ENVIRONMENTAL Catalysts & Systems

The Low Temperature Shell Denox System for Removal of NOx

CRI / Criterion Catalyst Co. , Shell Chemicals Europe

10/28/2010

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CRI / Criterion Catalyst Company
(100% subsidiary of Shell Chemicals Europe)

Supplier of the Shell *DeNOx* system

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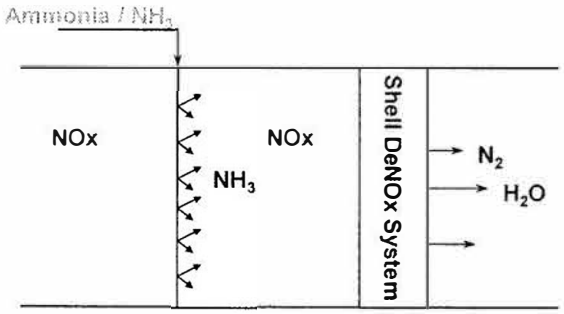
Typical Lay-out Shell DeNOx System



Typical requirements

NOx <70 mg/Nm³

NH_3 slip < 5 mg/Nm³ slip

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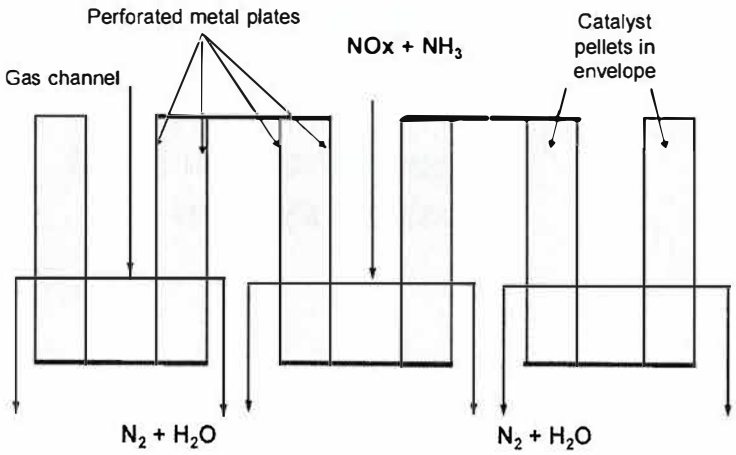
Flue gas flow through Shell DeNOx
(Lateral Flow Reactor technology)



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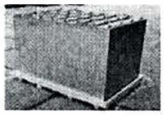
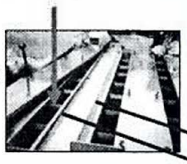
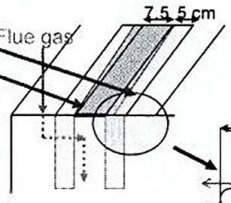
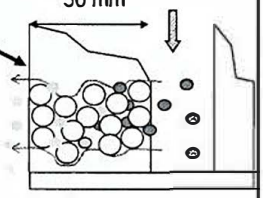
Shell DeNOx module – lay out details



Module







Module:
- stainless steel
- low pressure drop design
- no flue gas bypassing
- long hardware life
- easy module handling
- no maintenance
- one layer only

Turbulent flow increases the contact between NOx and catalyst: high conversion!

Catalyst 1.6 mm

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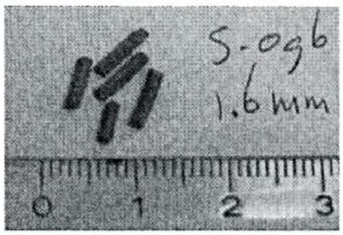
High activity Shell Catalyst for NOx removal

Explanation for high catalyst activity:

- small catalyst particle
  limited diffusion
  fast reaction rate
- high internal & external surface area
- high pore volume
- special manufacturing technology



