Industrial gasification demonstration plants by Metso

Finnish – Swedish Flame days
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Timo Honkola
Product manager, gasification
Metso CFB gasifier

Industrial experience

• Götavärken
  - Atmospheric CFB gasification
  - Värö project start-up 1987

• Tampella Power
  - 15 MWth pressurized FB gasifier and gas cleaning
  - Piloting ended 1996

• Metso BFB & CFB boilers
  - Fluid bed technology
  - Project execution resources

• New gasification development
  - Product gas filtration tests
  - Dryer technology
  - Own process dimensioning tools
Metso gasification offering

Product gas for industrial kilns
- Sawdust, forest residues, fresh wood, bark
- 20 – 80 MW_{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 – 150 MW_{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 – 100 MW_{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)
Lime kiln gasification process
Biomass drying and gasification
Applications for CFB gasifiers

Industrial kilns

- A lime kiln or other type of industrial kiln can be switched over to use gasified biomass
- In Värö, Sweden, at Södra Cell a Metso gasifier has been used since 1987
  ➞ Over 20 years of industrial experience and several test campaigns
- A dryer can be integrated if needed (flame temperature etc.)
- Gas cleaning can be used if needed for more sensitive processes
PC-boiler conversion
Vaskiluodon Voima Oy, City of Vaasa, Finland

- Substituting **coal for biomass**
- 140 MW\(_{th}\) biomass gasifier
- Gasifier adjoined to an existing coal-fired boiler (560 MW\(_{th}\))
- Gasification plant operational 12/2012
- Vaskiluodon Voima’s total investment < 40 MEUR
Main project drivers

Main drivers for the project:

- To replace large amount (25-40%) of coal with renewable CO2-neutral fuel.
  - The gasification plant will be run on full capacity and coal firing will be reduced on boiler part loads.

- To extend the lifetime of the existing power plant unit

- To achieve capability to use multiple fuels (fuel cost optimization)

- To guarantee a cost-effective district heating solution
Applications for CFB gasifiers

Vaskiluodon Voima – Gasifier

- CFB Gasifier
  - O.D. ~6 m
  - Height ~36 m
- Bed material
  - sand
- 2 fuel feeding lines
- 2 bottom ash screws
- The largest CFB-gasifier for biomass fuels in the world
  - 140 MW<sub>th</sub>
Applications for CFB gasifiers
Vaskiluodon Voima – Scope

- Metso’s scope
  - Fuel receiving and handling
  - Drying
  - Gasification
  - Boiler modifications
  - Automation, electrification and instrumentation

- Wet biomass
- Instrumentation, electrification and automation
- Large-scale belt dryer
- Dried biomass
- CFB gasifier 140 MW_{fuel}
- Existing PC boiler

Biomass receiving and pre-handling
Operation experiences

- There has been no instabilities in the boiler evaporator.

- NOx-emission level has been under the limits of environmental permit (500 mg/m3(n)) – after the modification the emission level is around 350 mg/m3 and has been around 400 mg/m3 last year.

- The warranty values are likely to be fulfilled. Warranty tests will be carried out in March 2013.

- The dyer has functioned fine. We have seen that investment quite successful also because biofuels have been abnormal wet this year.

- The potential risk of the hot corrosion of the superheaters was noticed and therefore a theoretical study was made by Metso. As a result it was decided to keep the rate of biofuel always under the rate of coal.
Project experiences

- Total project costs seems to stay in the frames of the budget

- Installation time:
  - The time schedule was very tight. That pressed final installation work to late autumn and made the test running period quite challenging.
  - Even so, the boiler modifications were made as planned during 5 weeks’ outage.
  - The site safety was organised fine and there was only one minor accident on site.

- Test run:
  - Only minor effects on PC-boiler operation, no boiler trips – great!
  - The fuel unloading pockets were designed with high separating walls and some types of trucks have had difficulties to operate between those walls.
  - In the fuel sampling system there has been jamming with wet and cold peat.
  - Temperature differences on the body material of air heaters have caused distortion and damaged bellows of the gas ducts.
In operation with biomass over 1000h
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

1. Fuel handling
2. Gasifier
3. Gas cooling
4. Gas filter
5. Gas boiler and flue gas cleaning
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
Commerical production since may 2012

• Design capacity reached
• Low parasitic load
• Fuel flexibility seen in practise
  - Forest residues
  - SRF
    • Demolition wood
    • Plastics
  - (Natural gas)
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 O₂

- 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
Development based on practical application

Plenty of measurement campaigns done in Lahti

• With bio fuel & waste-derived fuel

• Analyzed items
  - Fuel
  - Product gas & tar
  - Bottom, hot filter, fly ash
  - Emissions
  - Fouling and corrosion probes

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<th></th>
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Lahti Energia - Kymijärvi II
OPERATION WITH SRF OVER 6000h
GoBiGas – Project

Production: ~20 MW Bio Methane of wood pellets

Investor: Göteborgs Energi AB

Overall total cost about 100 MEUR

Schedule: In operation 2013

Gasification & Boiler Island: Metso Power

Methanation technology: Haldor Topsöe

EPCM for Methanation: Jacobs process

Source: Göteborg Energi
Indirect Gasification in Dual Fluidized Bed

- Fuel is feed to the BFB gasifier
- The gasifier is fluidized with steam
- Char in fly and bottom ash from the gasifier is burnt in the combustor riser
- Bed material is circulated to transport heat from the combustor to the gasifier
- Fly ash from the combustion is recirculated to the gasifier
GoBiGas process

Gasification: Metso scope

- Forest residues
  - Dryer
  - Fuel handling
  - Gasifier
  - Tar removal

- Wood pellets
  - Steam
  - Combustor
  - Air preheater
  - Air
  - Sulphur rich gas

- Flue gas
  - CO2 to inert gas system/atm

- Hot water
  - Bag filter De-NOx

Methanation

- Tar removal
- Sulphur removal
- Shift
- CO2 removal
- Biomethane
- Steam
- Drying Upgrading
- Methanation
- CO2 to inert gas system/atm

Source: GoBiGas
Cold commissioning ongoing
Thank You