MSW incineration: from waste processing to combined heat and power production

Bram Verbinnen, Jo Van Caneghem
KU Leuven, Campus Group T

Johan De Greef
Keppel Seghers Belgium NV

Bram.Verbinnen@kuleuven.be
Evolution of MSW treatment

Landfill

Waste incineration

WtE as CHP

Waste-to-Energy

KU LEUVEN
Energy from waste

- Energy from waste
  - Electricity
  - Heat, e.g. district heating
  - Steam

- Energy efficiency dependent on:
  - Calorific value of the waste
  - Heterogeneity of the waste
  - Chemical complexity of the combustion gases
  - Legal requirements
WtE as CHP

• Not straightforward

• Challenges:
  o General energetic optimization of the process
  o Design and operational challenges for WtE as CHP
    • Annual waste throughput
    • Plant availability
    • Plant operation: flexibility vs. continuity
    • Stability of energy supply
General energetic optimization

- **Optimization of process control**
  - Automated waste feeding, air management, grate movement
  - Energetic content of the waste released in most stable way possible
  - Stable flue gas conditions

- **Lowering of excess oxygen**
  - To avoid excessive cooling
  - > 5v% at boiler outlet!
General energetic optimization

• **Internal recycling of process heat**
  - Primary/secondary combustion air preheating

• **Recovery of low-temperature heat**
  - Flue gas $T >$ dewpoint acids

• **Increase of boiler steam parameters**
  - Need for costly extra protective measures

→ Up to 10% improvement of electrical efficiency
→ Increase of R1 value above limit value of 0.60
Design and operational challenges for WtE as CHP

• **Annual waste throughput**
  
  o **Needs to be ensured continuously**
  
  o **Also when no steam required by customer**
    • Send additional steam to a turbine
    • Send excess heat to buffering heat network
  
  o **Needs to be incorporated in design waste-fuelled CHP plant**
Design and operational challenges for WtE as CHP

• **Plant availability**

• **Customers:**
  - Chemical industry, paper mills, large greenhouses, district heating, 24/7 operation
  - Require steam 100% of the time, typical WtE availability 90-95%

• **Extend operation period between shutdowns**
  - Redundant equipment, additional on-line boiler cleaning, more frequent technical inspections and small reparations

• **Anticipate alternate downtimes of the WtE process lines**
Design and operational challenges for WtE as CHP

- **Plant operation: flexibility versus continuity**

- Different customers have different steam demands
  - Chemical industry vs. small paper mill vs. district heating

- Complex design of Rankine cycles
Design and operational challenges for WtE as CHP

- **Stability of energy supply**

- Steam stability dependent on definition
  - Standard deviation from process value
  - Average of deviation of the process value from setpoint
WtE as CHP

• Examples
  o Great Manchester Waste Disposal, Runcorn, UK
    • 17 bar steam to INOVYN + electricity, total plant efficiency 48%
  o Indaver site, Beveren, Belgium, Ecluse project
    • Steam network + electricity, total plant efficiency ± 50%
  o Attero site, Moerdijk, The Netherlands
    • 100 bar, 400°C steam to Essent→Shell, total plant efficiency 85%
Conclusions

• Electrical energy efficiency of WtE plants is low due to properties inherent to waste
• Nowadays integration in CHP schemes
• 3x increase of energy efficiency compared to stand-alone
• Tailored design to integrate WtE in CHP schemes, to meet criteria:
  o High yearly availability
  o A stable steam supply
  o Cope with variable/seasonal demand
  o Different types of energy to multiple energy consumers
Thank you for your attention!

Bram.verbinnen@kuleuven.be

www.kuleuven.be/chemarts