Eastman Gasification Overview

GTC Regulators Workshop

April 12, 2005
• Founded in 1920 as part of Eastman Kodak - wood to methanol plant
• Spun off from Kodak - January 1, 1994
• Over $6 B in annual sales
• Headquarters - Kingsport, TN
• Manufacturing sites around the world
What is Gasification?

Products (syngas):
- \( \text{CO} \) (Carbon Monoxide)
- \( \text{H}_2 \) (Hydrogen)

[\( \text{CO}/\text{H}_2 \) ratio can be adjusted]

By-products:
- \( \text{H}_2\text{S} \) (Hydrogen Sulfide)
- \( \text{CO}_2 \) (Carbon Dioxide)
- Slag (Minerals from coal)

- Controlled Chemical Reaction
- Up to 1,000 psig or more
- Nominal 2,600 Deg F

C + O\(_2\) + H\(_2\)O → CO + H\(_2\)
Carbon + Oxygen + Water → Carbon Monoxide + Hydrogen

Gas Clean-Up Before Product Use!
AGR Technologies Can Provide Near 100% Sulfur Removal If Required

(AGR = Acid Gas Removal)

Three Main Technologies:

• **MDEA** (methyldiethanolamine) – Chemical absorption, 98% to 99+% S removal, large CO₂ slip (unless use a second stage for CO₂ recovery), moderate operating temperature, lowest AGR capital cost

• **Selexol™** (primarily dimethyl ethers of polyethylene glycol, DEPE) – Physical absorption, 99+% S removal, variable CO₂ slip (based on design), higher AGR cost than MDEA but overall AGR/SRU system costs are similar

• **Rectisol™** (methanol) - Physical absorption, 99.5% to 99.9+% S removal, complete CO₂ removal possible, highest AGR cost, coldest operating temperatures

[Used by Eastman]
So what can you do with CO and H2?

Syngas

- Building Blocks for Chemical Industry
- Transportation Fuels
- Clean Electricity
Integrated Gasification Combined-Cycle (IGCC)

Air Separation Unit (ASU)

- Air
- Oxygen
- Slag

Gasification Block

- Coal (or other Carbon Source)
- Water
- Crude Syngas

Gas Clean-Up Block

- Volatile Mercury 90+% Removal
- Pure Sulfur 98-99+% Removal

- CO₂ Capture (ready for sequestration)

Clean Syngas

Combined-Cycle Power Block

- Electricity

Contaminants Removed Pre-Combustion !!!

Eastman Coal Gas Facility
What is IGCC?

- **Coal + H2O** → **GE "Quench" Gasifier**
- **Slurry** + **O2** → **Air Separation Unit (ASU)**
- **Particulate Scrubber**
- **Low Temp Gas Cooling**
- **Shift Rx (option)**
- **Volatile Mercury Removal**
- **Acid Gas Removal**
- **Sulfur Recovery Claus/Scot**
- **CO/H2**
- **CO2**

**PRE-COMBUSTION Treatment of Pollutants**
- High pressure
- Low Volume
- Concentrated stream (easier to treat)

**Flexibility for CO2 Sequestration** (Concentrated Stream)

**Combustion Turbine**
- **Electricity**

**Steam Turbine**
- **Electricity**

**HRSG**
- **Compressed Air to ASU**

**Slag/Frit**

**>90% Removal**

**98-99+% S Removal**
Gasification-Based Polygeneration: Replace NG and/or Oil With Coal/Petcoke

- Natural Gas and/or Oil
- Combined-Cycle Power Plant
- Chemical Facilities
- Electricity
- Chemicals, Synfuels, Fertilizers, and/or Hydrogen

Syngas from Coal/Petcoke Gasification (adjacent or via pipeline)
Benefits of Polygeneration

• Higher overall value creation
• Higher overall thermal efficiency and feedstock utilization
• Synergistic usage of low grade steam and waste streams
• Enhanced ability to load follow (intermediate vs. baseload operation)
• Higher employment for the community
• Enhanced reliability, with potential to store syngas as a liquid fuel
Why Gasification?

- **It is the cleanest coal/petcoke technology** …
  - Inherently lower $SO_x$, $NO_x$, and PM (approaching NG)
  - Lowest collateral solid wastes and wastewater (30-50% less)
  - Potential for lowest cost removal of mercury and $CO_2$

- **It is proven technology** …
  - 21+ years of successful commercial operation at Eastman
  - Multiple commercial IGCC’s (e.g., TECO Polk, Wabash)

- **It is becoming increasingly competitive** …
  - Capital cost at parity with other clean coal and dropping
  - Lowest dispatch cost of all fossil fuel technologies

- **It is gaining acceptance** …
  - Gaining support of environmental groups (e.g., NRDC, CATF)
  - Numerous state and federal initiatives and incentives

- **It provides great promise for the future** …
  - Flexible feedstocks, process options, and products
  - Opens new markets for coal (synfuels, chemicals, fertilizers)
  - It provides the only feasible bridge from coal to hydrogen (directly converts coal/petcoke to hydrogen)
Eastman Performance with Rectisol AGR

Eastman Operational Data, Jan-Mar '04
Total Sulfur in Clean Syngas, ppm

Sulfur levels in exhaust gas after combustion would be ~1/8 these levels for an IGCC.
Vapor-Phase Mercury Removal

High pressure, concentrated stream → low volume, low cost, high removal efficiency

Demonstrated for 21 years at Eastman!

