WTERT 2006 Annual Meeting At Columbia University

New York, Oct 19-20th, 2006

INDUSTRIAL INSTALLATION AND TESTING OF AN INNOVATIVE CATALYST SYSTEM FOR NOx REMOVAL IN WTE UNITS

Antonio Bonomo
Director, Energy Division
ASM Spa
Brescia - Italy

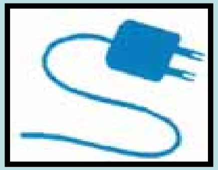
Historical centre

Augustus emperor Capitolium 70 A.D

Brescia - Ancient city

ASM Spa

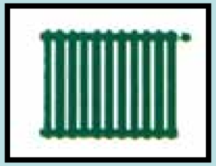
COMPANY OVERVIEW (2005 data)



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€

TERMOUTILIZZATORE
(The waste to energy plant of Brescia)

OPERATIONS DATA 2005

Treated waste (of which biomass 290.000 tons)	757,000	tons
Electricity production (net)	510	Gwh_{el}
District heating	491	Gwh_{th}
Fossil fuels saving (Tons of Oil Equivalent)	> 150,000	TOE
CO_2 avoided emissions	> 400,000	tons

DISTRICT HEATING SYSTEM OF BRESCIA

(Dec, 31st 2005)

523 km of double pipe

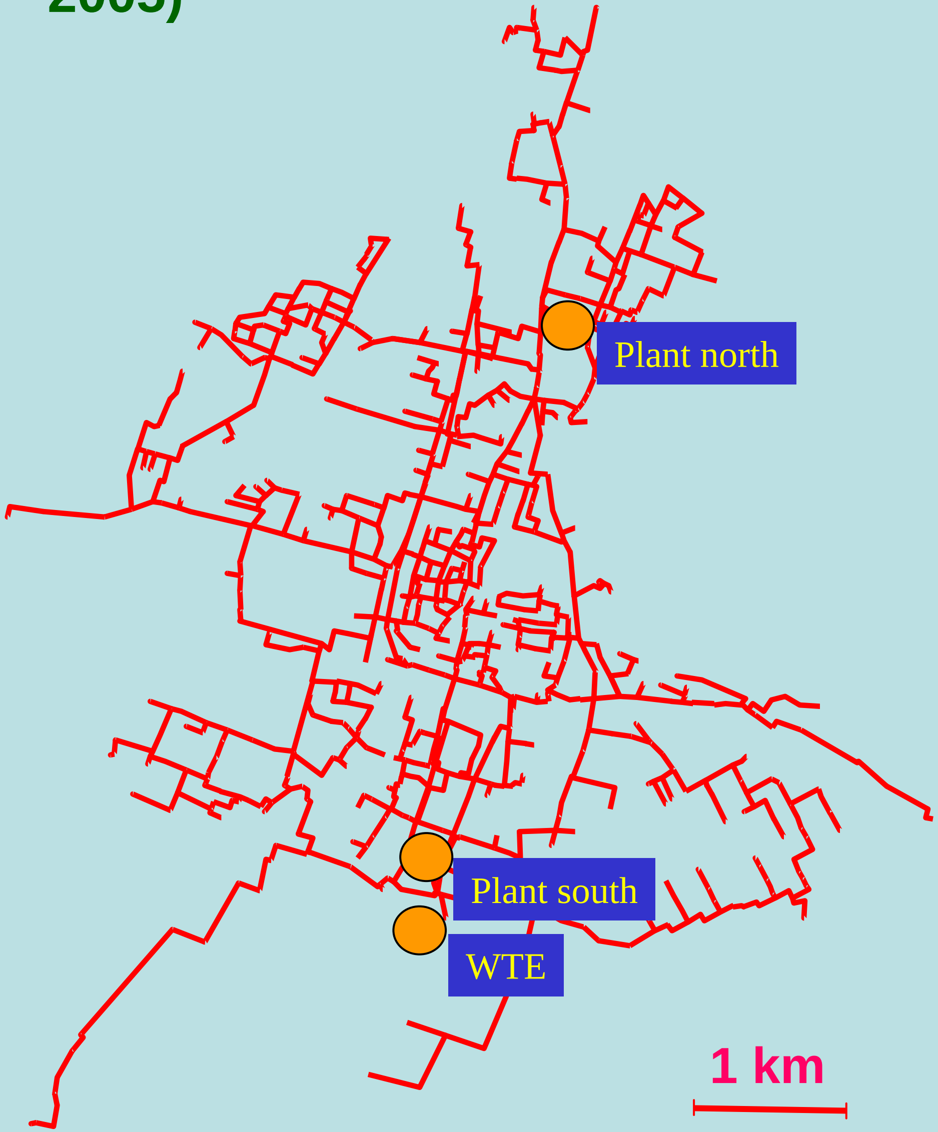
>130,000 inhabitants supplied

36.5 Mm^3 heated buildings

15,110 connected buildings

695 MW_{th}

223 MW_{el}



TERMOUTILIZZATORE
(The waste to energy plant of Brescia)

MAIN DATA

• Heat capacity of treated waste (3 boilers) 2 x 88,3 + 1 x 100 =	276	MW_{waste}
• Waste throughput	3 x 33	t/h
• Electric generation capacity	75	MW_{el}
• Heat generation capacity	160	MW_{th}
• INVESTMENT	300	M€
• Waste disposal fee	65	€/t

