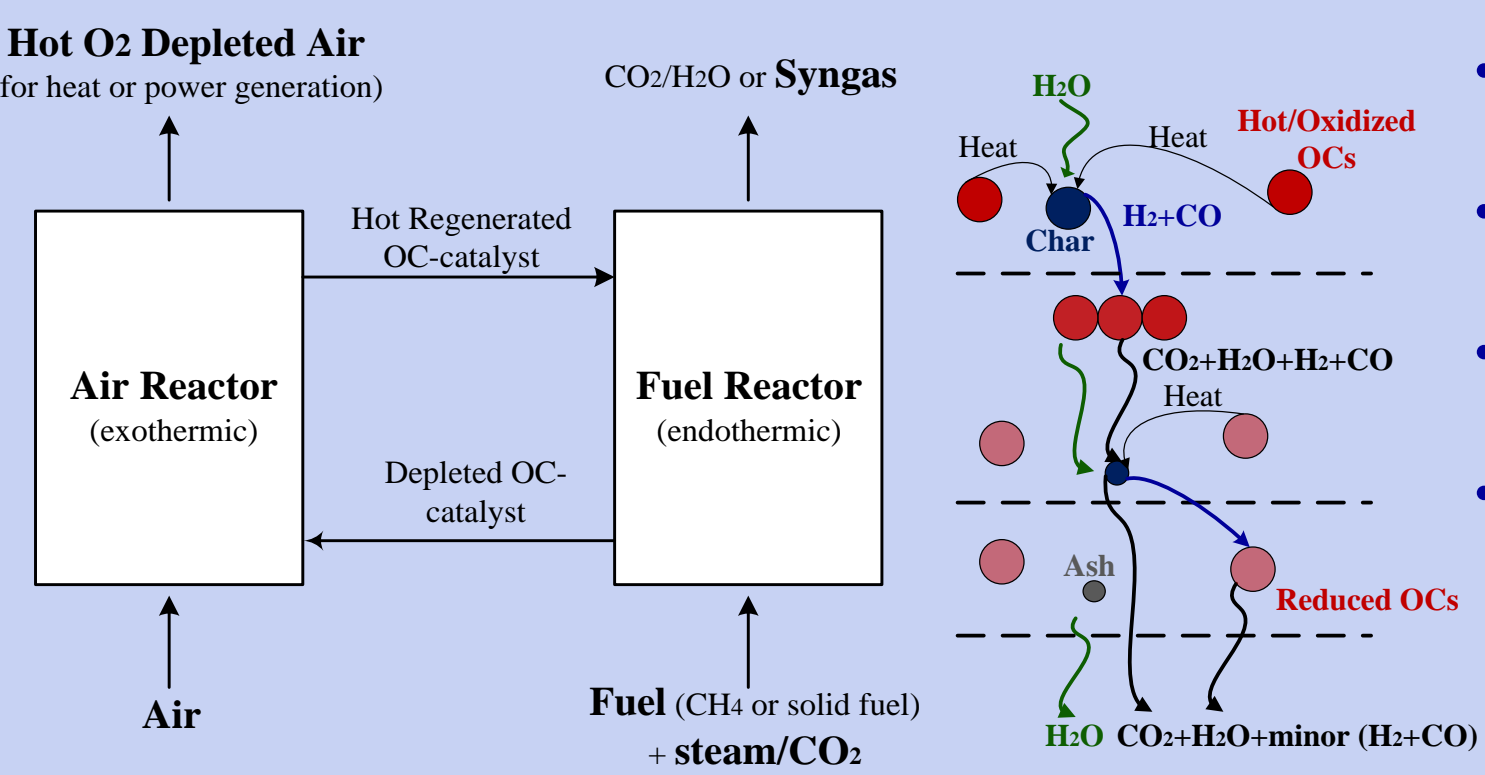


Chemical Looping Technology:

1. Application of Chemical Looping (CL) with Spouting Fluidized Bed for Hydrogen-Rich Syngas Production from Catalytic Coal Gasification (Supported by DOE – NETL), DE-FE0024000
2. Coal-fueled Pressurized Chemical Looping Combustion with a Spouting Fluidized Bed (Supported by DOE – NETL), DE-FE0025098

CLC Scheme

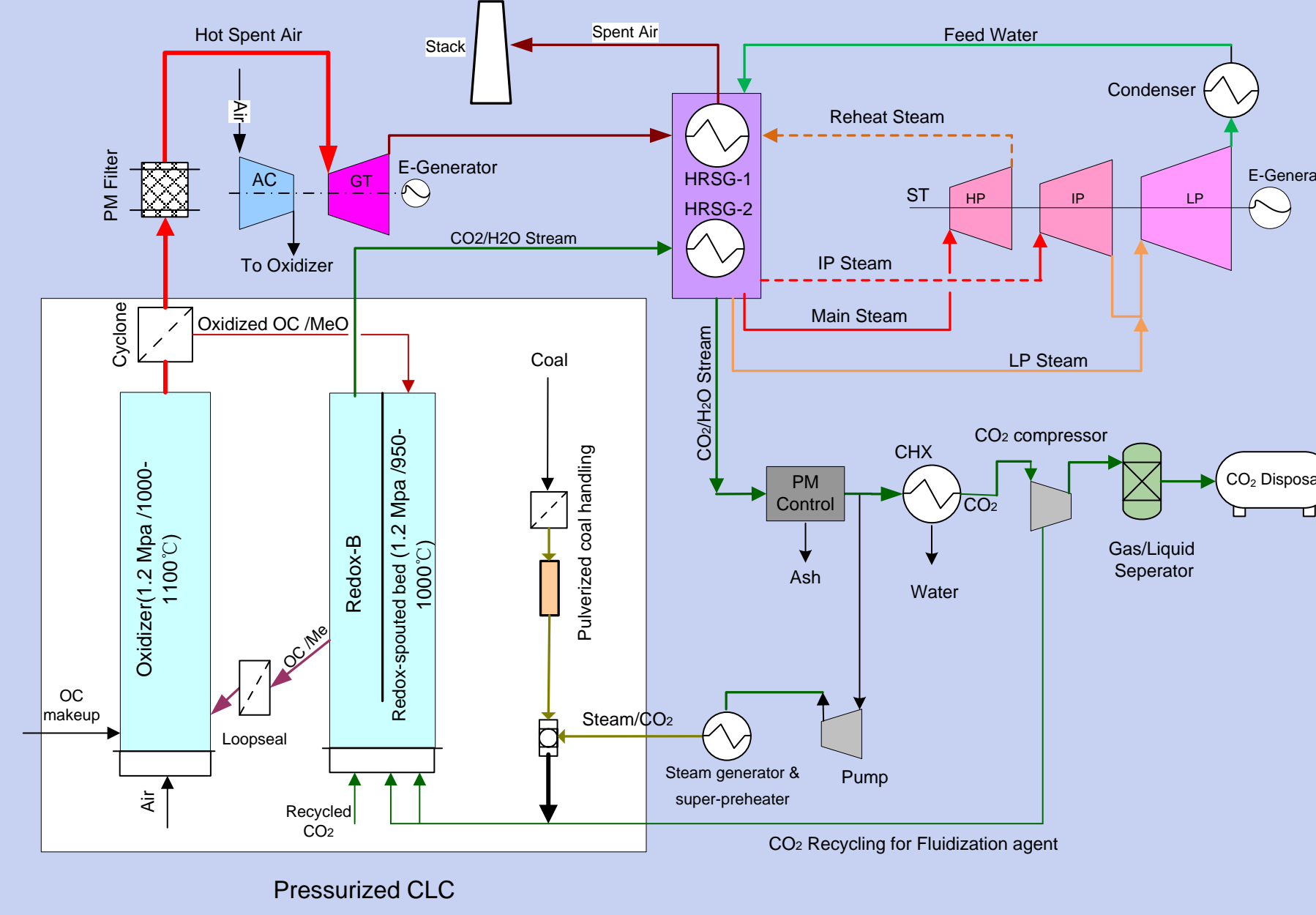


Key Features

- CLC: heat release = normal combustion
- CLG: poly-generation (fuel & power)
- Low energy penalty
- High purity CO₂ stream ready for sequestration

