Evolution of Black Liquor Gasifier Designs

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Outline

• Introduction
• History of BLG development
• Current BLG technologies
• Future of BLG
• Conclusions
Introduction – Future Industry Needs

- Eliminate Smelt-water Explosions
- Lower Capital Cost
- Lower Energy Use
- Lower Emissions
- Less Downtime
- Less Deadload
- Less Raw Material

Black Liquor Gasification

- Promising Advantages
  - More electricity per lb steam co-generated
  - New chemical recovery options
  - Higher availability
- Development & demonstration issues
  - Competitive system cost
  - Materials lifetime
  - Overall mill impact
Prehistory…

The First Black Liquor Gasifier?
(From a patent application by G.A. Richter, 1927)
First Chemicals Production from BL Syngas?
(From a patent by E.G Goodell, 1945)

First Application of Split Sulfidity?
(From a patent by W.L. Savell, 1951)
"Recent" BLG Development Efforts
(Underline = built pilot or demo facility, Bold = currently active)

- Low temperature
  - St. Regis*
  - Weyerhaeuser
  - Owens-Illinois
  - ABB*
  - KBR*
  - Copeland
  - SCA-Billerud*
  - Texaco*
  - VTT
  - B&W*
  - MTCI*
  - DARS

- High temperature
  - NSP*
  - U. California*
  - Paprican
  - Tampella*
  - B&W
  - Champion/Rockwell*
  - SKF
  - Ahlstrom
  - Noell
  - Chemrec*

Gasifier Design Categories

- High-pressure, hydro-thermal reactors
- Deconstructed/reengineered Tomlinson
- Molten salt reactors
- Bubbling beds
- Circulating fluidized beds
- Entrained flow reactors
St. Regis Hydropyrolysis Process
(~1967-1980)

Texaco Black Liquor Coking Process
(~1967-1974)
Champion/Rockwell Pilot Gasifier
(~1982-1988)

- Black liquor
- Product gas outlet
- Castable refractory
- Insulation
- Fuse cast alumina bricks
- Upper air nozzles (x6)
- Lower air nozzles (x6)
- Smelt withdrawal port
- Air nozzle and liquor drain port

B&W Bubbling-Bed Gasifier
(~1993-1998)
State of the Art: Bubbling Bed Design

Manufacturing Technology and Conversion International (MTCI)

Steam Reforming Process

State of the Art — MTCI

- Fluidized bed (bubbling)
- Low temperature (~600°C)
- Low pressure
- Steam for reaction / fluidizing
- Medium heating value fuel gas
  - 73% H₂
  - Approx. 13.3 MJ/Nm³
- Essentially all sulfur to gas as H₂S
MTCI Steam Reformer

MTCI System Configuration

Source: MT CI
State of the Art: Circulating Fluidized Bed

Kellogg, Brown and Root (KBR)

Transport and Spouting Bed Gasifiers
State of the Art — KBR

- Two fluidized bed reactor concepts
  - Transport reactor
  - Spouting bed
- Enriched air-blown
- Pressurized (>20 bar)
- "Medium temperature" (800–1000°C)
- Titanate addition
  - Allow operation at higher temperature
  - Effect direct causticization
- Medium heating value fuel gas (7–12 MJ/Nm³)
- Novel sulfur removal and recovery processes
KBR Conceptual Gasification Process

KBR Development Status

- Conceptual studies completed
- Initial pilot studies completed
  - 0.15 tds/day transport reactor test unit
  - Proof of concept successful
- Next stage of pilot testing planned
  - 2.4 tds/day transport reactor unit at UNDEERC
  - Verification of scale-up issues
- Titanate studies
  - Integrity and reactivity of low-attrition titanate
  - Leaching of Na from bed solids at high pressure
- Demonstration targeted for 2005-2008
SCA-Billerud Process
(~1958-1980)

Tampella Entrained-Flow Gasifier
(~1988-1993)
State of the Art: Entrained Flow Reactor

Chemrec

Entrained Flow Gasifier

State of the Art — Chemrec

- Entrained flow gasifier
- High temperature (~975°C)
- Two applications:
  - “Booster” system for capacity increase
  - “BLGCC” system to replace recovery boiler

More details in following presentation
The Future of BLG

• Continued interest in BLG is apparent
  – Pulp & paper industry
  – Utility suppliers
  – Oxygen suppliers
  
  Multi-party funding with government partners needed to overcome risk of first units

• Demonstration that “roadblocks” have been addressed
  – New Bern (refractory issues)
  – Big Island (carbon conversion)
  
  Success will accelerate development
The Future of BLG

• Demonstration of BLGCC / Tomlinson replacement capability
  – Performance / availability / economics
  – “First to market”
  ➢ Identification of favored technology

• Emergence of other BLG suppliers
  – BLG becomes more economically attractive
  – Improvements in BLG performance
  ➢ Competitive with Tomlinson in 15 years?

Conclusions

• Over 20 efforts to develop/commercialize BLG
  – 50/50 low/high temp
  – Mix of groups

• Currently 2 visibly active development efforts
  – MTCI
  – Chemrec

• Currently on brink of commercialization
  – MTCI involved in several commercial projects
  – Chemrec offering booster commercially
  – Chemrec progressing with BLGCC commercialization