

“Capacity Building and Strengthening Institutional Arrangement”

Workshop: “Best Available Techniques (BAT)”

**BAT on Fertilizers Industries
(Section 1)**

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APAT

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1. Introduction

Common Issues

- BAT is to carry out regular energy audits for the whole production site, to monitor key performance parameters and to establish and to maintain mass balances for Nitrogen, P₂O₅, Steam, Water and CO₂.
- Minimisation of energy losses is carried out by generally avoiding steam pressure reduction without using the energy or by adjusting the whole steam system in order to minimise the generation of excess steam.

1. Introduction

- Excess thermal energy should be used on-site or offsite and, if local factors prevent that, as a last option, steam might be used for generating only electrical power.
- BAT is to improve the environmental performance of the production site by a combination of recycling or re-routing mass streams, efficiently sharing equipment, increasing heat integration, preheating of combustion air, maintaining heat exchanger efficiency, reducing waste. Water volumes and loads by recycling condensates, process and scrubbing waters, applying advanced process control systems and by maintenance.

2. BAT for productive cycles

Production of Ammonia

BAT for new installations is to apply conventional reforming or reduced primary reforming or heat exchange autothermal reforming. In order to achieve the NO_x concentration emission levels given in the Table:

Plant concept	NO _x emission as NO ₂
	mg/Nm ³
Advanced conventional reforming processes and processes with reduced primary reforming	90 – 230 ^x
Heat exchange autothermal reforming	a) 80
	b) 20
a) Process air heater b) Auxiliary boiler	
^x Low end of the range: best existing performers and new installations	
No direct correlation between concentration levels and emission factors could be established. However, emission factors of 0.29 – 0.32 kg/tonne NH ₃ are seen as a benchmark for conventional reforming processes and processes with reduced primary reforming. For heat exchange autothermal reforming, an emission factor of 0.175 kg/tonne NH ₃ is seen as a benchmark.	

2. BAT for productive cycles

Techniques such as SNCR at the primary reformer (if the furnace allows the required temperature/retention time windows), low NO_x burners, ammonia removal from purge and flash gases or low temperature desulphurisation for autothermal heat exchange reforming, should be applied. BAT is to carry out routine energy audits.

Techniques to achieve the energy consumption levels

(see table) are:

2. BAT for productive cycles

Plant concept	Net energy consumption ^x
	GJ(LHV)/tonne NH ₃
Conventional reforming processes, processes with reduced primary reforming or heat exchange autothermal reforming	27.6 – 31.8
^x For interpretation of the given energy consumption levels, see Section 2.3.1.1. As a consequence, the levels might vary up to ± 1.5 GJ. Generally, the levels relate to steady state operation as would be typically experienced during a performance test directly following a revamp or an overhaul at intended capacity.	

- a) extended preheating of the hydrocarbon feed, preheating of combustion air;
- b) installation of a second generation gas turbine,
- c) modifications of the furnace burners (to assure an adequate distribution of gas turbine exhaust over the burners),
- d) rearrangement of the convection coils and addition of additional surface,
- e) pre-reforming in combination with a suitable steam saving project.

2. BAT for productive cycles

Other options are improved CO₂ removal, low temperature desulphurisation, isothermal shift conversion (mainly for new installations), use of smaller catalyst particles in ammonia converters, low pressure ammonia synthesis catalyst, use of sulphur resistant catalyst for shift reaction of syngas from partial oxidation, liquid nitrogen washfor final purification of the synthesis gas, indirect cooling of the ammonia synthesis reactor, hydrogen recovery from the purge gas of the ammonia synthesis or the implementation of an advanced process control system.

2. BAT for productive cycles

In partial oxidation, **sulphur** is recovered from flue-gases, e.g. by applying a combination of a Claus unit with tail gas treatment to achieve BAT associated emission levels and efficiencies given in the BREF on Oil and Gas Refineries.

BAT is to remove NH₃ from process condensates, e.g. by stripping.

