



PlasticsEurope
Association of Plastics Manufacturers

*Eco-profiles of the
European Plastics Industry*

ACETONE CYANOHYDRIN

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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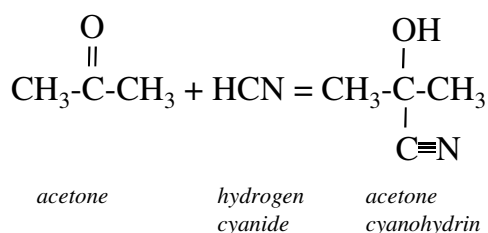
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ACETONE CYANOHYDRIN PRODUCTION

Acetone cyanohydrin is an intermediate used for the production of methyl methacrylate. It is produced by the direct reaction of acetone and hydrogen cyanide and follows the equation:



ECO-PROFILE OF ACETONE CYANOHYDRIN

Table 1 shows the gross or cumulative energy to produce 1 kg of acetone cyanohydrin 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 acetone cyanohydrin. (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	5.17	2.10	0.34	-	7.61
Oil fuels	1.03	15.37	0.10	20.40	36.90
Other fuels	1.43	20.22	0.05	12.08	33.77
Totals	7.63	37.69	0.49	32.47	78.28

Table 2

Gross primary fuels required to produce 1 kg of acetone cyanohydrin. (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	1.67	2.95	0.11	<0.01	4.73
Oil	1.12	15.52	0.19	20.40	37.23
Gas	2.64	30.41	0.10	12.00	45.16
Hydro	0.17	0.10	<0.01	-	0.27
Nuclear	1.91	0.80	0.08	-	2.78
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	0.07	0.07
Biomass (solid)	0.02	0.01	<0.01	<0.01	0.04
Hydrogen	<0.01	0.02	<0.01	-	0.02
Recovered energy	<0.01	-12.15	<0.01	-	-12.15
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)	0.04	0.01	<0.01	-	0.05
Industrial waste	0.01	<0.01	<0.01	-	0.01
Municipal Waste	0.03	0.01	<0.01	-	0.04
Wind	0.01	<0.01	<0.01	-	0.01
Totals	7.63	37.69	0.49	32.47	78.28

Table 3

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

Fuel type	Input in mg
Crude oil	830000
Gas/condensate	870000
Coal	170000
Metallurgical coal	98
Lignite	4
Peat	130
Wood	29

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

Raw material	Input in mg
Air	390000
Animal matter	<1
Barytes	82
Bauxite	58
Bentonite	44
Biomass (including water)	10000
Calcium sulphate (CaSO ₄)	4
Chalk (CaCO ₃)	<1
Clay	<1
Cr	<1
Cu	1
Dolomite	3
Fe	240
Feldspar	<1
Ferromanganese	<1
Fluorspar	4
Granite	<1
Gravel	1
Hg	<1
Limestone (CaCO ₃)	3000
Mg	<1
N ₂	110000
Ni	<1
O ₂	19000
Olivine	2
Pb	1
Phosphate as P ₂ O ₅	1700
Potassium chloride (KCl)	1
Quartz (SiO ₂)	<1
Rutile	<1
S (bonded)	<1
S (elemental)	7700
Sand (SiO ₂)	3200
Shale	12
Sodium chloride (NaCl)	24000
Sodium nitrate (NaNO ₃)	<1
Talc	<1
Unspecified	<1
Zn	<1

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

Source	Use for processing (mg)	Use for cooling (mg)	Totals (mg)
Public supply	4000000	-	4000000
River canal	590000	15000000	15000000
Sea	260000	5100000	5300000
Well	190000	37000	230000
Unspecified	2300000	35000000	38000000
Totals	7400000	55000000	63000000

Table 6

Gross air emissions associated with the production of 1 kg of acetone cyanohydrin. (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)	580	430	3	180	-	-	1200
CO	1800	980	38	330	-	-	3100
CO2	490000	2300000	9700	230000	-19	-	3000000
SOX as SO2	2100	9800	120	360	-	-	12000
H2S	<1	-	<1	<1	-	-	<1
mercaptan	<1	<1	<1	<1	-	-	<1
NOX as NO2	1500	4600	71	250	-	-	6400
NH3	<1	-	<1	30	-	-	30
Cl2	<1	<1	<1	<1	-	-	<1
HCl	46	45	<1	<1	-	-	91
F2	<1	<1	<1	<1	-	-	<1
HF	2	2	<1	<1	-	-	3
hydrocarbons not specified	1900	630	21	4700	-	1	7200
aldehyde (-CHO)	<1	-	<1	100	-	-	100
organics	<1	<1	<1	1300	-	-	1300
Pb+compounds as Pb	<1	<1	<1	<1	-	-	<1
Hg+compounds as Hg	<1	-	<1	<1	-	-	<1
metals not specified elsewhere	1	5	<1	<1	-	-	5
H2SO4	<1	-	<1	<1	-	-	<1
N2O	<1	<1	<1	<1	-	-	<1
H2	45	<1	<1	21	-	-	67
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	14	-	-	14
CH4	30000	800	<1	2400	-	<1	33000
aromatic HC not specified	<1	-	<1	17	-	1	18
polycyclic hydrocarbons (PAH)	<1	2	<1	<1	-	-	2
NM VOC	<1	-	<1	19	-	-	19
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	2	<1	<1	-	-	2
Sb+compounds as Sb	-	-	<1	<1	-	-	<1
ethylene C2H4	-	-	<1	3	-	-	3
oxygen	-	-	-	<1	-	-	<1
asbestos	-	-	-	<1	-	-	<1
dioxin/furan as Teq	-	-	-	<1	-	-	<1
benzene C6H6	-	-	-	1	-	6	6
toluene C7H8	-	-	-	<1	-	1	1
xylenes C8H10	-	-	-	<1	-	<1	<1
ethylbenzene C8H10	-	-	-	<1	-	<1	<1
styrene	-	-	-	<1	-	<1	<1
propylene	-	-	-	2	-	-	2

