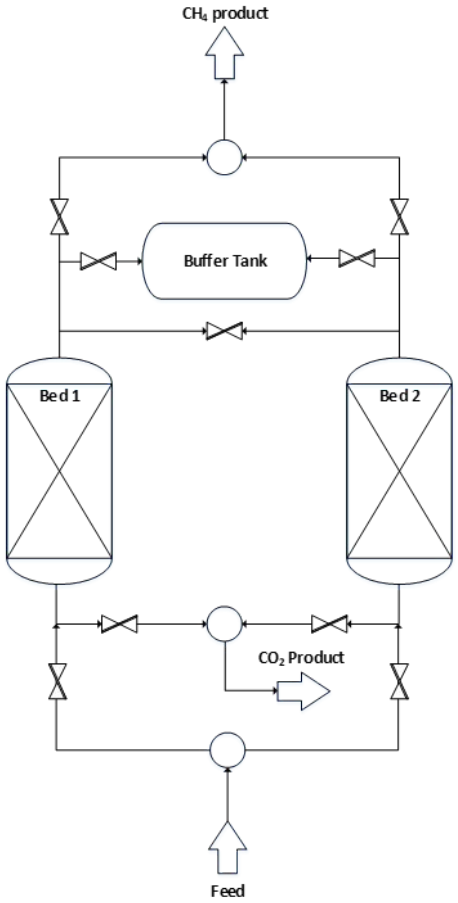
Flat sheet

Hollow fiber

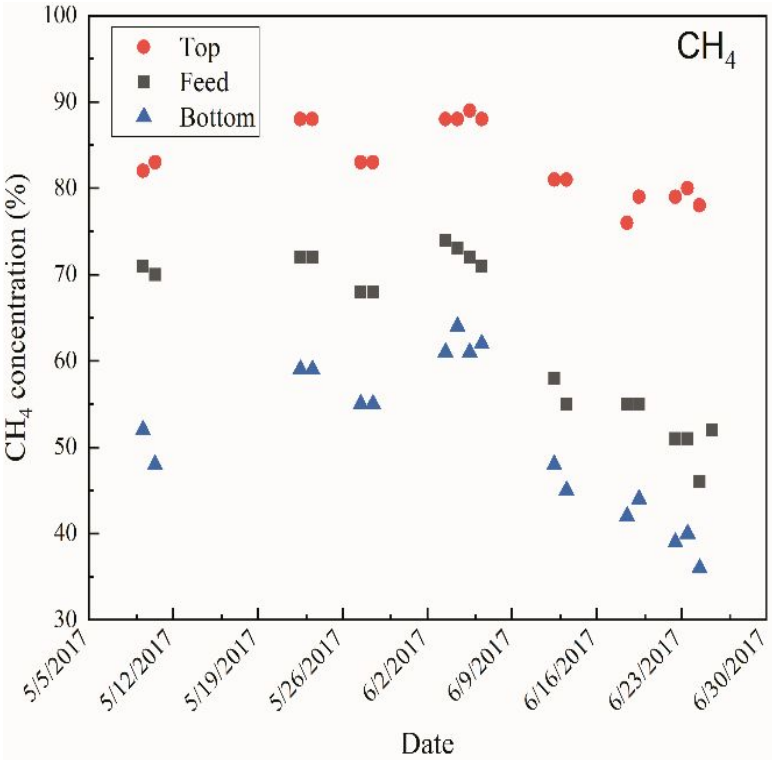
# Current Progresses for the Capture of $CO_2$ from Natural Gases by Pressure Swing Adsorption Technology