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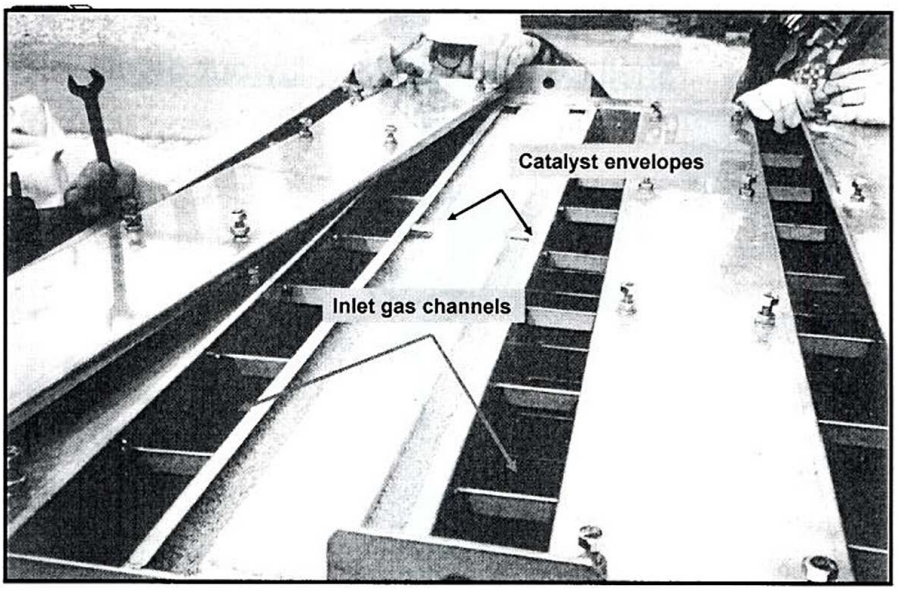
Catalyst envelopes
Inlet gas channels

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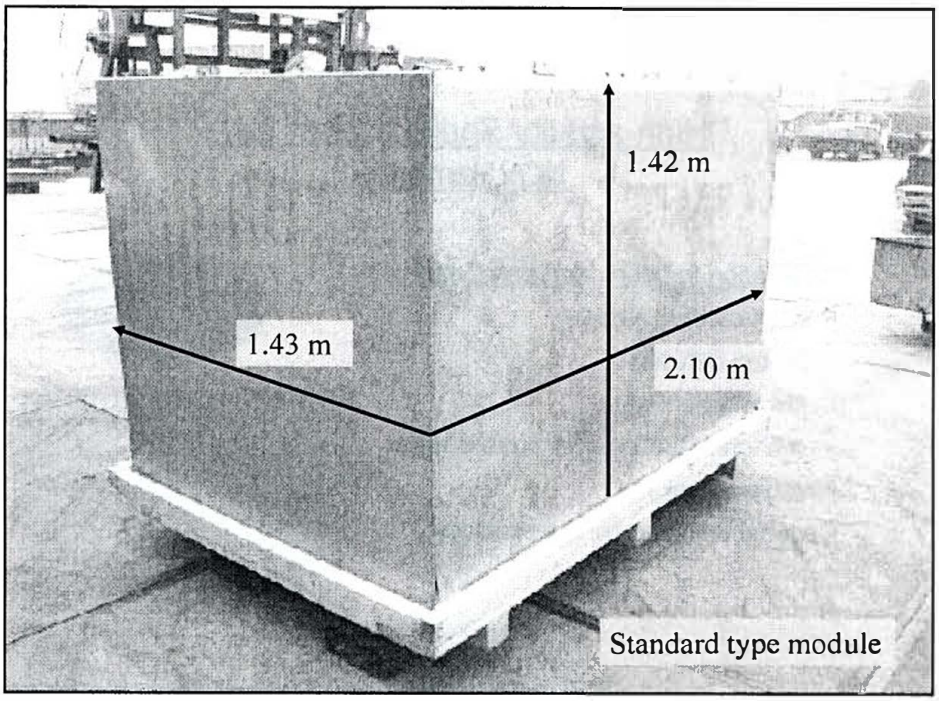
1.42 m
1.43 m
2.10 m
Standard type module

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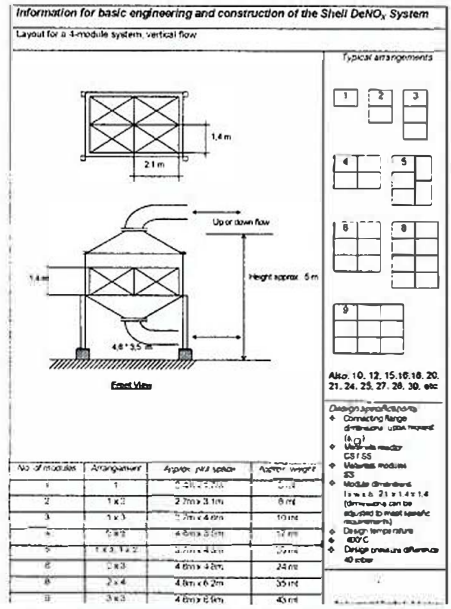

