Gasification of Biomass

Lyman Frost
Western Hydrogen LTD
Ceramatec, Inc
Typical Coal Gasification Unit

Typical plants: Cool Water – 1000 tpd, 92 MW; Buggenum – 2000 tpd, 250 MW
Heat rate/efficiency: Cool Water – 9060 / ~38%; Buggenum – 8000 / ~43%
Typical Process Flow – Biomass

1. **Biomass**
2. **Biomass Feed System** → **Steam Reformer** → **Gas Separation**
3. **Steam, Oxygen**
4. **Tail Gas**
5. **FT Catalytic Reactor** → **Secondary Syngas Clean-up**
6. **Syngas Compression** → **Primary Syngas Clean-up**
7. **FTL, Wax**

To reformer or turbine
Biomass Gasifier Problems

- Formation of refractory tars and oils
  - Viscous, sticky, smelly, and carcinogenic
  - Refractory materials that are difficult to reform
  - Condensing tars gum up engines & turbines
  - Tar poisons catalysts (Biomass to liquids)
  - Tar represents lost energy

- Tar removal
  - Toxic soluble fraction (phenols) in scrubbing water
  - Produces a hazardous waste disposal stream
  - Can condense the tars for disposal
Condense and Reform Tars & Oils

Air or Oxygen And Steam

Gasification Unit

Biomass

Condense Tars and Oils

Reformer

Clean Synthesis Gas

Fischer Tropsch synthesis

Methanation

Electric Power Generation
Air or Oxygen

Gasification Unit

Biomass or Other feed

Reheat Air or Oxygen

Non-thermal Plasma Reformer

Clean Synthesis Gas

Electric Power Generation

Fischer Tropsch synthesis

Methanation
Test of In-situ Reforming

- Emery Energy 10 TPD biomass gasifier
- Ceramatec non-thermal plasma catalyzed reformer
- Located at Western Research Institute, Laramie, WY
Another Option – Molten Salt Gasifier

Water

Carbon Compounds

MSG Reactor

CO₂ is Separated

Make-Up

Sodium Salts

Hydrogen ~2000 PSIG

Alternate Output – Synthesis gas

Fischer Tropsch

Sequestration Ready

No Oxygen Plant
No Gas Compression
Single, Small Reactor
Currently Constructing Pilot

• ~ 200,000 SCF/d $H_2$
• Operates at:
  • 2000 psi
  • ~900 deg C
Summary

- Biomass gasification based on previous technology
- Unique problem is the formation of refractory tars and oils
- Methods to address that formation
  - Condense and dispose
  - Condense and reform
  - In-situ reforming
  - High pressure – high temperature gasification