- ISO 14001 Environmental certification in april 2006

TERMOUTILIZZATORE
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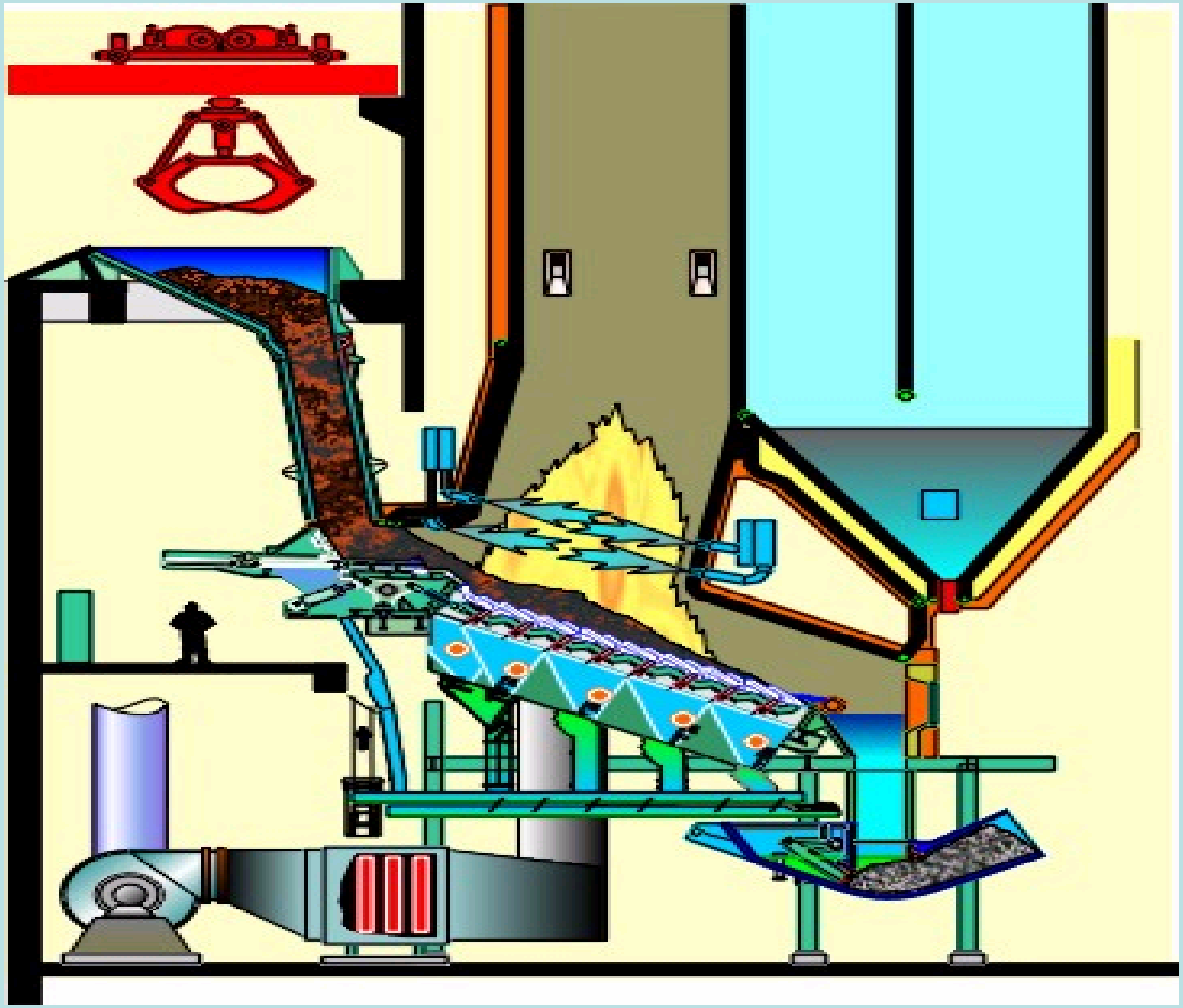

COMBUSTION SYSTEM

NOx CONTROL METHODS

- **PRIMARY (NOx prevention)**

  - **staged combustion (gradual O_2 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)

