- The mechanical mixing production route for the CSCM proved to be robust, reproducible and reliable as the granules produced by either IFE or MTEC showed similar chemical compositions and SER multi-cycling performance with regeneration in CO_2 at 925°C.

The next steps of the material development work will focus on the proof-of-concept testing in relevant SER process conditions and final characterisation of the materials produced.

ASCENT consortium

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

SEVENTH FRAMEWORK PROGRAMME

Newsletter 15 March 2017 – SER process towards proof-of-concept testing

After an initial period of the ASCENT project focused on the screening and development of suitable and reliable materials for the Sorption Enhanced Reforming (SER) process, the ASCENT project has now selected a promising sorbent material (HydroSORB) which has been tested in relevant process conditions at laboratory scale. This sorbent material has been produced in granule form and developed to be used in a SER process operated in a fluidized bed reactor system, mixed together with a methane reforming catalyst. Along with the HydroSORB material, combined sorbent-catalyst materials (CSCM) have been also developed and selected for preliminary proof-of-concept of the SER

Figure 1 Autoclave reactors used for the production of the sorbent and catalyst support powders

process. The materials have been developed with the objective of meeting selected performance criteria in relevant SER process conditions defined in the first period of the project. A mechanical mixing route followed by granulation has been chosen to produce the CSCMs. For the production of CSCMs, both a commercial reforming catalyst and a new developed catalyst have been used. The new reforming catalyst uses, like the HydroSORB material, a mayenite support

Figure 3 Fully automated rig for testing SER

The production methods have been developed in close collaboration between the material developers (research institutions: IFE, CSIC, UNIVAQ, ENEA) and the work package material producer/supplier Marion Technologies (MTEC) to insure that materials could be reproduced following the same aligned production methods and that the methods could be up-scaled without altering the materials performance. A detailed characterisation work has been carried out to strengthen our material knowledge and understanding, and to identify areas for further final optimisation before the final proof-of-concept testing. The granulated HydroSORB and CSCM materials have been tested and characterised using the following techniques: SER multi-cycling in a Thermo-Gravimetric Analyser (TGA), Particle Size Distribution measurement (PSD), Mercury-intrusion

porosimetry, Helium pycnometry, BET: Brunauer–Emmett–Teller specific area measurement, X-Ray Diffraction (XRD), Optical microscopy imaging, Scanning Electron Microscopy (SEM), Energy-Dispersive X-ray Spectroscopy (EDS-EDX), Jet attrition test (ASTM D5757). The materials have been characterised before and after SER multi-cycling to investigate their chemical stability in a packed bed laboratory reactor rig. The measurement of the Air Jet Index (AJI) gave valuable indications about the materials' mechanical stability for use in fluidized bed reactors. After completion of this detailed characterisation work, the following main conclusions can be drawn.

Figure 2 high shear granulator used for production of proof of concept granulated materials

As far as the granulated HydroSORB sorbent is concerned:

- HydroSORB granules with satisfactory sphericity were obtained by granulation.
- The granulated HydroSORB material mixed with a commercial reforming catalyst (2-particles system) showed high performance chemical stability in SER multi-cycle with regeneration at 850°C in steam environment and no reduction between cycles.

As far as the granulated CSCM is concerned:

- An efficient dry mechanical mixing of sorbent and catalyst powders prior to granulation is important to obtain homogeneous granules and a proper dispersion of catalyst in the CSCM material.