BEST AVAILABLE TECHNIQUES FOR THE PRODUCTION OF AMMONIA

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Definition Best Available Techniques

"techniques" includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned;

"available" techniques are those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator;

"best" means most effective in achieving a high general level of protection of the environment as a whole.

33 BAT REF's covering Industrial Activities

Pulp and Paper manufacture	Refineries	Food, Drink and Milk processes
Iron and Steel production	Large Volume Organic Chemicals	Ceramics
Cement and Lime production	Smitheries and Foundries	Management of Tailings and Waste-Rock in Mining Activities
Cooling Systems	Intensive Livestock Farming	Surface treatment of metals
Chlor-Alkali manufacture	Emissions from storage of bulk or dangerous materials	Surface treatments using solvents
Ferrous Metal processing	Common waste water and waste gas treatment and management systems in the chemical sector	Waste Incineration
Non-Ferrous Metal processes	Economic and cross media issues under IPPC	Waste Treatments [Previously Waste Recovery/Disposal activities]
Glass manufacture	Large Combustion Plant	Speciality inorganic chemicals
Tanning of hides and skins	Large Volume Inorganic Chemicals - Ammonia, Acids & Fertilisers	Organic fine chemicals
Textile processing	Large Volume Inorganic Chemicals - Solid & Others	Polymers
Monitoring systems	Slaughterhouses and Animal By-products	Energy Efficiency

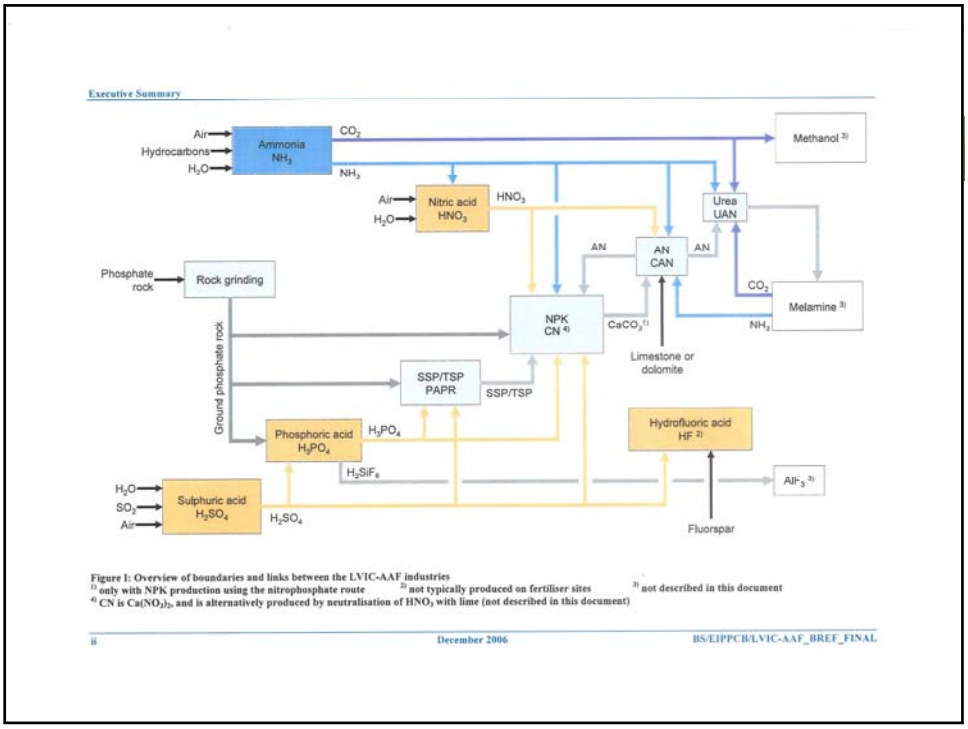
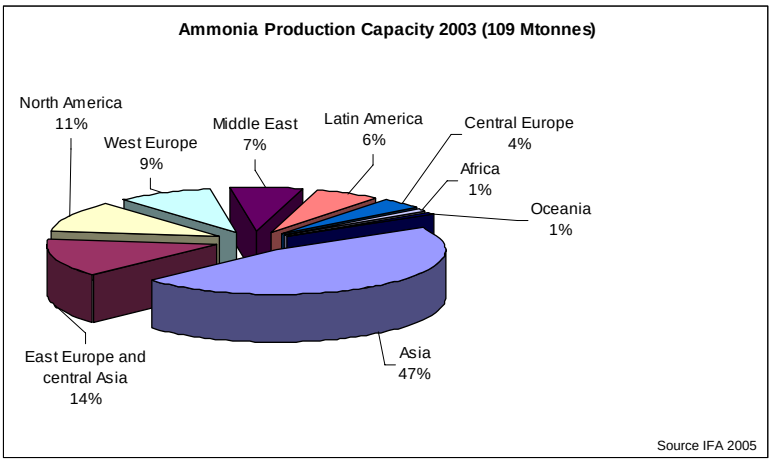


Figure 1: Overview of boundaries and links between the LVIC-AAF industries
1) only with NPK production using the nitrophosphate route 2) not typically produced on fertiliser sites 3) not described in this document
4) CN is $Ca(NO_3)_2$, and is alternatively produced by neutralisation of HNO_3 with lime (not described in this document)

Structure of the BATREF

- General information.
- Applied processes and techniques.
- Current emission and consumption levels.
- Techniques to consider in the determination of BAT.
- BAT for Ammonia.
- Emerging techniques.