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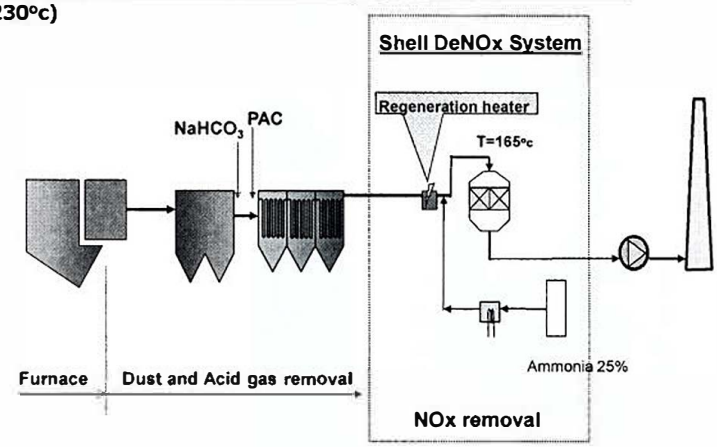
Low temperature Shell Denox solution

(165-230°c)



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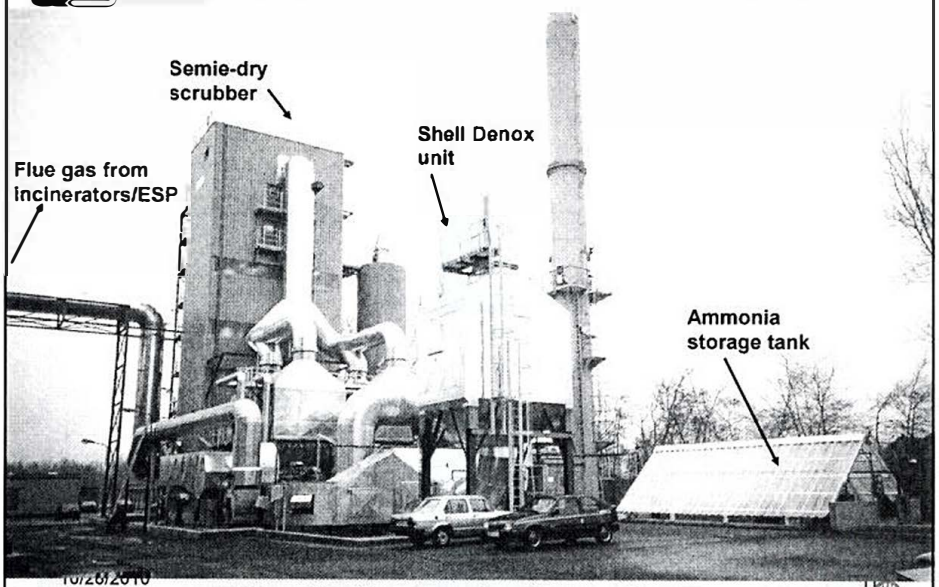
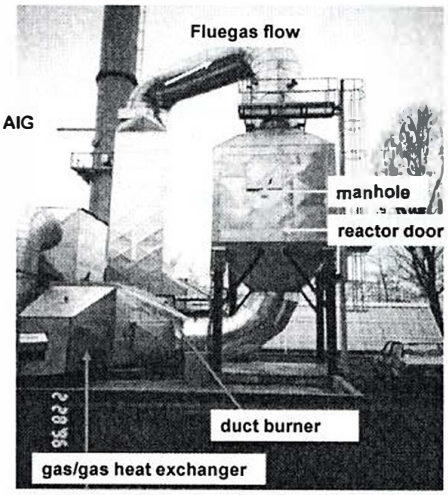
Sita ReEnergie MWI plant - 68,000 t/ year waste



Overview flue gas cleaning section

Shell DeNOx System
Sita Re-Energie, Netherlands



- flue gas flow 70,000 Nm3/h
- 4 modules - 6 m^3 catalyst
- temperature 230°C
- pressure drop 3 mbar

Outlet :

NOx	< 50	mg/Nm^3
NH3	< 2	ppmv

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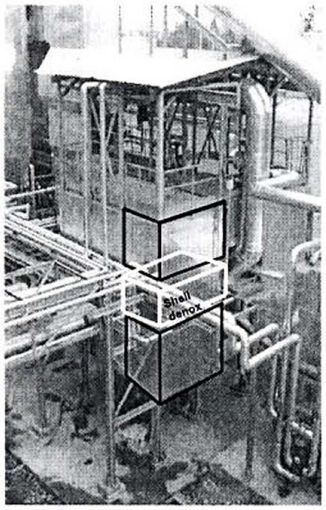
Municipal waste incinerator Bergamo, Italy with the Shell Denox System



Courtesy photograph by:

