ClearFuels-Rentech Integrated Biorefinery Pilot Project for Diesel and Jet Fuel Production by Thermochemical Conversion of Woodwaste (CF-RTK IBR)

DOE Workshop on Biomass Indirect Liquefaction

March 20, 2014

Principal Investigator: Joshua Pearson

Project Description

Project Location: 4150 E. 60th Ave. Commerce City, CO

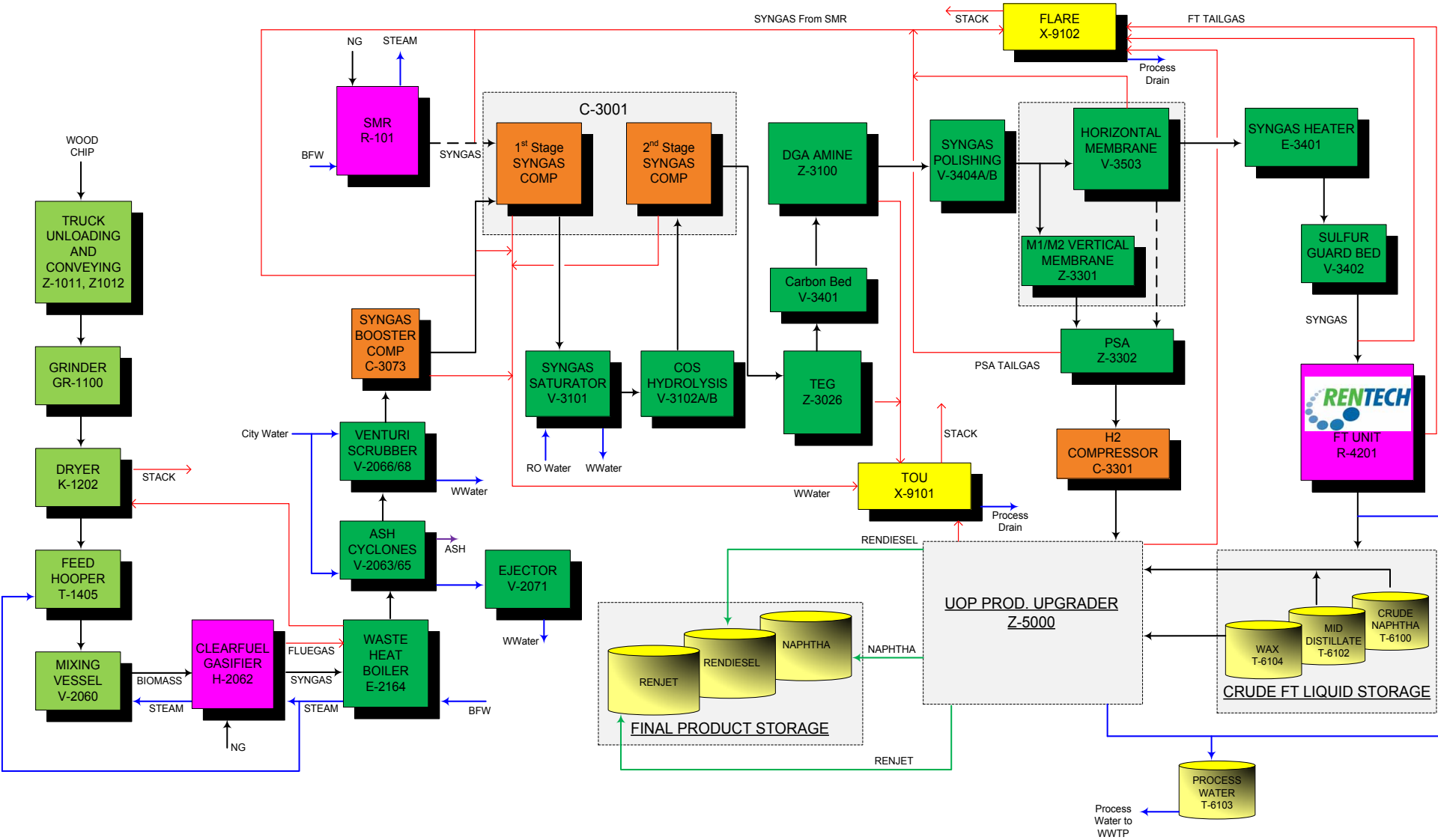
Rentech Corporate HQ: Los Angeles, CA

- Thermochemical Conversion of Wood and Bagasse:
  - DOE Project Added Biomass Handling and Gasification to Rentech's Gas-to-Liquids Demonstration Facility
