VTT TECHNICAL RESEARCH CENTRE OF FINLAND
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Development of new CLC concepts at VTT

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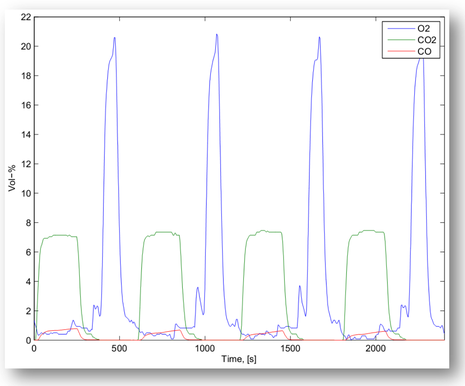
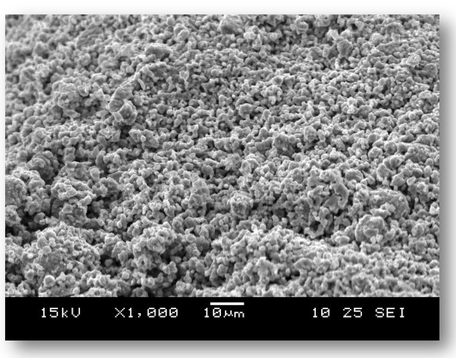
Background

VTT have conducted extensive research into fluidized bed combustion, fuel characterization and oxy-combustion. Chemical looping research was started a few years ago to broaden this knowledge to new areas of technology. Tests with various oxygen carriers have been carried out using thermogravimetry and a bench scale laboratory device.



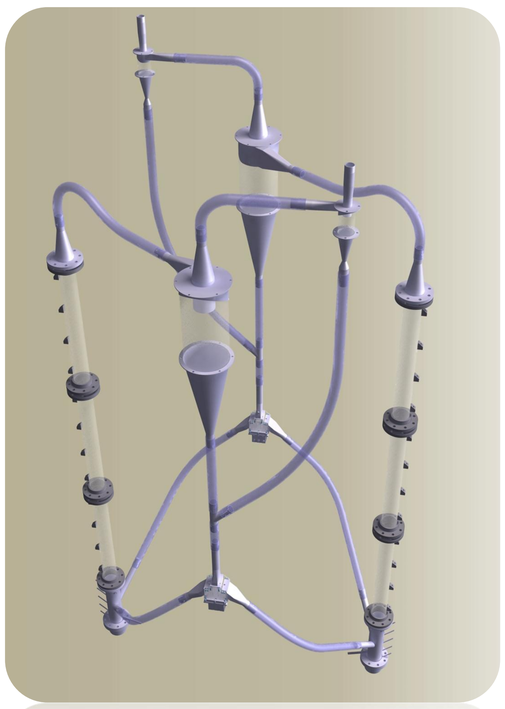


Reduction and oxidation cycles of an Fe-based oxygen carrier at bench scale. SEM image of ilmenite agglomerated powder resulting from excessive heat.

Initial tests and proof of concept

The first cold model of a solid recycle device was constructed in 2011. Initial tests showed that in CLC applications solid flow may be controlled with fluidization at a double exit loop-seal.

The new reactor system concept has been designed based on the model simulations and scaling laws. The cold model platform has been constructed in order to further develop the concept. The cold model has been commissioned and hydrodynamic tests started.



VTT DCFB/CLC* Cold model

*Dual Circulated Fluidized Bed / Chemical Looping Combustion

Research possibilities:

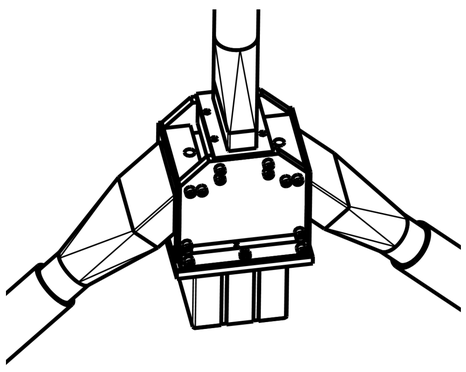
- Hydrodynamic research
- Research of interconnected and single CFB reactors and reactor dynamics
- Support and verification of computational models
- Adaption and development of measurement techniques
- Development of reactor connections
- Cyclone performance
- Solid recycle device development and geometrical optimization
- Fuel particle motion
- Bed diagnostics
- Verification of scaling

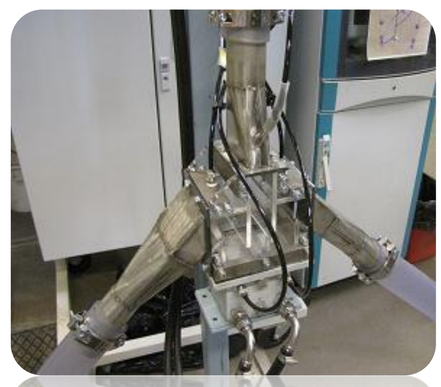
Features:

- Modularity, enables testing of different geometries
- Comprehensive measurements
- Enables special purpose measurements
- Scalability of hydrodynamics to CFB pilot at VTT
- Good optical visibility to reactors and cyclones

Technical specifications:

- Adjustable reactor height; 500 mm to 3500 mm
- Three inner dimensions of reactor risers; 40 mm, 69 mm and 104 mm
- Reactors and cyclones are acrylic





Design drawing of double exit loop-seal and actual device assembled to test rig.

Focus on the future

Upcoming research focuses on new concepts and process designs applicable to the chemical looping idea. Understanding of the specific characteristics of chemical looping processes, such as solid flow control, forms one of the research topics. This needs a strong understanding of hydrodynamics, adaption of new measurement techniques and validated process models for fluidized bed systems.

The cold model is highly modular, which facilitates the testing of different connections and concepts. Design of a hot test rig will be started once the cold model test results are available and the final concept has been chosen.

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ccsp
Carbon Capture and Storage Program