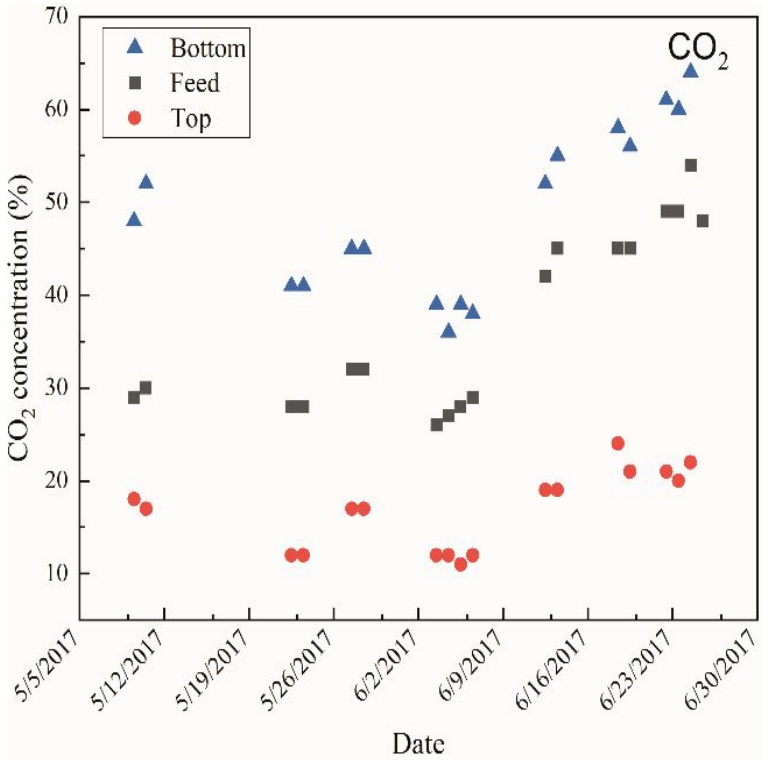
- Selected the adsorbents with high working capacity and $CO_2$ selectivity by screening a number of commercial adsorbents
- Developed novel adsorbents which have highly efficient $CO_2$ adsorption characteristics in our laboratory
- Successfully separated $CO_2$ from highly soured natural gases using a bench marked adsorbent when 30 bar pressure natural gases containing 30 % and 50 % $CO_2$ were treated within Otway PSA demonstration plant
- Achieved promising simulation results for $CO_2$ capture from various $CO_2$ content natural gases using the chosen adsorbents by PSA