  - 5- 16 DTPD of Wood Chips or Pellets or Bagasse
    - <2 inch feedstock with up to 50% moisture
  - Biomass Steam Reforming to syngas
  - Syngas Conversion to Hydrocarbons via Rentech Fischer-Tropsch
  - Hydrocarbons hydroprocessed to diesel fuel in Product Upgrader (Hydrocracking and Hydrotreating Units)
- Up to 420 gallons per day of liquid fuel can be produced at facility
  - Either Naphtha/Jet Fuel or Naphtha/Diesel produced
  - 75-80% of liquid fuel is Diesel for example

Rentech Site in Colorado

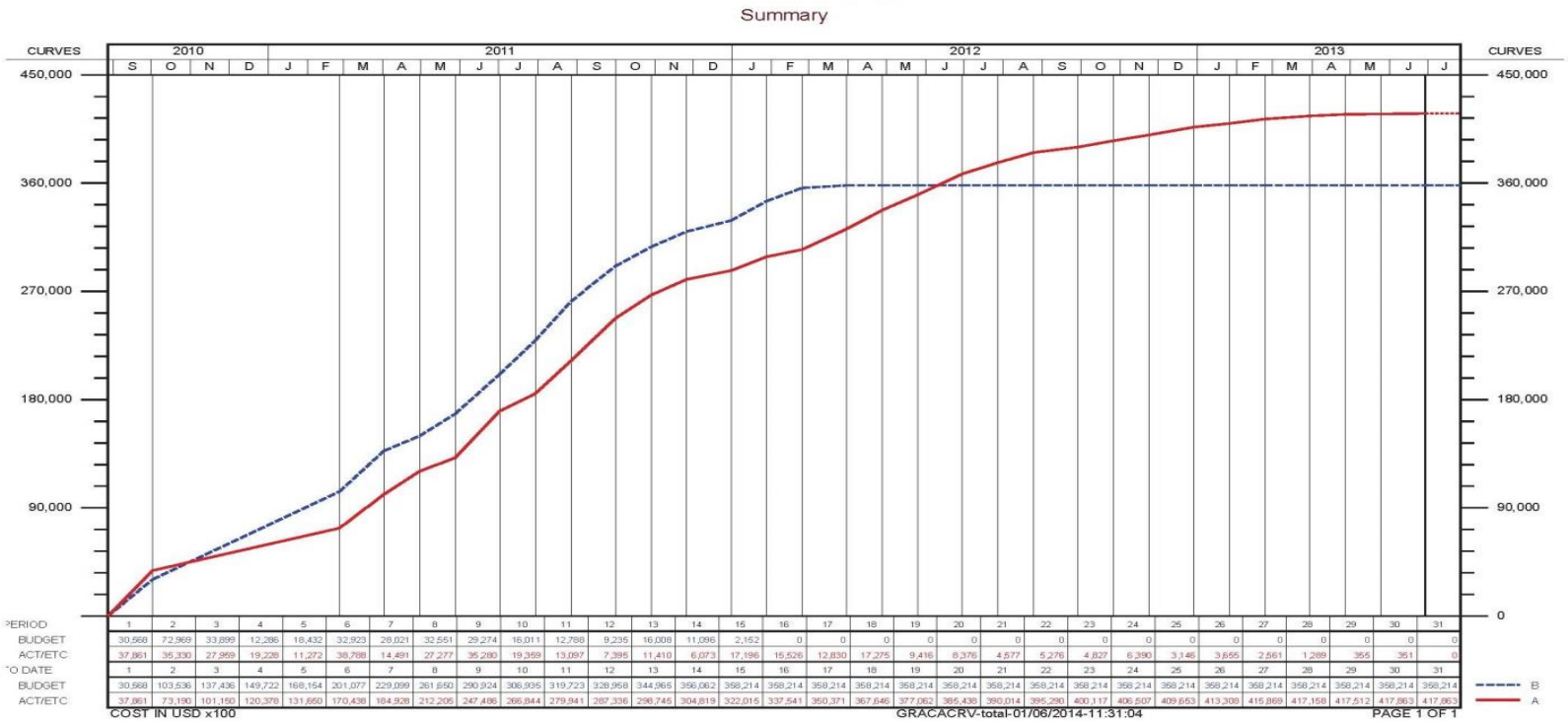
- Right 1/3 of Photo Added as Result of DOE Grant

