Metso Waste Gasification
Juhani Isaksson – Mesto power
Valtakunnalliset jätteen hyötykäyttöpäivät
19.11.2013 Lappeenranta
Metso Demerger

Two independent stock listed companies

**Metso**

Metso is a global supplier of technology and services to customers in the process industries, including mining, construction, pulp and paper, power, and oil and gas.

**October 1**
Approval from the Extraordinary General Meeting

By the end of 2013
Finalizing the demerger

**January 2014**
Listing of Valmet shares in the Helsinki Stock Exchange

**Valmet**

Valmet focuses on developing and supplying services and technologies especially for industries that use bio-based raw materials.

Metso and Valmet will continue to work closely together to offer winning automation solutions and services.

**Core customer industries:** mining, construction and oil and gas

Automation business is part of Metso
Power business line products

• Boilers
  - Fluidized bed boilers for combustion of biomass, recycled fuel and coal
  - Modularized power and heating plants
  - Oil and gas boilers and boiler plants
  - Recovery boilers for chemical recovery
• Evaporators
  - Evaporators for black liquor concentration
• Environmental protection systems
  - Air pollution control systems for the pulp and paper, and power generation industries
• Services
  - Rebuilds and upgrades
  - Maintenance
  - Spare parts
  - Accessory products
  - Partner Services
• New products and technologies
  - LignoBoost for lignin removal
  - AshLeach for reducing the harmful chemicals in fly ash
  - Biomass gasification to replace oil and natural gas
Metso Gasification
## Gasification technologies

### Position of Metso CFB gasification

<table>
<thead>
<tr>
<th>PRESSURE</th>
<th>OXIDISIER</th>
<th>PROCESS</th>
<th>ASH</th>
<th>FUEL</th>
<th>SIZE</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atmospheric</td>
<td>Air</td>
<td>Fixed bed</td>
<td>Slagging</td>
<td>Coal</td>
<td>SMALL 0 – 10 MW</td>
<td>Combustion engines</td>
</tr>
<tr>
<td>Pressurized</td>
<td>Oxygen</td>
<td>BFB</td>
<td>Non-slagging</td>
<td>Biofuel</td>
<td>MEDIUM 5-50 MW</td>
<td>Combustible gas for industrial furnaces</td>
</tr>
<tr>
<td>Steam</td>
<td>CFB</td>
<td>Entrained flow</td>
<td>Oil</td>
<td>LARGE 50 -200 MW</td>
<td>Fossil fuel replacement by bio/waste in power plants</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Plasma</td>
<td>Waste</td>
<td></td>
<td></td>
<td>IGCC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Flame gasification</td>
<td></td>
<td></td>
<td></td>
<td>Synthetic NG</td>
</tr>
</tbody>
</table>
# Metso’s CFB gasifier

<table>
<thead>
<tr>
<th>CFB Gasifier</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>20 – 300 MWth</td>
</tr>
<tr>
<td>Fuel</td>
<td>Biomass, waste</td>
</tr>
<tr>
<td>Gasification media</td>
<td>Air</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>750 – 900°C</td>
</tr>
<tr>
<td>Operating pressure</td>
<td>5-30 kPa(g)</td>
</tr>
<tr>
<td>Product gas heating value</td>
<td>3-7 MJ/nm³ (LHV)</td>
</tr>
</tbody>
</table>

![Diagram of CFB gasifier](image)
Metso gasification assortment

Product gas for industrial kilns
- Sawdust, forest residues, fresh wood, bark
- 20 – 150 MW\textsubscript{fuel} units
- Typically includes a dryer
- Dusty product gas
- Also other types of kilns possible

Product gas for power boilers
- Woody biomass, bark, peat, straw...
- Superior electricity efficiency
- (Existing) power boilers
- 50 – 300 MW\textsubscript{fuel} units
- Typically includes a dryer
- (Gas filtering)

Product gas from waste for power production
- Waste-derived fuel
- High electricity efficiency
- Typically a new gas boiler
- Gas filtering -> clean product gas
- 50 – 200 MW\textsubscript{fuel} units or multiple units connected to a boiler

Indirect gasification of biofuels
- Suitable for clean biofuels
- Suitable for cases HIGH HEATING VALUE GAS is needed (SNG, refinery feed motors)
Metso Waste Gasification
EU target is to maximize EfW efficiency

1. Grate 40 bar 400°C - Disposal
2. CFB with sand superheater 80 bar 500°C
3. Gasification with gas cleaning, efficiency > 30%

R1 > 0.65

Steam Temperature [°C]

Electrical Efficiency [%]