# Experimental results of $CO_2$ separation performance using bench mark adsorbent in Otway PSA demonstration plant



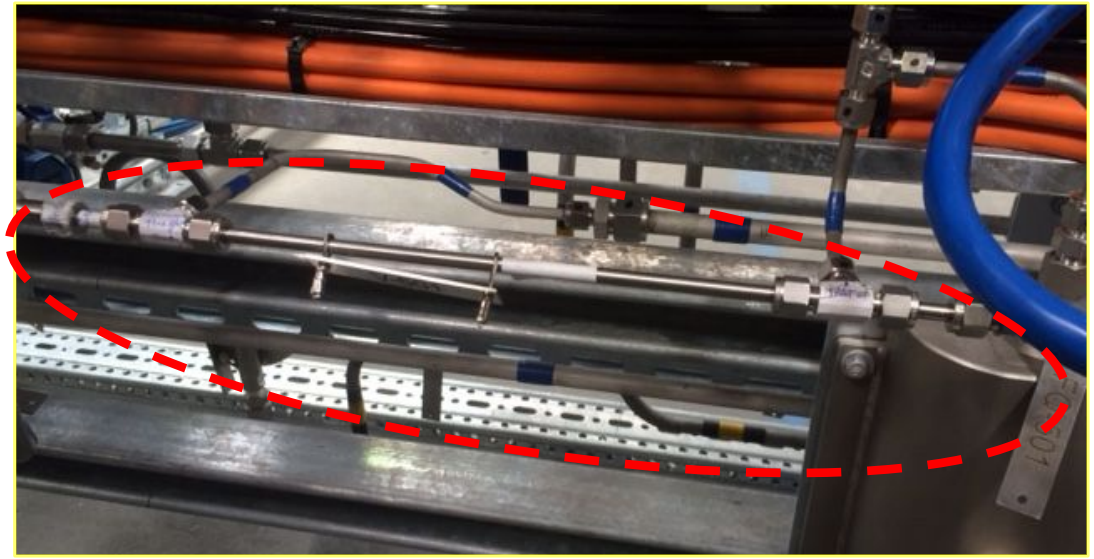

Schematic of Adsorption Plant

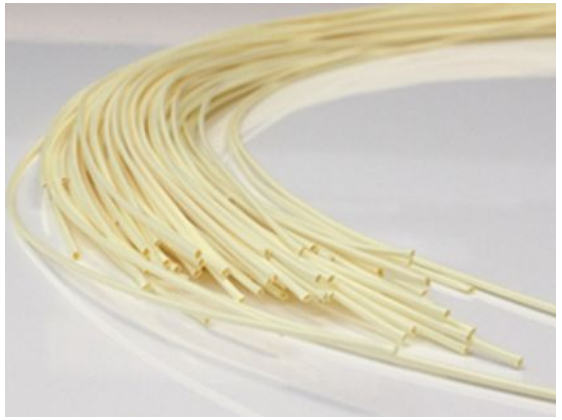


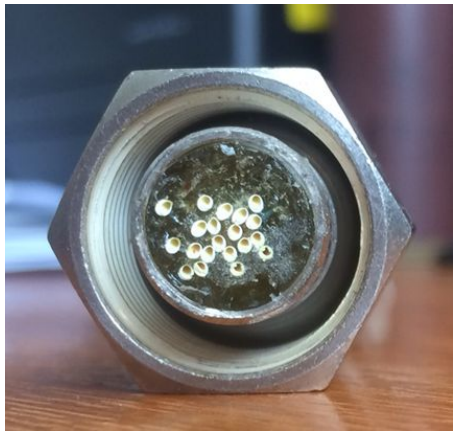




Separation performances of $CO_2$ and $CH_4$ at 30 bar.g from 5th May, 2017 to 4th July, 2017.

# Hollow Fiber Membranes



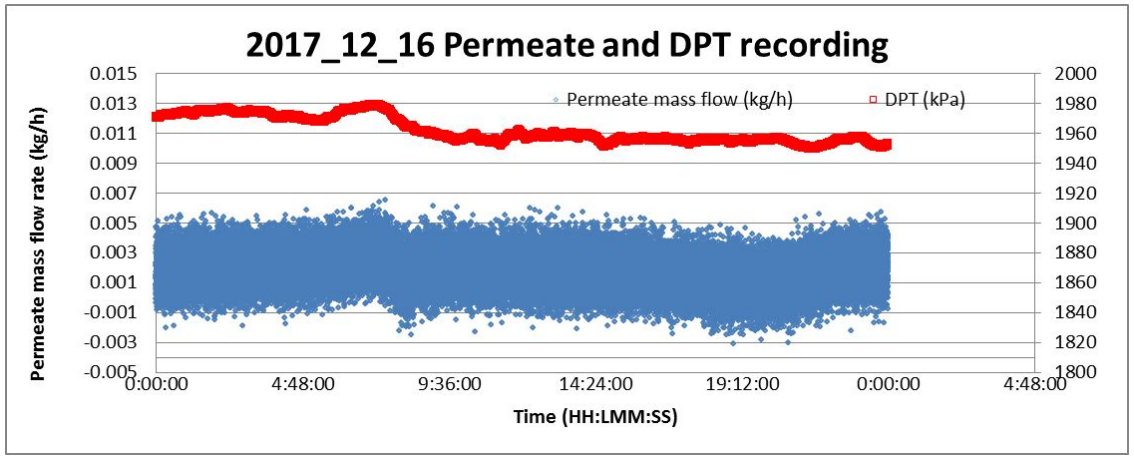


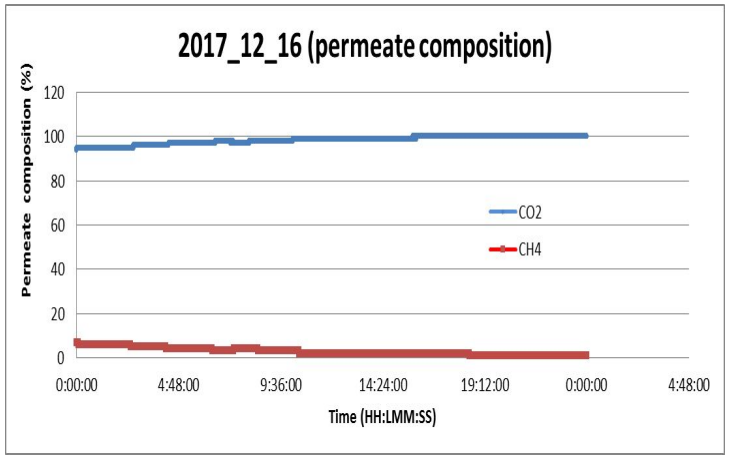


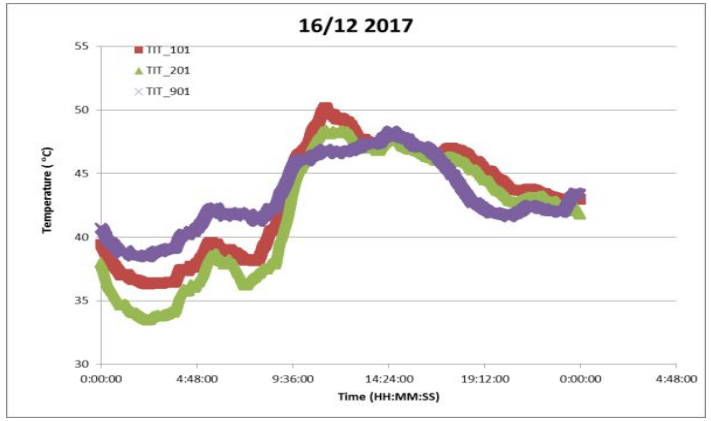
Membrane area: 50 to 200 $cm^2$.

