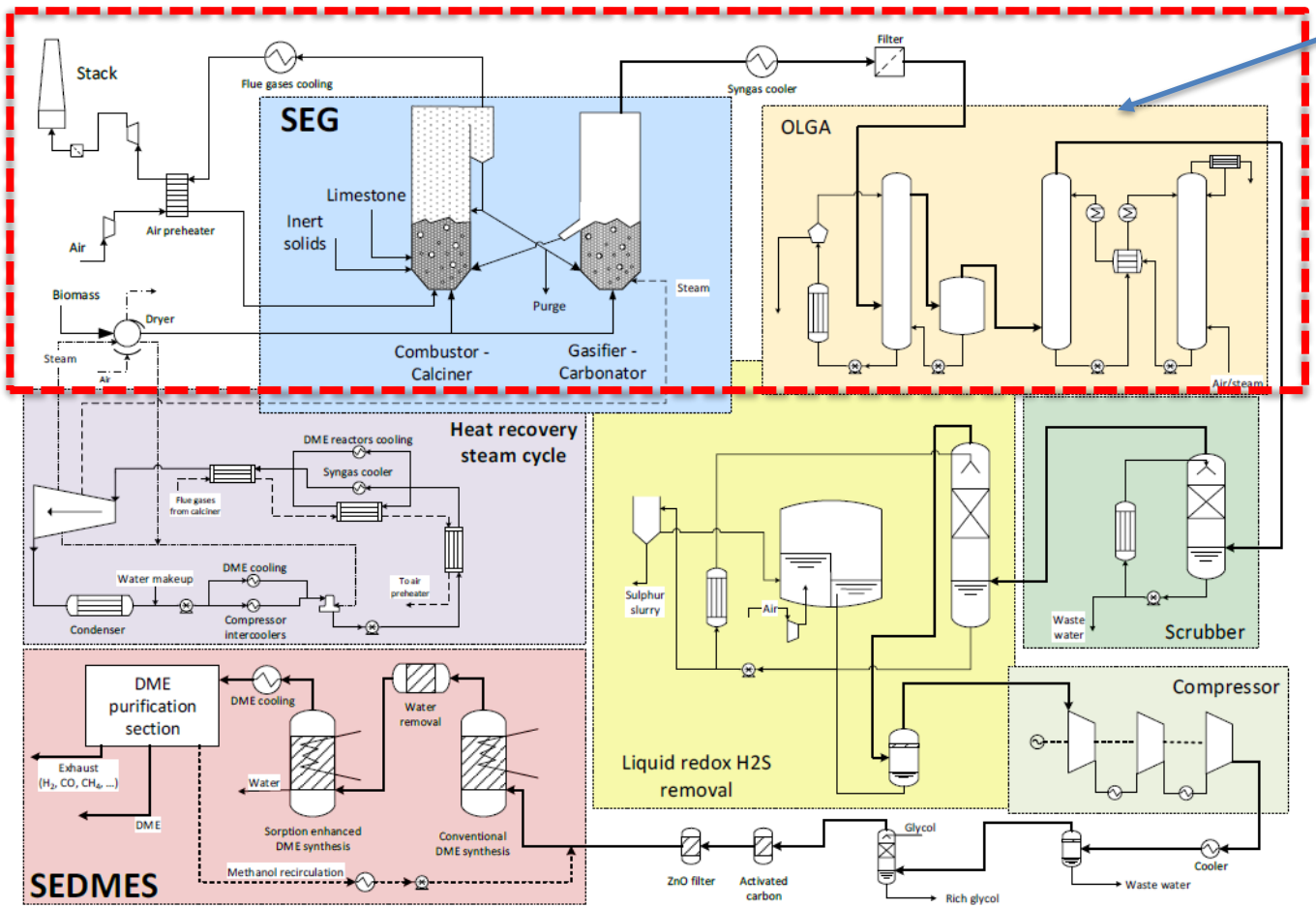
FLEXIBLE DIMETHYL ETHER PRODUCTION FROM BIOMASS GASIFICATION WITH SORPTION ENHANCED PROCESSES

Final Workshop

Large scale gasification unit for biomass-to-fuels
Juha Palonen / SFW

Fledged SEG + SEDMES process



For biomass OLGA replaced with a catalytic tar removal

Figure 1. Simplified flowsheet of the Fledged process for bio-DME production by SEG and SEDMES processes [2].