TERMOUTILIZZATORE
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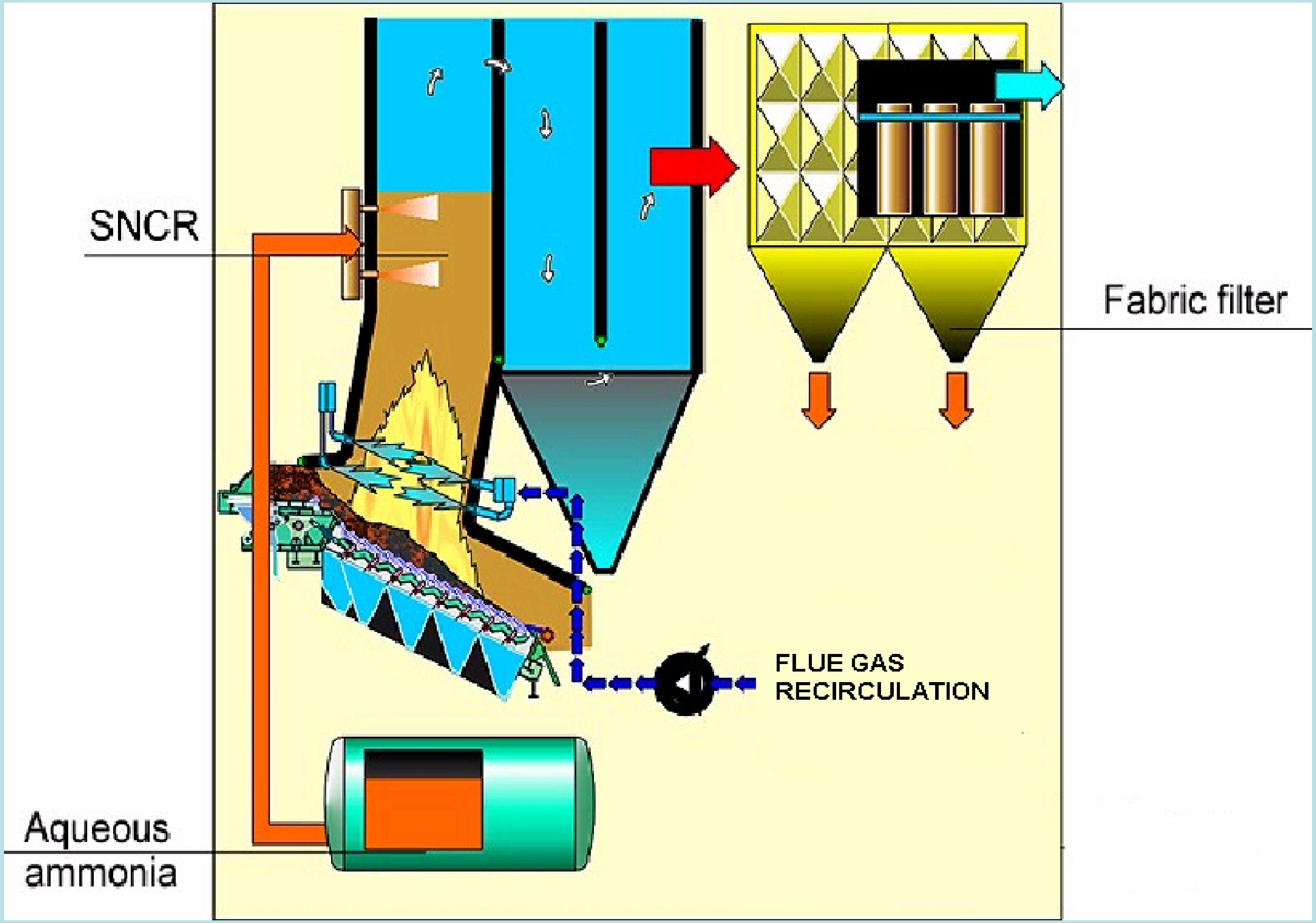
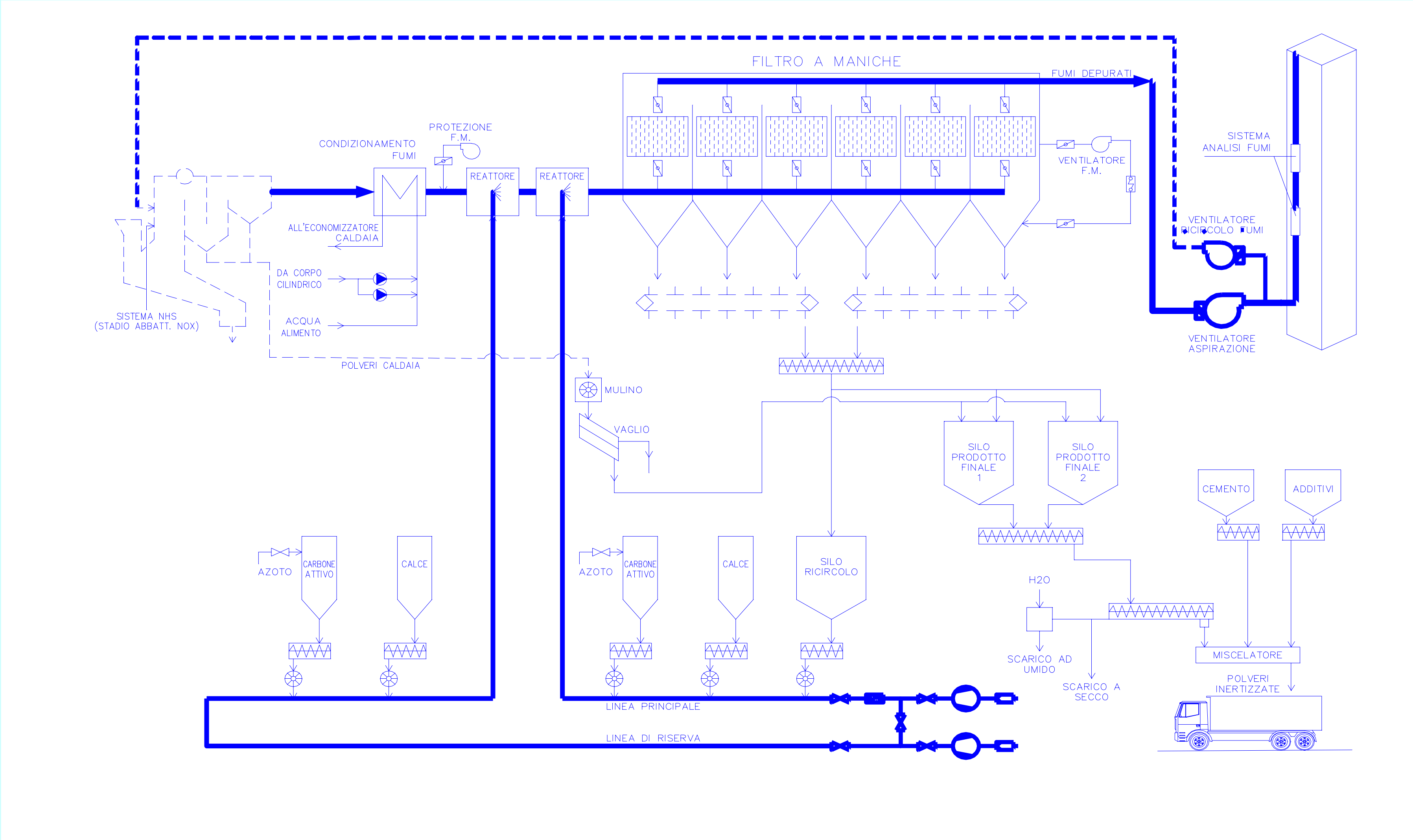


SNCR DENOX SYSTEM

TERMOUTILIZZATORE
(The waste to energy plant of Brescia)



