

Automation and Development of Dual-Piston Pressure Swing Adsorption Apparatus



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Overview of DP-PSA apparatus



Figure 1: Picture of DP-PSA apparatus

Aim: Testing of novel materials for the separation of CO₂ from flue gas

Benefits of DP-PSA

- Direct test of the separation performance
- Single column required
- Closed system with total reflux; only small amount of gas needed
- Rapid testing of adsorbent materials
- Model system for large-scale process
- Many different experiments are possible
- Particularly suitable to measure kinetic and equilibrium properties of novel adsorbent materials

Schematic of the DP-PSA apparatus with its automation

Project target:

Develop a totally automated DP-PSA system which can obtain enough information to estimate kinetic and equilibrium properties of novel adsorbent materials.

Challenges & Achievements:

- Realise control and communication between pistons, real time computer, pressure transducer, temperature sensor and PC
- Integrate the control code with user-friendly and robust interface
- Acquire piston positions with corresponding pressures in real time with high frequency
- Generate a scheduler to run a series of experiments
- Generate smooth, close to sinusoidal piston movement
- High frequency cycles (~1Hz) require fast and accurate motor control

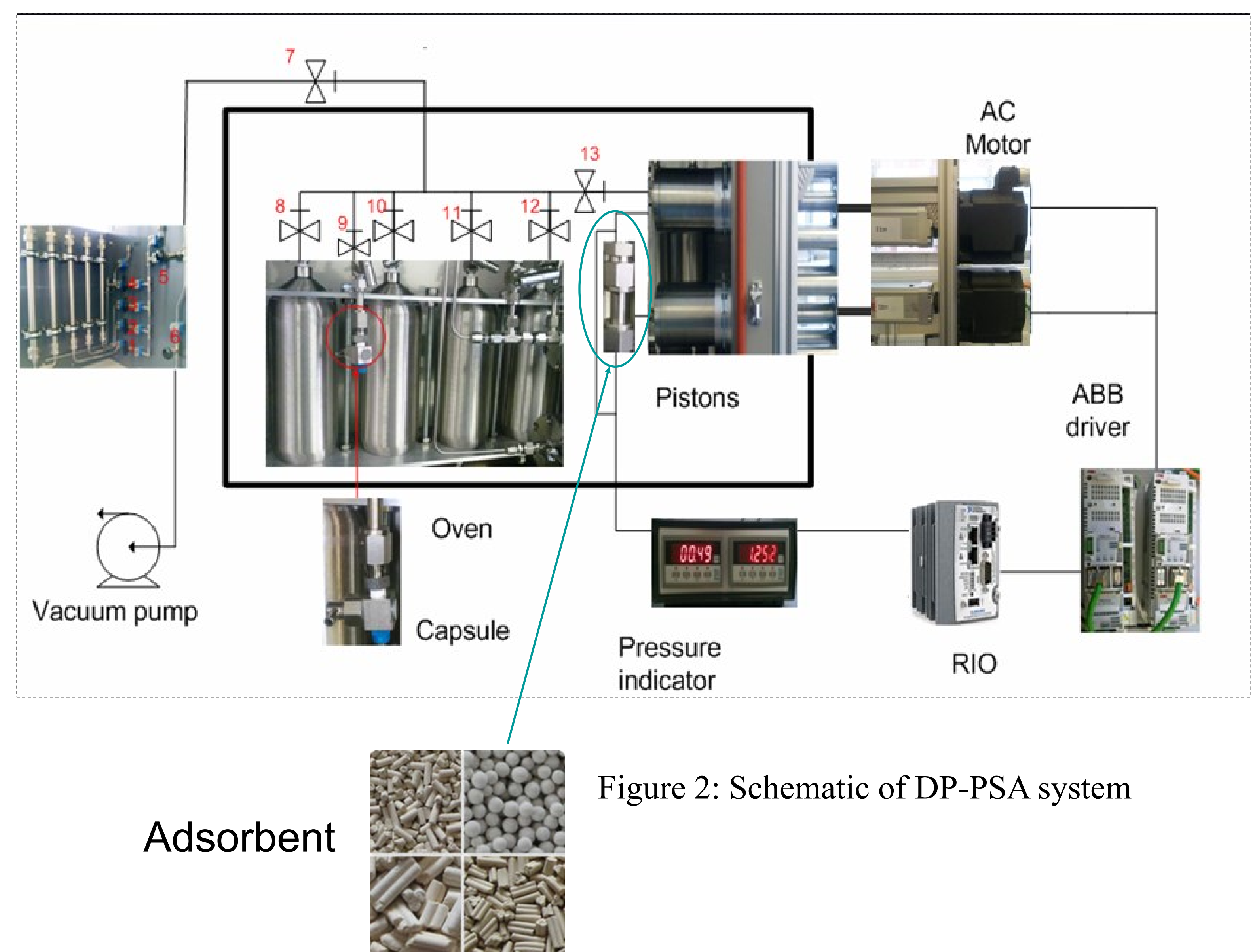


Figure 2: Schematic of DP-PSA system

Results of experiments

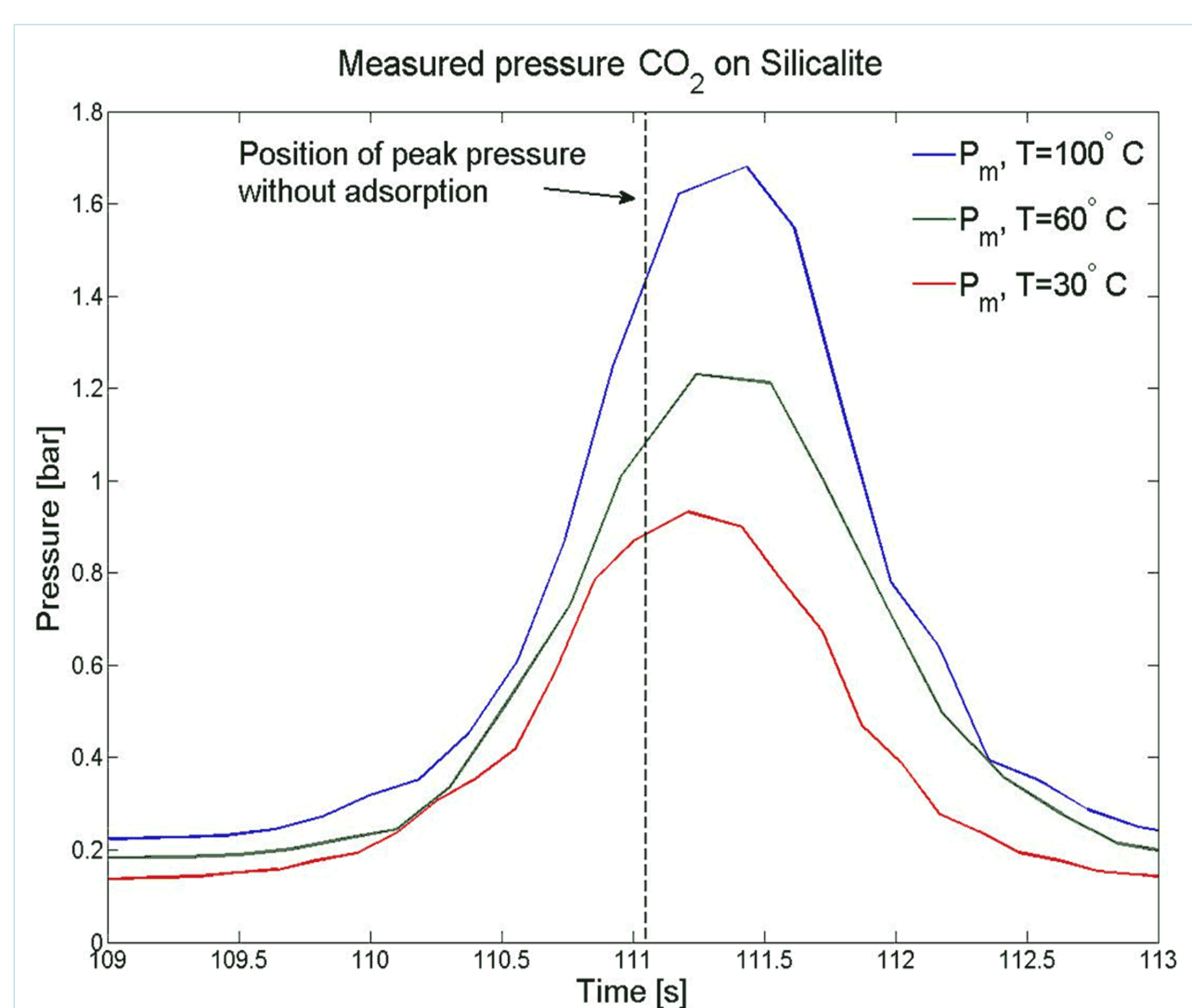


Figure 3: Comparison of CO₂ of different temperatures

- Pressure inside the column can be related to kinetic and equilibrium properties of adsorbents.
- Figure 3 shows that the pressure of strong adsorbing gas (CO₂ at low temperature) responds ahead of that of weakly adsorbing one (CO₂ at high temperature), if configurations are the same.
- Measurement of the differential pressure across the column is available to estimate pressure drop.
- Adsorption isotherm experiments can be implemented, see Figure 4, and the results are comparable to that by other equipment.