Ammonia Production Capacity (2003)



Applied Ammonia Processes

Feedstock	Process	% of world capacity
Natural gas	Steam reforming	77
Naphtha, LPG, refinery gas	Steam reforming	6
Heavy hydrocarbon fractions	Partial oxidation	3
Coke, coal	Partial oxidation	13,5
Water	Water electrolysis	0,5

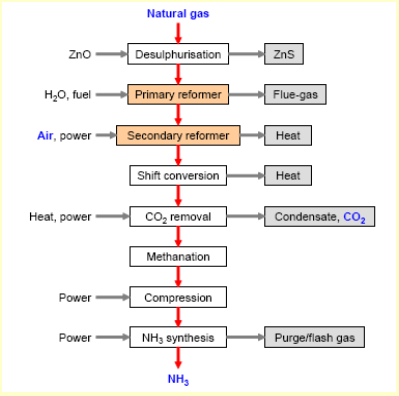
Table 1. Applied processes and feed stocks in the production of ammonia [Ref. 4].

Applied Ammonia Processes

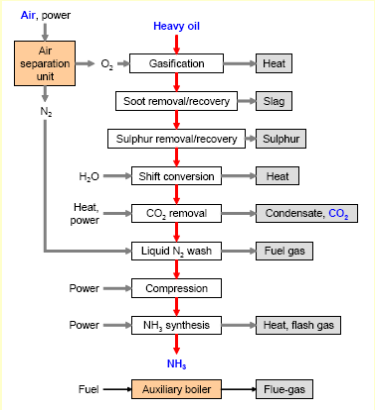
Feedstock	Process	Net primary energy consumption GJ/t NH^3 (LHV)	Relative investment
Natural gas	Steam reforming	28*	1
Heavy hydrocarbons	Partial oxidation	38	1,5
Coal	Partial oxidation	48	2-3
*Best achieved data			

Table 2. Cost differences and total energy demands for ammonia production [Ref 4].

Conventional steam reforming



Partial Oxidation



Techniques to consider in BAT: Criteria

- Description of the technique.
- Achieved environmental benefits.
- Cross media effects.
- Operational data.
- Applicability.
- Economics.
- Driving force for implementation.
- Reference to literature and example plants.

26 techniques considered in the determination of BAT: a selection

- Heat exchange auto thermal reforming.
- Advanced process control.
- Use of gas turbine to drive the process air compressor.
- SNCR at the primary reformer.
- Improved CO_2 removal systems.
- Preheating of combustion air.
- Stripping and recycling of process condensates.
- etc.

BAT for Ammonia: NOx emissions

BATREF AAF

Plant concept	NO_x emissions as NO_2
	mg/Nm³
Advanced conventional reforming processes and processes with reduced primary reforming	90-230*
Heat exchange auto-thermal reforming	a)80 b)20
a)Process air heater b)Auxiliary boiler * Low end of the range best existing performers and new installations.	

Table 3. NO_x emission levels associated with BAT.

Comparison BAT levels NOx: EU versus EFMA 2000

	EIPPC definition	EFMA 2000			BATREF AAF 2006	
		ppmv	mg.Nm³	kg.t⁻¹ of product	mg/Nm³	kg.t⁻¹ of product
New Plants	Conventional reforming	75	150	0.45	90-230	0,29-0,32
	Reduced primary reforming				90-230	0,29-0,32
	Heat exchange auto-thermal reforming				20-80	0,175
	Partial oxidation				Not considered BAT	
Existing Plants	Conventional reforming	150	200-400	0,9	90-230	0,29-0,32
	Reduced primary reforming				90-230	0,29-0,32
	Heat exchange auto-thermal reforming				20-80	0,175
	Partial oxidation					

Table 4. Comparison of the BAT Emission levels for NO_x (EFMA 2000 versus EU BATREF AAF).

Comparison BAT Energy consumption levels: EU versus EFMA 2000

	EFMA 2000			EU 2006
	Feed	Fuel	Total	Net
Plant concept	**GJ(LHV).t^{-1} NH$_3$**			
Conventional reforming	22.1*	7.2-9.0**	29.3-31.1***	27,6-31,8
Excess air reforming	23.4*	5.4-7.2**	28.9-31.6	27,6-31,8
Auto-thermal reforming	24.8*	3.6-7.2**	28.4-32	27,6-31,8
Partial oxidation	28.8*	5.4-9.0**	34.2-37.8	

*Modern plant
**Efficient stand-alone plant with no energy export and no other import than feed-stock and fuel
***In new reforming plants the total energy consumption should not exceed 29.3 GJ(LHV).t^{-1} NH$_3$

Concluding remarks

- **Limited number of Fertilizers**
- **Main focus on NOx and Energy consumption**
- **Partial oxidation not BAT for new plants**
- **Emerging techniques not considered**