FLUE GAS CLEANING

TERMOUTILIZZATORE

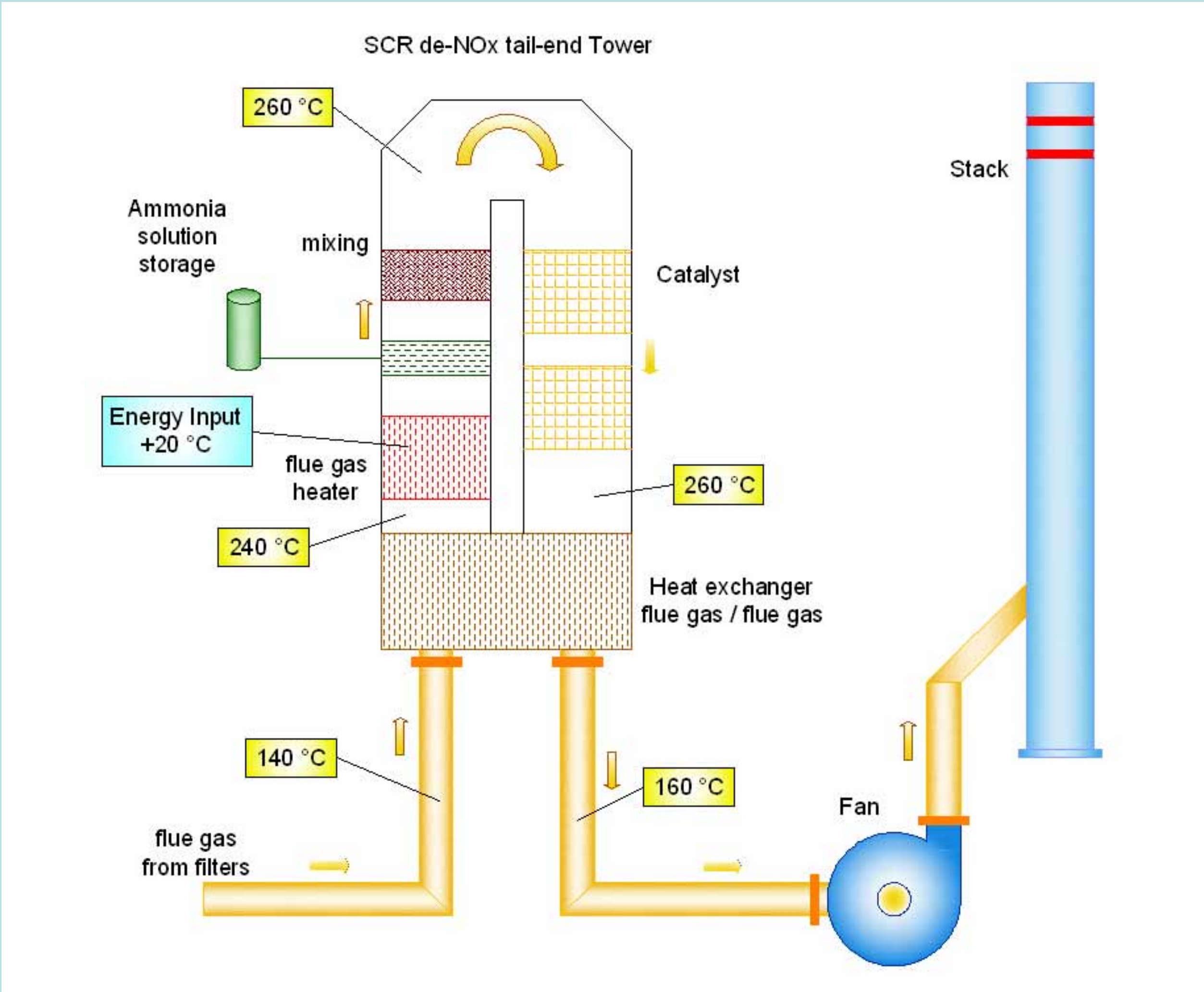
(The waste to energy plant of Brescia)

STACK EMISSIONS

All values in mg/Nm3 (except for Dioxin - ng/Nm3) Values referred to dry gas, normal conditions, 11 % O2	PLANT AUTHORIZATION LIMITS 1993	PLANT DESIGN DATA 1994	EUROPEAN UNION LIMITS 2000	ACTUAL OPERATION DATA 2005
Particulate matter	10	3	10	0,4
Suplhure doxide	150	40	50	6,5
Nitrogen oxides (NOx)	200	100	200	<80
Chlorine acid (HCl)	30	20	10	3,5
Fluorine acid (HF)	1	1	1	0,1
Carbon monoxide	100	40	50	15
Heavy metals	2	0,5	0,5	0,01
Cadmium (Cd)	0,1	0,02	0,05	0,002
Mercury (Hg)	0,1	0,02	0,05	0,002
PAH (Policyclic aromatic hydrocarbon)	0,05	0,01	-	0,00001
Dioxin (TCDD Teq) ng/Nm3	0,1	0,1	0,1	0,002

TYPICAL SCR TAIL-END SOLUTION

(industrially available)



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

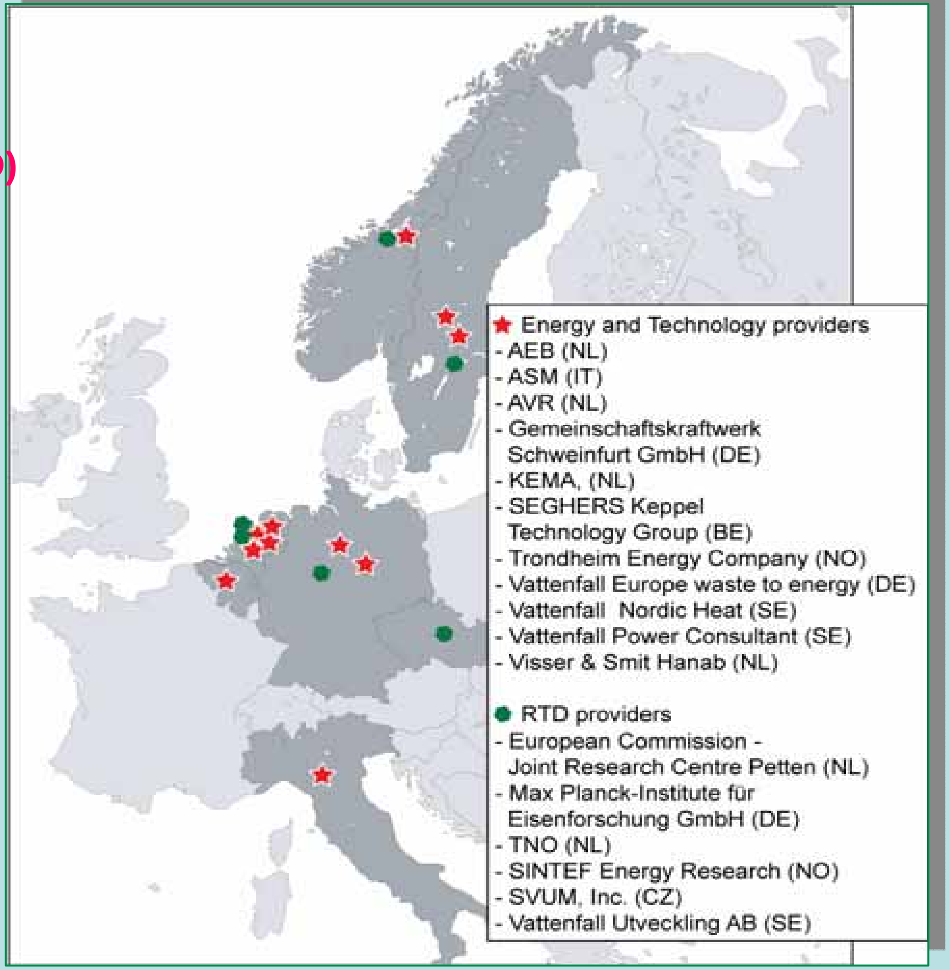
(Consortium : 17 partners from 7 countries)