Applications

- Coal gasification and H₂-rich syngas production
- PCLC Combined Cycle Power Generation

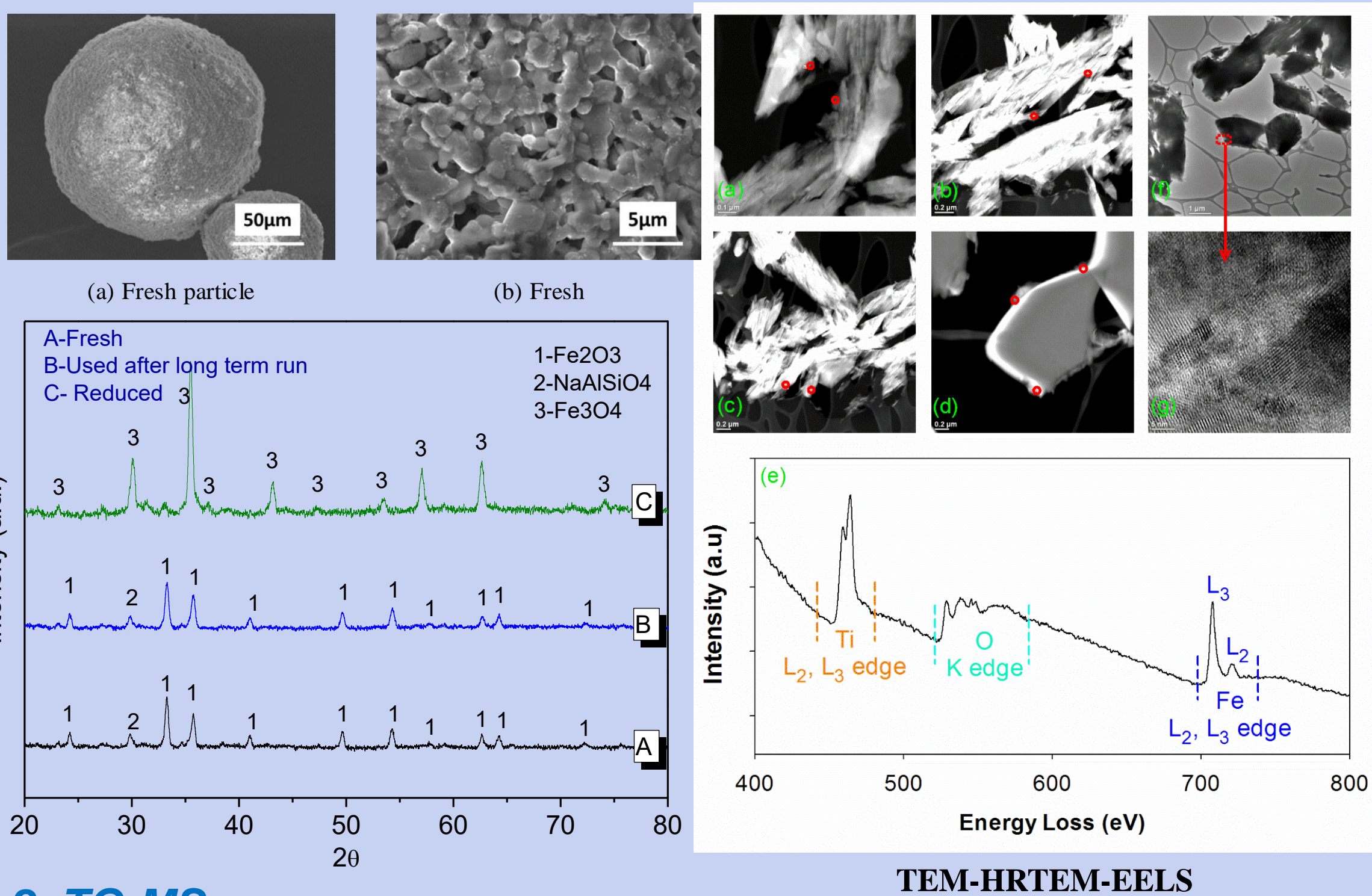


Efficiency 43% COE: \$ 40.61/MW_{th} lower CO₂ capture cost: \$25.12/t lower

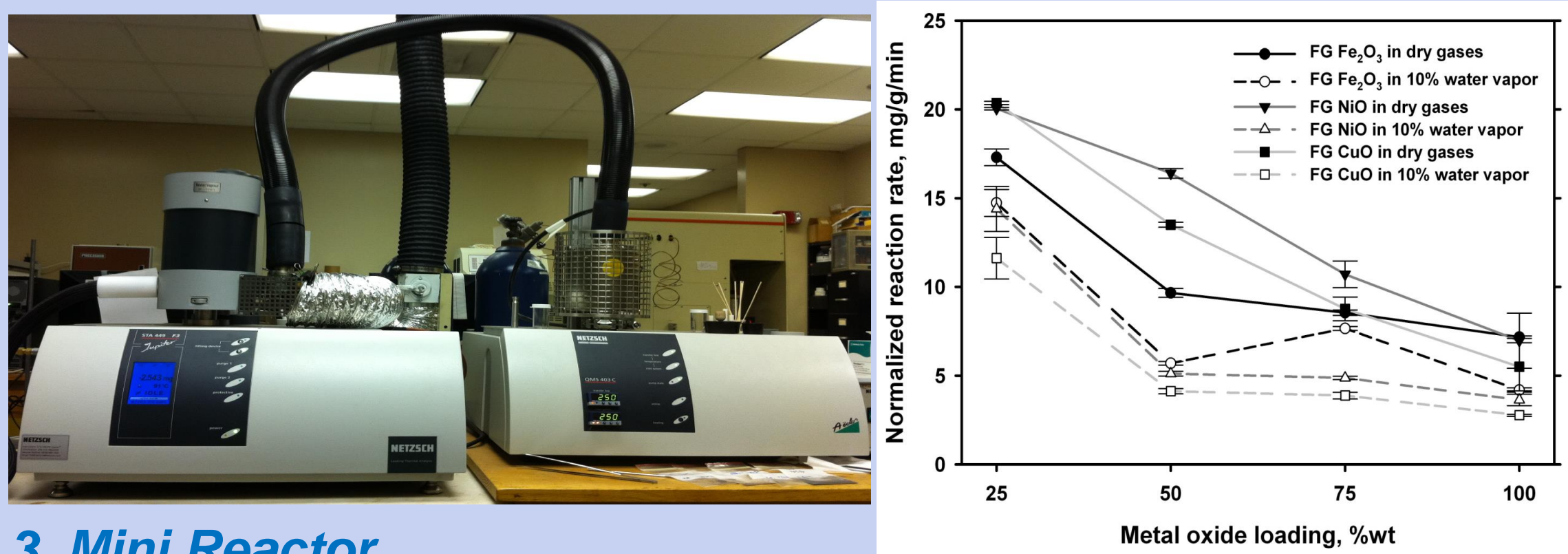
Focus at UKv-CAER

- Cost-effective oxygen carrier development (Fe-based, ilmenite & solid waste)
- Design & technical-economic evaluation of PCL for power generation / syngas production
- Demonstration of PCLC/CLG (1-50 kW_{th} fixed / fluidized / spouted bed)
- Fundamental: kinetics of coal gasification / OC reaction, pollutants, coal impurities

