PMW Technology

CO_2 CAPTURE BY FROSTING ON A MOVING PACKED BED

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The Project

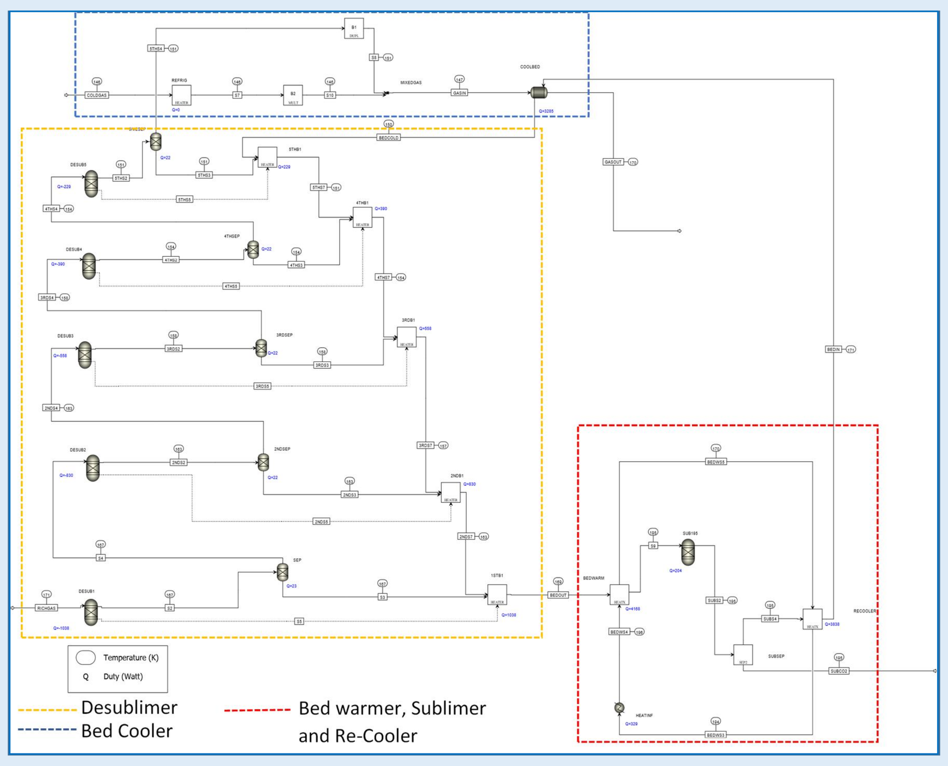
- A techno-economic feasibility study
- Benchmarking of A3C Process against other processes
- Part funded by Innovate UK under the Energy Catalyst Round 4 programme
- Completion October 2018
- Led by SME PMW Technology
- Six party collaboration

Scope

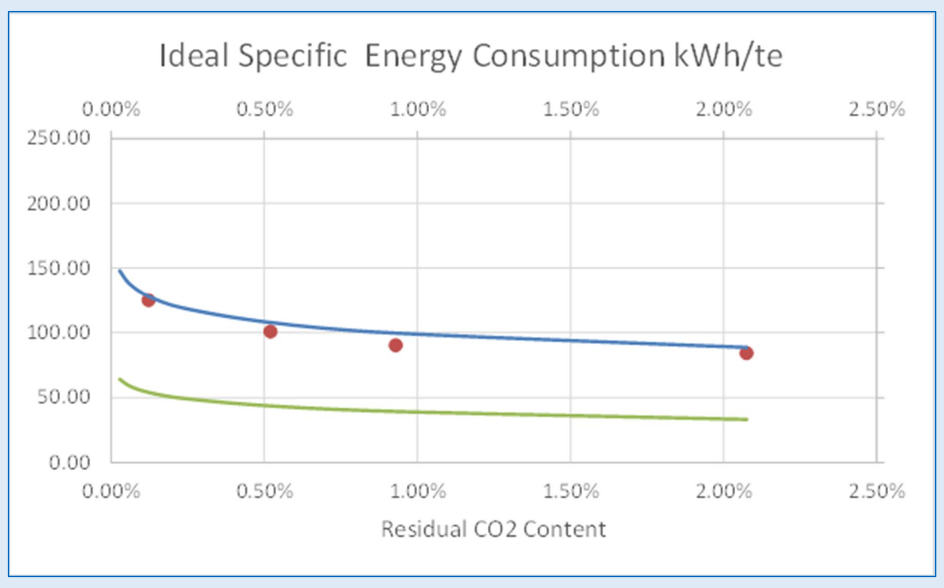
- Literature review
- CO_2 properties below triple point
- Develop and validate finite element model of the separation
- Develop and validate Aspen Plus® model of the separation process
- Define and model balance of process
- Model target applications
- Conceptual engineering of process
- Costing of process implementation
- Life cost analysis of A3C process
- Benchmarking of A3C applications against other capture technologies