Large scale SEG unit

Work package

- Techno-economic assessment of the reactor design and scale-up for a 10 MWth and 100 MWth cases
  - Process technical task
    - USTUTT and CSIC test runs (SEG process)
    - POLIMI and LUT simulations (SEG / whole cycle)
    - => SFW component dimensioning (SEG / front end)
  - Engineering task (SEG / front end)
  - Cost estimation task (SEG / front end)

Overall considerations

Process technical

- SEG process operation confirmed against the targets of the project
  - Fuel flexibility
  - Tailored, hydrogen rich gas
- Some issues (not included in this project) remain to be confirmed in the future test runs

Full scale plant design

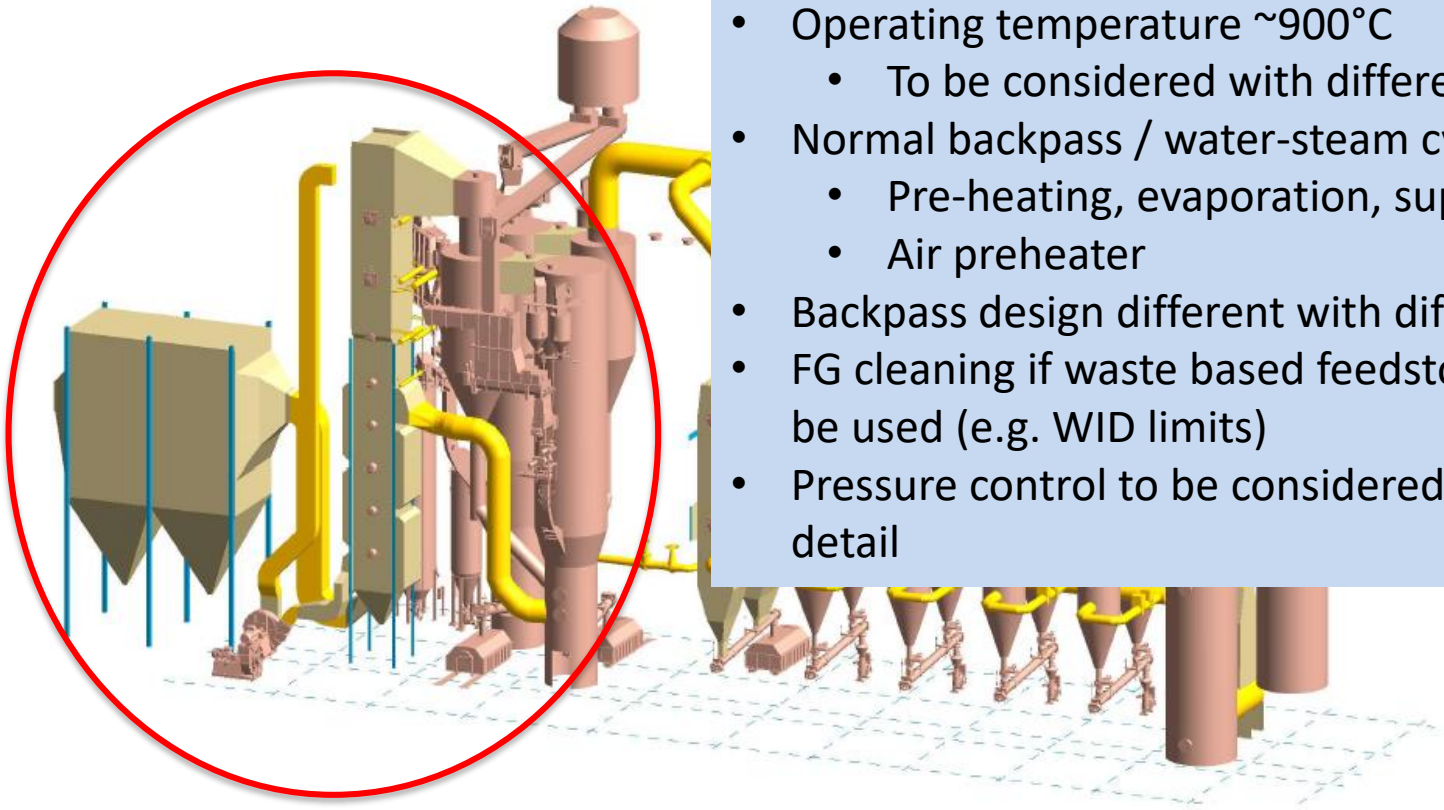
- Design developed – no case stoppers were recognized
- Some issues (not included in this project) require more detailed considerations in future
  - Solids flow control system
  - Combustor pressure control
  - Product gas clean-up

