

Furthermore, the presence of H<sub>2</sub>S or operation with syngas did not affect the cyclic performance of either of the sorbent materials tested. The materials reacted reversibly with H<sub>2</sub>S presenting the possibility of a consolidating CO<sub>2</sub> and sulfur gas removal into a single step in a sour sorption enhanced water gas shift reaction.

## ASCENT consortium

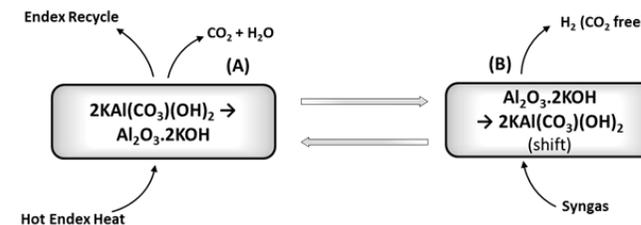


The research leading to these results has received funding from the European Union's Seventh Framework Programme under grant agreement n° 608512.



### Newsletter 5th April 2017 - H<sub>2</sub> production at proof-of-concept scale in a fast HP fluid bed reactor

The main objective of the ASCENT project is the proof of concept of three different advanced CO<sub>2</sub> capture processes. One of these processes, the carbonated shift (C-SHIFT) has now been performed at the Imperial College London, partner of the project consortium, in a dedicated test-rig. The aim of C-SHIFT is to produce a fuel stream consisting of high temperature H<sub>2</sub> and H<sub>2</sub>O stream, at a pressure above the compressor temperature of a gas turbine, with a CO<sub>2</sub> capture efficiency greater than 90%. Alkali carbonate promoted Mg/Al-hydroxaltes (HTCs) and magnesium oxides were considered the most promising of the sorbent materials reviewed. In



particular, high MgO containing Mg/Al-hydroxaltes impregnated with K<sub>2</sub>CO<sub>3</sub>

Figure 1 Concept of the CSHIFT

and high magnesium contents were identified as being strong candidates for high pressure, mid-temperature CO<sub>2</sub> capture in the presence of large quantities of steam. However, in the context of C-SHIFT, the cyclic performance information provided thus far is limited. There is a significant discrepancy between the long carbonation periods under which these materials have been investigated and the short residence time that the CO<sub>2</sub> sorbent material is expected to reside within the proposed C-SHIFT carbonator (< 60 s). At present there are no published studies reporting either the uptake capacity or



*Figure 2 Spouted bed at the laboratories of the Imperial College of London*

achieved using a pressurised spouted fluidised bed reactor for pressure-swing operation at pressures up to 10-20 bar with large concentrations of steam. Fluidised beds are particularly

kinetics for the reaction between CO<sub>2</sub> and HTC-derived materials over time scales relevant to C-SHIFT. The work performed recently at Imperial College within ASCENT project aims to address this gap in the knowledge and provide information relating to the kinetics and capacities for CO<sub>2</sub> uptake by K<sub>2</sub>CO<sub>3</sub>-promoted HTC-derived materials at conditions relevant to a C-SHIFT process. This has been

suitable for kinetic studies based on their superior heat and mass transfer characteristics when compared with other reactor configurations such as fixed beds and thermo-gravimetric analysis (TGA). The reactor has now been commissioned for use at pressures up to 10 bar with steam concentrations up to 40



*Figure 3 Fixed bed test rig at the ECN lab for testing sour conditions*

% v/v. Modifications to the water trap design and drainage protocol that enables continuous removal of water from the system without disruption to the system pressure stability. Results from initial testing of the cyclic performance of the selected material over carbonation/calcination cycles are also provided serving as a proof-of-concept for the pressurised fluidised bed reactor testing. The aim of this initial cyclic test was to provide empirical measurements of the carbonation calcination kinetics and cyclic capacities of K<sub>2</sub>CO<sub>3</sub>-promoted HTC-derived mixed metal oxide materials at conditions and within the time period relevant to an industrial C-SHIFT process. The capabilities of the pressurised fluidised bed reactor to test the cyclic performance of candidate mid-temperature CO<sub>2</sub> sorbents with pressure-swing regeneration was demonstrated with carbonation at 10 bar 400 °C, 20 % v/v CO<sub>2</sub> and 40 % v/v steam and regeneration at 1 bar, 400 °C under mild condition (100% N<sub>2</sub>). The presence of steam was also found to dramatically enhance both the carbonation rate and short-term carbonation capacity.