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)

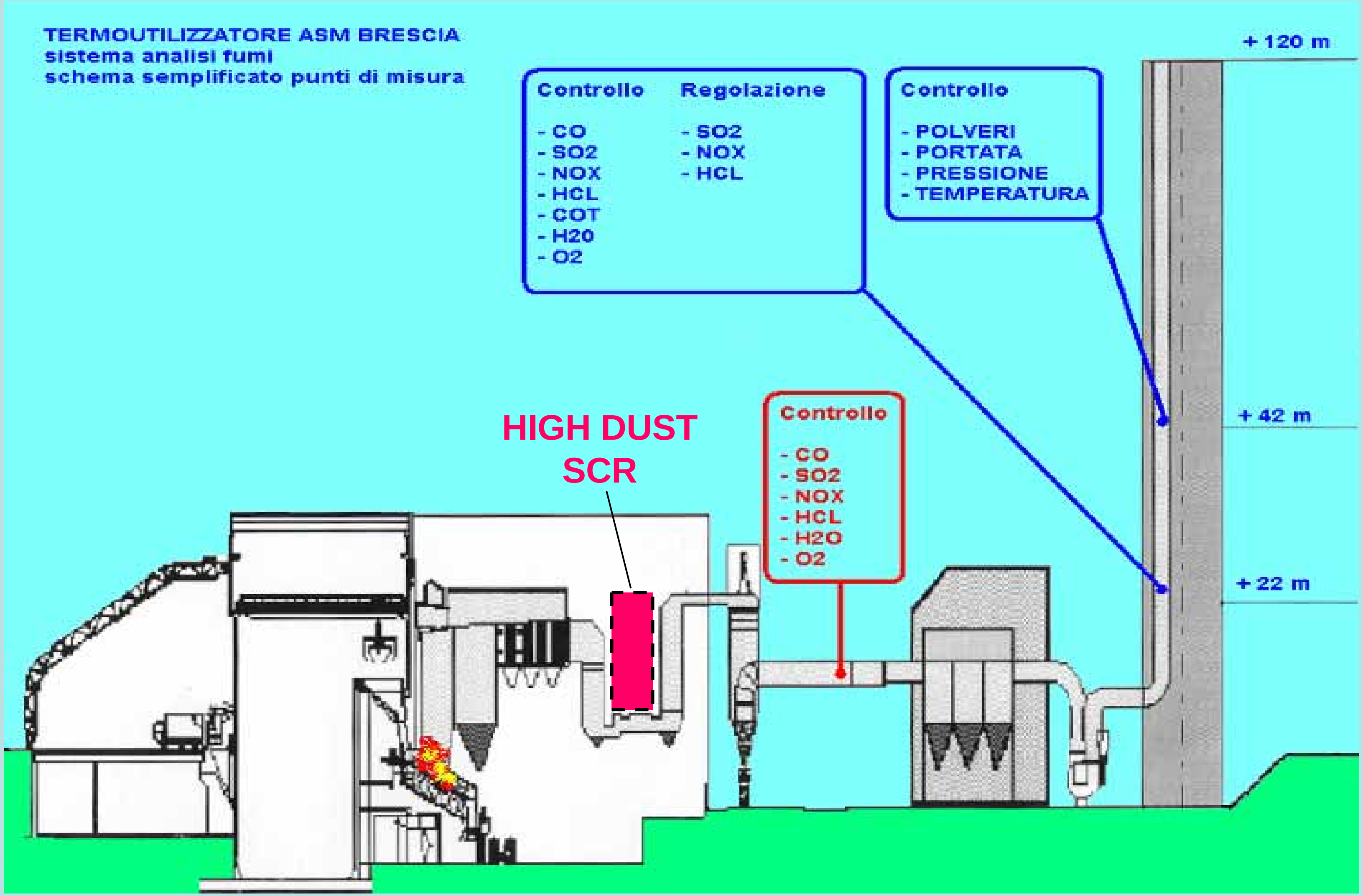


NextGenBioWaste

FUNDED BY THE EUROPEAN UNION

SIXTH FRAMEWORK PROGRAMME

TERMOUTILIZZATORE
(The waste to energy plant of Brescia)

