V-PSA (UK3.1)

Multi-column Vacuum Pressure Swing Adsorption

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Edinburgh, United Kingdom

Operated by

Description

The adsorptive gas separation system is to test a variety of pressure swing adsorption systems in a wide range of column pressure from vacuum to 40 bar. This system was designed to operate for both CO2 recovery (low pressure) and H2 production (high pressure). To achieve a high product recovery, the rig contains six identical adsorption columns with all the column interconnected to each other through the lines. All the columns are placed in an oven for temperature control. Each column has a dimension of 600 mm length x 25 mm diameter. It was designed on the basis of the feed flowrate of 5 LSTP/min.

In addition to the four steps of Skarstrom cycle, other steps for performance improvement can be incorporated into an adsorption cycle, such as product pressurisation, pressure equalization and light/heavy reflux. The gas compositions are analysed in situ by a mass spectrometer.

A dynamic simulator has been developed for the multi-column VPSA system with gPROMS, based on rigorous mathematical models developed by the rig owner.

Scientific Environment

nd

State of the Art

nd

Areas of Research

The rig can be used for testing a high-pressure adsorptive separation, e.g. hydrogen purification from the syngas.

Installations

Refer to the diagram in the figure "Process flow diagram" for components of this rig.

Quality Control / Quality Assurance (QA)

Quality Commitment

nd

CCUS Technologies

Capture

- Systems (full chain optimization)
- Sorbents
- Fixed-bed adsorption system

Research Fields

- Physical processes
- Engineering

Scale of Facility

- Small pilot

Research Facility Contact

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V-PSA (UK3.1)

Facility Availability

Unit of Access (UA)
Week

Availability Per Year (in UA)
Around 2 - 3 months each year

Forms of Access
In Person

Present Facility State of Access
Fully Accessible

Average Duration of a Typical Access
2 weeks

Number of External Users for Typical Access
Normally two external users to attend

Operational or Other Constraints

Specific Risks
Tests must be planned well ahead to have sufficient time for preparing for the experiments. Adsorbents to be tested must be provided by the user along with their full data sheet. Risk assessment must be carried out before access to the rig is granted. A user must be accompanied by an experienced UoE staff in accessing the rig.

Legal Issues
nd

Selected Publications

2015 - International Journal of Greenhouse Gas Control 35, 71 – 81, 2015

CO2 capture from syngas by an adsorption process at a biomass gasification CHP plant: Its comparison with amine-based CO2 capture

Oreggioni, G.D., Brandani, S., Luberti, M., Baykan, Y., Friedrich, D., Ahn, H.

2014 - Adsorption 20(2-3), 511 – 524, 2014

Design of a H2 PSA for cogeneration of ultrapure hydrogen and power at an advanced integrated gasification combined cycle with pre-combustion capture

Luberti, M., Friedrich, D., Brandani, S., Ahn, H.

2019 - Chemical Engineering Research and Design 151, 91 – 99, 2019

Equilibrium theory analysis of thermal regeneration of a humid adsorption column: Selection of optimal hot purge gas temperature

Ahn, H.

2015 - Adsorption 21(5), 353 – 363, 2015

New momentum and energy balance equations considering kinetic energy effect for mathematical modelling of a fixed bed adsorption column

Luberti, M., Kim, Y.-H., Lee, C.-H., Ferrari, M.-C., Ahn, H.

2017 - Journal of environmental chemical engineering 5(4), 3973 – 3982, 2017

V-PSA (UK3.1)

Design of a rapid vacuum pressure swing adsorption (RVPSA) process for post-combustion CO2 capture from a biomass-fuelled CHP plant
Luberti, M., Oreggioni, G.D., Ahn, H.