General Overview – Block Flow Diagram



Engineering Procurement & Construction

- Dedication to Project Controls and Project Management
  - EP&C on time and on budget
- Cost Reimbursable Fixed Fee Contracting Strategy



May 5 2011

September 12, 2011

Commissioning Progress

Challenges

- ✓ Biomass Feed Conveyer
- ✓ Grinder Material Compatibility
- ✓ Feed Hopper flow
- ✓ Rotary Valve Seal
- ✓ Syngas line support/insulation
- ✓ Fuel Gas, using FT Tailgas for BMS
- ✓ DCS related Issues
- ✓ Burner Design
- ✓ Cyclone related issues
- ✓ Venturi Scrubber

- ✓ **Resolution**
  - ✓ **Adequate Time and Budget for Commissioning**

Feed System

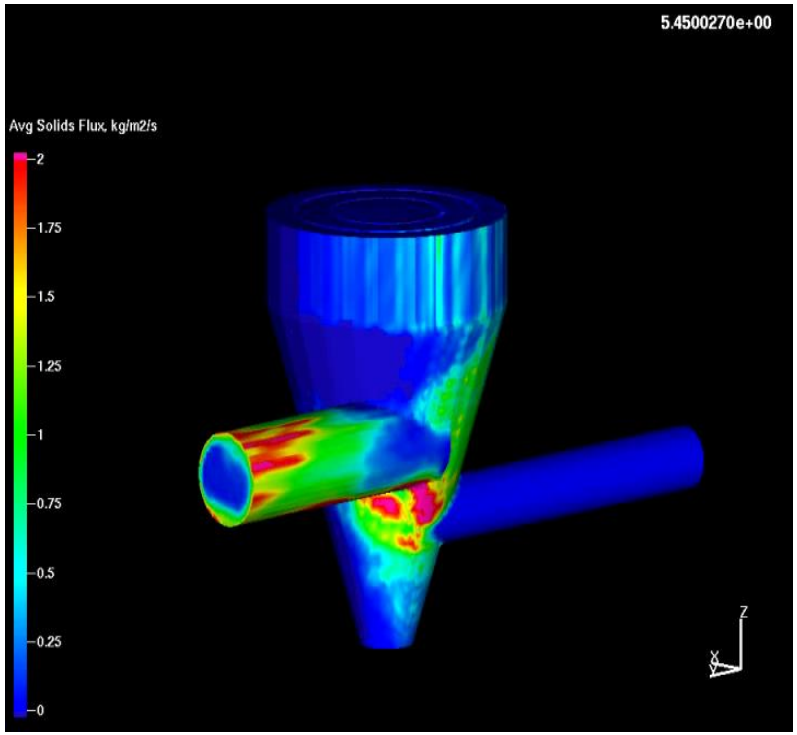
- Grinding
  - Feedstock Format
    - Hog Fuel
    - Pellets
    - Chips
    - Bagasse
  - Ground Feedstock Characteristics
  - Resolution
    - Start with simple feedstock specifications
    - Multi Step Grinding – tighter particle distribution

Feed System

- Drying
  - Particle Size Distribution Variation
    - % Fines Varies - Bagasse
  - Integrated Heat Recovery
    - Startup heat not available
    - Reformer Operation (Reduced Rates)
  - Resolution
    - Supplemental Heat added (seasonal issues)
    - Reduced Rates
    - Pre Dried Feedstock

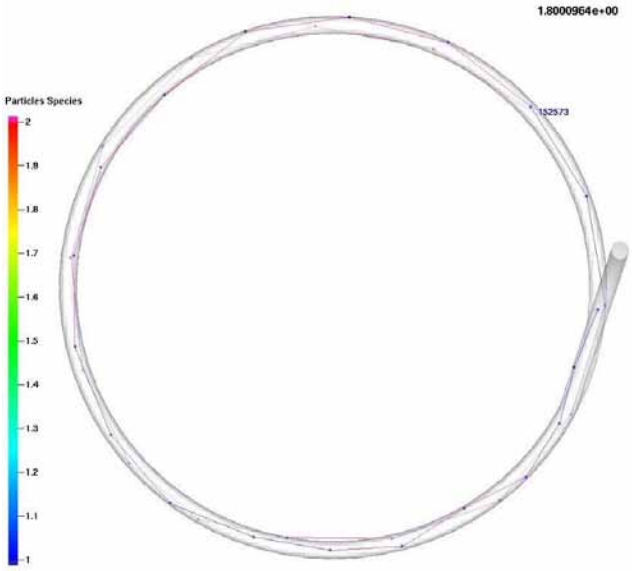
Feed System

- Mass Balance & Pressure Boundary
  - Feed Hopper
  - Metering Screw
  - Rotary Valve
  - Steam Mixing Vessel
- Resolution
  - Air Pulsation Devices
  - Used Upstream Weigh Belt
  - Steam Eductor
  - Redesign



