INDUSTRIAL INSTALLATION AND TESTING OF AN INNOVATIVE CATALYST SYSTEM FOR NOx REMOVAL IN WTE UNITS
Brescia - Ancient city

Historical centre

Augustus emperor Capitolium 70 A.D

Brescia - Ancient city
COMPANY OVERVIEW (2005 data)

- Electricity: 2,710 Gwh
  - Generation
  - W.T.E.
  - Transmission
  - Distribution
  - Trading
  - Sale
  - Public Lighting

- District heating: 1,159 Gwh
  - Generation
  - Distribution
  - Sale

- Gas: 779 Mm3
  - Import
  - Transmission
  - Distribution
  - Sale

- Water: 89,8 Mm3
  - Sourcing
  - Distribution
  - Sewage
  - Sewage treatment

- Waste Management: 1,193 Mt
  - Collection
  - Street cleaning
  - Disposal
ASM Spa

- **Share holding utility**

- **Since July 2002 listed in Milan stock exchange**

- **69 % of shares owned by Brescia municipality (200,000 inhab.)**

- **Employees nr.:** 2100

- **Revenues (year 2005):** 1,672 M€
OPERATIONS DATA 2005

Treated waste
757,000 tons
(of which biomass 290,000 tons)

Electricity production (net)
510 GWh\textsubscript{el}

District heating
491 GWh\textsubscript{th}

Fossil fuels saving (Tons of Oil Equivalent)
> 150,000 TOE

CO\textsubscript{2} avoided emissions
> 400,000 tons
DISTRICT HEATING SYSTEM OF BRESCIA
(Dec, 31st 2005)

523 km of double pipe
>130,000 inhabitants supplied
36.5 Mm³ heated buildings
15,110 connected buildings
695 MWth
223 MWel
TERMOUTILIZZATORE  
(The waste to energy plant of Brescia)

MAIN DATA

- Heat capacity of treated waste (3 boilers)  
  \[2 \times 88.3 + 1 \times 100 = 276 \text{ MW}_{\text{waste}}\]

- Waste throughput  \[3 \times 33 \text{ t/h}\]

- Electric generation capacity  \[75 \text{ MW}_{\text{el}}\]

- Heat generation capacity  \[160 \text{ MW}_{\text{th}}\]

- INVESTMENT  \[300 \text{ M€}\]

- Waste disposal fee  \[65 \text{ €/t}\]

- ISO 14001 Environmental certification in april 2006
TERMOUTILIZZATORE
(The waste to energy plant of Brescia)
NOx CONTROL METHODS

• PRIMARY (NOx prevention)
  - staged combustion (gradual O₂ supply)
  - combustion temperature control

• SECONDARY (NOx reduction)
  - SNCR (Selective Non-Catalytic Reduction)
  - SCR (Selective Catalytic Reduction):
    - “Tail-end” (after gas cleaning)
    - “Low dust” (after gas de-dusting)
    - “High dust” (on raw gas)
IMPLEMENTED NOx CONTROL IN BRESCIA WTE
(since 1998)

• PRIMARY
  - low combustion excess air
  - 30 compartment grate
  - infrared camera for optimization of primary and secondary air supply
  - flue gas recirculation
  - combustion air preheating

• SECONDARY (NOx reduction)
  - SNCR (NH$_3$ injection with 27 nozzles, positioned at three levels)
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SNCR DENOX SYSTEM

SNCR

Fabric filter

Aqueous ammonia

FLUE GAS RECIRCULATION
TERMOUTILIZZATORE
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FLUE GAS CLEANING
# TERMOUTILIZZATORE
(The waste to energy plant of Brescia)

## STACK EMISSIONS

<table>
<thead>
<tr>
<th></th>
<th>PLANT AUTHORIZATION LIMITS</th>
<th>PLANT DESIGN DATA</th>
<th>EUROPEAN UNION LIMITS</th>
<th>ACTUAL OPERATION DATA</th>
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<td>All values in mg/Nm³ (except for Dioxin - ng/Nm³)</td>
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<td>Values referred to dry gas, normal conditions, 11 % O₂</td>
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<td>Particulate matter</td>
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<td>Mercury (Hg)</td>
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<td>PAH ( Policyclic aromatic hydrocarbon)</td>
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SCR system downstream of a non-wet Flue Gas Treatment showing heat exchange and temperature profiles
TERMOUTILIZZATORE
(The waste to energy plant of Brescia)