NH₃ is recovered from purge and flash gases in a closed loop.

2. BAT for productive cycles

Production of Nitric Acid

BAT is to use recoverable energy: co-generated steam and/or electrical power.
BAT is to reduce emissions of N₂O and to achieve the emission factors or emission concentration levels given in the Table:

		N ₂ O emission level ^x	
		kg/tonne 100 % HNO ₃	ppmv
M/M, M/H and H/H	New plants	0.12 – 0.6	20 – 100
	Existing plants	0.12 – 1.85	20 – 300
L/M plants		No conclusion drawn	
* the levels relate to the average emission levels achieved in a campaign of the oxidation catalyst			

2. BAT for productive cycles

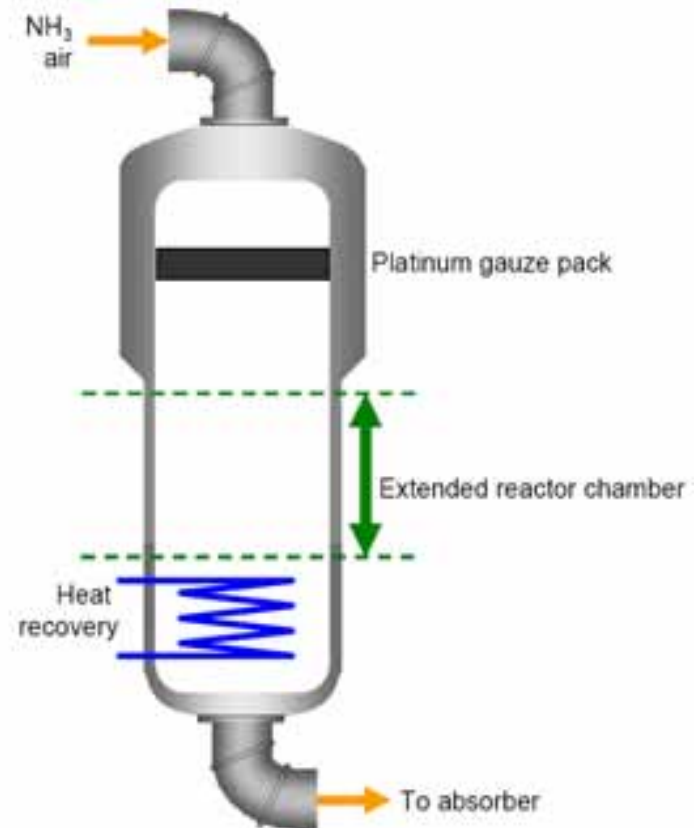
By applying a combination of the following techniques:

- optimising the filtration of raw materials
- optimising the mixing of raw materials
- optimising the gas distribution over the catalyst
- monitoring catalyst performance and adjusting the campaign length
- optimisation of the NH₃/air ratio
- optimising the pressure and temperature of the oxidation step
- N₂O decomposition by extension of the reactor chamber in new plants
- catalytic N₂O decomposition in the reactor chamber
- combined NO_x and N₂O abatement in tail gases.