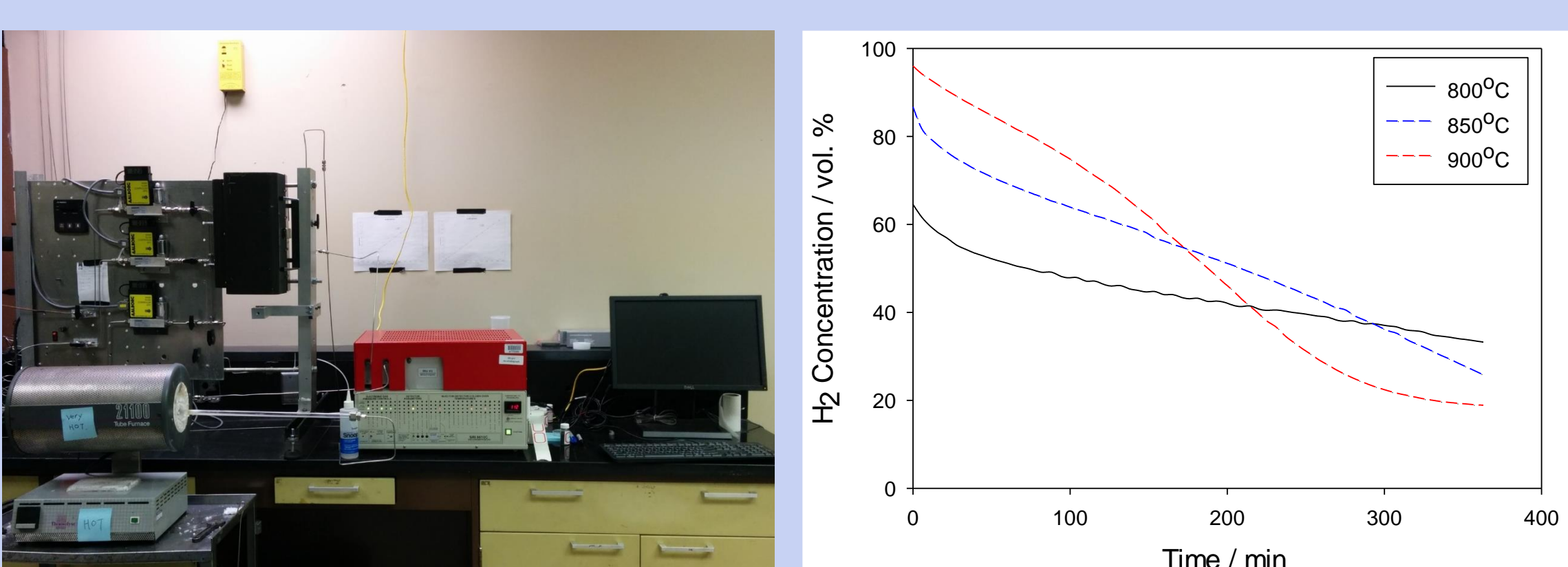
1. Fundamental



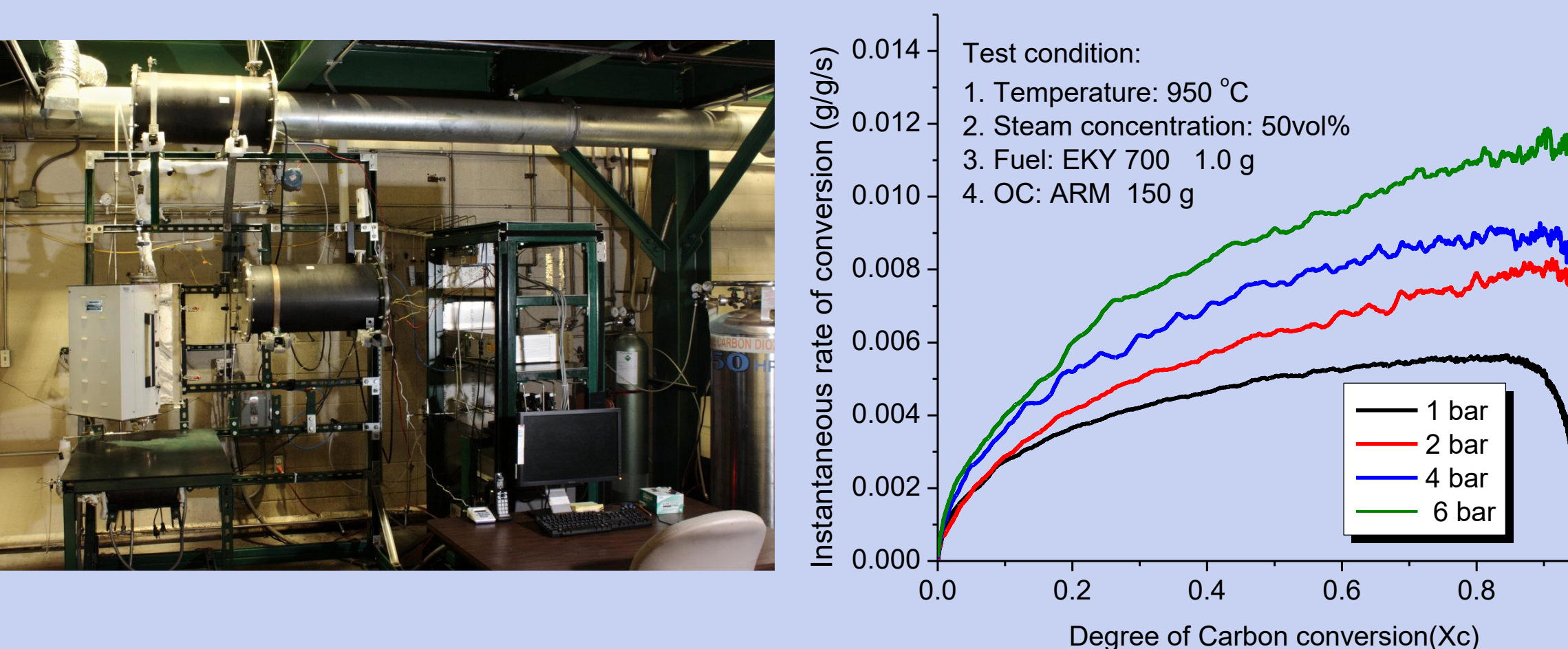
2. TG-MS



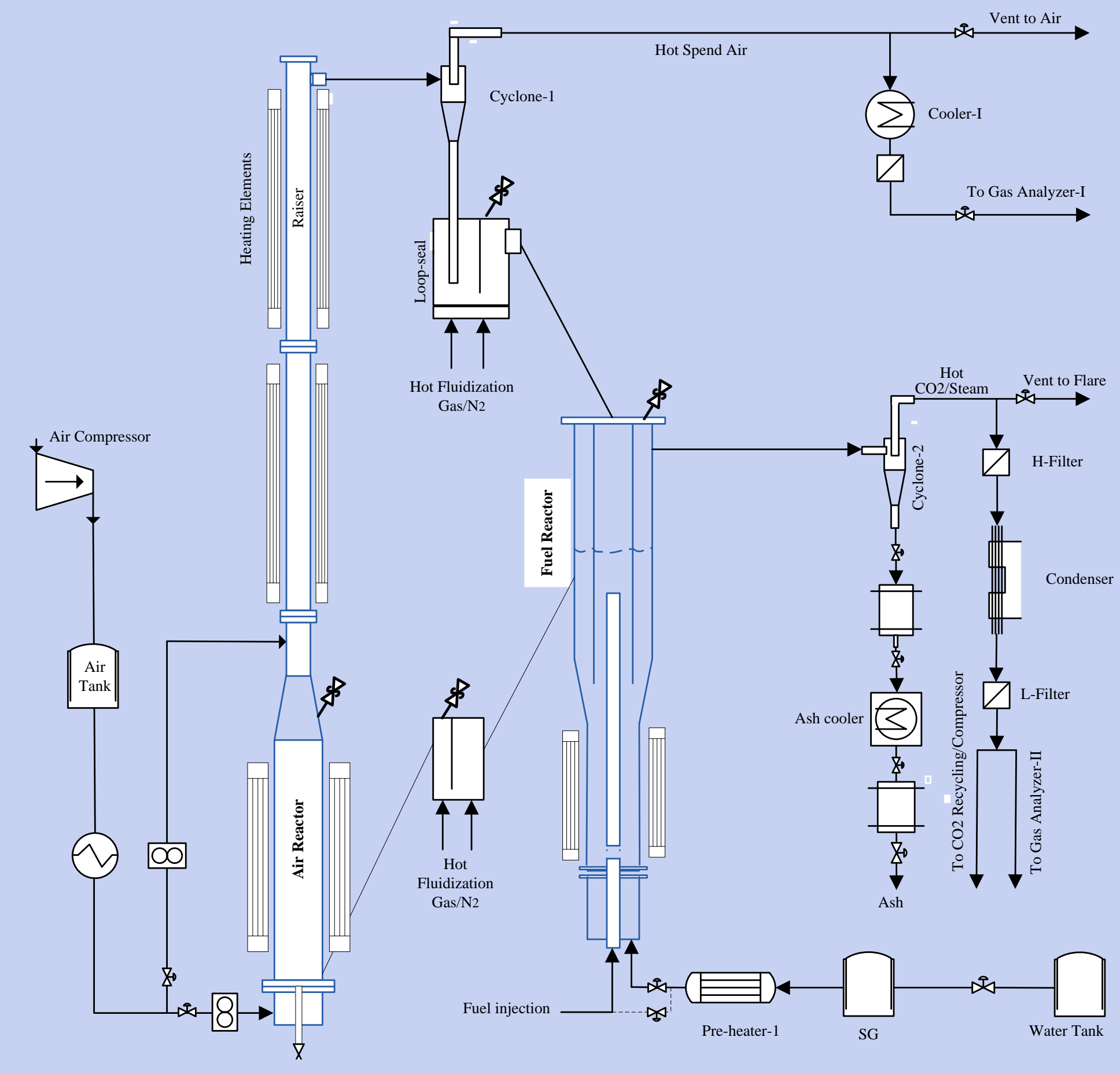
3. Mini Reactor



4. Bench-scale Unit

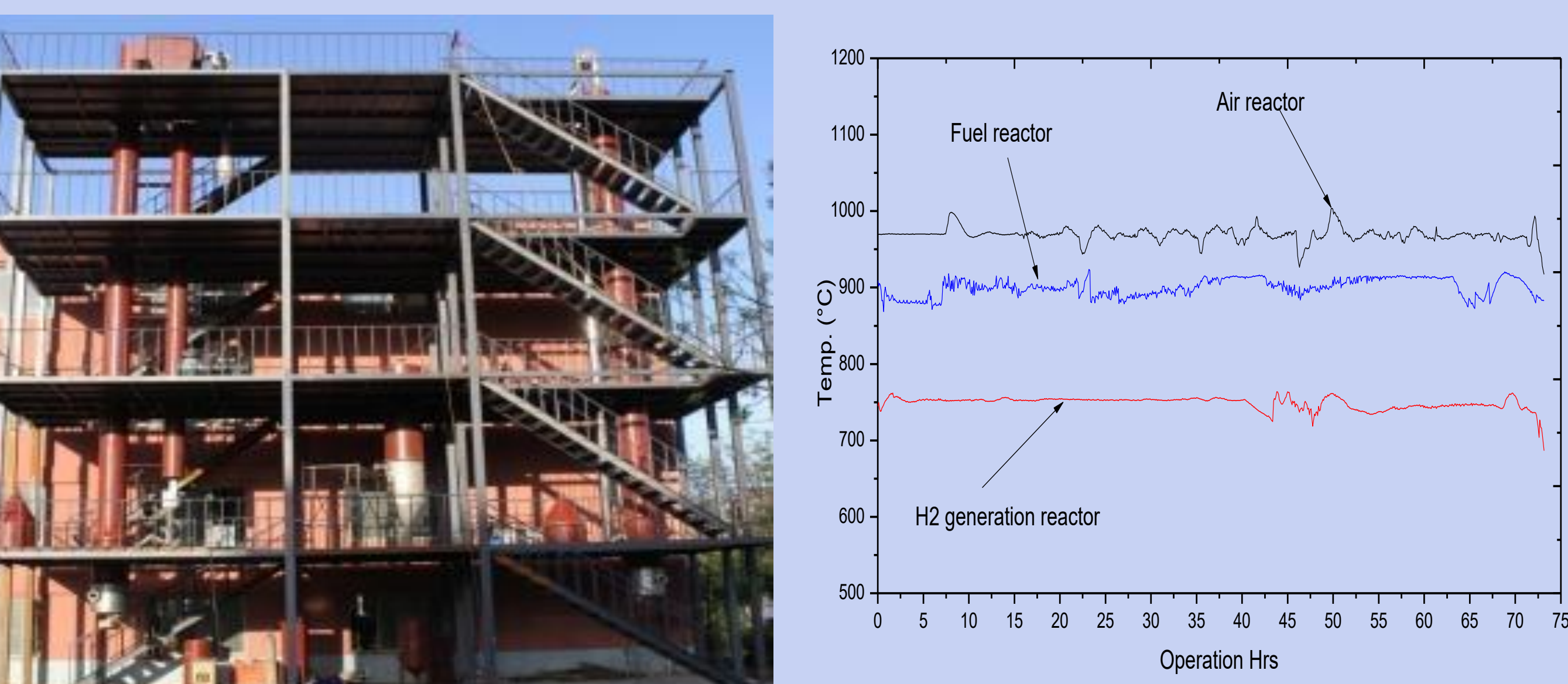


5. Pilot-scale Unit - 50 kW_{th} Pressurized Unit