Overall considerations

Plant control and safety issues

- Preliminarily, no specific concerns were recognized
  - Operational and control philopsophy were considered preliminarily
  - Safety issues discussed and considered preliminarily as well

SEG plant: Combustor part



Comments

- Air blown, refractory lined furnace design; no heat transfer surfaces in the furnace
- Operating temperature ~900°C
  - To be considered with different fuels
- Normal backpass / water-steam cycle
  - Pre-heating, evaporation, superheating
  - Air preheater
- Backpass design different with different fuels
- FG cleaning if waste based feedstocks would be used (e.g. WID limits)
- Pressure control to be considered in more detail

SEG plant: Gasifier and Gas cooler 1

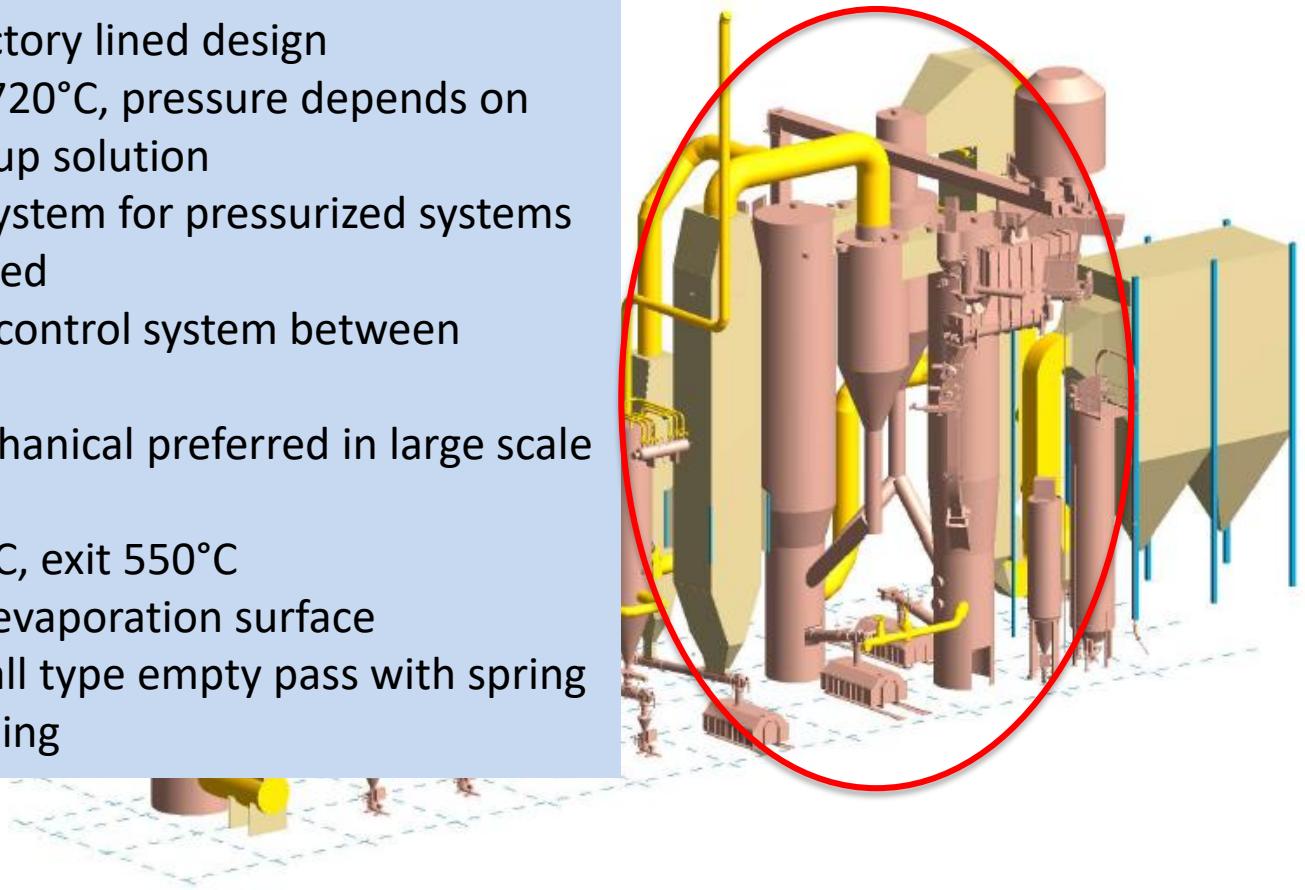
Comments

Gasifier

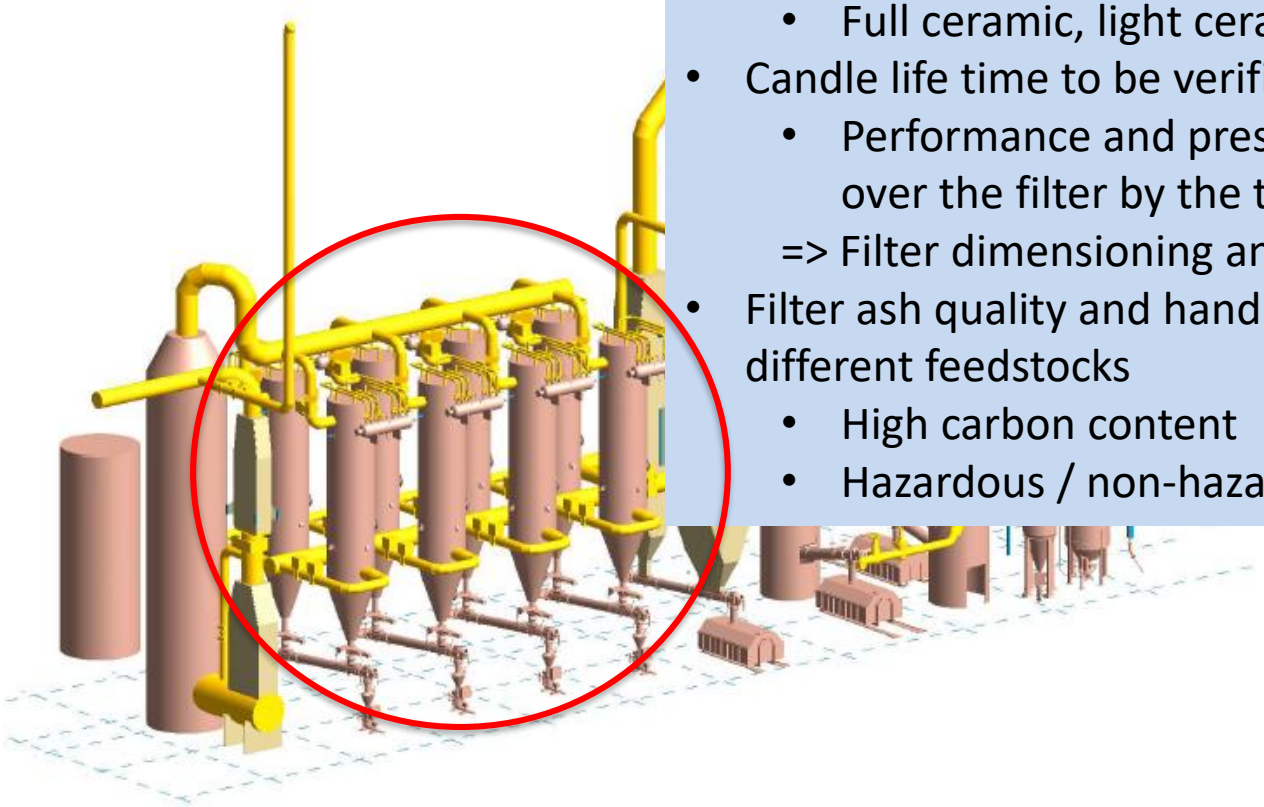
- Normal, refractory lined design
- Temperature 720°C, pressure depends on the gas clean-up solution
- Fuel feeding system for pressurized systems to be considered
- Material flow control system between reactors
    - Non-mechanical preferred in large scale

Gas cooler 1

- Gas inlet 720°C, exit 550°C
- Economizer / evaporation surface
- Membrane wall type empty pass with spring hammer cleaning



