Maximize ROI on Waste Through Cutting Edge Plasma Gasification Technologies

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Presentation Overview

- Gasification Technology Options
- Environmental Impacts
- Energy Optimization
- Project Considerations
- Application to MSW
S4 Energy Solutions

- Joint Venture Formed to Commercially Deploy Gasification of Waste
- 50/50 Joint Venture Between WM and InEnTec
- Venture Officially Launched in February 2009
- JV to Operate in Collaboration with, but Independent of JV Partners
Gasification 101

**Base Definition:** Gasification generally involves the conversion of carbonaceous materials into primarily synthesis gas (CO and H2) through partial oxidation and/or steam reforming reactions, for example:

\[
- C_xH_y + xH_2O \rightarrow xCO + (x + y/2)H_2 \\
- C_xH_y + (x/2)O_2 \rightarrow xCO + (y/2)H_2
\]
What is Plasma Gasification?

Power Supply

Electrodes

Very High Temperature Region
Gasifiers for Waste Conversion

- Primary Categories of traditional Gasification Technology:
  - Fixed Bed
    - Downdraft
    - Updraft
  - Fluidized bed (bubbling and circulating)
- Pyrolysis Systems
Up-Draft (Counter Current) Gasifier

- Waste
- Synthesis Gas

- Solids Flow
- Gas Flow

- Zone 1
- Zone 2
- Zone 3

- Ash/Slag
- Gasification Agent
Down-Draft (Co-Current) Gasifier

Waste

Gasification Agent

Solids Flow

Gas Flow

Zone 1

Zone 2

Ash/Slag

Synthesis Gas
PEM™ System Downdraft – Plasma Gasifier

Diagram showing the components and flow of gases in a Plasma Gasifier system.
PEM™ Unit
Environmental Performance
For
Plasma Technology
Potential Waste Volume Reduction

1 Ton = 182 Cu Ft

2 Cu Ft Recycled
Ultra Low Emissions

- Advanced Plasma processes typically exceed US EPA emission requirements by an order of magnitude depending on the ultimate use of the synthesis gas
  - Dioxin emissions 10x to 100x lower than US EPA requirements
  - No detectible mercury emissions
Potential Carbon Credits

- Reduced Transportation
- Production of alternative fuels
- Reduced net CO$_2$ emissions in comparison to other technology options
- Increased efficiency and use of landfills
- Potential to capture and sequester CO$_2$
Gasification Options

And

Project Considerations
Primary Project Parameters

- Waste Feedstock
- Facility Scale
- Energy Off-Take
- By-products
- Facility Integration Considerations
- Permitting
- Economic Incentives and Subsidies
Feedstock Considerations

• Availability and Quality

• Advanced Plasma Gasification is designed to provide flexibility
  – Pretreatment requirements minimized
  – Blends
  – High Conversion Efficiency
Capacity Considerations

- Is Bigger Better?
  - Risk
  - Flexibility
  - Modular
Energy Off-Take Products

- Syngas fuel
- Electric Power (reciprocating engines)
- Hydrogen
- Methanol
- Ethanol
- Other GTL options (e.g. Syn-diesel)
Potential Products

- AMMONIA
- UREA
- FORMAL-DEHYDE
- RESINS
- METHANOL
- DME
- ACETIC ACID
- POLYURETHANE
- CARBON MONOXIDE
- PHOSGENE
- COAL
- BIOMASS
- WASTE
- GASIFICATION
- HYDROGEN
- OXO ALCOHOLS
- DETERGENTS, PLASTICIZERS
- FISHER-TROPSCH
- FUELS, WAXES, OTHERS
- SNG
- IC RECIP ENGINE
- ELECTRIC POWER
- HYDROGEN
- FUEL CELL ELECTRIC POWER
- GAS TURBINES
- ELECTRIC POWER
By-Products

- Ash vs Slag vs Glass
- Liability
- Cost
- Completely Inert
Facility Integration

- Utilities
- Staff-Sharing
- Host - Customer for Off-take
  - Primary
  - Secondary
Permitting

• Scale
  – Local feedstock
• Public Receptivity
• High Environmental Performance
• Low Carbon Footprint
Potential Incentives

- Carbon Credits
- RECs
- Tax Credits
- Producer Credits
- Various State and Federal
- Others
Opportunities for MSW in North America
Mass Balance Example (Varies with Waste Composition)

Waste Feed: 125 Tons/day

Plasma Gasifier

- Syngas Cleaning

- Hydrogen Production
  - Estimates: ~ 2 to 3 MMSCF/day

- Alcohol Production
  - ~6000 to 10000 gal/day

- Electricity Production
  - ~ 3 to 5 MW net

Thermal Energy
  - ~ 40 to 55 MMBTU/hr

Products:
- Glass
- Metal
Potential Energy Off-Take Value

$ (US) / Ton Waste

- Syngas: $6/MMBtu
- Hydrogen: $6/MMBtu
- Electricity: $0.10/kWh
- Alcohol: $2/gal
Summary

• Conversion of waste into clean energy products can be economically viable option in the near term

• Risk can be mitigated through proper project analysis and deployment
  – Start Small
  – Build in Flexibility