

*Eco-profiles of the
European Plastics Industry*

AMMONIA

A report by

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for

PlasticsEurope

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IMPORTANT NOTE

Before using the data contained in this report, you are strongly recommended to look at the following documents:

1. Methodology

This provides information about the analysis technique used and gives advice on the meaning of the results.

2. Data sources

This gives information about the number of plants examined, the date when the data were collected and information about up-stream operations.

In addition, you can also download data sets for most of the upstream operations used in this report. All of these documents can be found at: www.plasticseurope.org.

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AMMONIA PRODUCTION

Ammonia, NH_3 , is produced by the direct reaction between hydrogen and nitrogen. Most hydrogen is produced by the steam reforming of natural gas and nitrogen is derived from air.

ECO-PROFILE OF AMMONIA

Table 1 shows the gross or cumulative energy to produce 1 kg of ammonia and Table 2 gives this same data expressed in terms of primary fuels. Table 3 shows the energy data expressed as masses of fuels. Table 4 shows the raw materials requirements and Table 5 shows the demand for water. Table 6 shows the gross air emissions and Table 7 shows the corresponding carbon dioxide equivalents of these air emissions. Table 8 shows the emissions to water. Table 9 shows the solid waste generated and Table 10 gives the solid waste in EU format.

Table 1

Gross energy required to produce 1 kg of ammonia. (Totals may not agree because of rounding)

Fuel type	Fuel prod'n & delivery energy (MJ)	Energy content of delivered fuel (MJ)	Energy use in transport (MJ)	Feedstock energy (MJ)	Total energy (MJ)
Electricity	1.94	0.64	0.51	-	3.09
Oil fuels	0.23	2.30	0.03	<0.01	2.56
Other fuels	0.06	-2.75	<0.01	32.80	30.11
Totals	2.22	0.20	0.54	32.80	35.76

Table 2

Gross primary fuels required to produce 1 kg of ammonia. (Totals may not agree because of rounding)

Fuel type	Fuel prod'n & delivery energy (MJ)	Energy content of delivered fuel (MJ)	Fuel use in transport (MJ)	Feedstock energy (MJ)	Total energy (MJ)
Coal	0.65	0.28	0.17	<0.01	1.11
Oil	0.22	2.34	0.06	<0.01	2.62
Gas	0.67	1.18	0.16	32.80	34.81
Hydro	0.23	0.19	<0.01	-	0.42
Nuclear	0.40	0.07	0.12	-	0.59
Lignite	<0.01	<0.01	<0.01	-	<0.01
Wood	<0.01	<0.01	<0.01	<0.01	<0.01
Sulphur	<0.01	<0.01	<0.01	<0.01	<0.01
Biomass (solid)	0.03	0.02	<0.01	<0.01	0.05
Hydrogen	<0.01	<0.01	<0.01	-	<0.01
Recovered energy	<0.01	-3.89	<0.01	-	-3.89
Unspecified	<0.01	<0.01	<0.01	-	<0.01
Peat	<0.01	<0.01	<0.01	-	<0.01
Geothermal	<0.01	<0.01	<0.01	-	<0.01
Solar	<0.01	<0.01	<0.01	-	<0.01
Wave/tidal	<0.01	<0.01	<0.01	-	<0.01
Biomass (liquid/gas)	0.02	<0.01	0.01	-	0.03
Industrial waste	<0.01	<0.01	<0.01	-	<0.01
Municipal Waste	0.01	<0.01	<0.01	-	0.02
Wind	<0.01	<0.01	<0.01	-	<0.01
Totals	2.22	0.20	0.54	32.80	35.76

Table 3

Gross primary fuels used to produce 1 kg of ammonia expressed as mass.

Fuel type	Input in mg
Crude oil	58000
Gas/condensate	650000
Coal	39000
Metallurgical coal	10
Lignite	<1
Peat	1
Wood	4

Table 4
Gross raw materials required to produce 1 kg of ammonia.

