Eco-profiles of the
European Plastics Industry

ETHYLENE DICHLORIDE

A report by

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for

The European Council of Vinyl Manufacturers
(ECVM) & Plastics*Europe*

Data last calculated

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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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ETHYLENE DICHLORIDE

Ethylene dichloride ($C_2H_4Cl_2$) is a colourless, oily liquid that is used in the production of polyvinylchloride (PVC), chlorinated hydrocarbons and polyvinylidene chloride (PVdC).

PRODUCTION ROUTE

Ethylene and chlorine can be reacted directly in the liquid or gaseous phases to produce 1,2-dichloroethane (ethylene dichloride) according to the equation:

$$C_2H_4(g) + Cl_2(g) = C_2H_4Cl_2(g) \qquad (1)$$

When used in the production of vinyl chloride (for PVC production), 1,2-dichloroethane is converted to vinyl chloride monomer (C_2H_3Cl) by heating in a high temperature furnace (cracking). It then decomposes to produce vinyl chloride and hydrogen chloride according to the reaction:

$$C_2H_4Cl_2(g) = C_2H_3Cl(g) + HCl(g) \qquad (2)$$

If the process were stopped at this stage, it is clear that 50% of the input of chlorine would be lost from the system and, unless there were a sufficient demand for hydrogen chloride, this would represent a significant loss of raw materials. In practice, however, the hydrogen chloride from reaction (2) can be reacted with further ethylene in the presence of oxygen (a reaction known as oxychlorination), to produce further 1,2-dichloroethane:

$$C_2H_4(g) + 2HCl(g) + \tfrac{1}{2}O_2(g) = C_2H_4Cl_2(g) + H_2O(l) \qquad (3)$$

By carrying out direct chlorination and oxychlorination in tandem, it is clear that the whole of the chlorine input can be utilised.

Frequently it is not possible to separate the production of EDC from that of vinyl chloride because the plants are closely inter-linked. However, for 8 of the plants examined it is possible to isolate the production data for EDC. For these plants. the average process inputs are given in Table 1.

Table 1
Average process inputs for the production of 1 kg of EDC.

Input	Quantity	
Ethylene	0.306	kg
Chlorine	0.714	kg
HCl gas	0.021	kg
NaOH	0.003	kg
Other chemicals	0.001	kg
Process water	0.504	kg
Cooling water	49.329	kg
Electricity	0.379	MJ
Thermal fuels	1.794	MJ
Steam	0.044	kg
Compressed air	0.020	cu m
Nitrogen	0.006	kg
Oxygen	0.052	kg

ECOPROFILE OF ETHYLENE DICHLORIDE

Table 2 shows the gross or cumulative energy to produce 1 kg of ethylene dichloride and Table 3 gives this same data expressed in terms of primary fuels. Table 4 shows the energy data expressed as masses of fuels. Table 5 shows the raw materials requirements and Table 6 shows the demand for water. Table 7 shows the gross air emissions and Table 8 shows the corresponding carbon dioxide equivalents of these air emissions. Table 9 shows the emissions to water. Table 10 shows the solid waste generated and Table 11 gives the solid waste in EU format.

Table 2
Gross energy required to produce 1 kg of ethylene dichloride. (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	8.28	4.30	0.22	-	12.81
Oil fuels	0.18	3.34	0.07	8.41	12.00
Other fuels	0.34	6.17	0.03	7.14	13.68
Totals	8.80	13.80	0.33	15.54	38.48

Table 3
Gross primary fuels required to produce 1 kg of ethylene dichloride. (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	1.81	1.98	0.05	0.18	4.02
Oil	1.33	3.93	0.18	8.41	13.85
Gas	1.92	6.46	0.05	6.93	15.36
Hydro	0.75	0.59	<0.01	-	1.35
Nuclear	2.66	1.40	0.04	-	4.10
Lignite	0.01	<0.01	<0.01	-	0.01
Wood	<0.01	<0.01	<0.01	0.03	0.03
Sulphur	<0.01	<0.01	<0.01	<0.01	<0.01
Biomass (solid)	0.05	0.03	<0.01	<0.01	0.08
Hydrogen	<0.01	0.08	<0.01	-	0.08
Recovered energy	<0.01	-0.80	<0.01	-	-0.80
Unspecified	<0.01	<0.01	<0.01	-	<0.01
Peat	<0.01	<0.01	<0.01	-	<0.01
Geothermal	0.14	0.07	<0.01	-	0.21
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	-	0.04
Industrial waste	0.03	0.02	<0.01	-	0.05
Municipal Waste	0.05	0.03	<0.01	-	0.08
Wind	0.02	0.01	<0.01	-	0.03
Totals	8.80	13.80	0.33	15.54	38.48

Table 4
Gross primary fuels used to produce 1 kg of ethylene dichloride expressed as mass.

Fuel type	Input in mg
Crude oil	310000
Gas/condensate	300000
Coal	140000
Metallurgical coal	54
Lignite	660
Peat	350
Wood	3200

Table 5
Gross raw materials required to produce 1 kg of ethylene dichloride.