CCUS Projects

2008-2014 -Other CCUS Projects - EPSRC, EP/F034520/1
Carbon Capture from Power Plant and Atmosphere

2012-2013 -Other CCUS Projects - EPSRC, EP/J018198/01
Carbon Capture in the Refining Process

2011 -Other CCUS Projects - KETEP 2011 International Joint Research on Energy Technology, funded by Korean government
Development of a Pre-combustion Capture IGCC Process integrated with H2 PSA

Patents

2014
Hydrogen production processing
WO2015104532A1

Figures

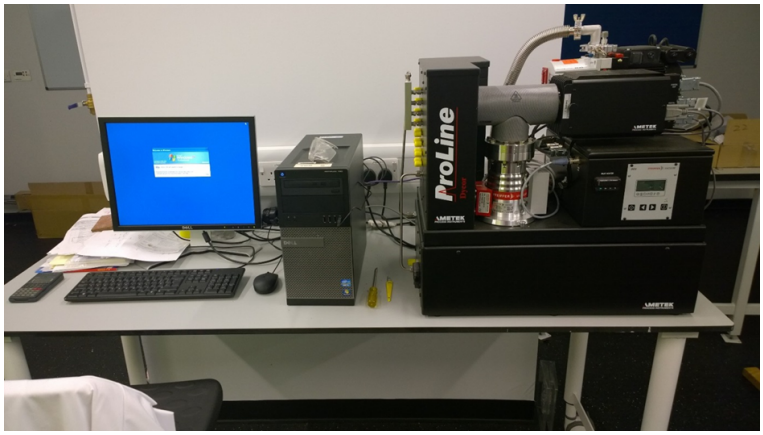
Multi-column VPSA system at UoE consisting of gas dosing system, six columns in the oven, vacuum pump and control system.

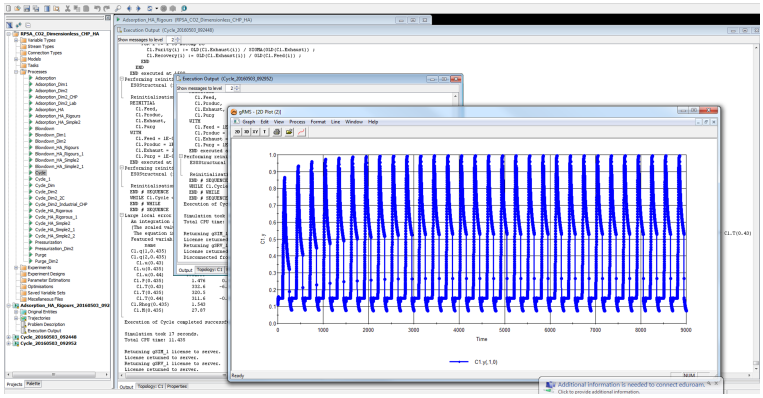
Solenoid valves

Six columns in the oven

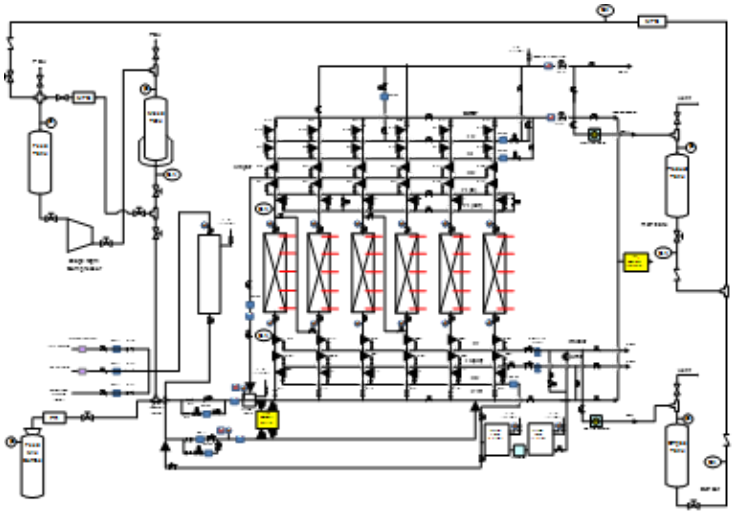
Gas analyser

V-PSA (UK3.1)





Dynamic gPROMS simulation of a cyclic adsorption system



Process flow diagram

Multi-column VPSA system at UoE consisting of gas dosing system, six columns in the oven, vacuum pump and control system

The University of Edinburgh