2. BAT for productive cycles

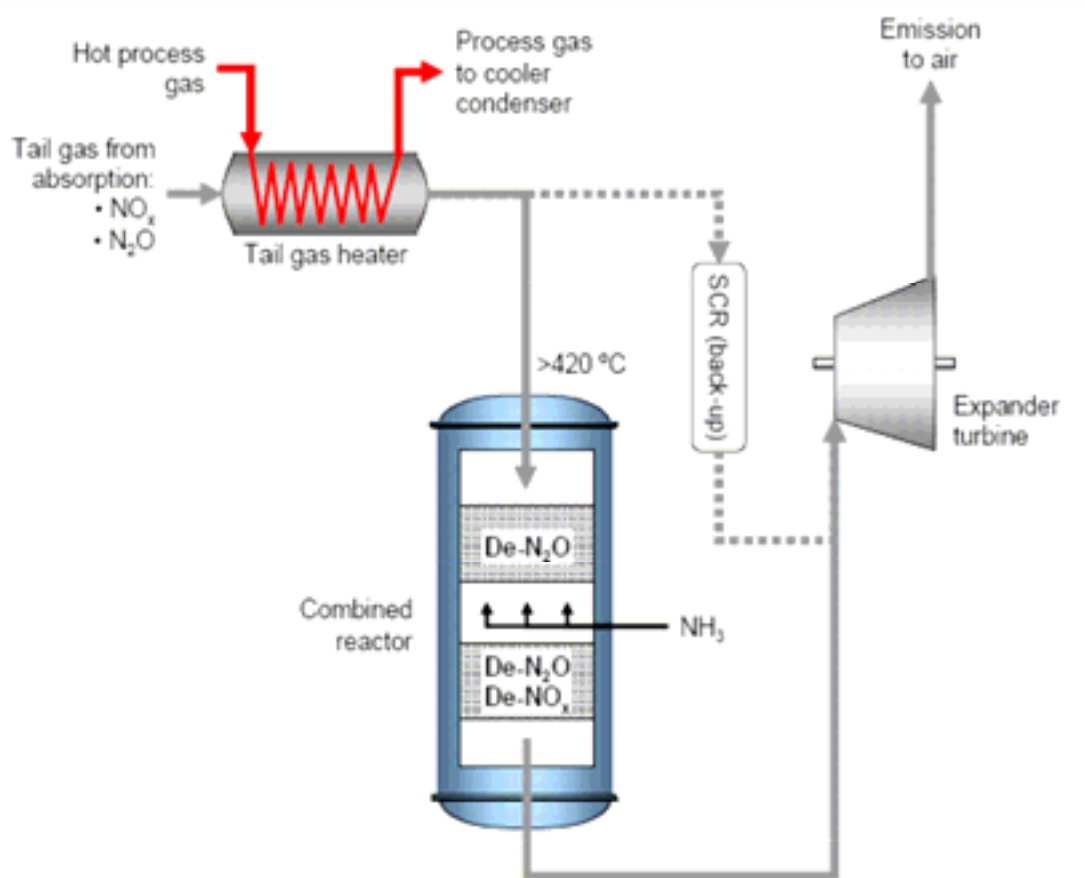
Industry and one Member State do not agree with the N₂O emission levels associated with the application of BAT for existing plants due to the limited experience with the **De-N₂O techniques**.

Industry and one Member State claim that the BAT range should include 2.5 kg N₂O/tonne 100% HNO₃ for existing plants.



2. BAT for productive cycles

BAT is to reduce emissions during startup and shutdown conditions. BAT is to reduce emissions of NO_x and to achieve the emission levels given in the Table:



2. BAT for productive cycles

		N₂O emission level ^x	
		kg/tonne 100 % HNO₃	ppmv
M/M, M/H and H/H	New plants	0.12 – 0.6	20 – 100
	Existing plants	0.12 – 1.85	20 – 300
L/M plants		No conclusion drawn	
^x the levels relate to the average emission levels achieved in a campaign of the oxidation catalyst			

by applying one or a combination of the following techniques: a) optimisation of the absorption stage; b) combined NO_x and N₂O abatement in tail gases; c) SCR;d) addition of H₂O₂ to the last absorption stage.

2. BAT for productive cycles

Production of Sulphuric Acid

BAT is to use recoverable energy: co-generated steam, electrical power, hot water. The options to achieve the conversion rates and emission levels given in the Table:

Example plant	Conversion type	SO ₂ level in mg/Nm ³		
		Tail gas	Emission	Efficiency
Degussa, Wesseling	Double contact	1100	8	99 %
Lenzing AG	Wet catalysis process	2000	170	91.5 %
Kemira Kemi, Helsingborg	Double contact with 5 th catalyst bed	250	30	88 %
Newmont Gold, US	Double contact			
CPM, Brazil	Double contact			