Raw material	Input in mg
Air	160000
Animal matter	<1
Barytes	<1
Bauxite	<1
Bentonite	<1
Biomass (including water)	8300
Calcium sulphate (CaSO ₄)	<1
Chalk (CaCO ₃)	<1
Clay	<1
Cr	<1
Cu	<1
Dolomite	<1
Fe	24
Feldspar	<1
Ferromanganese	<1
Fluorspar	4
Granite	<1
Gravel	<1
Hg	<1
Limestone (CaCO ₃)	10
Mg	<1
N ₂	13000
Ni	<1
O ₂	<1
Olivine	<1
Pb	<1
Phosphate as P ₂ O ₅	<1
Potassium chloride (KCl)	<1
Quartz (SiO ₂)	<1
Rutile	<1
S (bonded)	<1
S (elemental)	96
Sand (SiO ₂)	890
Shale	<1
Sodium chloride (NaCl)	790
Sodium nitrate (NaNO ₃)	<1
Talc	<1
Unspecified	<1
Zn	<1

Table 5
Gross water consumption required for the production of 1 kg of ammonia. (Totals may not agree because of rounding)

Source	Use for processing (mg)	Use for cooling (mg)	Totals (mg)
Public supply	3300000	-	3300000
River canal	2200000	71000000	74000000
Sea	64	610	680
Well	430000	<1	430000
Unspecified	84000	11000	95000
Totals	6000000	71000000	77000000

Table 6

Gross air emissions associated with the production of 1 kg of ammonia. (Totals may not agree because of rounding)

Emission	From fuel prod'n (mg)	From fuel use (mg)	From transport (mg)	From process (mg)	From biomass (mg)	From fugitive (mg)	Totals (mg)
dust (PM10)	130	14	1	140	-	-	290
CO	430	120	7	240	-	-	800
CO2	180000	1600000	2200	370000	-3	-	2200000
SOX as SO2	850	910	30	<1	-	-	1800
H2S	<1	-	<1	<1	-	-	<1
mercaptan	<1	<1	<1	<1	-	-	<1
NOX as NO2	420	1300	15	470	-	-	2200
NH3	<1	-	<1	14	-	-	14
Cl2	<1	<1	<1	<1	-	-	<1
HCl	19	1	<1	<1	-	-	20
F2	<1	<1	<1	<1	-	-	<1
HF	1	<1	<1	<1	-	-	1
hydrocarbons not specified	580	220	5	7	-	<1	810
aldehyde (-CHO)	<1	-	<1	<1	-	-	<1
organics	<1	<1	<1	32	-	-	32
Pb+compounds as Pb	<1	<1	<1	<1	-	-	<1
Hg+compounds as Hg	<1	-	<1	<1	-	-	<1
metals not specified elsewhere	<1	<1	<1	<1	-	-	<1
H2SO4	<1	-	<1	<1	-	-	<1
N2O	<1	<1	<1	<1	-	-	<1
H2	22	<1	<1	<1	-	-	22
dichloroethane (DCE) C2H4Cl2	<1	-	<1	<1	-	<1	<1
vinyl chloride monomer (VCM)	<1	-	<1	<1	-	<1	<1
CFC/HCFC/HFC not specified	<1	-	<1	<1	-	-	<1
organo-chlorine not specified	<1	-	<1	<1	-	-	<1
HCN	<1	-	<1	<1	-	-	<1
CH4	1600	71	<1	7000	-	<1	8700
aromatic HC not specified	<1	-	<1	<1	-	<1	<1
polycyclic hydrocarbons (PAH)	<1	<1	<1	<1	-	-	<1
NM VOC	<1	-	<1	1	-	-	1
CS2	<1	-	<1	<1	-	-	<1
methylene chloride CH2Cl2	<1	-	<1	<1	-	-	<1
Cu+compounds as Cu	<1	<1	<1	<1	-	-	<1
As+compounds as As	-	-	-	<1	-	-	<1
Cd+compounds as Cd	<1	-	<1	<1	-	-	<1
Ag+compounds as Ag	-	-	-	<1	-	-	<1
Zn+compounds as Zn	<1	-	<1	<1	-	-	<1
Cr+compounds as Cr	<1	<1	<1	<1	-	-	<1
Se+compounds as Se	-	-	-	<1	-	-	<1
Ni+compounds as Ni	<1	<1	<1	<1	-	-	<1
Sb+compounds as Sb	-	-	<1	<1	-	-	<1
ethylene C2H4	-	-	<1	<1	-	-	<1
oxygen	-	-	-	<1	-	-	<1
asbestos	-	-	-	<1	-	-	<1
dioxin/furan as Teq	-	-	-	<1	-	-	<1
benzene C6H6	-	-	-	<1	-	<1	<1
toluene C7H8	-	-	-	<1	-	<1	<1
xylenes C8H10	-	-	-	<1	-	<1	<1
ethylbenzene C8H10	-	-	-	<1	-	<1	<1
styrene	-	-	-	<1	-	<1	<1
propylene	-	-	-	<1	-	-	<1

Table 7

Carbon dioxide equivalents corresponding to the gross air emissions for the production of 1 kg of ammonia. (Totals may not agree because of rounding)

Type	From fuel prod'n (mg)	From fuel use (mg)	From transport (mg)	From process (mg)	From biomass (mg)	From fugitive (mg)	Totals (mg)
20 year equiv	280000	1600000	2200	810000	-3	<1	2700000
100 year equiv	210000	1600000	2200	530000	-3	<1	2400000
500 year equiv	190000	1600000	2200	420000	-3	<1	2300000

Table 8

Gross emissions to water arising from the production of 1 kg of ammonia.
(Totals may not agree because of rounding).