Raw material	Input in mg
Air	100000
Animal matter	<1
Barytes	190
Bauxite	2
Bentonite	15
Biomass (including water)	13000
Calcium sulphate (CaSO4)	2
Chalk (CaCO3)	<1
Clay	2
Cr	<1
Cu	39
Dolomite	2
Fe	130
Feldspar	<1
Ferromanganese	<1
Fluorspar	<1
Granite	<1
Gravel	<1
Hg	3
Limestone (CaCO3)	19000
Mg	<1
N2	28000
Ni	<1
O2	36000
Olivine	1
Pb	1
Phosphate as P2O5	<1
Potassium chloride (KCl)	1200
Quartz (SiO2)	<1
Rutile	<1
S (bonded)	<1
S (elemental)	-540
Sand (SiO2)	91
Shale	4
Sodium chloride (NaCl)	1100000
Sodium nitrate (NaNO3)	<1
Talc	<1
Unspecified	<1
Zn	<1

Table 6
Gross water consumption required for the production of 1 kg of ethylene dichloride. (Totals may not agree because of rounding)

Source	Use for processing (mg)	Use for cooling (mg)	Totals (mg)
Public supply	490000	-	490000
River canal	210000	3300000	3600000
Sea	62000	27000000	27000000
Well	<1	1	1
Unspecified	3800000	6900000	11000000
Totals	4600000	37000000	42000000

Table 7
Gross air emissions associated with the production of 1 kg of ethylene dichloride. (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)	360	98	2	250	-	-	710
CO	870	270	24	140	-	-	1300
CO2	560000	730000	7100	50000	-2900	-	1300000
SOX as SO2	3900	1800	99	190	-	-	6000
H2S	<1	-	<1	<1	-	-	<1
mercaptan	<1	<1	<1	<1	-	-	<1
NOX as NO2	1800	1300	49	86	-	-	3200
NH3	<1	-	<1	3	-	-	3
Cl2	<1	<1	<1	150	-	-	150
HCl	50	12	<1	12	-	-	73
F2	<1	<1	<1	<1	-	-	<1
HF	2	<1	<1	<1	-	-	2
hydrocarbons not specified	850	120	14	400	-	<1	1400
aldehyde (-CHO)	<1	-	<1	<1	-	-	<1
organics	<1	<1	<1	28	-	-	28
Pb+compounds as Pb	<1	<1	<1	<1	-	-	<1
Hg+compounds as Hg	<1	-	<1	<1	-	-	<1
metals not specified elsewhere	2	1	<1	<1	-	-	3
H2SO4	<1	-	<1	<1	-	-	<1
N2O	<1	<1	<1	<1	-	-	<1
H2	42	<1	<1	1200	-	-	1200
dichloroethane (DCE) C2H4Cl2	<1	-	<1	32	-	15	46
vinyl chloride monomer (VCM)	<1	-	<1	3	-	3	6
CFC/HCFC/HFC not specified	<1	-	<1	12	-	-	12
organo-chlorine not specified	<1	-	<1	4	-	-	4
HCN	<1	-	<1	<1	-	-	<1
CH4	11000	290	<1	1200	-	<1	12000
aromatic HC not specified elsewhere	<1	-	<1	11	-	<1	11
polycyclic hydrocarbons (PAH)	<1	<1	<1	<1	-	-	<1
NMVOC	<1	-	<1	23	-	-	23
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	14	-	-	14
oxygen	-	-	-	2	-	-	2
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 8
Carbon dioxide equivalents corresponding to the gross air emissions for the production of 1 kg of ethylene dichloride. (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	1200000	750000	7200	130000	-2900	<1	2100000
100 year equiv	810000	730000	7200	80000	-2900	<1	1600000
500 year equiv	640000	730000	7200	60000	-2900	<1	1400000