Reformer Scale Up

- Incorrect Scale up Parameter Selected – Scale up based on Resonance Time, Critical parameter was heat transfer.
  - Resolution
    - Revisited Pilot Unit, Repeated pilot parametric testing
    - Enhanced Analytical data collection
    - Modification of demonstration Unit
- Validate Pilot Plant Data
    - Financing – Freeze Design Basis – Re-FEED



Gas Cleanup

- Analytical Capabilities
  - NREL
  - RTK
  - DCS & PI Historian
- Tars
  - Exchanger Fouling
  - Cyclones / Scrubber Fouling
  - Compressor Precipitation
- On Spec Gas to Fischer Tropsch
- Spec Bio Derived Diesel

Current Technology Status

- This gasification technology is unique, due to the beneficial effects of fast or flash pyrolysis of the biomass, produced as a result of fast particle heating rates due to particle/wall contact, which provides for high carbon conversions. In addition, the unique helical coil geometry results in volatiles released from the biomass and char having to pass through a layer of very hot char, which catalyzes volatile decomposition reactions, and results in a low tar content syngas and in particular very low heavy tar contents. Char catalyzed reactions also allow a high H_2:CO syngas to be produced in the HEHTR, which is a unique feature of this technology.

- The technology does suffer from limitations in scale-up potential due to limited surface area being available for fast particle heating, in the early part of the helical coil(s), and ultimately due to potential for coil deposits building up at high biomass feedrates.

R&D Needs Outstanding

- Tar Management
  - Tar Cracking Technologies
    - RTK – NIDFB
    - Catalytic Filtration (reformation)
- Mechanical Challenges of Reactor Design
    - Rapid Heating / Wall contact
    - Metallurgy
- Biomass Pressure Boundary
    - Rotary Valve
    - Lock Hopper
    - Plug Screw
- Intellectual Property - Perception
  - Lessons re-learned over and over and over again

- Department of Energy
- National Renewable Energy Laboratory (NREL) for Tar Measurement (TMBMS)
- URS for Engineering and Construction Management
- Linde HydroChem for design and fabrication of ClearFuels High Efficiency Hydro-Thermal Reformer (HEHTR)

- Joshua Pearson – Principal Investigator, Manager of Biorefinery Integration, Rentech
- Harold Wright – Senior Vice President and Chief Technology Officer, Rentech
- Eric Darmstaedter – President, ClearFuels Technology
- Randy Blevins – Director of Engineering, ClearFuels Technology
- Mark Robertson – Senior Lead Process Engineer, Rentech
- Weibin Jiang – Senior Principal Engineer, Rentech
- Mark Still – Process Development Engineer, Rentech
- Randy Shearer – Manager Lab Services, Rentech
- Josefa Griffith – Senior Analytical Chemist, Rentech
- Ernesto Bustamante – Process Development Engineer, Rentech
- Matt Greer – Principal Operation Engineer, Rentech
- Ray Huang – Manager, Iron Fischer-Tropsch Technology, Rentech
- Ute Duvenhage – Data Statistician, Rentech
- Eric Elrod – Lead Process Engineer, Rentech
- Eric Bemiss – Project Controls Engineer, Rentech
- Mark Anselmo – Construction Manager, Rentech
- Nick Cozzi – Senior Mechanical Engineer, Rentech
- Phil Weathers – Director of Operations, Rentech
- Perry Herrick – Operations Manager, Rentech
- Rentech Energy Technology Center (RETC) – Analytical and Lab Services
- RETC – Operations & Maintenance

ClearFuels-Rentech Integrated Biorefinery Pilot Project for Diesel and Jet Fuel Production by Thermochemical Conversion of Woodwaste (CF-RTK IBR)

DOE Workshop on Biomass Indirect Liquefaction

Questions

Principal Investigator: Joshua Pearson