6. Collaboration with China

1MW_{th} Chemical-looping hydrogen production from bio-oil

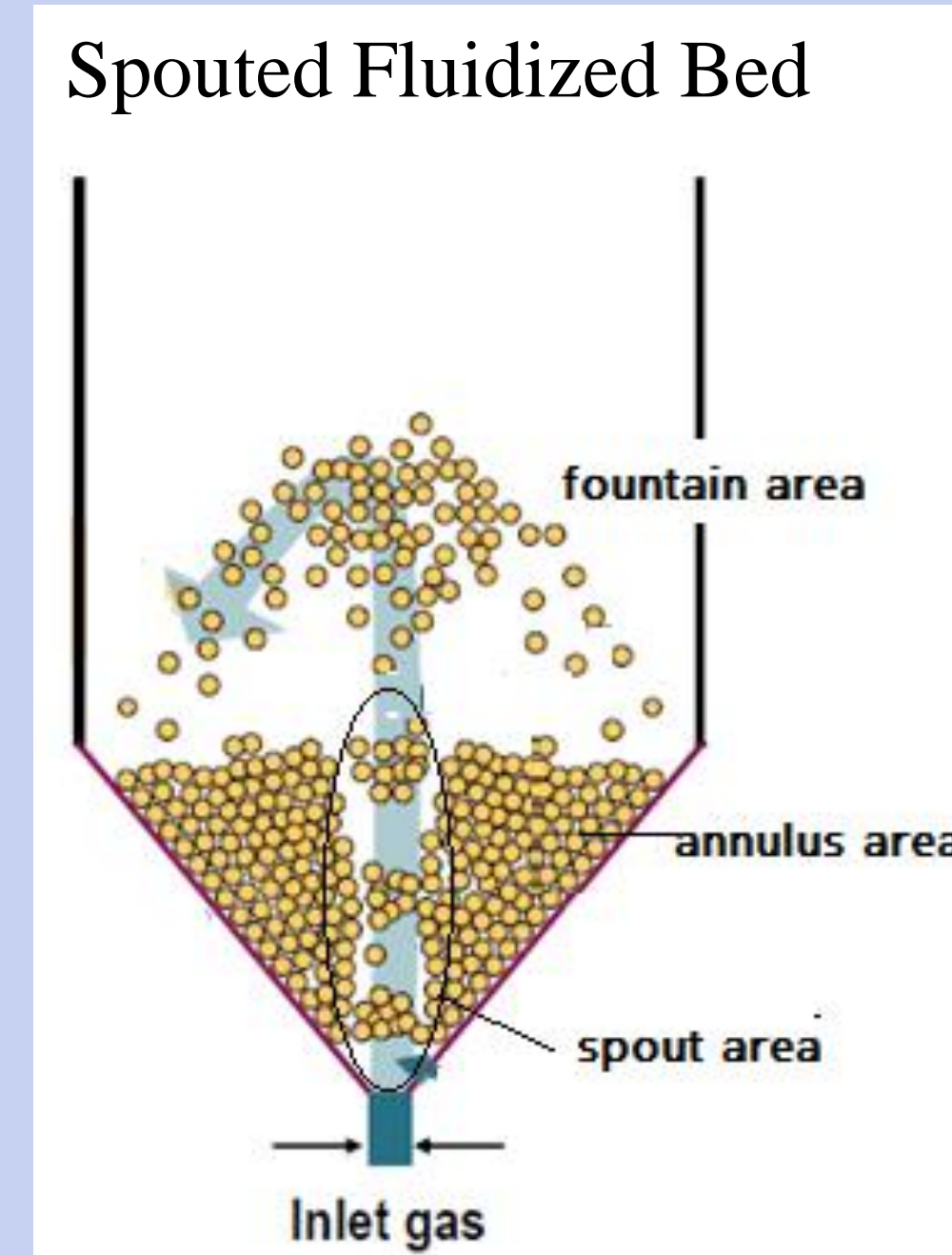


7. Challenges/hurdles

- Agglomeration by coal tar
- Slow kinetics
- Costly oxygen carriers
- Stability and longevity