Emission	From fuel prod'n (mg)	From fuel use (mg)	From transport (mg)	From process (mg)	Totals (mg)
COD	1	-	<1	610	610
BOD	<1	-	<1	<1	<1
Pb+compounds as Pb	<1	-	<1	<1	<1
Fe+compounds as Fe	<1	-	<1	<1	<1
Na+compounds as Na	<1	-	<1	230	230
acid as H+	<1	-	<1	15	15
NO3-	<1	-	<1	36	36
Hg+compounds as Hg	<1	-	<1	<1	<1
metals not specified	<1	-	<1	68	68
ammonium compounds	<1	-	<1	460	460
Cl-	<1	-	<1	640	640
CN-	<1	-	<1	<1	<1
F-	<1	-	<1	<1	<1
S+sulphides as S	<1	-	<1	<1	<1
dissolved organics	<1	-	<1	<1	<1
suspended solids	10	-	1	5	16
detergent/oil	<1	-	<1	<1	<1
hydrocarbons not	<1	<1	<1	<1	<1
organo-chlorine not	<1	-	<1	<1	<1
dissolved chlorine	<1	-	<1	<1	<1
phenols	<1	-	<1	<1	<1
dissolved solids not	<1	-	<1	200	200
P+compounds as P	<1	-	<1	<1	<1
other nitrogen as N	<1	-	<1	<1	<1
other organics not	<1	-	<1	<1	<1
SO4--	<1	-	<1	120	120
dichloroethane (DCE)	<1	-	<1	<1	<1
vinyl chloride monomer	<1	-	<1	<1	<1
K+compounds as K	<1	-	<1	<1	<1
Ca+compounds as Ca	<1	-	<1	<1	<1
Mg+compounds as Mg	<1	-	<1	<1	<1
Cr+compounds as Cr	<1	-	<1	<1	<1
ClO3--	<1	-	<1	<1	<1
BrO3--	<1	-	<1	<1	<1
TOC	<1	-	<1	<1	<1
AOX	<1	-	<1	<1	<1
Al+compounds as Al	<1	-	<1	<1	<1
Zn+compounds as Zn	<1	-	<1	<1	<1
Cu+compounds as Cu	<1	-	<1	<1	<1
Ni+compounds as Ni	<1	-	<1	<1	<1
CO3--	-	-	<1	<1	<1
As+compounds as As	-	-	<1	<1	<1
Cd+compounds as Cd	-	-	<1	<1	<1
Mn+compounds as Mn	-	-	<1	<1	<1
organo-tin as Sn	-	-	<1	<1	<1
Sr+compounds as Sr	-	-	<1	<1	<1
organo-silicon	-	-	-	<1	<1
benzene	-	-	-	<1	<1
dioxin/furan as Teq	-	-	<1	<1	<1

Table 9

Gross solid waste associated with the production of 1 kg of ammonia. (Totals may not agree because of rounding)

Emission	From fuel prod'n (mg)	From fuel use (mg)	From transport (mg)	From process (mg)	Totals (mg)
Plastic containers	<1	-	<1	<1	<1
Paper	<1	-	<1	<1	<1
Plastics	<1	-	<1	1	1
Metals	<1	-	<1	<1	<1
Putrescibles	<1	-	<1	<1	<1
Unspecified refuse	680	-	<1	<1	680
Mineral waste	8	-	11	93	110
Slags & ash	2900	60	4	98	3100
Mixed industrial	440	-	<1	5	440
Regulated chemicals	830	-	<1	39	870
Unregulated chemicals	630	-	<1	28	660
Construction waste	<1	-	<1	<1	<1
Waste to incinerator	<1	-	<1	1200	1200
Inert chemical	<1	-	<1	8600	8600
Wood waste	<1	-	<1	<1	<1
Wooden pallets	<1	-	<1	<1	<1
Waste to recycling	<1	-	<1	<1	<1
Waste returned to mine	7500	-	<1	<1	7500
Tailings	<1	-	<1	1	2
Municipal solid waste	-1600	-	-	<1	-1600
Note: Negative values correspond to consumption of waste e.g. recycling or use in electricity generation.					