SEG plant: Product gas filter

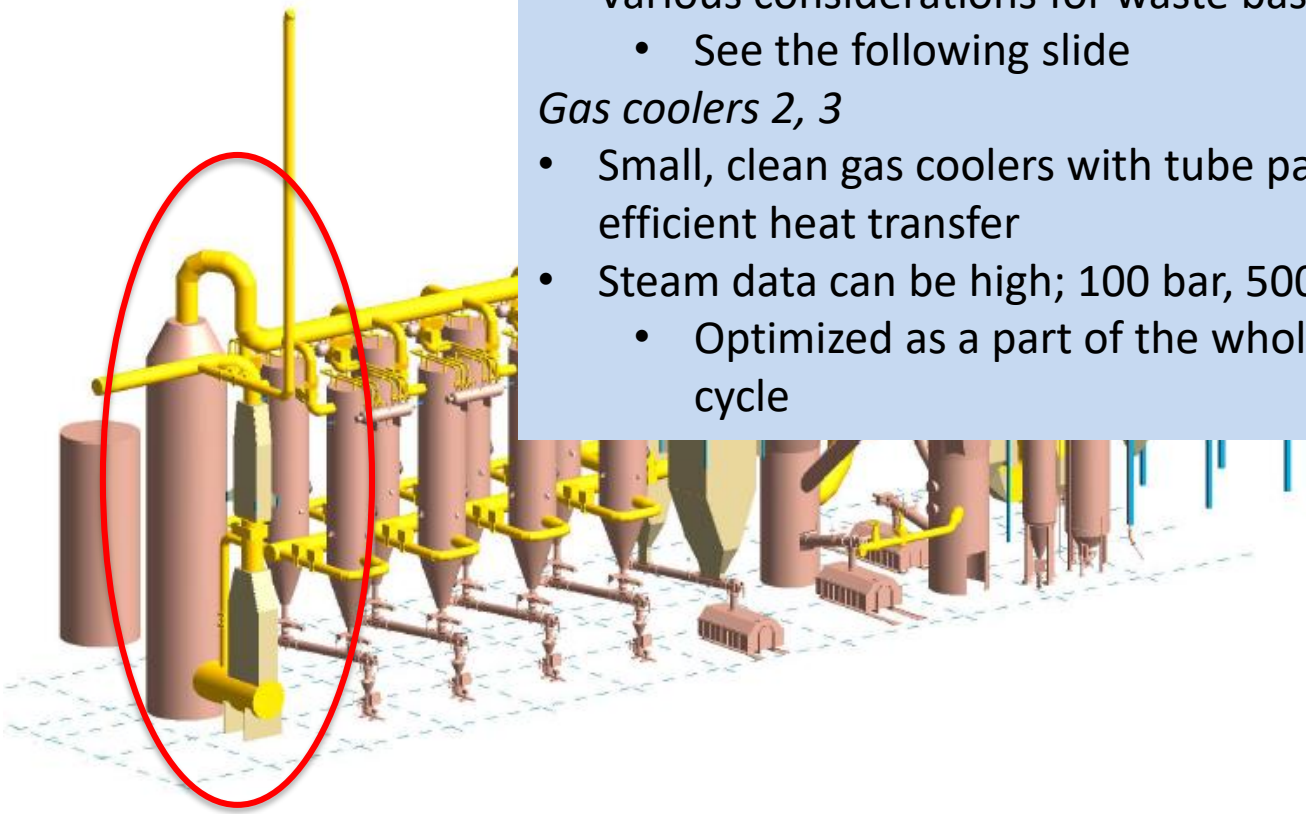


Comments

- Filtration temperature 550°C
- Different options for candles
  - Full ceramic, light ceramic, metal
- Candle life time to be verified (long term)
  - Performance and pressure difference over the filter by the time

  => Filter dimensioning and maintenance
- Filter ash quality and handling with different feedstocks
  - High carbon content
  - Hazardous / non-hazardous

SEG plant: Tar removal concept and Gas coolers 2, 3



Comments

Tar removal

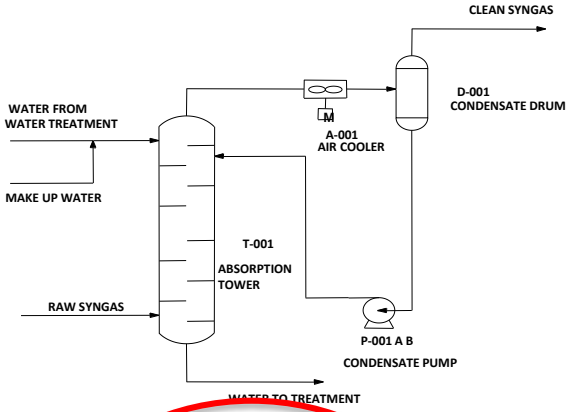
- Catalytic tar removal for biomass
- Various considerations for waste based feedstocks
  - See the following slide

