Adsorption of CO_2 and H_2O on K-promoted hydrotalcite

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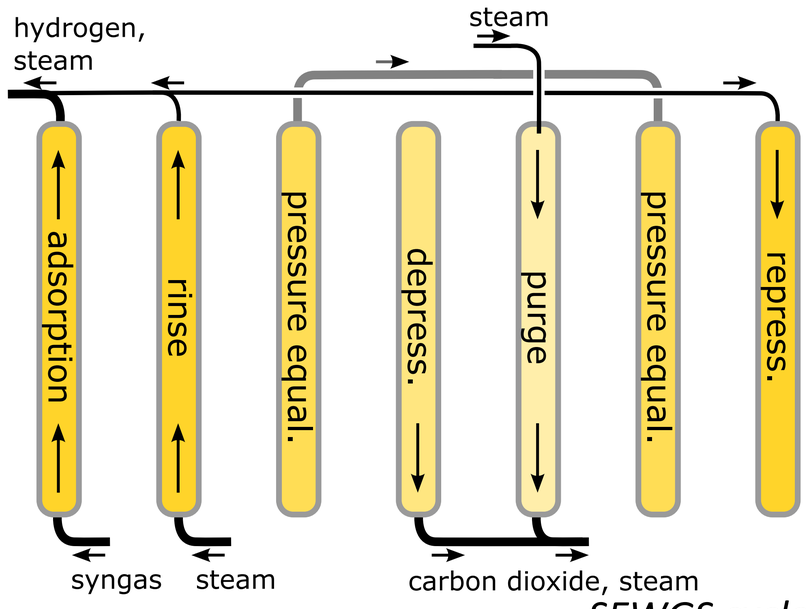
New description of CO_2 and H_2O interaction with the solid sorbent indicates potential for improved performance of the hot sorption-enhanced water-gas shift (SEWGS) process.

Sorption-enhanced water-gas shift (SEWGS)

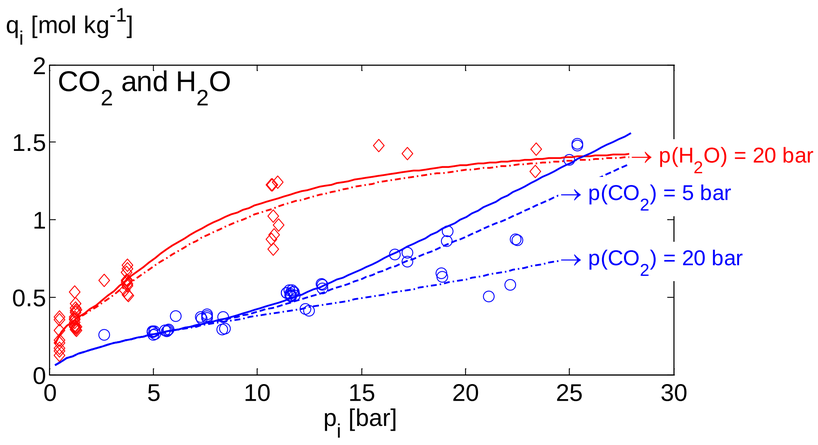
- Water–gas shift reaction with in situ adsorption of CO_2 on potassium-promoted hydrotalcite (K-HTC) at 350-450°C
- SEWGS is a cyclic process, that comprises high pressure adsorption and *steam rinse*, pressure equalisation, low pressure *steam purge*



SEWGS cycle example

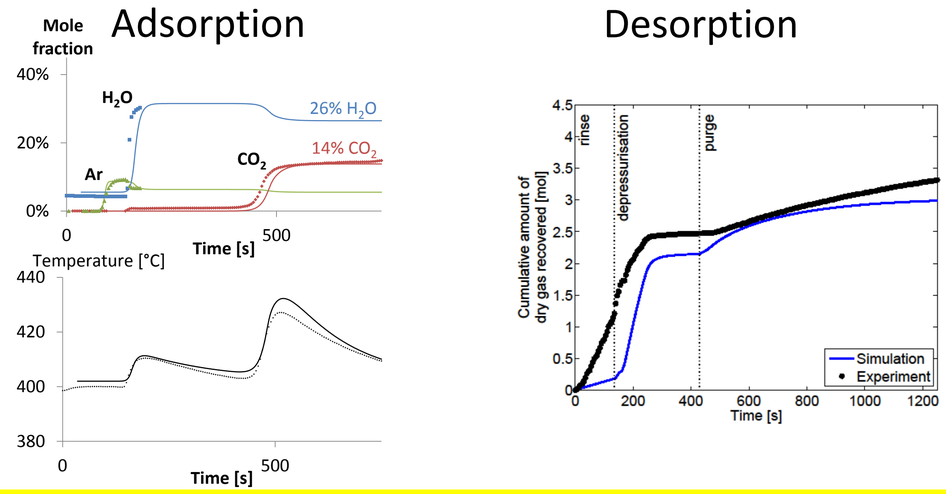
CO_2 – H_2O – K-HTC adsorption isotherm

- Surface adsorption occurs at specific sites for CO_2 or H_2O up to 5 bar
- CO_2 and H_2O adsorb competitively in nanopores at higher partial pressures



Sorption kinetics and reactor model

- Intraparticle mass transfer: linear driving force model
- Validated using a 1D pseudohomogeneous reactor model

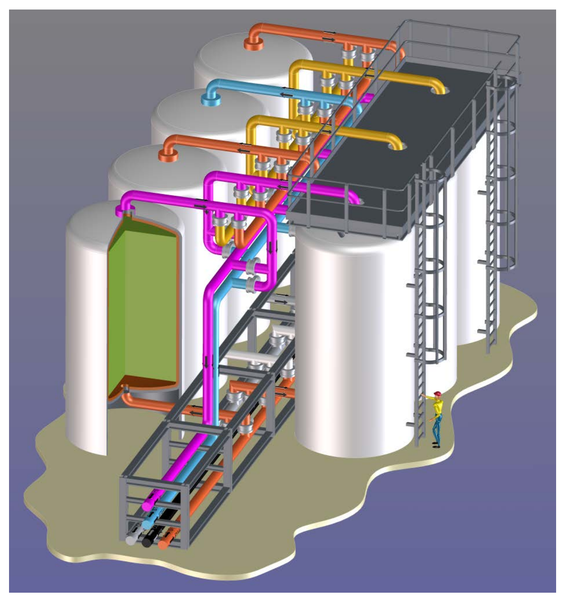


SEWGS bench-scale setup at ECN

- Experiments were performed in the multicolumn SEWGS test rig
- Six columns of 6 m tall and 38 mm internal diameter, 400°C, 1-27 bar
- Sorbent: K-promoted HTC pellets 4.7×4.7 mm

Improved SEWGS cycle performance

- Steam adsorption improves effectiveness rinse, enhances CO_2 purity
- Better understanding of kinetics indicates more efficient purge
- A significant (factor 5) reduction of rinse and purge steam use might be possible



Conclusion

- Validated adsorption isotherm and sorption kinetics
- Indication of factor 5 decrease in rinse and purge steam consumption
- SEWGS promising for
  - precombustion CO_2 capture in IGCC
  - iron and steel making industries
  - H_2 production for ammonia
  - Syngas conditioning

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