INSTALLATION AND TESTING OF A SCR “HIGH DUST” SYSTEM
(non industrially available yet)

GOALS:

- further NOx reduction
- ammonia slip improvement
- lowering ammonia consumption
- keep high energy plant efficiency
SCR “HIGH DUST” SYSTEM
(non industrially available yet)

PROBLEMS:
- catalyst clogging
- catalyst poisoning

ADVANTAGES:
- much higher energy efficiency (no need of gas reheating and lower gas pressure losses)
- simpler installation
- lower investment and operating cost
The "NextGenBioWaste" Project

"Innovative demonstrations for the next generation of biomass and waste combustion plants for energy recovery and renewable electricity production"

• Funded by the European Commission (6th Framework Research Program)
• Project duration: 2006-2010 (48 months)
• Budget: 29 M€
NextGenBioWaste Project
(Consortium: 17 partners from 7 countries)

Co-ordinator:
SINTEF Energiforskning AS (NO)

Partners:
- Afval Energie Bedrijf, Amsterdam (NL)
- ASM BRESCIA SPA (IT) (16% share – 4.5 M€ SCR HD)
- Gemeinschaftskraftwerk Schweinfurt GmbH (DE)
- Joint Research Centre of the EC (NL)
- KEMA (NL)
- Max-Planck-Institute (DE)
- N.V. Afvalverwerking Rijnmond (NL)
- SEGHERS Keppel Technology Group (BE)
- SINTEF Energiforskning AS (NO)
- SVUM, a.s., Prague (CZ)
- TNO (NL)
- Trondheim Energiverk Fjernvarme AS (NO)
- Vattenfall AB Business unit Nordic Heat (SE)
- Vattenfall Europe Waste to Energy GmbH (DE)
- Vattenfall Power Consultant AB (SE)
- Vattenfall Utveckling AB (SE)
- Visser & Smit Hanab (NL)
HIGH DUST SCR LOCATION

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(The waste to energy plant of Brescia)
TERMOUTILIZZATORE
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SPACE FOR SCR HIGH DUST INSTALLATION
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HIGH DUST SCR LAYOUT

CATALYST LAYER
(SPACE FOR UP TO 5 LAYERS)

MIXER

DAMPERS

NOx

FLUE GAS
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SCR “HIGH DUST”

FIRST TEST RESULTS

• operation: started 2006 Mar. (1st phase – one cat. layer)
• inspection: 2006 Sep.
• 2nd phase: started 2006 Oct.
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HIGH DUST SCR RESULTS  (1 LAYER)

SCR Catalyst Effect

Reduction:
~ 31 mg/Nm³
= 40%

NO (as NO₂) [mg/Nm³]

NO before cat.
NO after cat.


Antonio Bonomo – WTERT 2006.10.19
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HIGH DUST SCR RESULTS (1 LAYER)

Start of the test

NOx – NH3 consumption – ammonia slip

NH3 slip
NOx
NH3 consumption [l/h]
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HIGH DUST SCR RESULTS  (1 LAYER)

SCR Catalyst Pressure Loss

~ 0.35 mbar

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CATALYST AFTER 5 MONTHS OF OPERATION
1 SCR LAYER (5 months operation):

- NOx: 80 → ~50 mg/Nm³
- NH₃ slip: 12 → 4 - 8 mg/Nm³
- NH₃ consumption: 0.22 → 0.18 m³/h (25% concentrated)

2 SCR LAYER (2 weeks operation – very preliminary!):

- NOx: → ~40 mg/Nm³
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HIGH DUST SCR


- monitoring of fouling and activity of catalyst
- optimization of catalyst layout (single / multiple layers)
- optimization of dust cleaning
- testing of different NH₃ injection points
- testing of NH₃ air vs. water injection
- lifetime assessment of the catalyst
- industrial cost evaluation