AREA IMPIANTI

- Start of operation June 2003
- Waste 90.000 ton per year
- Flow 72.400 Nm^3/hr
- Temperature 165°C
- SO_2 < 10 mg/Nm^3*
- Pressure drop < 3.5mbar
- NOx inlet 300-500 mg/Nm^3*
- **Outlet:**
  - ✓ **NOx < 70 mg/Nm^3***
  - ✓ **NH3 < 5 mg/Nm^3***

* 11vol.% O_2 dry base

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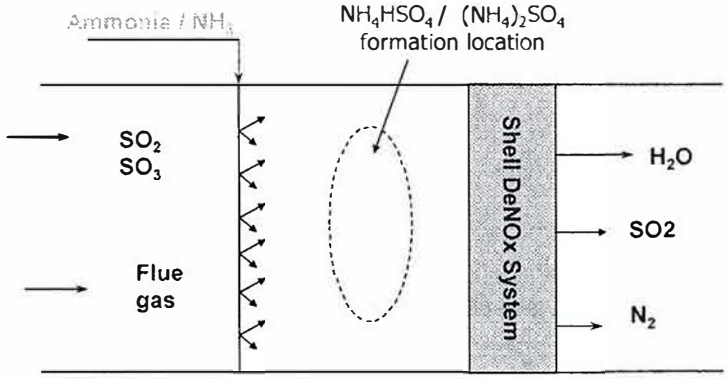
Formation of Ammonium(bi)Sulphate



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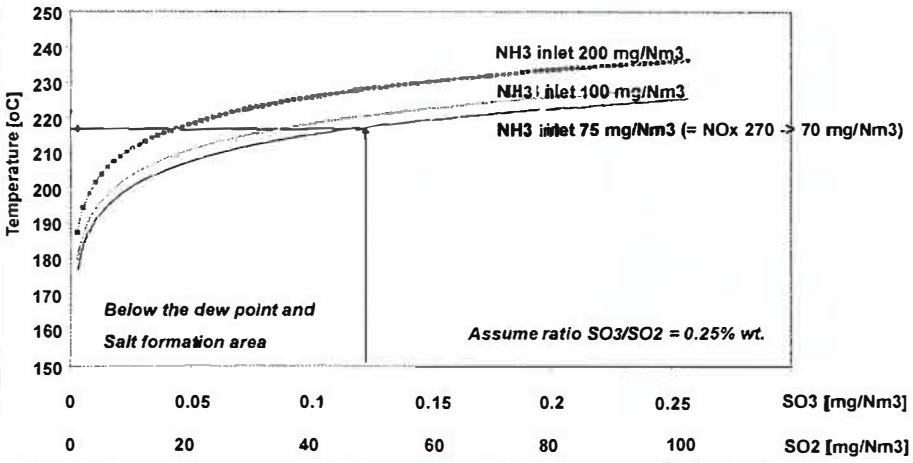
Dew point curves for incineration flue gas

(example only)



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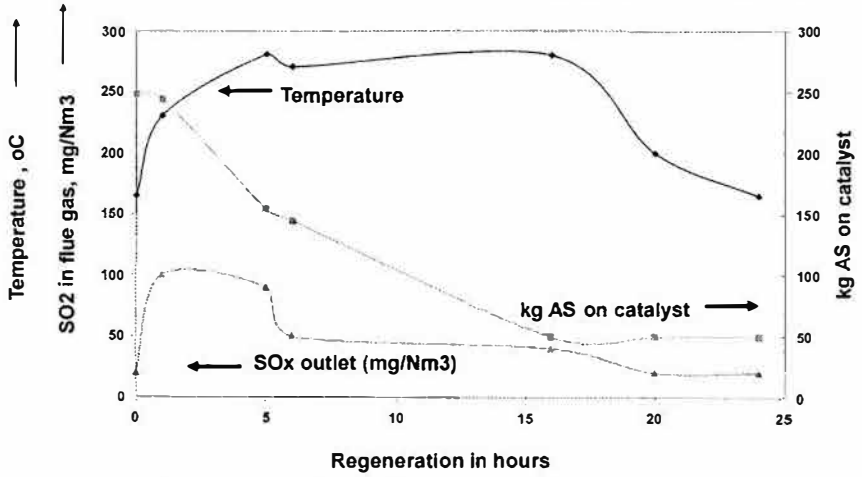
Thermal decomposition of A.S. salts from the catalyst