Gas coolers 2, 3

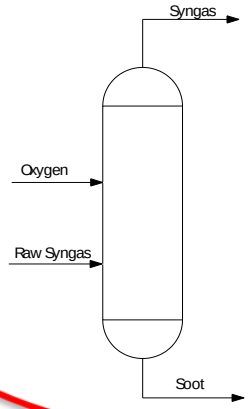
- Small, clean gas coolers with tube packages having efficient heat transfer
- Steam data can be high; 100 bar, 500°C
  - Optimized as a part of the whole water/steam cycle

SEG plant: Tar removal concept alternatives

AQUEOUS SCRUBBING

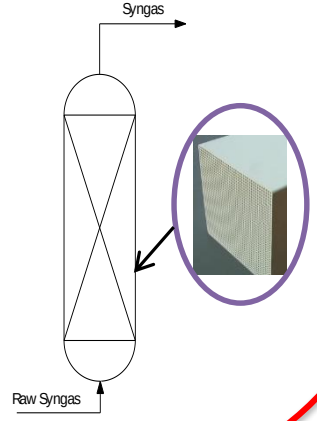


THERMAL CRACKING

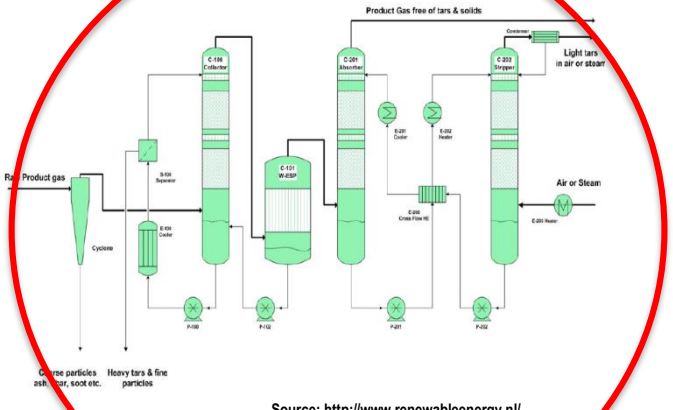


Plasma enhanced thermal cracking

CATALYTIC CRACKING



OIL SCRUBBING



Source: http://www.renewableenergy.nl/

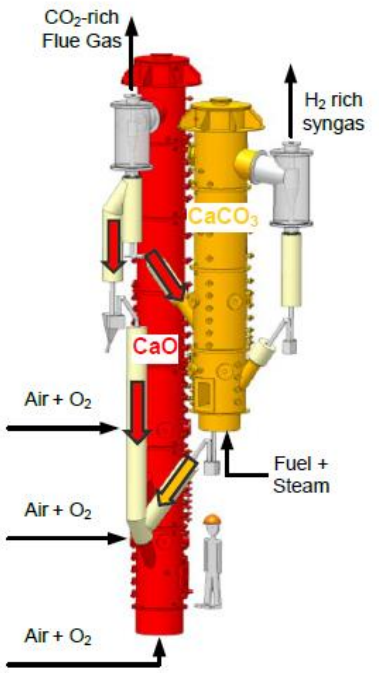
SEG plant development and commercialization: Next steps

Additional pilot scale tests / optimization

- Gas clean up
- Partial load operation
- Fresh make-up feed
- Alternative solids flow control systems

Demonstration plant

- *Long term demonstration* plant to verify and confirm the process performance



200 kWth dual fluidized bed facility at IFK, University of Stuttgart

SEG plant commercialization: SEG process scale up considerations

Scale up path

1. Additional pilot tests to confirm
2. Long term demonstration plant (1-) 5-15 MWth
    - Stepwise approach: SEG, SEDMES
3. Semi-commercial plant 50(-100) MWth => FOAK, limited guarantees
4. Commercial scale plant

Synthesis products

- DME
- H2
    - In-situ CO2 capture, additional WGS reactors
- SNG (e.g. VESTA SNG synthesis)
- Consider for flue gas CO2 capture with oxy-combustion

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