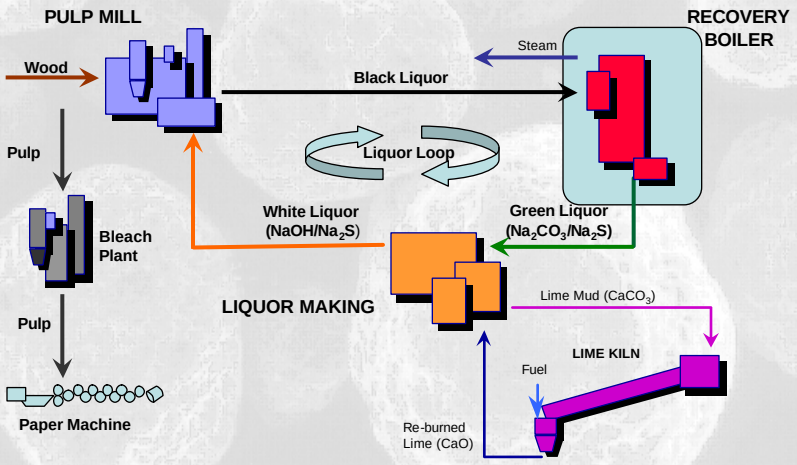
ExCo54 Doc 04.02

An Introduction to

Thermo Chem Recovery International

www.tri-inc.net

Pulp Mill – *Current Technology*



Thermo Chem Recovery International

World wide commercialization of proprietary technology for advanced chemical and energy recovery systems in the pulp and paper industry

- 21 years in development
- Over $30 million in R&D investment, grants and cost-sharing agreements with the U.S. Department of Energy, California Energy Commission, the Pulp and Paper Industry, U.S. Trade and Development Agency, National Labs
- Two commercial facilities in startup

What is …Biomass Steam Reforming?

It is NOT Combustion:

$$C + O_2 = CO_2 + Heat$$

$$H + O_2 = H_2O + Heat$$

What is …Biomass Steam Reforming?

- Medium temperature, atmospheric pressure exposure to steam in the absence of air or oxygen
- Organics are converted to hydrogen and carbon monoxide

$$H_2O + C + Heat = H_2 + CO$$

- Carbon Monoxide reacts with steam to form more hydrogen and carbon dioxide

$$CO + H_2O = H_2 + CO_2$$

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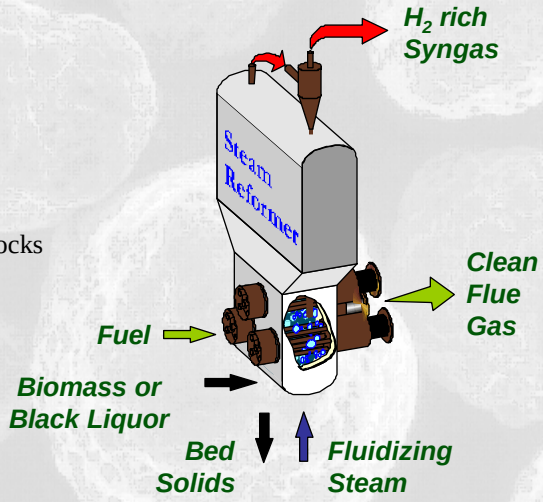
TRI's Technology

- Proprietary Technology
  - Unique application of steam reforming
  - PulseEnhanced™ combustion
- Converts Organic Feedstocks to a H_2 Rich Syngas
- Power Generation
- Production of Bio-based Fuels and Chemicals



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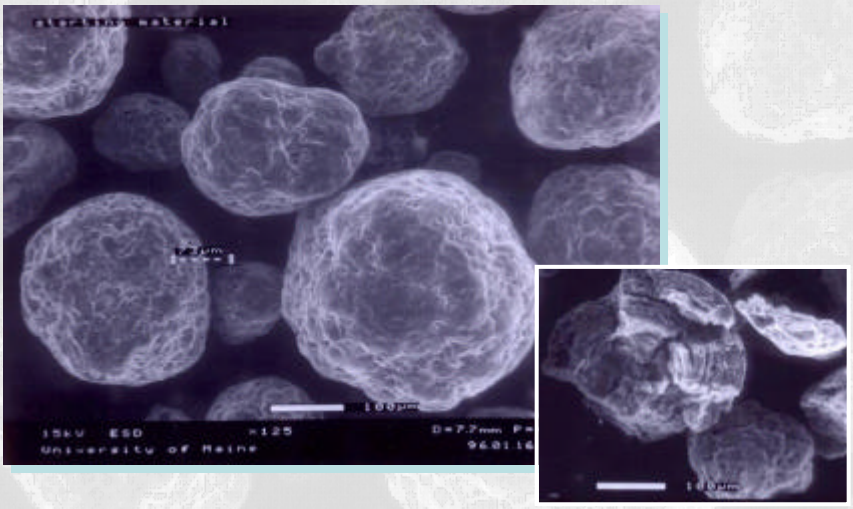
Reformer Bed Solids (Na_2CO_3)