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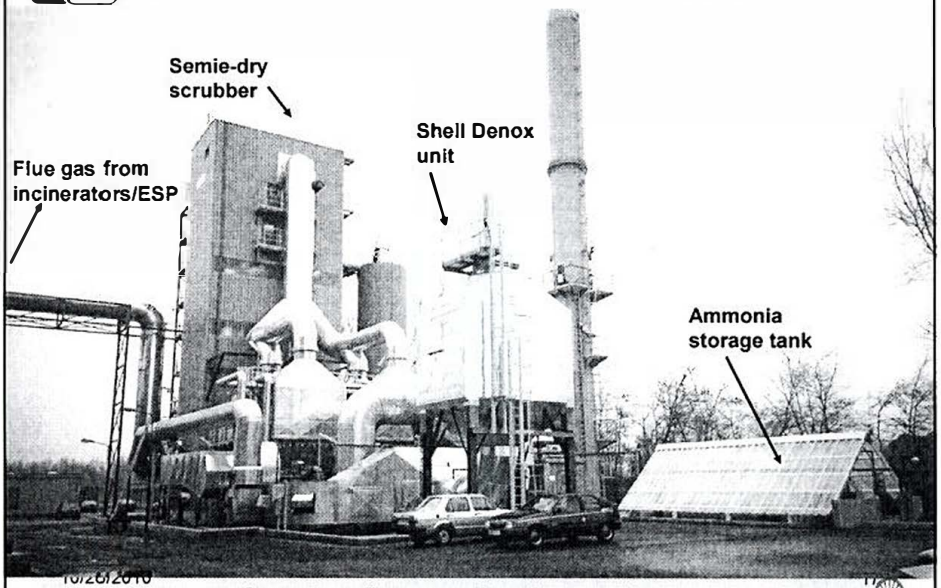
Sita ReEnergie MWI plant - 68,000 t/ year waste



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Overview flue gas cleaning section

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Country	Application	Start-up	Gas Flow Nm3/hr	Temperature
Germany	E.C Furnaces	1996	56.000	140° C
Victorville USA	Boiler	2000	13.500	165° C
Bergamo Italy	Incinerator	2003	85.000	165° C
Sardinia Italy	Incinerator	2003	2 x 25.000	165° C
CA USA	Refinery heater	1991	22.000	166° C
USA	Nitric acid	1999	13.900	166° C
Japan	Incinerator	2000	100.000	170° C
Netherlands	Gas turbine	1998	275.000	175° C
Netherlands	Gas turbine	1999	275.000	175° C
USA	Gas turbine	1997	48.300	175° C
Pittsburgh USA	Gas turbine	1996	370.000	177° C
Pittsburgh USA	Gas turbine	1996	320.000	177° C
Pittsburgh USA	Gas turbine	1996	370.00	177° C
Sweden	boiler	1998	130.000	177° C
Texas City USA	Gas turbine	2003	905.000	177° C
Texas City USA	Gas turbine	2004	905.000	177° C
Japan	Incinerator	2001	40.000	180° C
Belgium	Incinerator	2004	2 x 35.000	180° C
San Francisco USA	Gas turbine	1996	350.000	184° C
San Francisco USA	Gas turbine	1996	350.000	184° C
San Francisco USA	Gas turbine	1996	350.000	184° C

Overview of Shell Systems operating at low temperatures
(140 - 230°C)

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Country	Application	Start-up	Gas Flow Nm3/hr	Temperature
Netherlands	Gas turbine	1999	140,000	185° C
Japan	Incinerator	2000	2100	188° C
Japan	Incinerator	2002	18,300	190° C
USA	Nitric acid	1999	27,000	190° C
UK	Incinerator	2003	6,875	200° C
Sagunto Spain	Nitric acid	2003	120,000	200° C
Lithuania	Nitric acid	2002	140,300	203° C
USA	Gas turbine	1996	253,000	204° C
South Africa	Nitric acid	1995	70,000	205° C
Como Italy	Incinerator	2003	2 x 46,000	210° C
Frederice Denmark	Nitric acid	1998	30,000	210° C
Belgium	Incinerator	2004	2 x 38,650	210° C
Netherlands	E.C furnace	2000	83,000	214° C
Japan	Incinerator	2002	37,000	220° C
Puertollano Spain	Nitric acid	2000	50,000	220° C
Sevilla Spain	Nitric acid	2002	45,000	220° C
Billingham UK	Nitric acid	2001	107,000	225° C
Richmond USA	H2 reformer	2000	26,000	229° C
USA	Nitric acid	1999	27,500	229° C
Netherlands	Incinerator	1996	56,000	230° C
Belgium	Incinerator	2004	2 x 86,000	230° C

Continued

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