The cost of volatile mercury removal by IGCC is estimated to be < $0.25/MWh, almost an order of magnitude lower than for PC technologies using activated carbon, according to a 2002 DOE report by Parsons (DOE Report, "The Cost of Mercury Removal in an IGCC Plant", September, 2002).
IGCC: Low-Risk Option for Carbon Capture

DOE Report "Major Environmental Aspects of Gasification-Based Power Generation Technologies", December 2002
IGCC's True Environmental Capability is More than Marginal Improvement

- Inherently lower in air emissions and collateral solid wastes and wastewater; consumes substantially less water than coal combustion options.
- For ≤ $100/KW estimated added cost, IGCC's can reduce sulfur in syngas by 99.5% or more (vs. 98 to 99+% standard).
- For ≤ $0.25/MWh, IGCC's can remove essentially all volatile mercury from syngas (>90-95+% removal).
- IGCC's can capture CO₂ at a fraction of the comparative cost for PC or NGCC (~1/5 the parasitic power loss).
- These enhanced capabilities are all commercially proven. Eastman has practiced high sulfur removal plus volatile mercury removal and CO₂ capture (but without sequestration) for more than 21 years.
Eastman’s Experience with Gasification

• We were a pioneer in coal gasification …
  – First commercial U.S. coal gasification facility in 1983
  – Designated as ACS National Historic Chemical Landmark

• Industry leading operating performance …
  – > 98% on-stream time since 1984
  – < 1-2% forced outage rate
  – Highest production rate per unit of capacity
  – Single-train reliability of ~88-90% (~94% excl. refractory change)

• Excellent safety record …
  – Plantwide OSHA recordable rate of ~1.0
  – No lost time in gasification area in over 12 yrs

• Exceptional environmental performance …
  – Remove >99.9% of sulfur
  – Patented sulfur-free start-up process
  – Volatile mercury removal for over 21 years

• Continual process improvement …
  – Reduced maintenance costs 20-30% in past 6 years
  – Patented feed injector designs for longer run life
Chemicals from Coal – The Chemistry

Primary Reactions:

- $\text{CO} + \text{H}_2 \rightarrow \text{CH}_3\text{OH}$ (methanol)
- $\text{CH}_3\text{OH} + \text{CO} \rightarrow \text{CH}_3\text{COOH}$ (acetic acid)
- $\text{CH}_3\text{OH} + \text{CH}_3\text{COOH} \rightarrow \text{CH}_3\text{CO}_2\text{CH}_3$ (methyl acetate)
- $\text{CO} + \text{CH}_3\text{CO}_2\text{CH}_3 \rightarrow (\text{CH}_3\text{CO})_2\text{O}$ (acetic anhydride)
Total area, all operations, parking, Control room, shops, coal storage and unloading, etc = 32 Acres
Eastman Chemicals from Coal – The Big Picture

It’s likely you have used a product based on coal gasification from Eastman’s facility!

Several major products are single-sourced from Eastman's coal gasification process!! Thus, reliability is critical!!!
Reliable Gasification Operation

Yes, it can be done!

“The Devil is in the details.”
Eastman Operating Statistics
Three-Year Cycle (09/01 – 09/04) including planned shutdown

On-Stream 98.0%

Unplanned 1.2%
Not Needed 0.0%
Planned 0.8%

Industry-Leading Performance !!!
Eastman Operating Statistics
One-Year Cycle (Sept 2002 - Sept 2003)

On-Stream: 98.9%

- Planned: 0.0%
- Unplanned: 1.1%
- Not Needed: 0.0%
Sustained Low Forced Outage Rate

Forced Outage Rate has Averaged < 2% since 1984 !!!
Keys to High Reliability:

• Feedstock Characteristics and Operational Experience Incorporated into Design:
  • Every coal seam is different; petcoke is different than coal
  • Fluxant or no Fluxant?
  • Redundancy where needed based on reliability experience

• Effective Functional Checkout
  • Involving field operators where possible

• Training
  • Real-time DCS simulators (Eastman Simulator)
  • Effective training programs for both apprentices and experienced operators

• Standardized Operating Procedures and Checklists

• Maintenance Program
  • Efficient gasifier "turnaround" process is critical
  • Preventative and Predictive Maintenance Programs
Reliability-Based Maintenance

- Preventative/predictive mode
- Advanced monitoring tools utilized
- Data on individual equipment analyzed
- Equipment criticality rankings vs. reliability performance set the maintenance schedule
Safety

- Plantwide OSHA recordable injury rate ~ 1.0
  [Equates to one injury in over 15 years for a family of four!]
  [OSHA injuries = injuries that require more than minor 1st aid]
- Last gasification area work day out case was over 12 years ago (sprained ankle stepping off a curb)
- Plant site received Tennessee OSHA “Volunteer Star” safety certification in 2001
Eastman Environmental Performance

- Cleanest U.S. coal gasification facility.
- Sulfur removal is > 99.9% (with Rectisol); <0.1 ppm sulfur in our syngas.
- Eastman has a patented sulfur-free start-up process (no SO₂ from flare).
- Eastman has practiced essentially complete vapor-phase mercury removal from syngas since our initial plant start-up.
- Excellent environmental record and reputation.
Eastman will help gasifier owners get more out of their plants, including faster start-ups and improved long-term availability and reliability.

- World-class operational performance
- Intelligent design choices to limit capital costs
- Patented technology improvements
- Exceptional safety and environmental records
- Best partner for polygeneration options
Building on Past Success

Eastman Gasification Services Company
A subsidiary of Eastman Chemical Company

Service Offerings:

• Operations, maintenance, and management contracts
• Technical services
• Critical spare parts fabrication
• Specific technology licensing
• Cooperative services agreement with ChevronTexaco/GE
• Project development
Together we can realize the full potential of gasification!
QUESTIONS?

www.gasificationservices.eastman.com