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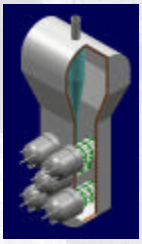
PulseEnhanced™ Steam Reformer

- Indirectly Heated
- Low Temperature
- No Air/No Oxygen
- Dry Inorganic Recovery
- High Residence Time
- Uniformity



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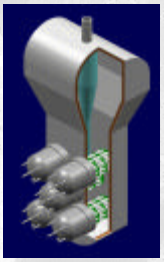
PulseEnhanced™ Steam Reforming

- H_2 - Rich Product Gas
- Low Emissions
- Additional Export Steam
- Elimination of Smelt/Eutectics
- Purging of NPEs
- Low Capital Cost
- Stable Operation
- Versatile Processing...



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Versatile Processing…. P&P

<u>Spent Liquors</u>
- Soda
- Kraft
- Sulfite
- Semi-Chemical
- Cross Recovery
- Silica-Laden Liquors

<u>Biomass</u>
- Sludge
- Hogged Bark
- Sawdust
- Wood Chips
- Pith

Pulsed Jet Heater

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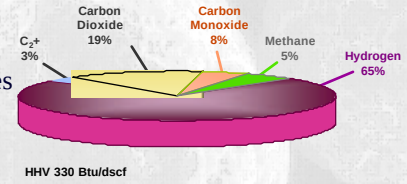
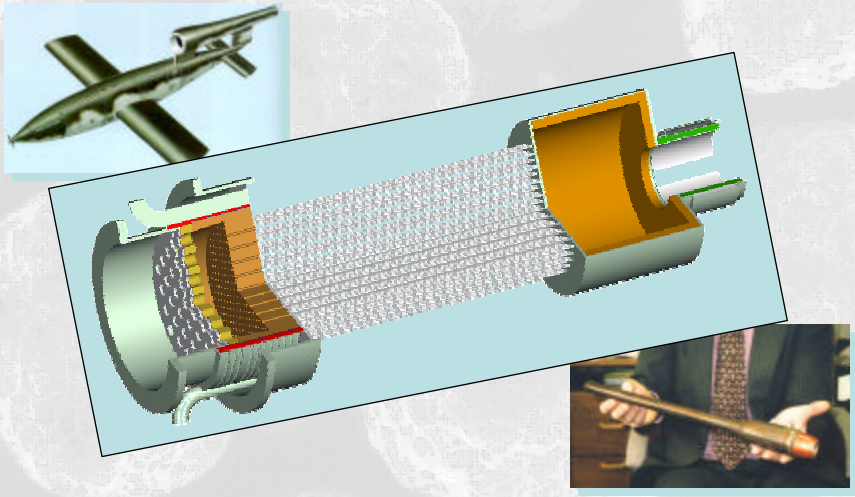
Versatile Syngas Production

H_2:CO Ratio can be varied to meet Process Requirements

- BL 8:1 to 2:1
  - High H_2 production for fuel cells
  - High energy fuel for combustion
- Biomass 2:1 to 0.5:1
  - Feed for Fischer-Tropsch processes
  - Feed for digester processes
  - Ethanol production