2. BAT for productive cycles

Are: the application of double contact/double absorption, single contact/single absorption, the addition of a 5th catalyst bed, using a cesium promoted catalyst in bed 4 or 5, the change over from single to double absorption, wet or combined wet/dry processes, regular screening and replacement of the catalyst (especially in catalyst bed 1), the replacement of brick-arch converters by stainless steel converters, improving raw gas cleaning (metallurgical plants), improving air filtration, e.g. by two stage filtration (sulphur burning), improving sulphur filtration, e.g. by applying polishing filters (sulphur burning), maintaining heat exchanger efficiency or tail gas scrubbing (provided that by-products can be recycled on-site).

2. BAT for productive cycles

BAT is to continuously monitor the SO₂ levels required to determine the SO₂ conversion rate and the SO₂ emission level. The options to achieve SO₃/H₂SO₄ mist emission levels (see Table) are:

	Emission level as H ₂ SO ₄
All processes	10 – 35 mg/Nm ³
Yearly averages	

the use of sulphur with a low impurity content (in case of sulphur burning), adequate drying of inlet gas and combustion air (only for dry contact processes), the use of a larger condensation area (only for the wet catalysis process)

2. BAT for productive cycles

Adequate acid distribution and circulation rate, applying high performance candle filters after absorption, controlling concentration and temperature of the absorber acid or applying recovery/abatement techniques in wet processes, such as ESP, WESP or wet scrubbing.

BAT is to minimise or abate NO_x emissions.

BAT is to recycle exhaust gases from product H₂SO₄stripping to the contact process.

2. BAT for productive cycles

Phosphate rock grinding and prevention of rock Dust dispersion

BAT is to reduce dust emissions from rock grinding, e.g. by application of fabric filters or ceramic filters and to achieve dust emission levels of 2.5 – 10 mg/Nm³.

BAT is to prevent dispersion of phosphate rock dust by using covered conveyor belts, indoor storage, and frequently cleaning/sweeping the plant grounds and the quay.

2. BAT for productive cycles

Production of Phosphoric Acid

BAT for existing installations using a wet process is to achieve P₂O₅ efficiencies of 94.0 – 98.5 %, e.g. by applying one or a combination of the following techniques:

- dihydrate process or improved dihydrate process
- increasing the residence time
- recrystallisation process
- repulping
- double-stage filtration
- recycling the water from the phosphogypsum pile
- selection of phosphate rock.

2. BAT for productive cycles

BAT for new installations is to achieve P2O5 efficiencies of 98.0 % or higher, e.g. by applying a hemi-dihydrate recrystallisation process with double-stage filtration. BAT for the wet process is to minimise the emissions of P2O5 by applying techniques like entrainment separators (where vacuum flash coolers and/or vacuum evaporators are used), liquid ring pumps (with recycling of the ring liquid to the process) or scrubbing with recycling of the scrubbing liquid. BAT is to reduce dust emissions from rock grinding, e.g. by application of fabric filters or ceramic filters and to achieve dust emission levels of 2.5 – 10 mg/Nm³.

2. BAT for productive cycles

BAT is to prevent dispersion of phosphate rock dust by using covered conveyor belts, indoor storage, and frequently cleaning/sweeping the plant grounds and the quay.

BAT is to reduce fluoride emissions by the application of scrubbers with suitable scrubbing liquids and to achieve fluoride emission levels of 1 – 5 mg/Nm³ expressed as HF.

2. BAT for productive cycles

BAT for wet processes is to market the generated phosphogypsum and fluosilicic acid, and, if there is no market, to dispose of it. Piling of phosphogypsum requires precautionary measures and recycling of water from these piles.

BAT for wet processes is to prevent fluoride emissions to water, e.g. by the application of an indirect condensation system or by a scrubbing with recycling or marketing the scrubbing liquid.

2. BAT for productive cycles

BAT is to treat waste water by applying a combination of the following techniques:

- neutralisation with lime
- filtration and optionally sedimentation
- recycling of solids to the phosphogypsum pile.