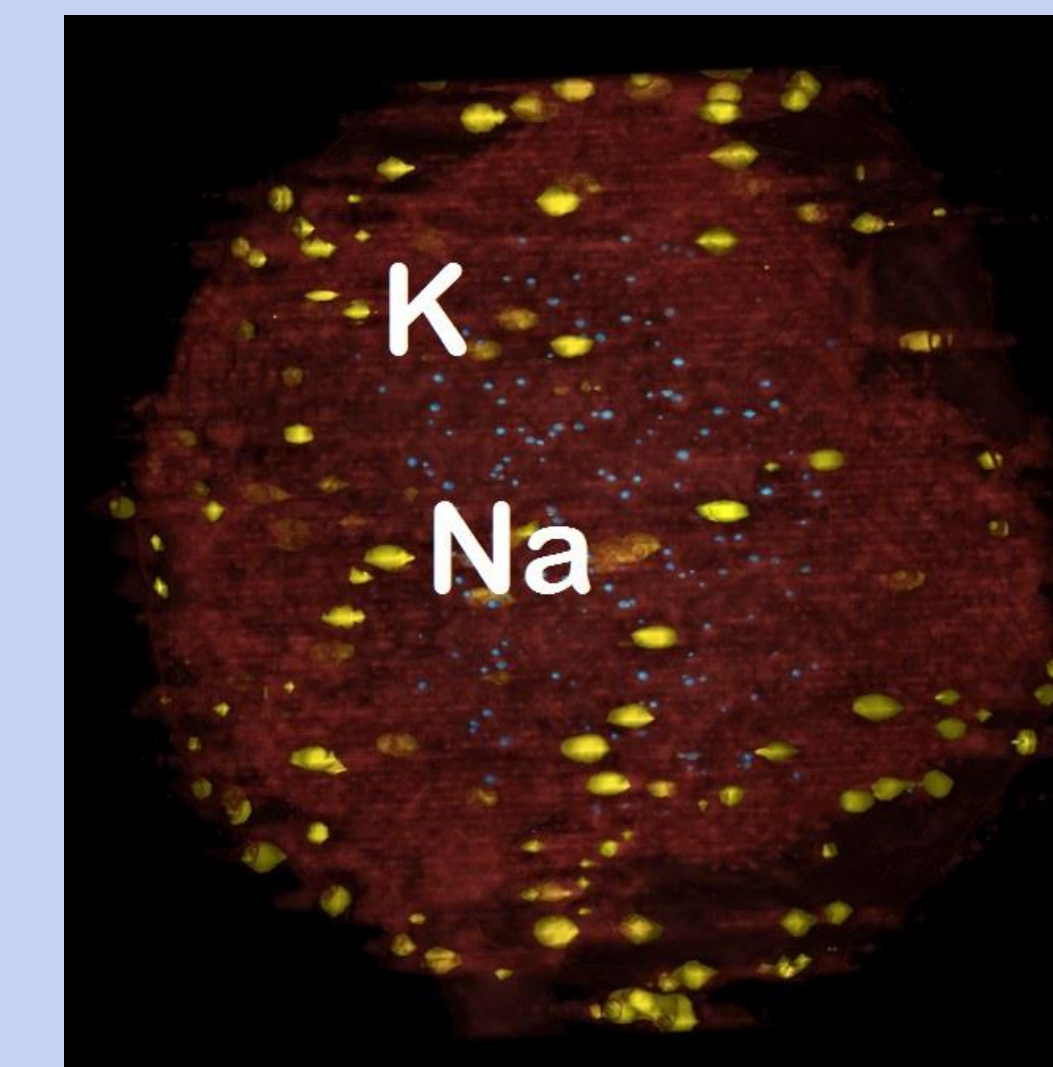
Our Solution

OC agglomeration

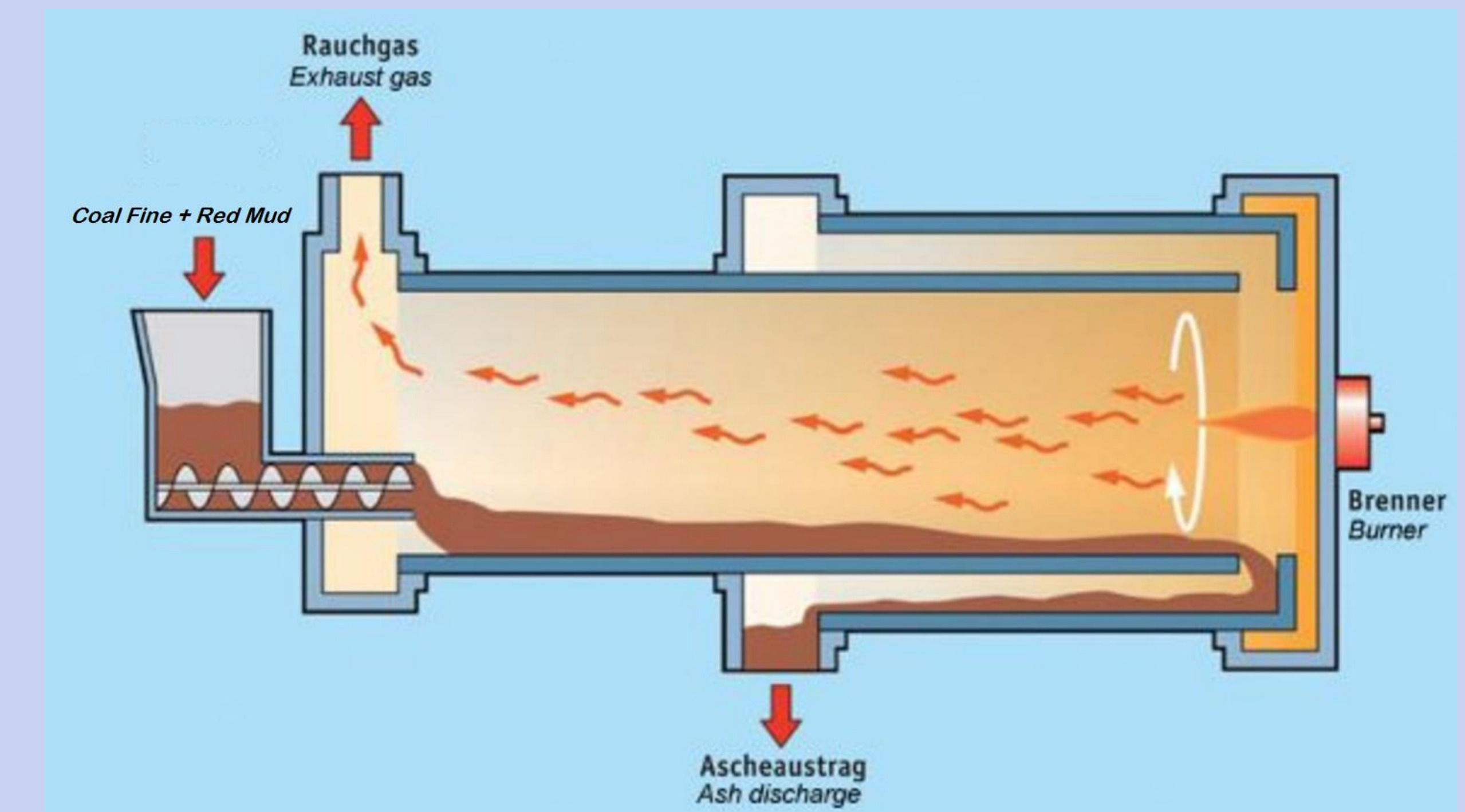


Limited gasification rate

Pressurizing Catalyst



Large-scale OC Production



Small-scale Pilot Plant for the Gasification of Coal and Coal/Biomass