Advanced Solids Cycles for CO_2 capture and H_2 production

Gas-solid reactions have been proposed in the last decades for several applications in the energy and chemical industries. The most studied applications include calcium looping and chemical looping.

Calcium looping is based on the use of CaO as CO_2 sorbent to form $CaCO_3$ and therefore separate CO_2 from a CO_2-rich gas. The $CaCO_3$ is later regenerated so that pure CO_2 is available for carbon capture, utilisation and storage (CCUS). Calcium looping has been proposed for post-combustion CO2 capture from flue gas in which pre-commercial plant has been already built and operated, as well as for enhanced CO_2 separation in cement plant and also for H_2 production in enhanced reforming and water gas shift.

Chemical looping is based on an oxygen carriers (Fe, Ni, Cu, Mn oxides are the most common elements studied) that is alternatively oxidised in presence of air to form metal oxide and reduced in presence of fuel gases to form pure CO_2 and H_2O. As a result, an unmixed combustion is occurring, thus pure CO_2 is generated as in the case of oxy-combustion technology. In case of sub-stoichiometric oxygen content, the process can also operate as partial oxidation or reforming.

The development of advanced solid looping processes implies research on material development, reactor engineering, flowsheet optimisation. Most of the challenges associated with gas-solid reactions are related to the components lifetime, heat management and costing. As novel and advanced CO_2 capture technologies, they have overcome technological and market barriers in view of the fact that other technologies like amine-based CO_2 absorption unit are well established and commercially available.