Pulsed Jet Heater Module



Pulsed Heater Operator Principle

1. Ignition

2. Expansion

3. Purge and Recharge

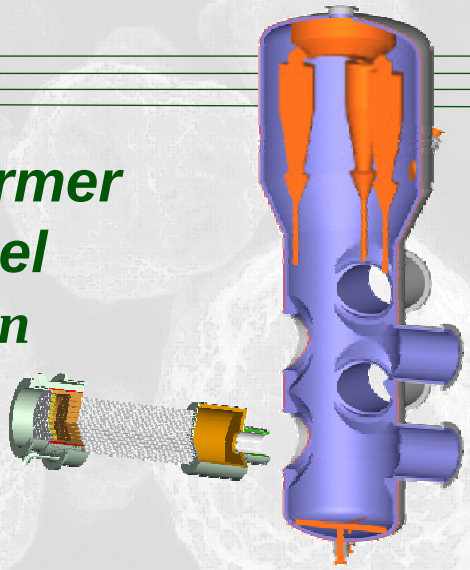
4. Compression

Pulsed Combustor - Components

Pulsed Jet Combustion - Advantages

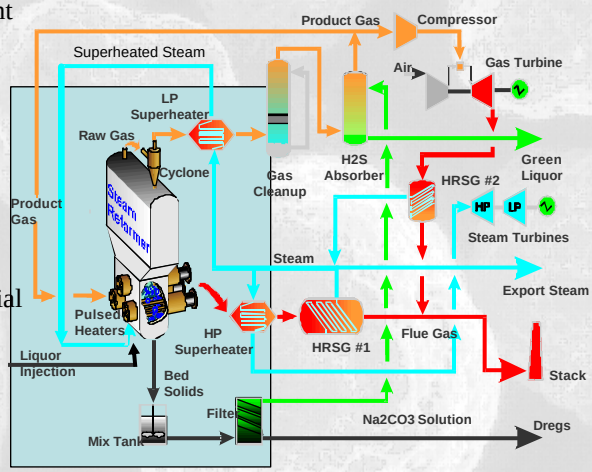
- Fuels Flexibility
- Enhanced Heat Transfer
- Uniform Heat Flux
- High Combustion Efficiency
- Low NO_X Emissions
- No Moving Parts
- Self Aspiration
- Pressure Boost

Reformer Vessel Design



TRI's Products

- Proprietary Equipment & Systems
  - Steam Reformer
  - Pulse Heaters
  - Steam Injection
  - Liquor Injection
- Ancillary systems
  - Cyclones
  - Superheaters
  - Bed Solids Material Handling & Dissolving
  - Green Liquor Filtering
- Process Design
- Technology License



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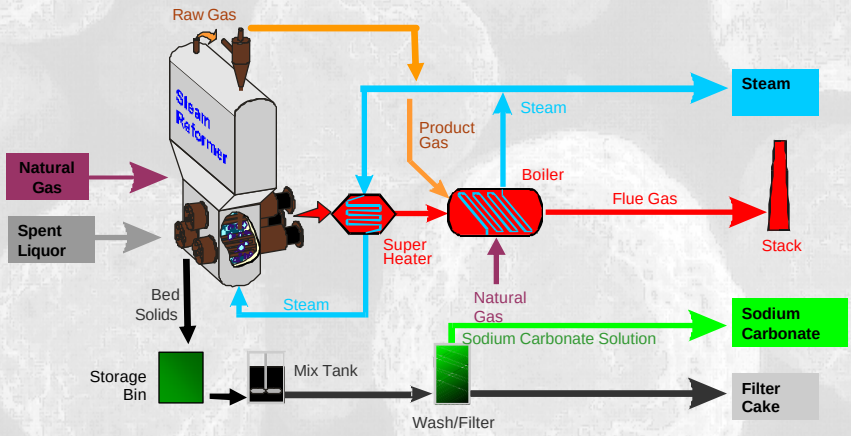
Norampac

- Norampac, Inc., a joint venture between Domtar and Cascade, is Canada's largest containerboard manufacturer
- Norampac currently has no recovery system; previously used black liquor as a binders on forestry roads
- StoneChem scope includes:
  - Steam Reformer
  - Pulse Combustors and Fuel Train
  - Detailed engineering and startup support
  - Materials handling equipment
  - Instrumentation

ThermoChem Recovery Int'l

Norampac



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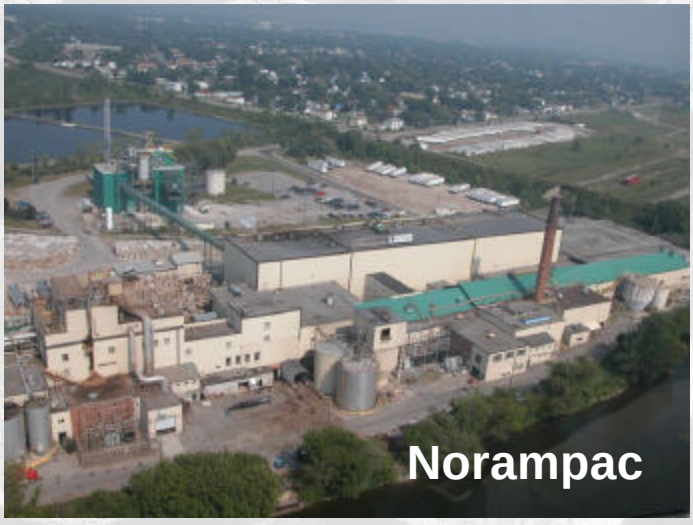
Steam Reformer Island