Table 9

Gross emissions to water arising from the production of 1 kg of ethylene dichloride. (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	2	-	<1	110	110
BOD	<1	-	<1	14	14
Pb+compounds as Pb	<1	-	<1	<1	<1
Fe+compounds as Fe	<1	-	<1	2	2
Na+compounds as Na	<1	-	<1	33000	33000
acid as H+	2	-	<1	3	6
NO3-	<1	-	<1	1	1
Hg+compounds as Hg	<1	-	<1	<1	<1
metals not specified elsewhere	1	-	<1	6	6
ammonium compounds as NH4+	2	-	<1	2	4
Cl-	<1	-	<1	51000	51000
CN-	<1	-	<1	<1	<1
F-	<1	-	<1	<1	<1
S+sulphides as S	<1	-	<1	<1	<1
dissolved organics (non-	<1	-	<1	2	3
suspended solids	37	-	4	5800	5800
detergent/oil	<1	-	<1	3	3
hydrocarbons not specified	2	<1	<1	<1	2
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	22000	22000
P+compounds as P	<1	-	<1	3	3
other nitrogen as N	1	-	<1	6	7
other organics not specified	<1	-	<1	<1	<1
SO4--	<1	-	<1	2900	2900
dichloroethane (DCE)	<1	-	<1	1	1
vinyl chloride monomer (VCM)	<1	-	<1	<1	<1
K+compounds as K	<1	-	<1	38	38
Ca+compounds as Ca	<1	-	<1	190	190
Mg+compounds as Mg	<1	-	<1	1	1
Cr+compounds as Cr	<1	-	<1	<1	<1
ClO3--	<1	-	<1	180	180
BrO3--	<1	-	<1	<1	<1
TOC	<1	-	<1	5	5
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	290	290
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 10
Gross solid waste associated with the production of 1 kg of ethylene dichloride. (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	240	240
Metals	<1	-	<1	<1	<1
Putrescibles	<1	-	<1	<1	<1
Unspecified refuse	920	-	<1	<1	920
Mineral waste	190	-	35	6600	6900
Slags & ash	10000	1200	14	2900	14000
Mixed industrial	-1300	-	1	1000	-290
Regulated chemicals	1100	-	<1	2200	3300
Unregulated chemicals	860	-	<1	2100	2900
Construction waste	<1	-	<1	2	2
Waste to incinerator	<1	-	<1	3300	3300
Inert chemical	<1	-	<1	620	620
Wood waste	<1	-	<1	64	64
Wooden pallets	<1	-	<1	<1	<1
Waste to recycling	<1	-	<1	440	440
Waste returned to mine	27000	-	1	3100	30000
Tailings	1	-	1	1600	1600
Municipal solid waste	-7700	-	-	<1	-7700
Note: Negative values correspond to consumption of waste e.g. recycling or use in electricity generation.					

Table 11
Gross solid waste in EU format associated with the production of 1 kg of ethylene dichloride. 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	610
010102 non-metal min'l excav'n waste	29000
010306 non 010304/010305 tailings	2
010308 non-010307 powdery wastes	2
010399 unspecified met. min'l wastes	170
010408 non-010407 gravel/crushed rock	61
010410 non-010407 powdery wastes	<1
010411 non-010407 potash/rock salt	5000
010499 unsp'd non-met. waste	2
010505*oil-bearing drilling mud/waste	1100
010508 non-010504/010505 chloride mud	860
010599 unspecified drilling mud/waste	920
020107 wastes from forestry	64
050106*oil ind. oily maint'e sludges	1
050107*oil industry acid tars	57
050199 unspecified oil industry waste	81
050699 coal pyrolysis unsp'd waste	50
060101*H2SO4/H2SO3 MFSU waste	8
060102*HCl MFSU waste	3
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	2700
060314 other salt/sol'n MFSU waste	180
060399 unsp'd salt/sol'n MFSU waste	440
060404*Hg MSFU waste	81
060405*other h. metal MFSU waste	710
060499 unsp'd metallic MFSU waste	480
060602*dangerous sulphide MFSU waste	<1
060603 non-060602 sulphide MFSU waste	-1
060701*halogen electrol. asbestos waste	120
060702*Cl pr. activated C waste	<1
060703*BaSO4 sludge with Hg	32
060704*halogen pr. acids and sol'ns	140
060799 unsp'd halogen pr. waste	550
061002*N ind. dangerous sub. waste	<1
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	740
070108*other still bottoms/residues	3
070111*org. chem. dan. eff. sludge	<1
070112 non-070111 effluent sludge	<1

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Table 11 - continued
Gross solid waste in EU format associated with the production of 1 kg of ethylene dichloride. Entries marked with an asterisk (*) are considered hazardous as defined by EU Directive 91/689/EEC

070199 unsp'd organic chem. waste	63
070204*polymer ind. other washes	<1
070207*polymer ind. hal'd still waste	3500
070208*polymer ind. other still waste	460
070209*polymer ind. hal'd fil. cakes	<1
070213 polymer ind. waste plastic	<1
070214*polymer ind. dan. additives	140
070216 polymer ind. silicone wastes	<1
070299 unsp'd polymer ind. waste	270
080199 unspecified paint/varnish waste	<1
100101 non-100104 ash, slag & dust	11000
100102 coal fly ash	150
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	9
100115 non-100115 co-incin'n ash/slag	180
100116*dangerous co-incin'n fly ash	<1
100199 unsp'd themal process waste	100
100202 unprocessed iron/steel slag	40
100210 iron/steel mill scales	3
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	2
130208*other engine/gear/lub. oil	<1
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	620
200101 paper and cardboard	<1
200108 biodeg. kitchen/canteen waste	<1
200138 non-200137 wood	<1
200139 plastics	240
200140 metals	<1
200199 other separately coll. frac'ns	-2300
200301 mixed municipal waste	<1
200399 unspecified municipal wastes	-6800
Note: Negative values correspond to consumption of waste e.g. recycling or	