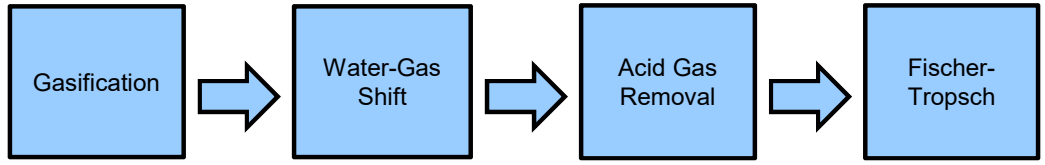


Introduction and Background

- 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 UK-CAER
- Purposely designed as modular, skid-mounted, anticipating frequent change-outs; "plug and play;" and future re-purposing.



Process Overview



Gasification Unit



Acid Gas Removal Module

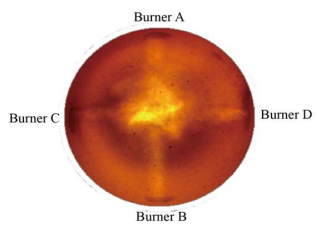


WGS and F-T Module

Gasification and Feed Preparation

Opposed Multi-Burner Gasification

- Includes biomass/coal feed preparation tower
- Entrained flow gasifier
 - Coal/water slurry
 - Oxygen blown
 - Molten slag
- Dry coal consumption: 1 ton/day
- Syngas production: 179 lbs/hr
- H₂/CO molar ratio: ~0.75/1



Acid Gas Removal

Aqueous Amine Syngas Treatment

- UK-CAER has 8+ years Experience with Similar Technology
- NCMA Patented Amine Solvent
- Sulfur Treatment on Both Rejected Acid Gas and Treated Gas
- Operates Under Pressure (up to 450psi) to Reduce Costs Downstream

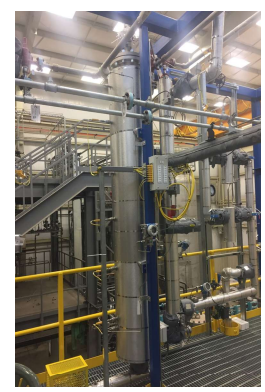


Syngas Compressor

Water-Gas Shift and Fischer-Tropsch

Sour Shift Reactor

- Controllable output up to a molar H₂/CO ratio of 11



WGS Reactor

Chart Energy F-T Reactor

- Microchannel reactor with production capacity of 1bbl./day
- Capable of utilizing either Fe or Co based catalysts



Chart Energy F-T Reactor

Project Status

- Gasification System installed and tested
 - Initial experimental data matched design specifications
- Acid Gas plant installed and ready for testing
- WGS and F-T module arrived at UK-CAER in December
 - Installation nearing completion
- F-T Catalyst, coal and biomass have been sourced
- Full system operation expected to occur in Summer/Fall 2017