Modelling

Aspen Separation Model



Model Result Comparison

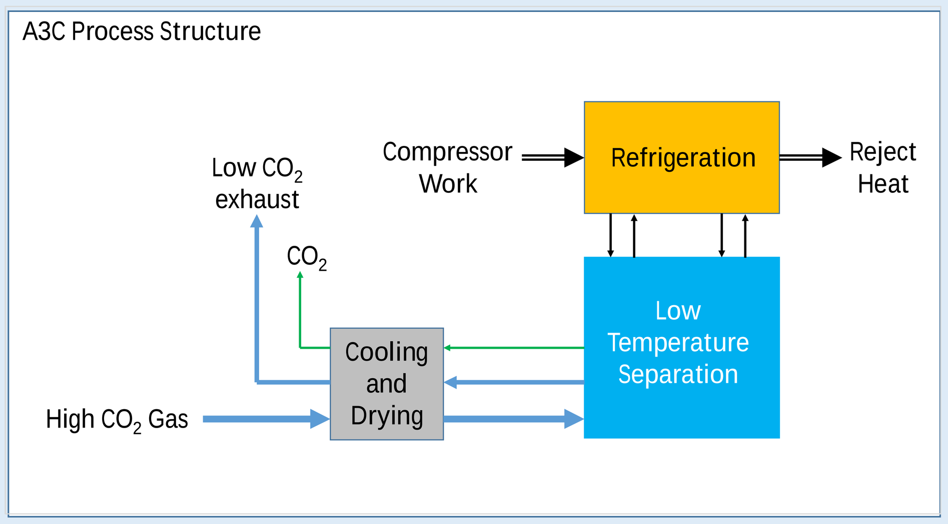


- Aspen Plus® results
- Finite element model results
- Thermodynamic limit

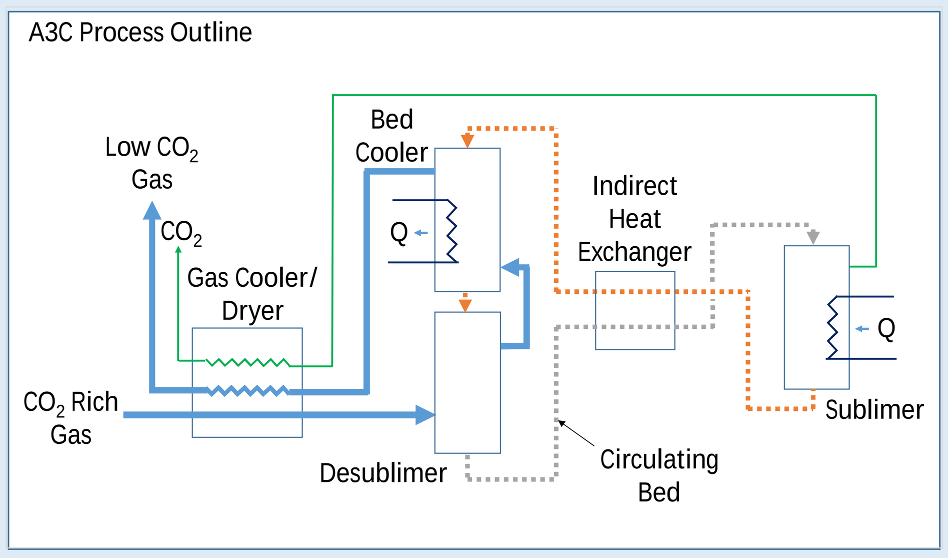
The A3C Process

- The patented Advanced Cryogenic Carbon Capture (A3C) process separates CO_2 as a frost
- Minimises energy consumption by being highly regenerative
- Uses intensive heat and mass transfer in a moving packed bed
- Comprises three core elements:
  - o Gas cooler/dryer
  - o CO_2 separation
  - o Refrigeration

