DECARBit - SP2

ADVANCED PRE-COMBUSTION CO2 SEPARATION

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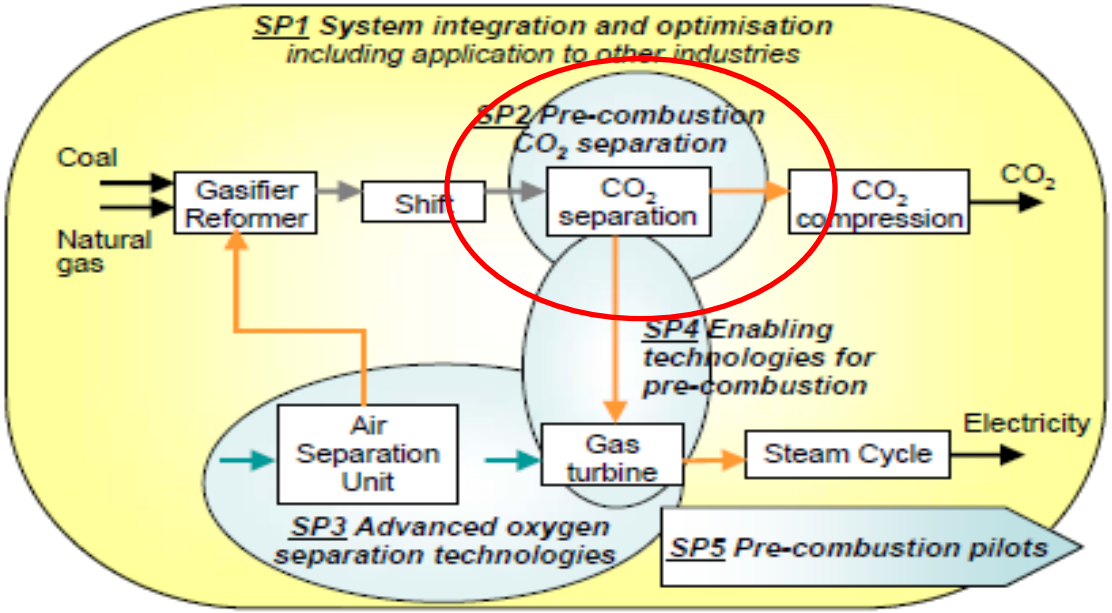
CO-FUNDED BY THE EUROPEAN UNION
SEVENTH FRAMEWORK PROGRAMME

SP2 content



- Development of advanced CO2 capture technology
- Focus on:
  - CO_2 selective membranes
  - CO_2 sorbents
  - Novel solvent systems

Work packages

- SP2 – Work packages
  - WP 2.1: CO_2 Selective membranes
    - Development and testing of a selective membranes on a permeable support
    - Goal: selectivity CO_2/H_2 of 25, permeance exceeding 2,5E-8 mol/m^2sPa
  - WP 2.2: CO_2 Sorbents
    - Development of sorbents and sorbents process concepts
    - CO2 reversible capacity of: >15 wt% at 100 ^{0}C, >10wt% at 250-400 ^{0}C
  - WP 2.3: Novel solvent systems
    - Development of advanced chemical and physical solvents
    - Targeting at less than 1 MJ/kg CO_2 (currently 1-2 MJ/kg)

SP2 Partners

- WP 2.1: CO_2 Selective membranes
  - CORNING S.A.S. (France)
  - NTNU - Norwegian University of Science and Technology
  - SINTEF (Norway)
  - TNO - Netherlands Organisation for Applied Scientific Research

- WP 2.2: CO_2 Sorbents
  - SINTEF (Norway)
  - ETH - Eidgenössische Technische Hochschule Zürich (Switserland)
  - SHELL - Shell International Renewables B.V. (Netherlands)

- WP 2.3: Novel solvent systems
  - TNO - Netherlands Organisation for Applied Scientific Research
  - SHELL - Shell International Renewables B.V (Netherlands)
  - SINTEF (Norway)
  - TIPS - Topchiev Institute of Petrochemical Synthesis (Russian Federation)
  - TUD - Delft University of Technology (Netherlands)

WP2.1: CO_2 Selective Membranes (1/5)

	State of the Art	Baseline Beyond state of the art
Membranes	Selective polymer membranes are not stable in MT-range	Stable selective hybrid membranes for cheap polymer processing
	Selective carbon membranes stable up to MT-range	Stable above 200 ^{o}C
	Dual phase membranes	Novel asymmetric membranes based on porous oxides and molten carbonate on supports with high specific membrane surface area.
	Microporous membranes	Novel membrane materials with high CO_2 adsorption and selectivity at HT

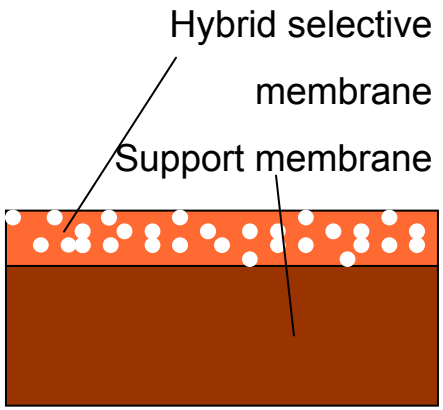
WP2.1: CO_2 Selective Membranes (2/5)

- Result Y1: Hybrid Membranes
  - Discriminating layer on outside of support membrane to enable test
  - Nano-zeolites and nano-hydrotalcites used for membrane selectivity
  - First attempts to coat support membrane with nano-particle dispersed in polymeric matrix performed

- Work Y2:
  - Perform tests with several inorganic nano-particles

  in polymeric phase membranes.

