Solid Fuel Gasification and Syngas Applications

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About Eastman

- Founded by George Eastman in 1920 to supply photographic chemicals for Eastman Kodak
- Became an independent company in 1994
- Headquartered in Kingsport, TN
- Global manufacturer of chemicals, plastics and fibers
- Approximately 11,000 employees worldwide
- 2007 sales revenue of $6.8 B
- Pioneer in coal gasification – first commercial U.S. coal gasification facility in 1983
Chemicals from Wood (1920)

A History Based on Use of Domestic Alternative Feedstocks

Chemicals from Coal (1983)
"Gasification 101"

Just the Basics

\[ C + O_2 + H_2O \rightarrow CO + H_2 \]

Carbon + Oxygen + Water \quad Carbon Monoxide + Hydrogen

The partial oxidation of carbon to produce a "synthesis" gas or "syngas".

Gasification is not combustion (\(C + O_2 \rightarrow CO_2\)).
Gasification Basics

Gasifier Section:
- Controlled chemical reaction
- High temperature
- High pressure
- Short residence time

Products (syngas):
- CO
- H₂ (can adjust CO/H₂ ratio)

By-products:
- H₂S
- Ash (slag)
- CO₂
- Steam

Quench Zone (quench gasifier only):
- Gas and molten ash quenched in circulating water bath
- Ash/slag discharged out bottom as inert, glassy frit (saleable byproduct)

Gas Clean-Up Before Product Use!

Air Separation Unit

Rod Mill

Slag
Industrial Gasification (IG)

- Carbon Source
- Air Separation (ASU)
- $\text{CO}_2$
- Products: Chemicals, Fertilizers, Hydrogen, Etc.
- Syngas Conversion
- Gas Cooling
- Shift Reactor
- Mercury Removal
- Carbon Beds
- Particulate Scrubber
- Quench Gasifier
- LockHopper
- Slag/Frit
- Water-Gas Shift Reaction: $\text{CO} + \text{H}_2\text{O} \rightarrow \text{CO}_2 + \text{H}_2$
- Sulfur
- Acid Gas Removal e.g., Rectisol
- > 99.9% Deep Sulfur Removal
- Non-Leachable Heavy Metal Removal
- Conversion of Carbon into Useful Products
- CO/H$_2$
- Syngas Conversion
- CO$_2$
- Capture of Essentially all CO$_2$
- Products: Chemicals, Fertilizers, Hydrogen, Etc.
Solids Handling – Feedstock Slurry Preparation
(with some gasifiers, can feed as dry solids)
Shift Reactor Adjusts H\textsubscript{2}/CO Ratio

CO + H\textsubscript{2}O $\rightarrow$ H\textsubscript{2} + CO\textsubscript{2}

Exothermic Shift Reaction
Major Technology Options:

- **MDEA** (methyldiethanolamine) – Chemical absorption, 98% to 99+% S removal, large CO₂ slip, moderate operating temperature, lowest capital cost, often inadequate for chemical production from syngas.

- **Selexol™** (UOP) – Physical absorption, 99+% S removal, variable CO₂ slip, higher cost than MDEA.

- **Rectisol™** (Lurgi/Linde) – Physical absorption, 99.5% to 99.9+% S removal, complete CO₂ removal possible, similar total cost to Selexol™, coldest operating temp.

- **Warm Syngas Cleanup** - New technologies (e.g., RTI/Eastman) being developed that operate at high temperatures (> 600°F) and at ppm sulfur levels. The H₂S recovered from these technologies is further converted to either elemental sulfur (e.g., Claus/SCOT) or sulfuric acid.
Vapor-Phase Mercury Removal

Essentially complete mercury removal (> 95%) via activated carbon beds
Eastman's Coal Gasification Facility – Kingsport, TN
It’s likely you have used a product based on coal gasification from Eastman’s facility.
Syngas from Gasification has Multiple Applications

- Transportation/Aviation Fuels (Civilian & Military)
- Building Blocks for Chemical Industry
- Clean Electricity
- Iron Reduction
Gasification Can Produce Almost Any Product Made from Oil or NG
Questions?

We Believe So.

Eastman – Making It Happen.