

*Eco-profiles of the  
European Plastics Industry*

**PENTANE**

*A report by*

**I Boustead**

*for*

**PlasticsEurope**

*Data last calculated*

**March 2005**

## 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](http://www.plasticseurope.org).

Plastics*Europe* may be contacted at

Ave E van Nieuwenhuyse 4  
Box 3  
B-1160 Brussels

Telephone: 32-2-672-8259  
Fax: 32-2-675-3935

# CONTENTS

<b>PENTANE.....</b>	<b>4</b>
<b>ECO-PROFILE OF PENTANE.....</b>	<b>4</b>

## PENTANE

Pentane is a saturated hydrocarbon with the empirical formula  $C_5H_{12}$ . It is a colourless liquid with a boiling point of 36°C and is widely used as a blowing agent in the production of foamed plastics.

It occurs naturally as one of the components of crude oil and is extracted and purified in oil refining. It is also produced in smaller quantities in a number of hydrocarbon reactions such as the production of iso-butane.

In the data reported here approximately 90% is derived from oil refining and 10% from by-product pentane.

## ECO-PROFILE OF PENTANE

Table 1 shows the gross or cumulative energy to produce 1 kg of pentane 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 pentane. (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	2.34	0.41	0.50	-	3.25
Oil fuels	0.10	31.46	0.14	45.36	77.06
Other fuels	0.16	3.19	<0.01	1.79	5.14
Totals	2.60	35.06	0.65	47.15	85.45

*Table 2*

*Gross primary fuels required to produce 1 kg of pentane. (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	0.47	0.09	0.17	<0.01	0.73
Oil	1.04	31.73	0.18	45.36	78.31
Gas	0.65	3.33	0.16	1.79	5.93
Hydro	0.02	<0.01	<0.01	-	0.03
Nuclear	0.39	0.06	0.12	-	0.57
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)	0.01	<0.01	<0.01	<0.01	0.01
Hydrogen	<0.01	<0.01	<0.01	-	<0.01
Recovered energy	<0.01	-0.17	<0.01	-	-0.17
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	-	0.02
Industrial waste	<0.01	<0.01	<0.01	-	<0.01
Municipal Waste	0.01	<0.01	<0.01	-	0.01
Wind	<0.01	<0.01	<0.01	-	<0.01
Totals	2.60	35.06	0.65	47.15	85.45

*Table 3*

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

Fuel type	Input in mg
Crude oil	1700000
Gas/condensate	110000
Coal	26000
Metallurgical coal	15
Lignite	<1
Peat	29
Wood	8

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

Raw material	Input in mg
Air	98000
Animal matter	<1
Barytes	<1
Bauxite	<1
Bentonite	5
Biomass (including water)	3900
Calcium sulphate (CaSO <sub>4</sub> )	1
Chalk (CaCO <sub>3</sub> )	<1
Clay	<1
Cr	<1
Cu	<1
Dolomite	<1
Fe	36
Feldspar	<1
Ferromanganese	<1
Fluorspar	<1
Granite	<1
Gravel	<1
Hg	<1
Limestone (CaCO <sub>3</sub> )	37
Mg	<1
N <sub>2</sub>	18000
Ni	<1
O <sub>2</sub>	1
Olivine	<1
Pb	<1
Phosphate as P <sub>2</sub> O <sub>5</sub>	<1
Potassium chloride (KCl)	<1
Quartz (SiO <sub>2</sub> )	<1
Rutile	<1
S (bonded)	<1
S (elemental)	6
Sand (SiO <sub>2</sub> )	7
Shale	2
Sodium chloride (NaCl)	1300
Sodium nitrate (NaNO <sub>3</sub> )	<1
Talc	<1
Unspecified	<1
Zn	<1

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

Source	Use for processing (mg)	Use for cooling (mg)	Totals (mg)
Public supply	31000	-	31000
River canal	47000	110000	160000
Sea	33000	290000	320000
Well	<1	<1	<1
Unspecified	760000	3500000	4200000
Totals	870000	3900000	4800000

Table 6

Gross air emissions associated with the production of 1 kg of pentane. (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)	170	31	<1	310	-	-	510
CO	1200	210	6	720	-	-	2100
CO2	210000	580000	10000	130000	-8	-	940000
SOX as SO2	800	680	200	880	-	-	2600
H2S	<1	-	<1	<1	-	-	<1
mercaptan	<1	<1	<1	<1	-	-	<1
NOX as NO2	1300	790	51	240	-	-	2400
NH3	<1	-	<1	<1	-	-	<1
Cl2	<1	<1	<1	<1	-	-	<1
HCl	13	1	<1	<1	-	-	13
F2	<1	<1	<1	<1	-	-	<1
HF	<1	<1	<1	<1	-	-	<1
hydrocarbons not specified	480	59	17	2600	-	<1	3200
aldehyde (-CHO)	<1	-	<1	<1	-	-	<1
organics	<1	<1	<1	17	-	-	17
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	19	<1	<1	5	-	-	24
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	3800	160	<1	2600	-	<1	6600
aromatic HC not specified	<1	-	<1	4	-	<1	4
polycyclic hydrocarbons (PAH)	<1	<1	<1	6	-	-	6
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
xylene 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 pentane. (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	450000	600000	10000	310000	-8	<1	1400000
100 year equiv	300000	590000	10000	200000	-8	<1	1100000
500 year equiv	240000	590000	10000	160000	-8	<1	1000000