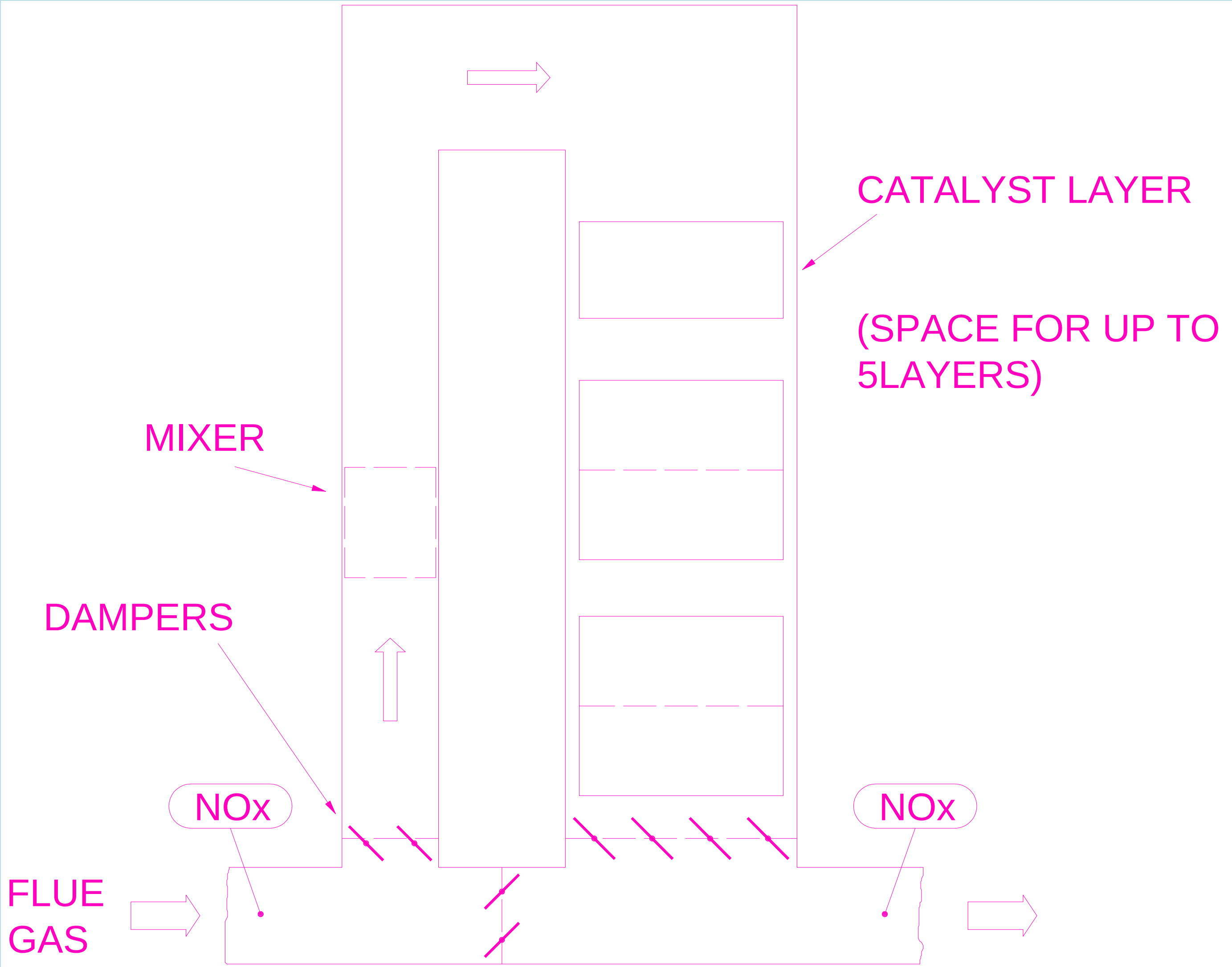


HIGH DUST SCR LOCATION

TERMOUTILIZZATORE
(The waste to energy plant of Brescia)

SPACE FOR SCR HIGH DUST INSTALLATION

TERMOUTILIZZATORE
(The waste to energy plant of Brescia)



HIGH DUST SCR LAYOUT

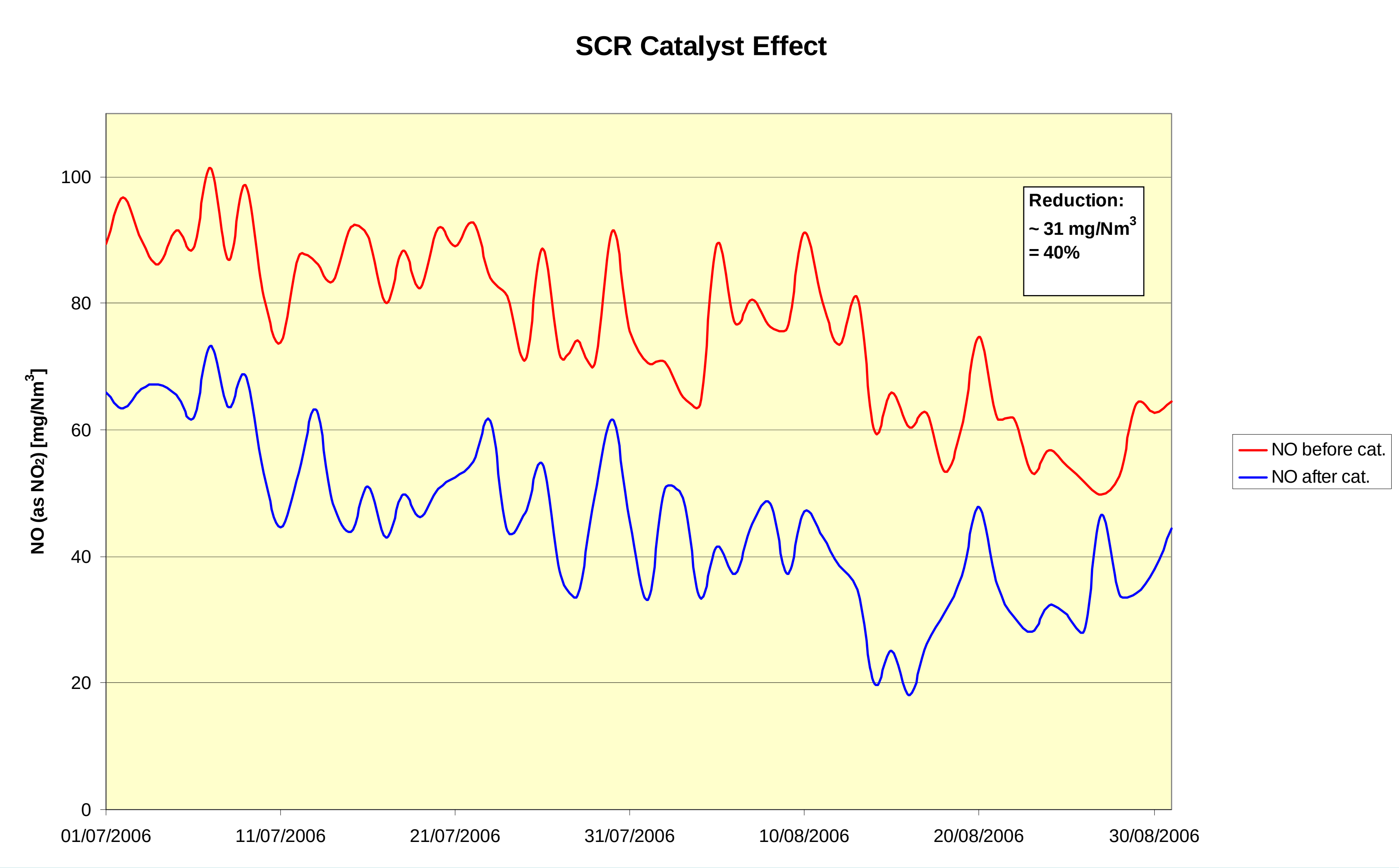
SCR “HIGH DUST”