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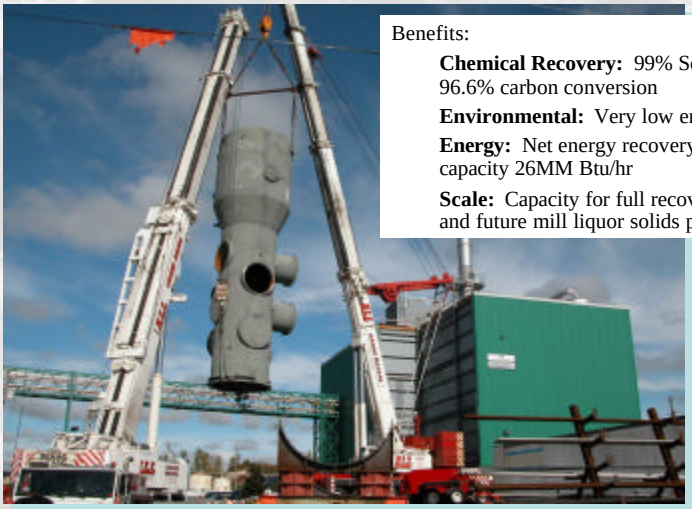
Norampac

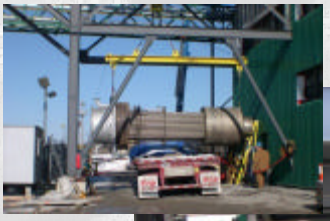


Benefits:

- **Chemical Recovery:** 99% Sodium recovery. 96.6% carbon conversion
- **Environmental:** Very low emissions
- **Energy:** Net energy recovery at design capacity 26MM Btu/hr
- **Scale:** Capacity for full recovery of current and future mill liquor solids production

Steam Reformer Building

Pulse Heater Installation



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Pulsed Heater In Operation

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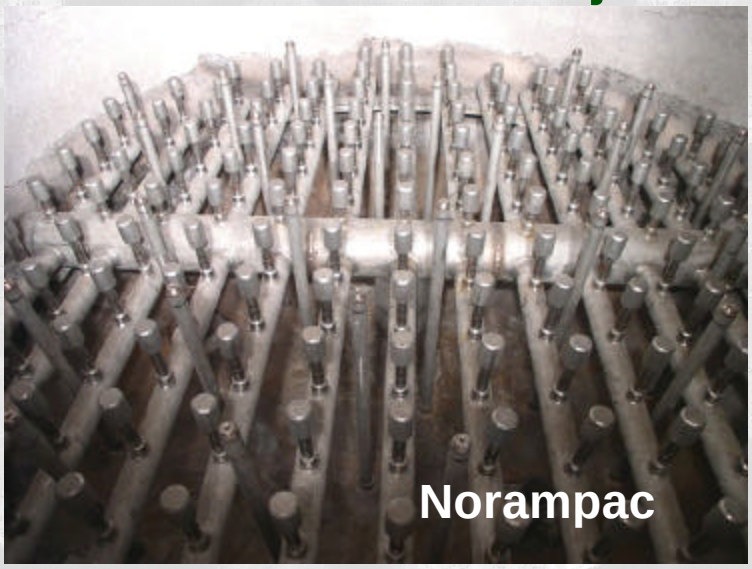
Pulse Heater Tubes in Reformer