  Measurements with H_2 or CO_2 in tubular module

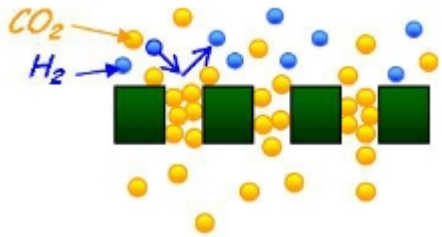


WP2.1: CO_2 Selective Membranes (3/5)

- Result Y1: Microporous membranes
  - Development of microporous membrane layers on top of asymmetric ceramic support requires pore sizes below 4nm.

- Work Y2:
  - Further development with other (commercial) supports that meet criteria
  - Develop CO_2 selectivity layers, starting from powders

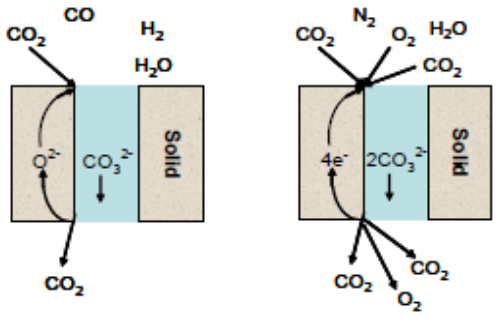
  → Materials to evaluate: Zirconia, Titania



WP2.1: CO_2 Selective Membranes (4/5)

- Result Y1: Dual-phase membrane system
  - Literature study made on oxygen ion conducting based materials.
  - Dual-phase mixtures have been made and are evaluated

- Work Y2:
  - Performance testing in high temperature (>1000 C) measurement cell.
  - Investigation of sealants for gas tightness of membrane (glasses and metallic seals)



WP2.1: CO_2 Selective Membranes (5/5)

- Result Y1: Carbon membranes
  - Development of:
    (1) Self supported hollow fibre carbon membranes
    (2) Preparation of ceramic supported carbon membranes.
  - (1) Single gas test experiments performed concluding that metallic additives appear to have positive effect
  - (2) literature study on precursor materials

- Work Y2:
  - (1) Work on increasing permeance by using additives and optimize carbonization process
  - (2) Continue development on carbon membrane

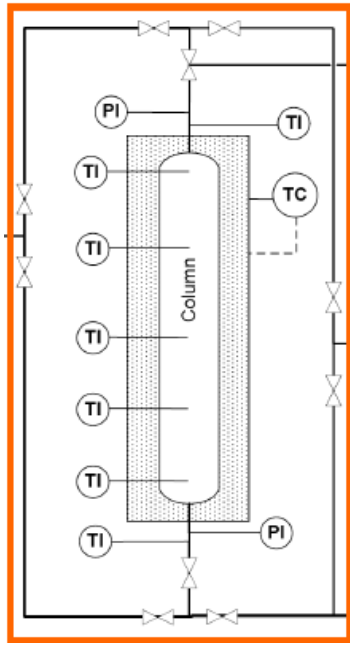
WP2.2: CO_2 Sorbents

	State of the Art	Baseline Beyond state of the art
Sorbents	LT polymer and supported polymer sorbents Carbonate forming metal oxides and mixed metal oxides operating above 400 ºC.	New sorbents combining the properties of LT and HT sorbents (dual phase, surface carbonate, etc) for operation above 200 ºC.

WP2.2: CO_2 Sorbents

- Result Y1:
  - Sorbent development for medium (70-200 C) and high (>200 C) temperature
  - Measurement of adsorption isotherms
  - Pressure swing adsorption (PSA) set-up available

- Work Y2:
  - Continuing sorbent development
  - Finishing lab-scale adsorption column set-up,
    2 to 4 columns fully automated setup



Adsorption column set-up

WP2.3: Novel solvent systems

	State of the Art	Baseline Beyond state of the art
Solvent systems	Pressure or/and temperature swing.	pH/ electrochemical **Solvent** swing, membrane gas desorption.
	Solvents for LT	Solvent systems for MT and HT.

WP2.3: Novel solvent systems

- Result Y1:
  - Desktop study evaluating different solvent systems performed
  - Three different membranes with 7 solvents have been studied concluding that membrane should be in glassy state. After which chemical stability tests have been performed
  - Evaluation of amine-based solvent for pre-combustion

- Work Y2:
  - Continuation of amine-based solvent and physical solvent development
  - Delivery of bench-scale demonstrator for testing membrane contactor at pre-combustion conditions