Blends and Conversion of Derived Syngas to Liquid Fuels via Fischer-Tropsch Synthesis

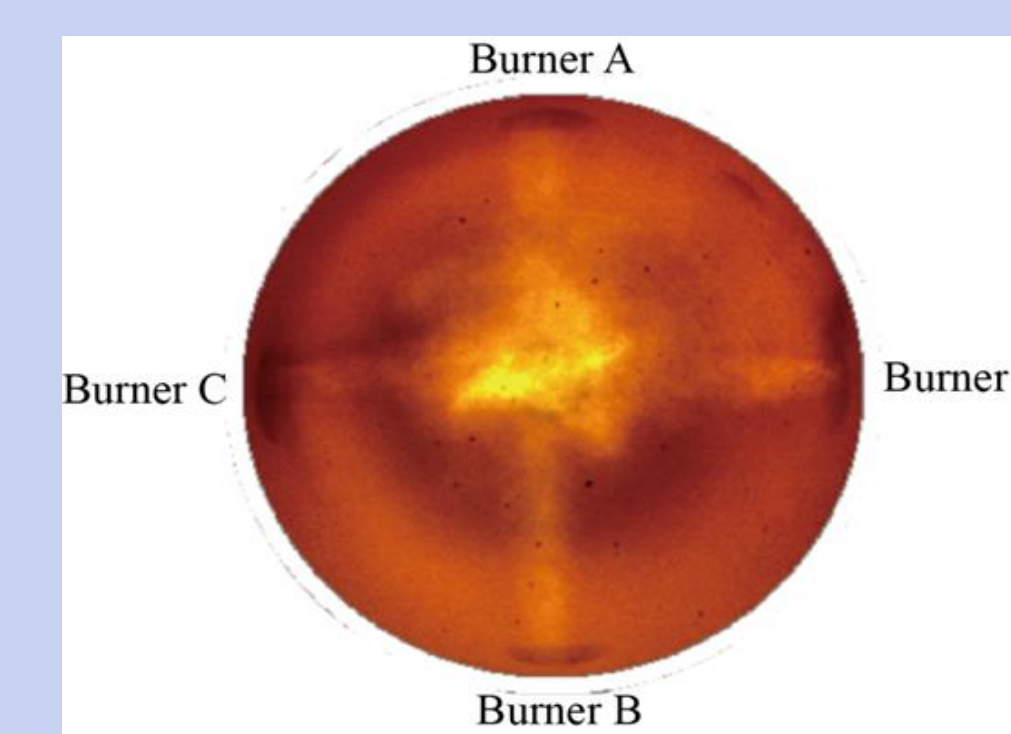
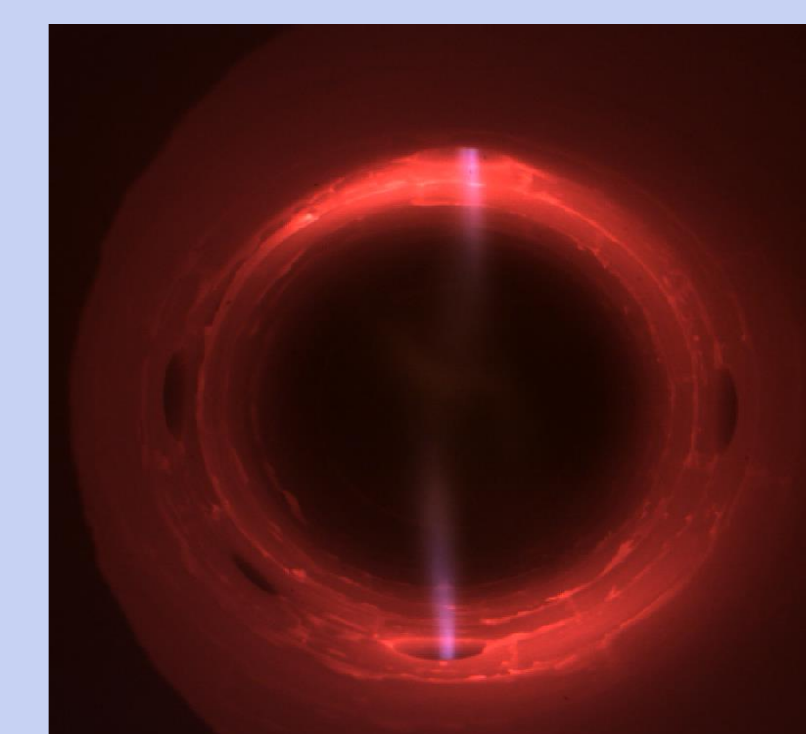
U.S. Department of Energy (DOE) - National Energy Technology Laboratory (NETL)
DE-FE0010482