# Hollow Fiber Membrane on-site test __ stable performance

Feed pressure and flow rate controlled as stable.




Matrimid with Silwet additive, hollow fiber membrane.
Feed composition: 30% $CO_2$, 70% $CH_4$
Permeate stage cut: 0.3

Permeate composition:> 95% $CO_2$, selectivity >50 (lab test 40 to 50).

Permeate flowrate: ~10 GPU (Lab test 15 GPU with pure gas)

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UNSW AUSTRALIA

# Tests Outcomes for Hollow Fiber Membranes

Otway well gas

Feed pressure: 25 bars.

Membrane (Matrimid) area: 45 $cm^2$

Stage cut: 0.2

Test duration: two weeks continuous

Stable permeance, permeate composition, selectivity slightly higher than lab results.

**Lessons learnt in on site tests:**

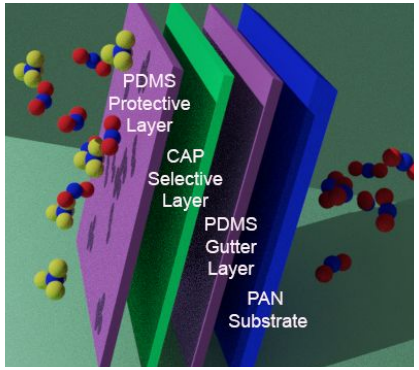
1) Safe-guard pressure fluctuation, particularly sudden change in pressure in permeate side.

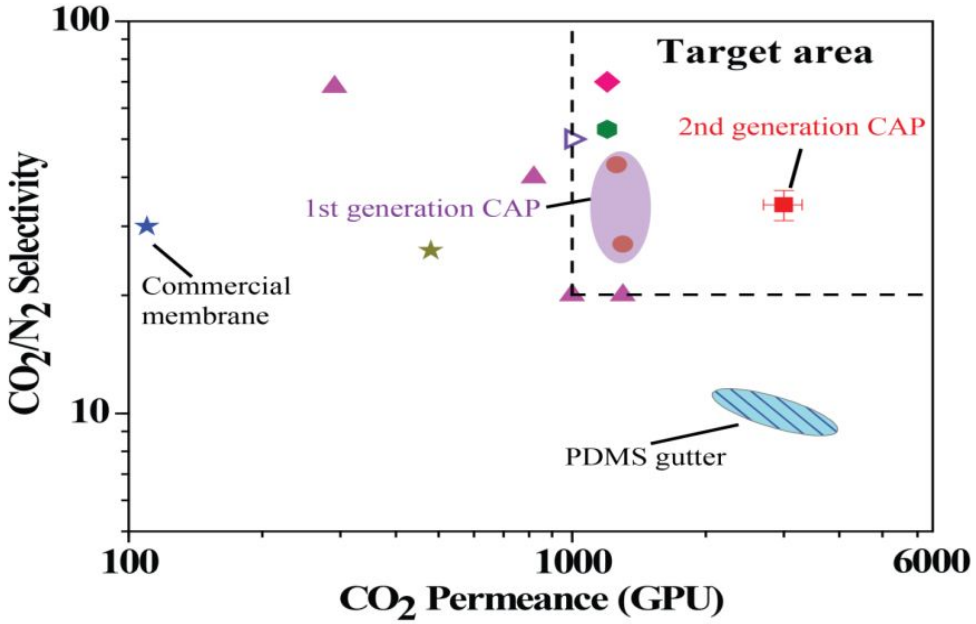
2) A good stage cut (ratio of permeate flow rate over feed flow rate) is important for avoidance of high concentration polarization.

# Otway Capture Project – CAP Membranes

- Develop CAP membrane materials to evaluate the effects of pressure, $CO_2$ content, physical aging, plasticization, thermal annealing, contaminant like $H_2S$ on membrane's performance (1st Gen CAP).