Table 10

Gross solid waste in EU format associated with the production of 1 kg of ammonia. Entries marked with an asterisk (*) are considered hazardous as defined by EU Directive 91/689/EEC

Emission	Totals (mg)
010101 metallic min'l excav'n waste	19
010102 non-metal min'l excav'n waste	7600
010306 non 010304/010305 tailings	2
010308 non-010307 powdery wastes	1
010399 unspecified met. min'l wastes	<1
010408 non-010407 gravel/crushed rock	<1
010410 non-010407 powdery wastes	<1
010411 non-010407 potash/rock salt	2
010499 unsp'd non-met. waste	<1
010505*oil-bearing drilling mud/waste	810
010508 non-010504/010505 chloride mud	630
010599 unspecified drilling mud/waste	680
020107 wastes from forestry	<1
050106*oil ind. oily maint'e sludges	<1
050107*oil industry acid tars	<1
050199 unspecified oil industry waste	25
050699 coal pyrolysis unsp'd waste	6
060101*H ₂ SO ₄ /H ₂ SO ₃ MFSU waste	<1
060102*HCl MFSU waste	<1
060106*other acidic MFSU waste	<1
060199 unsp'd acid MFSU waste	<1
060204*NaOH/KOH MFSU waste	<1
060299 unsp'd base MFSU waste	<1
060313*h. metal salt/sol'n MFSU waste	2
060314 other salt/sol'n MFSU waste	<1
060399 unsp'd salt/sol'n MFSU waste	<1
060404*Hg MFSU waste	<1
060405*other h. metal MFSU waste	<1
060499 unsp'd metallic MFSU waste	<1
060602*dangerous sulphide MFSU waste	<1
060603 non-060602 sulphide MFSU waste	<1
060701*halogen electrol. asbestos waste	<1
060702*Cl pr. activated C waste	<1
060703*BaSO ₄ sludge with Hg	<1
060704*halogen pr. acids and sol'ns	1
060799 unsp'd halogen pr. waste	<1
061002*N ind. dangerous sub. waste	1200
061099 unsp'd N industry waste	4
070101*organic chem. aqueous washes	<1
070103*org. halogenated solv'ts/washes	<1
070107*hal'd still bottoms/residues	<1
070108*other still bottoms/residues	<1
070111*org. chem. dan. eff. sludge	<1
070112 non-070111 effluent sludge	<1
070199 unsp'd organic chem. waste	<1
070204*polymer ind. other washes	<1
070207*polymer ind. hal'd still waste	<1

continued over

Table 10 - continued

Gross solid waste in EU format associated with the production of 1 kg of ammonia. Entries marked with an asterisk () are considered hazardous as defined by EU Directive 91/689/EEC*

070208*polymer ind. other still waste	26
070209*polymer ind. hal'd fil. cakes	<1
070213 polymer ind. waste plastic	<1
070214*polymer ind. dan. additives	<1
070216 polymer ind. silicone wastes	<1
070299 unsp'd polymer ind. waste	<1
080199 unspecified paint/varnish waste	<1
100101 non-100104 ash, slag & dust	2900
100102 coal fly ash	<1
100104*oil fly ash and boiler dust	<1
100105 FGD Ca-based reac. solid waste	<1
100113*emulsified hydrocarbon fly ash	<1
100114*dangerous co-incin'n ash/slag	97
100115 non-100115 co-incin'n ash/slag	<1
100116*dangerous co-incin'n fly ash	<1
100199 unsp'd thermal process waste	14
100202 unprocessed iron/steel slag	7
100210 iron/steel mill scales	1
100399 unspecified aluminium waste	<1
100501 primary/secondary zinc slags	<1
100504 zinc pr. other dust	<1
100511 non-100511 Zn pr. skimmings	<1
101304 lime calcin'n/hydration waste	<1
130208*other engine/gear/lub. oil	13
150101 paper and cardboard packaging	<1
150102 plastic packaging	<1
150103 wooden packaging	<1
150106 mixed packaging	<1
170107 non-170106 con'e/brick/tile mix	<1
170904 non-170901/2/3 con./dem'n waste	<1
190199 unspecified incin'n/pyro waste	<1
190905 sat./spent ion exchange resins	8600
200101 paper and cardboard	<1
200108 biodeg. kitchen/canteen waste	<1
200138 non-200137 wood	<1
200139 plastics	1
200140 metals	<1
200199 other separately coll. frac'ns	-240
200301 mixed municipal waste	<1
200399 unspecified municipal wastes	-930
Note: Negative values correspond to consumption of waste e.g. recycling or	