Introduction and Overview

- The objective to advance the design, construction and commissioning of an integrated coal/biomass-to-liquids (CBTL) facility at a capacity of 1 bbl/day at UKy-CAER.
- Purposely designed as modular, skid-mounted, anticipating frequent change-outs; "plug and play;" and future re-purposing.
- A test platform to take lab scale work to the next level of scale-up and to have a fully integrated gas to final products continuous proof-of-concept facility.
- An important syngas production facility for a variety of future and complimentary research.

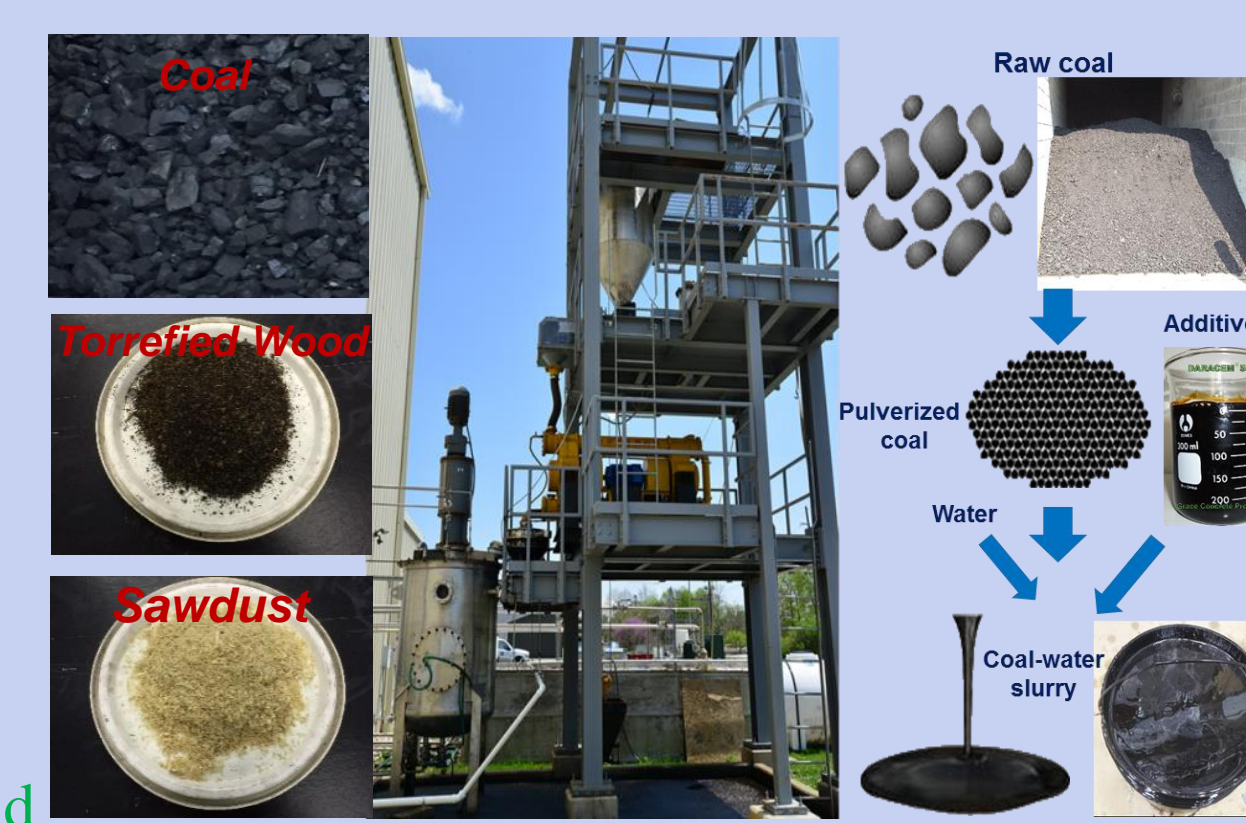
Facility Description and Process Units

Opposed Multi-Burner Gasification and Coal Water Slurry

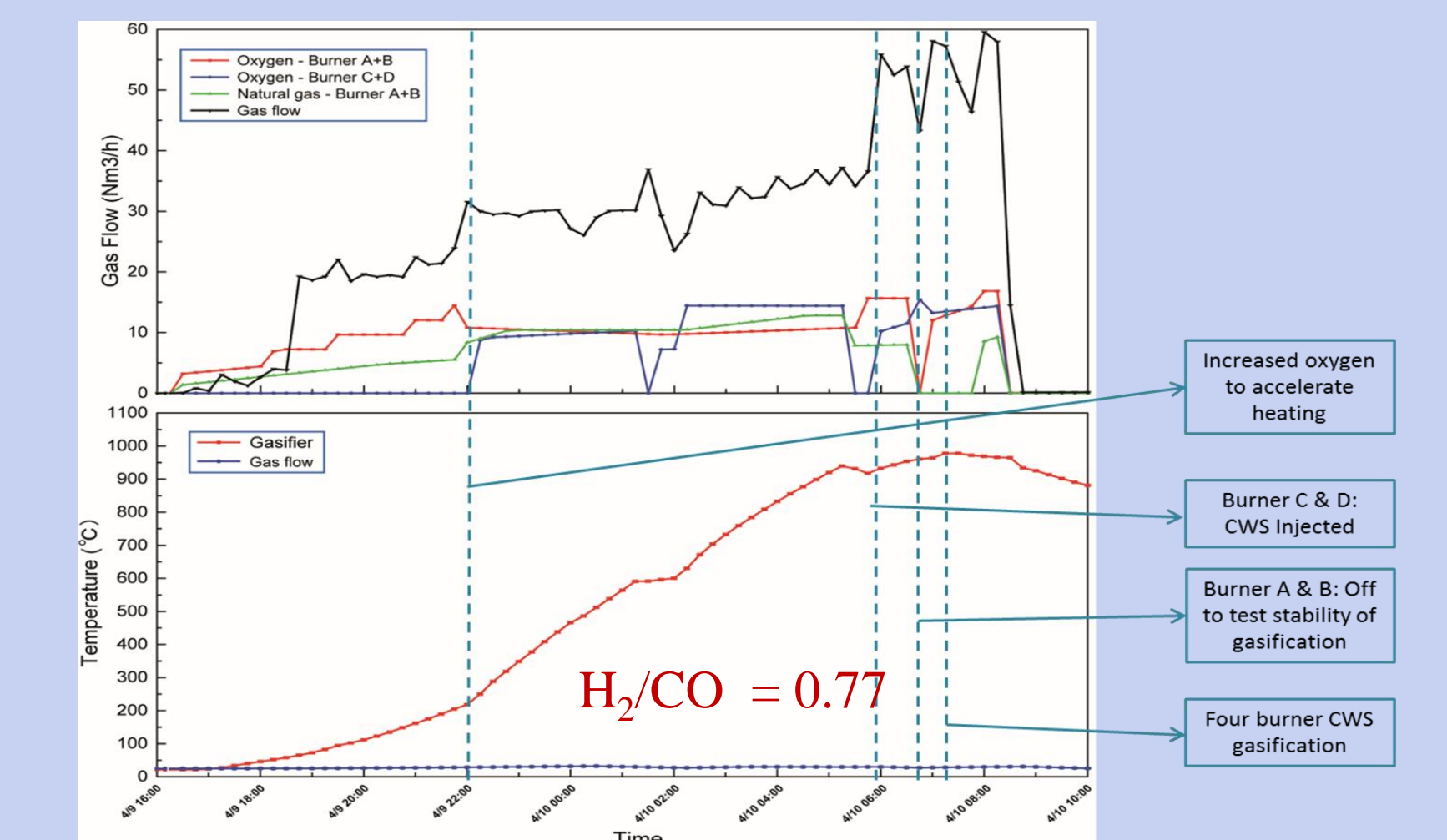