- Plan to develop next generation membrane materials, such as nanoparticles and two-dimensional MOF facilitated membranes and pressure test them in Lab to carry out the tests at Otway (2nd Gen CAP).



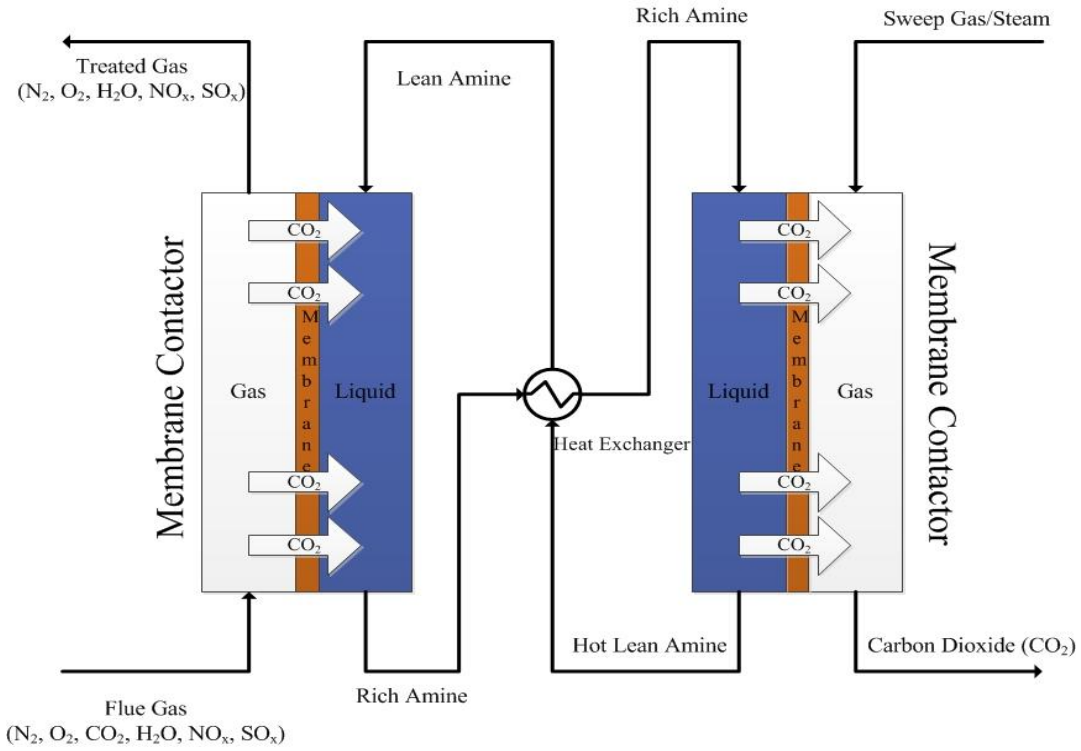




*Spiral Wound Module with membrane sample*

# Learning by Doing

| ITEM | Challenges | Comments |
|---|---|---|
| Operation & Management | Lots of unknown factors as it is first of a kind built by CO2CRC<br>The location of the plant was in the premises of the gas well which is under a strict site management and regulatory environment<br>Safeguarding public and landowners interest | Extra training to the operator, careful planning, regulatory approval took long time, public liaison officer working from site. |
| Technical | Simultaneous operation of membrane & PSA modules, long test duration.<br>Lowering the desorption pressure in PSA to acceptable limit (from 5 barg to around 2 barg) | Comprehensive design review and data analysis, modifications on the rig to improve performance |
| Towards Commercialization | Proving the technology is capable of fulfilling the main objectives of NG separation as outlined in this paper<br>Scaling up of the technology with economic analysis<br>Investment from industries to furthering this technologies towards commercial readiness | Regular review of research progress by industry partners |

# Vales Point Capture Project




Processing flue gas from a black coal power station (~10 % $CO_2$).

Solvent: 30 wt% Monoethanolamine

Absorber Contactor: LDPE (spiral wound)

Desorber Contactor: PDMS (hollow fibre)

Flue Gas: 5 kg/hr

Steam Sweep: 2 – 5 kg/hr (variable regeneration temperature)

# CO2CRC Capture Facilities at Hazelw

# Government, Industry and Research Partners

























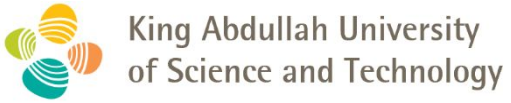










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