FIRST TEST RESULTS

- **installation:** 2005 Sep. – 2006 Feb.
- **operation:** started 2006 Mar. (1st phase – one cat. layer)
- **inspection:** 2006 Sep.
- **2nd phase:** started 2006 Oct.

TERMOUTILIZZATORE
(The waste to energy plant of Brescia)

HIGH DUST SCR RESULTS (1 LAYER)



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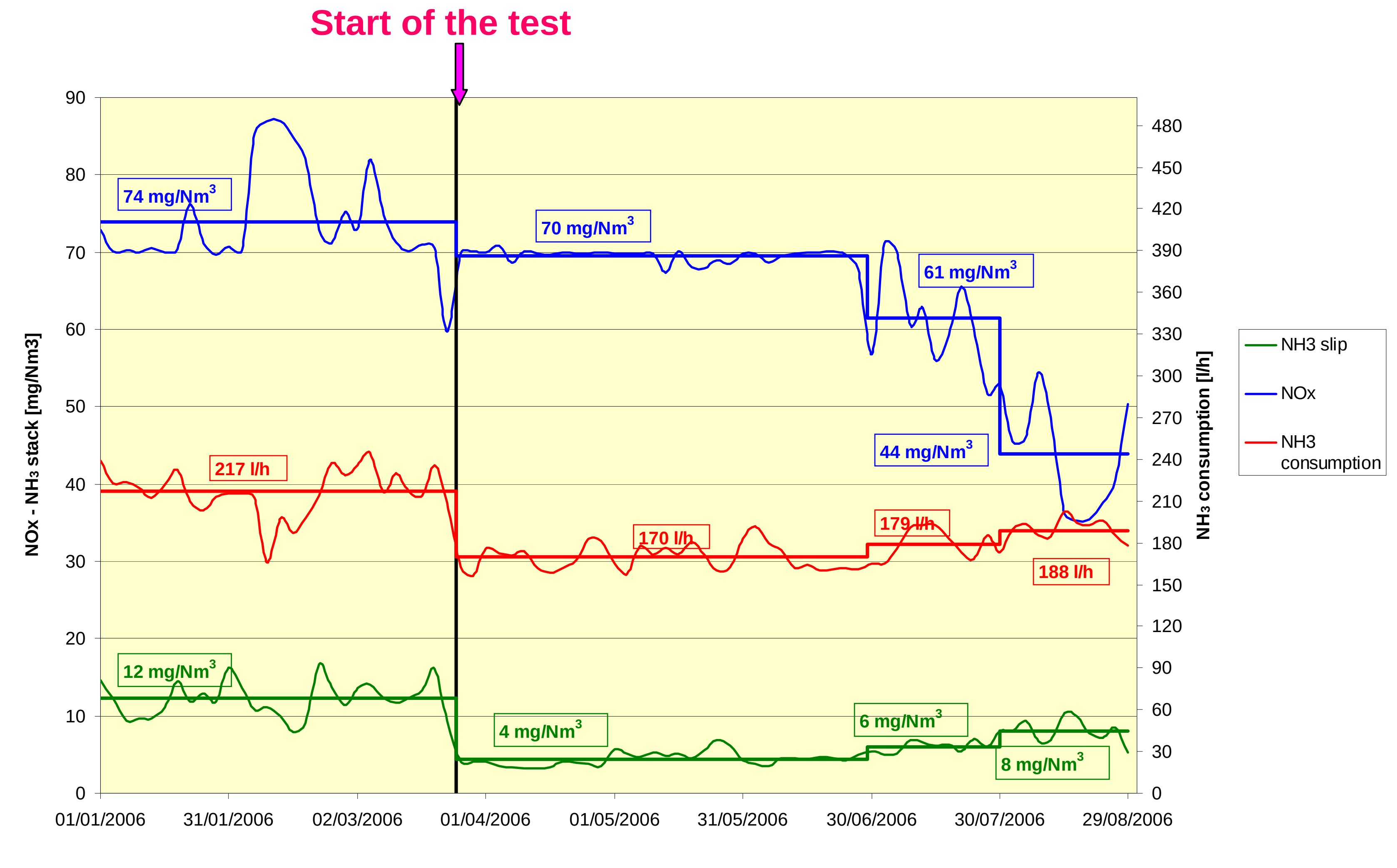
HIGH DUST SCR RESULTS (1 LAYER)