© Metso
High efficiency waste to energy
Lahti Energia, City of Lahti, Finland

- Green-field plant “Kymijärvi II”
- SRF 250 000 tn/a
- Metso’s delivery
  - 2 x 80 MW$_{th}$ gasifiers
  - Gas cooling and filtration
  - Gas boiler
  - SCR, dry APC
  - Plant automation
- Start up April 2012
- Total investment 160 M€
Unique way to solve corrosion
SRF gasification + gas cleaning + combustion + flue gas cleaning

- Gasify waste (SRF) at 850 – 900 °C
- Cool it down to about 400 °C
  - all corrosive components, alkalichlorides, Pb, Zn will be in solid form
- Filter dust out so the resulting gas is clean
- Burn clean gas in gas fired boiler (> 850 °C & 2 s)
- Capture mercury after the boiler
Benefits of waste gasification

- High steam parameters → higher efficiency
  - Lahti 160 MW fuel => 50 MWe + 90 MW district heat
  - Lahti 120 bar, 540 C live steam
  - Technology can offer even higher electricity efficiency

- Tolerance for fuel quality → multiple fuel sources
  - Lahti fuel: Household waste (origin sorted), Industrial waste, demolition wood, waste wood from industry

- No corrosive components in flue gas → less expensive materials in the boiler

1. Fuel handling
2. Gasifier
3. Gas cooling
4. Gas filter
5. Gas boiler and flue gas cleaning
Performance values are achieved
Commercial production since May 2012

- Design capacity reached
- Low parasitic load
- Fuel flexibility seen in practice
  - Forest residues
  - SRF
    - Demolition wood
    - Plastics
  - (Natural gas)
Low emissions proven
At stack (red. 11 % O2)

<table>
<thead>
<tr>
<th>Emission</th>
<th>Limit</th>
<th>Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOx</td>
<td>200 mg/m³</td>
<td>161 mg/m³</td>
</tr>
<tr>
<td>SO₂</td>
<td>50 mg/m³</td>
<td>7 mg/m³</td>
</tr>
<tr>
<td>CO</td>
<td>50 mg/m³</td>
<td>&lt; 2 mg/m³</td>
</tr>
<tr>
<td>Dust</td>
<td>10 mg/m³</td>
<td>&lt; 2 mg/m³</td>
</tr>
<tr>
<td>HCl</td>
<td>10 mg/m³</td>
<td>&lt; 1 mg/m³</td>
</tr>
<tr>
<td>HF</td>
<td>1 mg/m³</td>
<td>&lt; 0.5 mg/m³</td>
</tr>
<tr>
<td>TOC</td>
<td>10 mg/m³</td>
<td>&lt; 1 mg/m³</td>
</tr>
<tr>
<td>PCDD/F compounds</td>
<td>0.1 ng/m³</td>
<td>&lt; 0.002 ng/m³</td>
</tr>
<tr>
<td>Hg</td>
<td>0.05 mg/m³</td>
<td>&lt; 0.0001 mg/m³</td>
</tr>
<tr>
<td>Cd+Tl</td>
<td>0.05 mg/m³</td>
<td>&lt; 0.0003 mg/m³</td>
</tr>
<tr>
<td>Sb+As+Co+Cr+Cu+Mn+Ni+Pb+V</td>
<td>Total 0.5 mg/m³</td>
<td>&lt; 0.03 mg/m³</td>
</tr>
</tbody>
</table>

* NOx, SO₂, HCl are usually close to limit to minimize the cost of additives

Final emission control:
- DeNox – catalyst
- Sodiumbicarbonate injection
- Activated carbon injection
- Bag house
Stable operation in varying conditions

- Stable flame
  - No need for support fuel
  - Over 35% moisture content

- Excellent combustion
  - 2s, 850°C
  - Very low CO, with low O$_2$

- Process recovers from interruptions
  - Load changes
  - Fuel feeding blockages

- Reliable fluidization
  - No problems with sintering
Basic idea works - No corrosion detected

Gas cooler and boiler inspected

- **Gas cooler walls**
  - Smooth steel surface below fouling layer
  - Manufacturing tracks are still visible
  - Thicknesses measured after 4500h are the same than original ones

- **Gas boiler**
  - Smooth pipe surfaces
  - Manufacturing tracks are still visible
  - No visible marks of corrosion anywhere
  - Next measurement in spring
Metso Waste gasification

- Eligible for ACT ROC band
- WID compliant solution
- High net electrical efficiency
- Demonstrated at large scale
- Metso’s extensive gasification experience
- Ready for market