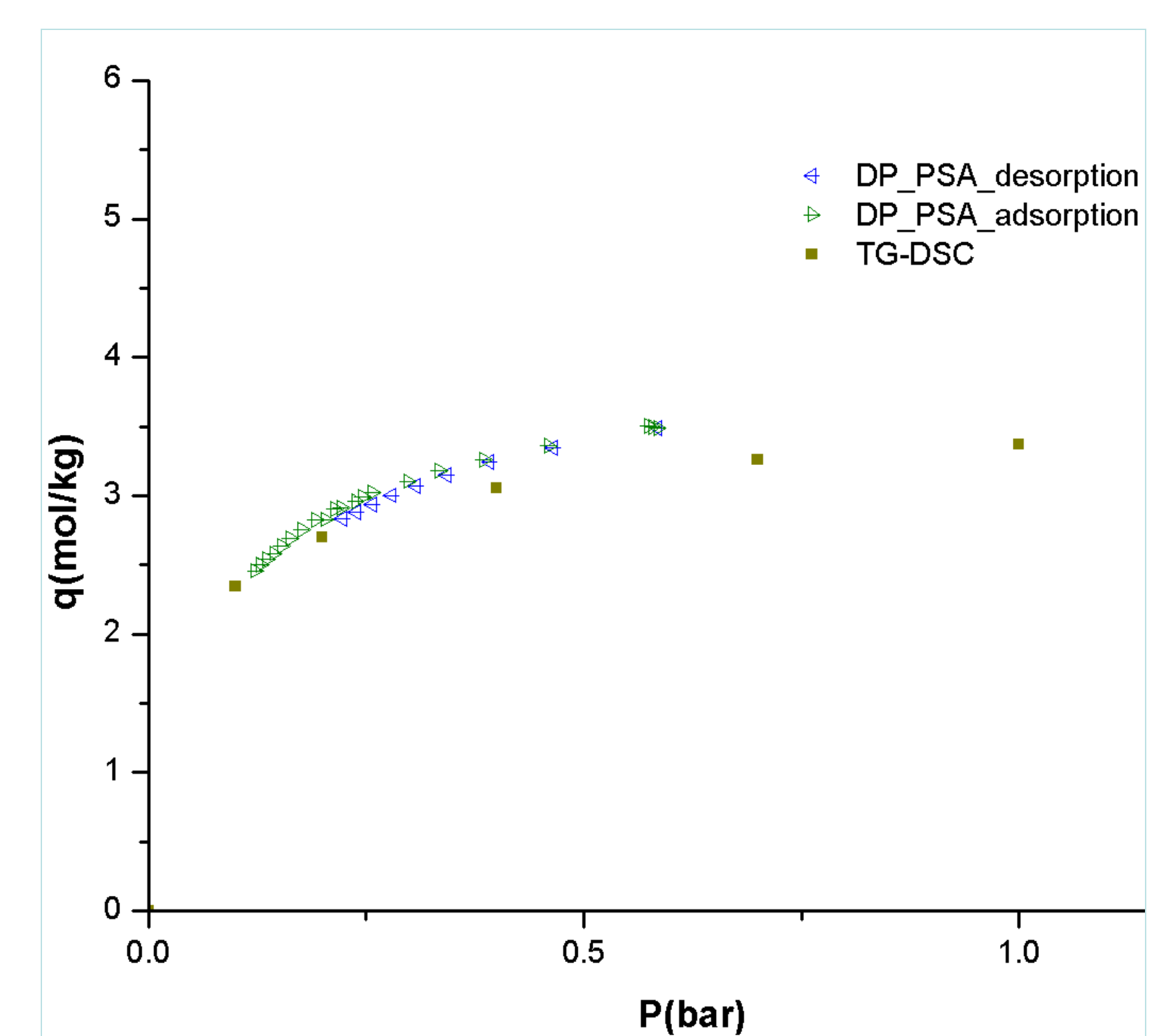


Figure 4: Isotherm experiment with 13X at 30°C

Further work

- Temperature measurement in the gas and solid phase in the column.
- Experiments with different adsorbent materials.

Acknowledgements

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