Table 8

Gross emissions to water arising from the production of 1 kg of pentane.  
(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	44	45
BOD	<1	-	<1	7	7
Pb+compounds as Pb	<1	-	<1	<1	<1
Fe+compounds as Fe	<1	-	<1	<1	<1
Na+compounds as Na	<1	-	<1	160	160
acid as H+	<1	-	<1	<1	<1
NO <sub>3</sub> -	<1	-	<1	1	1
Hg+compounds as Hg	<1	-	<1	<1	<1
metals not specified elsewhere	<1	-	<1	1	1
ammonium compounds as NH <sub>4</sub> +	<1	-	<1	3	4
Cl-	<1	-	<1	64	64
CN-	<1	-	<1	<1	<1
F-	<1	-	<1	<1	<1
S+sulphides as S	<1	-	<1	<1	<1
dissolved organics (non-	<1	-	<1	39	39
suspended solids	7	-	<1	510	520
detergent/oil	<1	-	<1	2	2
hydrocarbons not specified	1	<1	<1	<1	1
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	33	33
P+compounds as P	<1	-	<1	<1	<1
other nitrogen as N	<1	-	<1	<1	<1
other organics not specified	<1	-	<1	<1	<1
SO <sub>4</sub> --	<1	-	<1	44	44
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
ClO <sub>3</sub> --	<1	-	<1	<1	<1
BrO <sub>3</sub> --	<1	-	<1	<1	<1
TOC	<1	-	<1	20	20
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
CO <sub>3</sub> --	-	-	<1	8	8
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 pentane. (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	570	-	<1	<1	570
Mineral waste	11	-	4	30	45
Slags & ash	1700	69	2	94	1900
Mixed industrial	540	-	<1	700	1200
Regulated chemicals	700	-	<1	510	1200
Unregulated chemicals	530	-	<1	88	620
Construction waste	<1	-	<1	<1	<1
Waste to incinerator	<1	-	<1	5	6
Inert chemical	<1	-	<1	48	48
Wood waste	<1	-	<1	<1	<1
Wooden pallets	<1	-	<1	<1	<1
Waste to recycling	<1	-	<1	12	12
Waste returned to mine	5000	-	<1	<1	5000
Tailings	<1	-	<1	<1	1
Municipal solid waste	-930	-	-	<1	-930
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 pentane. 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	28
010102 non-metal min'l excav'n waste	5000
010306 non 010304/010305 tailings	1
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	4
010499 unsp'd non-met. waste	<1
010505*oil-bearing drilling mud/waste	680
010508 non-010504/010505 chloride mud	530
010599 unspecified drilling mud/waste	570
020107 wastes from forestry	<1
050106*oil ind. oily maint'e sludges	63
050107*oil industry acid tars	420
050199 unspecified oil industry waste	750
050699 coal pyrolysis unsp'd waste	7
060101*H <sub>2</sub> SO <sub>4</sub> /H <sub>2</sub> SO <sub>3</sub> 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	4
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 <sub>4</sub> sludge with Hg	<1
060704*halogen pr. acids and sol'ns	2
060799 unsp'd halogen pr. waste	1
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	<1
070108*other still bottoms/residues	2
070111*org. chem. dan. eff. sludge	<1
070112 non-070111 effluent sludge	<1

continued over .....

*Table 10 - continued*

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

070199 unsp'd organic chem. waste	10
070204*polymer ind. other washes	<1
070207*polymer ind. hal'd still waste	<1
070208*polymer ind. other still waste	14
070209*polymer ind. hal'd fil. cakes	<1
070213 polymer ind. waste plastic	<1
070214*polymer ind. dan. additives	26
070216 polymer ind. silicone wastes	<1
070299 unsp'd polymer ind. waste	30
080199 unspecified paint/varnish waste	<1
100101 non-100104 ash, slag & dust	1800
100102 coal fly ash	81
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	5
100115 non-100115 co-incin'n ash/slag	<1
100116*dangerous co-incin'n fly ash	<1
100199 unsp'd themal process waste	<1
100202 unprocessed iron/steel slag	11
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	<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	48
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	-29
200301 mixed municipal waste	<1
200399 unspecified municipal wastes	-350
Note: Negative values correspond to consumption of waste e.g. recycling or	