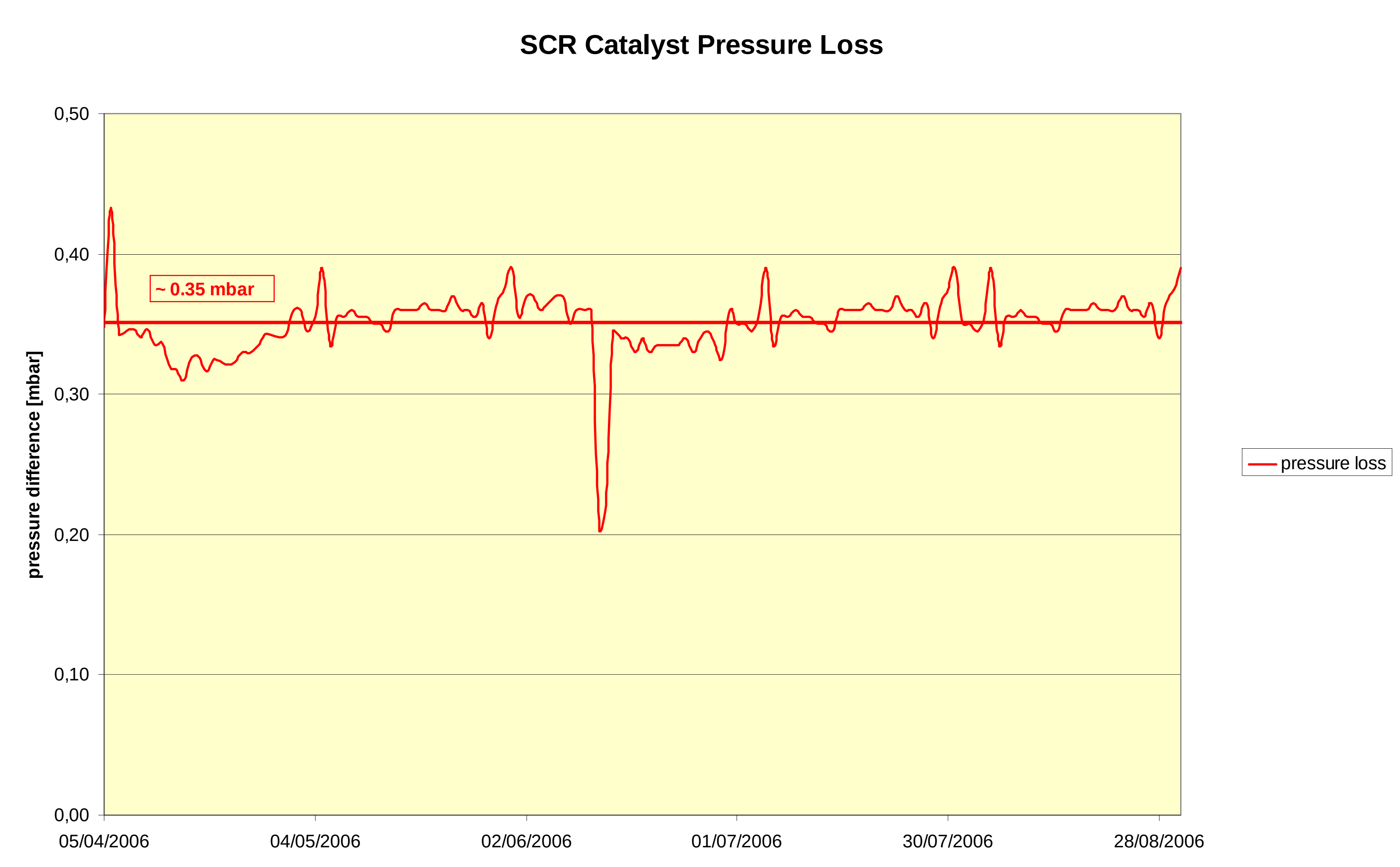


NOx – NH_3 consumption – ammonia slip

TERMOUTILIZZATORE

(The waste to energy plant of Brescia)

HIGH DUST SCR RESULTS (1 LAYER)



TERMOUTILIZZATORE
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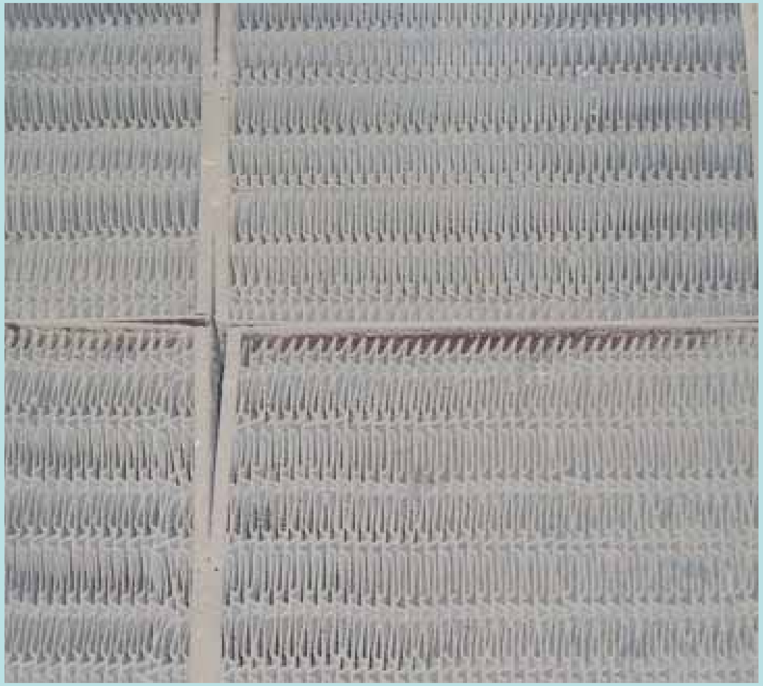
CATALYST AFTER 5 MONTHS OF OPERATION



SCR “HIGH DUST”

FIRST TEST RESULTS (preliminary)

1 SCR LAYER (5 months operation):

- NOx: 80 → ~50 mg/Nm^3
- NH_3 slip: 12 → 4 - 8 mg/Nm^3
- NH_3 consumption: 0.22 → 0.18 m^3/h (25% concentrated)

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

- NOx: → ~40 mg/Nm^3

HIGH DUST SCR

FUTURE TEST STEPS (2006 – 2009):

- monitoring of fouling and activity of catalyst
- optimization of catalyst layout (single / multiple layers)
- optimization of dust cleaning
- testing of different NH_3 injection points
- testing of NH_3 air vs. water injection
- lifetime assessment of the catalyst
- industrial cost evaluation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