Advanced Syngas Production for Fuels, Chemicals and Power

June 27, 2019
Advanced Integrated BioRefineries for drop-in fuels, chemicals and power

Agenda

- Introductions
- Review meeting objective
- Overview of client business capabilities and resources
- Overview of the Technology – How it Works
- Tour of the PDU and demonstration of the Pulse Combustion
- Question and Answer session
- Next Steps/Wrap-up
TRI’s Technology Enables Biorefineries for Green Fuels, Chemicals and Power

Feedstock-flexible biorefineries are key to sustainable economics

- High value chemicals and/or distributed fuels production for maximum revenues
- Wide range of biomass feedstocks that can be switched on the fly to respond to market conditions
  - High carbon conversion for maximum fuels yield
  - Superior environmental footprint
Drop-in Fuels for Strategic Domestic Markets

MSW Derived Feedstock

Woody Residuals

Confidential

MFTL – diesel fraction

HFTL – wax fraction
Integration Configurations
Distributed Drop-in Fuels via Integrated Plantations for Strategic Fuels and Job Creation
Biomass to Green Fuels and Chemicals

Integration with an energy host can provide overall thermal efficiencies in the 60-75% range.
Biomass to Green Fuels and Chemicals

Integration with an energy host can provide overall thermal efficiencies in the 60-75% range

Agriculture

Cane

Prep & Dry

TRI Reformer

Bagasse

Sugar Mill /Ethanol Plant

Sugar

Ethanol

Steam
Hot Water
Power

Clean Syngas

GTL

Biofuels

Green Electricity

Tail Gas for Endothermic heat

Biomass to Green Fuels and Chemicals Integration with an energy host can provide overall thermal efficiencies in the 60-75% range
Biomass and Waste to Green Power

High efficiency conversion of a wide range of biomass sources to power
How it works
Our Technology – Flexible Feedstocks

**TRI**’s steam reforming technology is the foundation of the integrated Thermochemical Biorefinery and Power Plant

- Processes a **wide range of waste and biomass feedstocks** for improved economics
- Suitable for **greenfield or can be integrated with host** to maximize thermal efficiency and capitalize on existing infrastructure
- **End product can be augmented** at a later date to respond to changing market conditions with modest capital investment, e.g. adding a catalytic or fermentation fuels module to the existing plant.
- **Is sustainable** for maximum economic life
- **Low emissions profile** for enhanced environmental performance
Our Technology – Product Optionality

Produces a clean, high-quality syngas – the key to a wide range of product options

- **Fuels**
  Customizable H₂:CO ratio suited to catalytic and fermentation fuels pathways

- **Chemicals**
  Ideal for chemical production via the methanol pathway

- **Power**
  Suitable for high efficiency combined cycle power production
TRI’s Proprietary Steam Reforming Process

How it works and why it is better

- **Unique two stage gasification system** that provides process flexibility for a wide range of feedstocks
  - High carbon conversion to maximize yields
  - Capable of customizing syngas $\text{H}_2:\text{CO}$ ratio ranging from 1:1 to 3.5:1
  - Contaminants are kept dry for easy removal

- **Deep fluidized bed** first stage where feedstock undergoes drying, pyrolysis and steam reforming in a reducing environment to produce a high value syngas
  - Indirectly-heated steam reforming process operates at medium temperature and low pressure which is well suited for contaminant laden feedstocks

- **3 inputs and 3 outputs**
  - In - Feedstock, steam and fuel for pulse heaters (typically tail gas from downstream syngas conversion processes)
  - Out - Syngas, clean flue gas for heat recovery and dry solids for contaminant removal
Steam Reformer Animation

Animation viewable at http://tri-inc.net/steam-reforming-gasification/
Pulse Heater Animation

Animation viewable at http://tri-inc.net/high-efficiency-heat-transfer/
High Combustion Efficiency
Low NOX Emissions for improved environmental performance
Fuels Flexibility to meet the project’s economic and environmental objectives
Enhanced Heat Transfer to maximize thermal efficiency
Uniform Heat Flux to reduce heat exchanger size for a given duty
No Moving Parts to dramatically improve life of the equipment
Self Aspiration to simplify controls
Pressure Boost to reduce fan size and power consumption
Advanced Development Center

ADC

Process Demonstration Unit

PDU
**TRI Advanced Development Center**

A complete range of testing and validation facilities to support development

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**Process Demonstration Unit (PDU)**
- Large scale integrated biorefinery pilot (4 dry tons/day)
- Integration validation testing for complete systems
- Feedstock and process validation is support of commercial scale designs

**Feedstock Test Reformer (FTR)**
- Feedstock screening tests to determine optimum operating conditions including temperature and pressure, eutectics, etc.

**Advanced Development Center (ADC)**
- Continuous process improvement
- 2nd generation technology development
- Cold flow modeling
- Process concept testing
Every process needed in a commercial biorefinery is replicated here.
Review of Integrated PDU Results

Integrated Woody Biorefinery PDU Demonstration Successfully Completed

- Integrated Biorefinery trial met or exceeded all performance criteria
- Generated high quality F-T products for off-take agreements testing
- Non-detect level of contaminants after gas clean-up
- No observable F-T catalyst deactivation

Integrated MSW Biorefinery PDU Demonstration Successfully Completed

- Integrated trial met all performance criteria
- Generated high quality F-T products for upgrading to Spec diesel and jet
- Syngas cleanliness after gas clean-up met F-T tolerance criteria
- System performance and operability on target
- **Woody biomass**
  Logging residuals, chips and saw dust

- **Ag Residuals**
  Corn Stover, wheat straw  
  Swine waste, Poultry litter  
  Rice hulls, switch grass  
  Grape plant pruning's  
  Pistachio nut shells  
  Olive waste

- **Low Rank Coal**
  Lignite, sub bituminous

- **Wastes**
  Refuse Derived Fuel  
  Municipal and mill sludge

- **Blends**
  Wood/Coal  
  MSW/Coal

- **Spent Liquors**
  Kraft  
  Sulfite  
  Soda  
  Straw  
  Distillery spent wash
- Proven, scalable commercial technology
- Highly flexible & interchangeable feedstocks
- IP-protected core processes
- Integrated biomass feed/steam reforming/gas clean-up/gas-to power and gas-to-liquids processes
- Customizable biofuels/biochemical end products
- Enables thermal integration with energy host for superior economic performance
- Lowest possible emissions & water usage from Ultra-Green technology
- Partnerships established with world-wide EPC firms
We believe our technology can make the world cleaner and better

TRI's advanced steam reforming technology transforms everyday garbage into fuel. Using garbage, waste wood or energy crops, we can create gasoline, jet fuels, fertilisers and other renewable energy.

Learn more at www.tri-inc.net.

ThermoChem Recovery International, Inc.
Creating clean energy out of waste since 1996.