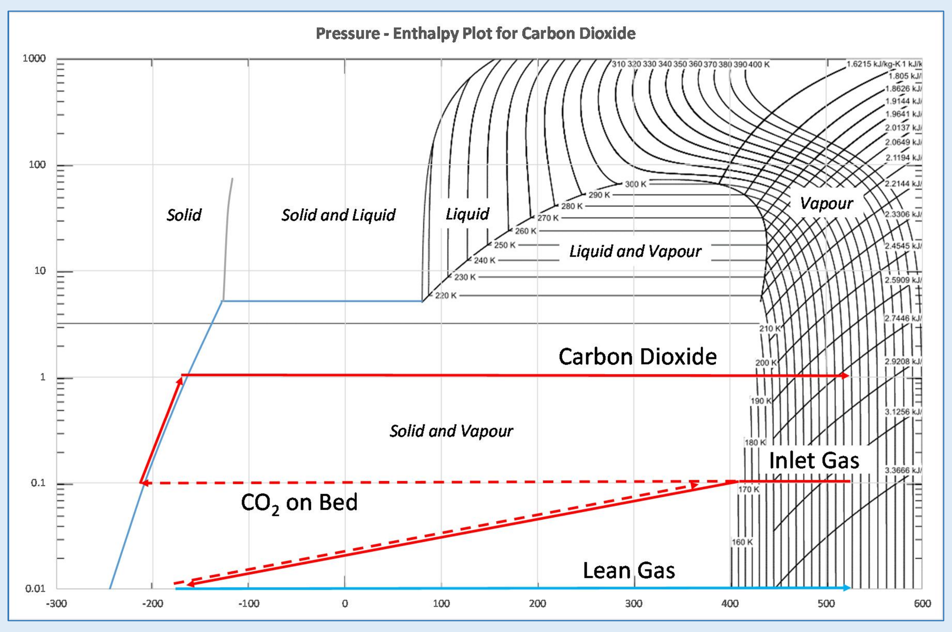
A3C Process Overview



A3C Process Outline



Process P-h Diagram



Moving Packed Bed

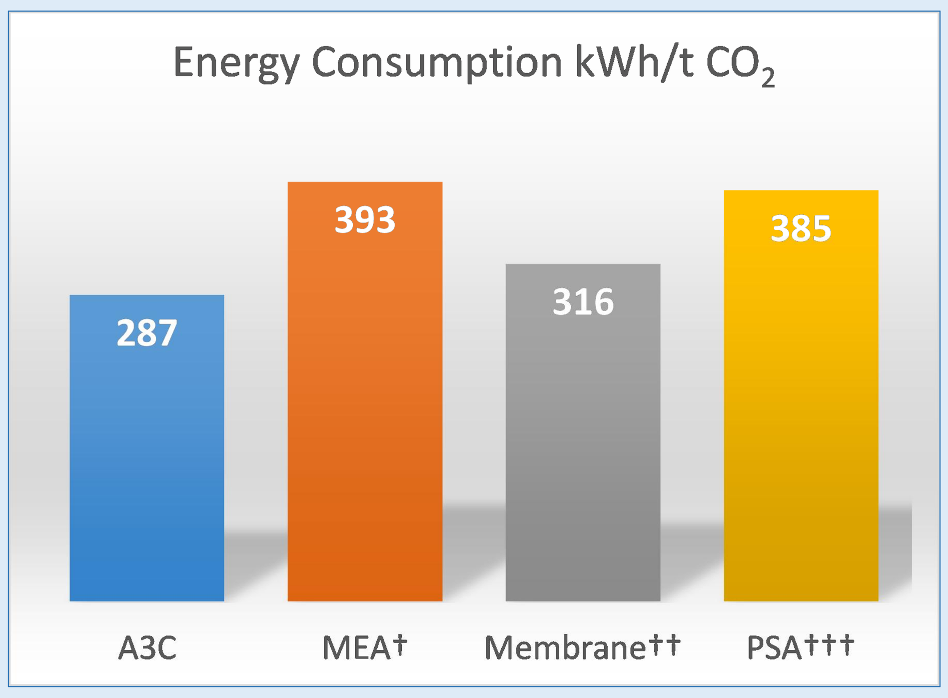
- Metallic or ceramic beads
- Typical diameter: 2 mm
- Surface area per m³: 1800 m²
- Heat transfer coef.: 100-300 W/m²K
- Rate of movement: 1-5 mm/s
- Typical bed depth: 0.3-0.5 m

Benefits

Low Cost of Ownership

- Low energy consumption
- Low estimated capital cost
- No consumable chemicals
- No chemical hazards

Process Energy Comparison



Application: 13% CO_2 in, 90% capture, 110 bar CO_2 delivery

† Excluding CO_2 purification, ref 1

†† Low CO_2 recovery, excluding CO_2 purification, ref 2

††† Low CO_2 recovery, excluding CO_2 purification, ref 3

Ease of Integration

- Simple application – no heat integration necessary
- Small footprint for capacity
- Readily installed as stand alone package unit
- Specific cost and performance not highly sensitive to scale

Flexibility

- Residual CO_2 levels as low as 100ppm without excessive size, cost or energy consumption
- High pressure operation to 20% CO_2 at 25 Bara
- Produces high purity CO_2 without additional processing
- CO_2 delivery as high pressure gas or refrigerated liquid
- Economic at small unit capacities

Potential Applications

- Biogas upgrading
- SMR CO_2 separation
- Utility carbon capture
- Industrial CO_2 capture
- Low emission freight transport

References

1. EU CESAR Project (2011), ASC test case, 19, European best practice guidelines for CO_2 capture technologies.
2. He, X. and Hägg, M-B., (2014) *Energy Procedia* 63, 174. Energy efficient process for CO_2 capture from flue-gas with novel fixed-site-carrier membranes.
3. Webley, P. A., (2010) *Proceedings of the Post-Combustion Carbon Capture Workshop, Talloires*, 21, CO_2 from adsorption processes; from materials to process development to practical implementation.

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