Steam Distributor and Injectors

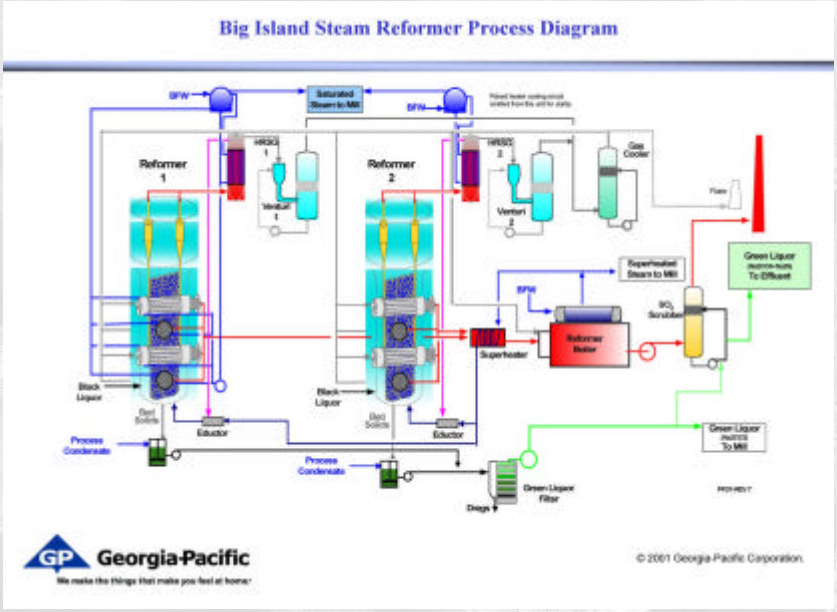


Norampac Startup Update

- Construction was completed and commissioning and Start-up begun in Sept. 03
- The reformer operated at essentially 100% availability from October through December of 03
  - System reliably recovered chemicals to meet pulp mill needs
  - Ancillary systems worked per design
  - Product gas fired in the boiler per design
  - Mill personnel assumed all operational responsibility
- The process was shutdown in January 04 to install process modifications
- The plant was re-started in May 04 and significant progress made against syngas production and throughput targets

Georgia-Pacific

- Containerboard mill in Big Island, Virginia
- Part of the "Agenda 2020" initiative and 50% funded by the U.S. Department of Energy
- Steam Reformers replace existing smelters and provide total chemical recovery for the mill
- Meets MACT environmental regulations
- Co-funded by DOE
- StoneChem scope :
  - Process design package for reformer system
  - 8 Pulse Combustion Heaters

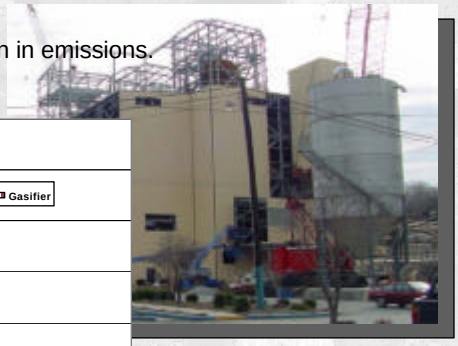


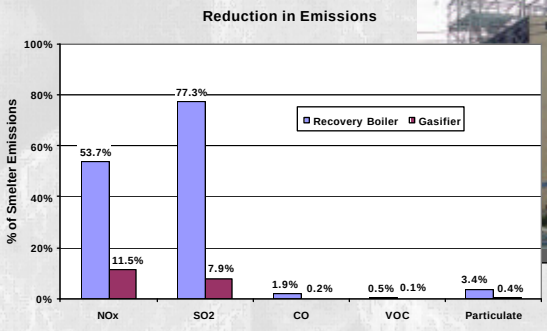
ThermoChem Recovery Int'l

Georgia-Pacific

Benefits:

- **Environmental:** 90% reduction in emissions.





- **Chemical Recovery:** Sodium recovery efficiency increase of 2%.
- **Pulp Yield and Quality:** Potential pulp yield increase of up to 5%.
- **Energy:** Use of non-renewable and fossil fuels will be reduced.

ThermoChem Recovery Int'l

Georgia-Pacific Startup Update

- Construction was completed in 4th quarter of 03 and commissioning was commenced in the 1st quarter of 04
- There were significant bed fluidization problems caused by incorrect steam distributor design.
- A cold flow model study was undertaken and a new distributor design was developed and installed.
- The system was then successfully started up and is currently in commissioning

TRI's Technology Benefits

- **Utilization of FP Industry's Biomass Resources**
  - Wide variety of Spent Liquors
  - Broad range of Biomass (Residuals to Sludge)
  - Host for other Biomass processing (agricultural waste to RDF)
- **Aging Recovery Assets & Technology**
  - Improved Energy production efficiency
  - Elimination of smelt/water explosions
  - Improved environmental performance
  - Cost effective capacity debottlenecking – incremental production
  - Enables advanced pulping technologies for increased fiber yields

Potential of *TRI's* Technology

Bio-Refinery of the Future

- Maximizes value of forest resources
- Utilizes other biomass resources
- Manufactures paper and wood products
- Manufactures bio-chemicals and fuels
- Exports electricity
- Provides compelling ROI
- Improves the environment