Tar Removal From Biomass/Waste Derived Syngas: Technical Considerations and Options
Global Network:

- Global headquarters: Tokyo
- Regional headquarters: New York, Singapore, Shanghai
- Overseas offices: 15
- Subsidiaries: 231 (incl. 158 overseas companies)

Further info.
https://www.ihi.co.jp/en/
IHI E&C International Corporation

- Joined IHI Group: 2012
- Offices in Houston, TX
- Full-Service Engineering Design

Further info.
https://www.ihi-ec.com

IHI E & C International Corp. Office, Houston
• Legacy Syngas Projects
• Innovative Projects
  - Renewable hydrogen project for power generation
  - Waste plastic to oil via pyrolysis project
  - Gas-to-Liquids project
  - Methanol project
  - Two hydrogen projects from natural gas
  - HyCO project from natural gas
Biomass/Waste Gasification: Current State

• Drivers
  - RIN Credits
  - Waste Disposal
  - Reduce GHG emissions
  - CO₂ Capture Incentives

• Failures/Lesson Learnt
  - Multiple Failures
  - Innovative gasifiers/pyrolyzers
  - Taxpayers Money Wasted?
  - Expected?

• Successes

• Future
SYNGAS VALUE CHAIN

Feedstocks
- Natural Gas
- Coal / Petcoke
- Biomass
- Plastics
- Waste / RDF

Syngas Production
- Steam Reformer
- Auto Thermal Reformer
- Secondary Reformer
- Gas Heated Reformer

Gasification / Pyrolysis  Tar Removal

Syngas Processing
- Water Gas Shift
- Contaminant Removal
- Compression
- Product Synthesis

Products
- Hydrogen
- Hydrogen / Carbon Monoxide
- Fuel (diesel, jet fuel, etc.)
- Ammonia
- Methanol
- Power
- Gasoline
- Olefins
- Acetic Acid
- Formaldehyde
- DME
- Urea
Tar Considerations

• “Tars' is a broad term, widely recognized as meaning the organic products, usually aromatics, that typically condense under operating conditions, produced from thermal treatment of organic feedstock.

• Type of gasifier
  - Residence Time
  - Temperature

• Types of tar
  - Primary
  - Secondary
  - Tertiary

• Other Classifications

• Tar Tolerance
Tar Removal Options

• Physical Methods

• Thermal Cracking

• Catalytic Cracking
Tar Removal – Physical Methods

• Cyclone Separators

• Cooling/Scrubbing Towers/Venturi

• Demisters

• Granular Filters

• Electrostatic Precipitators (ESP's)

• Oil Gas Scrubbing
Physical Methods - Disadvantages

- Loss of sensible heat
- Generates wastewater
- Tar solid-waste streams
- Few literature data.
- Reduced overall plant efficiency
Tar Removal – Thermal Cracking

• Partial Oxidation (POx) – the tar is subjected to high temperature along with the addition of oxygen or air to convert tars.

Advantages

- Convert tars to syngas
- Provides a constant $H_2/CO$ ratio
- Reduced possibility of fouling
- Ease of Water Treatment
- All sulfur species is converted to $H_2S/COS$

Disadvantages

- $O_2$ requirement
- Metallurgy/Equipment cost
- Soot Production
Tar Removal – Catalytic Cracking

• Catalyst reduce temperature required
• Catalyst – Naturally Occurring minerals
  - Dolomite
  - Olivine

• Disadvantages
  - Catalyst sensitivity
  - Soot Ash Deposition
  - Catalyst Disposal
Summary

• Biomass/Waste Gasification strong drivers

• Tar significant issue
  - POx with physical methods

• New technologies
  - POx Burner Technology
  - Heat Exchangers Innovations

• Co-ordinated effort ?