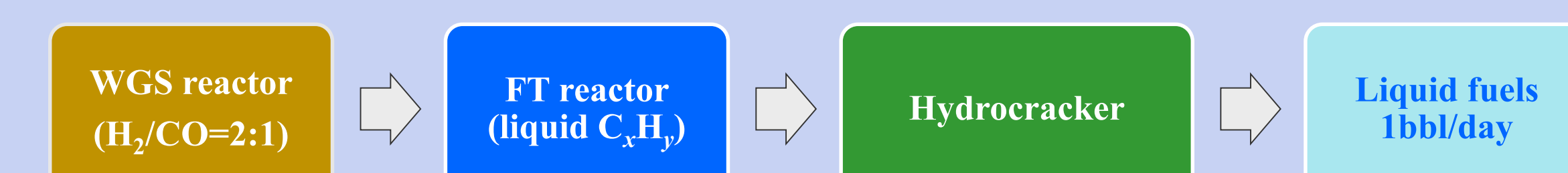


- Gasification and Quench Chamber
- Dry coal consumption: 1 ton/day
- Syngas production: 179 lbs/hr
- H₂/CO: ~0.75/1

- Improved flow distribution
- Enhanced residence time
- Higher carbon conversion
- High syngas production
- Wide capacity range and flexible load

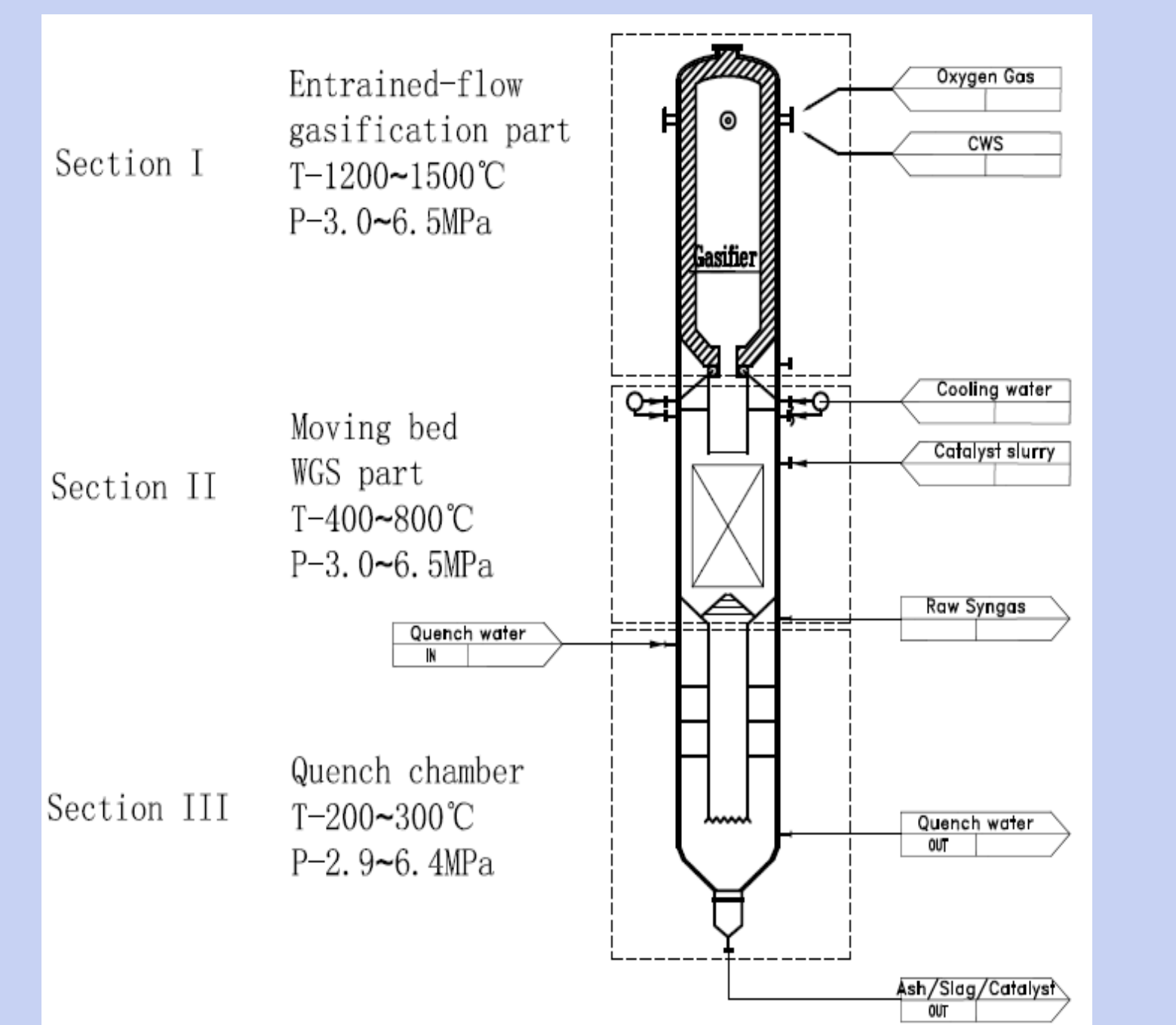


Downstream Processing



Platform for Future Research

In-Situ WGS and Warm Sulfur Removal



- WGS Chamber (moving bed) directly after Gasification Chamber
- Red mud (industrial by-product) catalyzes WGS with simultaneous H₂S/COS removal. Eliminate external WGS reactor
- H₂/CO ratio ≥ 4
- Reduce capital and improve efficiency

Syngas Cleanup – Solvent and Membrane Evaluation