Table 7

Carbon dioxide equivalents corresponding to the gross air emissions for the production of 1 kg of acetone cyanohydrin. (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	2400000	2300000	9800	390000	-19	16	5100000
100 year equiv	1200000	2300000	9800	300000	-19	8	3800000
500 year equiv	710000	2300000	9800	260000	-19	4	3300000

Table 8

Gross emissions to water arising from the production of 1 kg of acetone cyanohydrin. (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	3	-	<1	380	380
BOD	1	-	<1	45	45
Pb+compounds as Pb	<1	-	<1	<1	<1
Fe+compounds as Fe	<1	-	<1	<1	<1
Na+compounds as Na	<1	-	<1	8500	8500
acid as H+	1	-	<1	28	29
NO3-	<1	-	<1	10	10
Hg+compounds as Hg	<1	-	<1	<1	<1
metals not specified elsewhere	<1	-	<1	72	72
ammonium compounds as NH4+	1	-	<1	200	200
Cl-	1	-	<1	7400	7400
CN-	<1	-	<1	12	12
F-	<1	-	<1	1	1
S+sulphides as S	<1	-	<1	<1	<1
dissolved organics (non-	1	-	<1	850	850
suspended solids	41	-	6	660	700
detergent/oil	<1	-	<1	13	13
hydrocarbons not specified	5	<1	<1	1	6
organo-chlorine not specified	<1	-	<1	<1	<1
dissolved chlorine	<1	-	<1	<1	<1
phenols	<1	-	<1	1	1
dissolved solids not specified	<1	-	<1	270	270
P+compounds as P	<1	-	<1	540	540
other nitrogen as N	<1	-	<1	1	1
other organics not specified	<1	-	<1	<1	<1
SO4--	<1	-	<1	4000	4000
dichloroethane (DCE)	<1	-	<1	<1	<1
vinyl chloride monomer (VCM)	<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	18	18
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	57	57
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 acetone cyanohydrin. (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	6	6
Metals	<1	-	<1	<1	<1
Putrescibles	<1	-	<1	<1	<1
Unspecified refuse	2800	-	<1	<1	2800
Mineral waste	21	-	60	1500	1600
Slags & ash	6800	4500	23	310	12000
Mixed industrial	2100	-	2	310	2400
Regulated chemicals	3400	-	<1	260	3700
Unregulated chemicals	2600	-	<1	430	3000
Construction waste	<1	-	<1	17	17
Waste to incinerator	<1	-	<1	320	320
Inert chemical	<1	-	<1	8600	8600
Wood waste	<1	-	<1	1	1
Wooden pallets	<1	-	<1	<1	<1
Waste to recycling	<1	-	<1	150	150
Waste returned to mine	32000	-	2	160	32000
Tailings	1	-	2	53	56
Municipal solid waste	-3600	-	-	<1	-3600
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 acetone cyanohydrin. 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	290
010102 non-metal min'l excav'n waste	33000
010306 non 010304/010305 tailings	4
010308 non-010307 powdery wastes	3
010399 unspecified met. min'l wastes	17
010408 non-010407 gravel/crushed rock	<1
010410 non-010407 powdery wastes	<1
010411 non-010407 potash/rock salt	16
010499 unsp'd non-met. waste	<1
010505*oil-bearing drilling mud/waste	3300
010508 non-010504/010505 chloride mud	2600
010599 unspecified drilling mud/waste	2800
020107 wastes from forestry	1
050106*oil ind. oily maint'e sludges	3
050107*oil industry acid tars	150
050199 unspecified oil industry waste	220
050699 coal pyrolysis unsp'd waste	16
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	16
060314 other salt/sol'n MFSU waste	<1
060399 unsp'd salt/sol'n MFSU waste	380
060404*Hg MFSU waste	<1
060405*other h. metal MFSU waste	<1
060499 unsp'd metallic MFSU waste	4
060602*dangerous sulphide MFSU waste	<1
060603 non-060602 sulphide MFSU waste	15
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	6
060799 unsp'd halogen pr. waste	3
061002*N ind. dangerous sub. waste	240
061099 unsp'd N industry waste	1
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	37
070111*org. chem. dan. eff. sludge	<1
070112 non-070111 effluent sludge	6
070199 unsp'd organic chem. waste	49
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 acetone cyanohydrin. Entries marked with an asterisk () are considered hazardous as defined by EU Directive 91/689/EEC*

070208*polymer ind. other still waste	190
070209*polymer ind. hal'd fil. cakes	<1
070213 polymer ind. waste plastic	1
070214*polymer ind. dan. additives	150
070216 polymer ind. silicone wastes	<1
070299 unsp'd polymer ind. waste	490
080199 unspecified paint/varnish waste	<1
100101 non-100104 ash, slag & dust	11000
100102 coal fly ash	190
100104*oil fly ash and boiler dust	<1
100105 FGD Ca-based reac. solid waste	<1
100113*emulsified hyrdocarbon fly ash	<1
100114*dangerous co-incin'n ash/slag	67
100115 non-100115 co-incin'n ash/slag	1
100116*dangerous co-incin'n fly ash	<1
100199 unsp'd themal process waste	4
100202 unprocessed iron/steel slag	73
100210 iron/steel mill scales	5
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	6
130208*other engine/gear/lub. oil	3
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	17
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	5
200140 metals	<1
200199 other separately coll. frac'ns	-740
200301 mixed municipal waste	1
200399 unspecified municipal wastes	-760