



Eco-profiles and Environmental Product Declarations of the European Plastics Manufacturers

Benzene, Toluene, and Xylenes (Aromatics, BTX)

PlasticsEurope
February 2013

Environmental Product Declaration

This Environmental Product Declaration (EPD) is based upon life cycle inventory (LCI) data from PlasticsEurope's Eco-profile programme. It has been prepared according to **PlasticsEurope's Eco-profiles and Environmental Declarations – LCI Methodology and PCR for Uncompounded Polymer Resins and Reactive Polymer Precursors** (PCR version 2.0, April 2011). EPDs provide environmental performance data, but no information on the economic and social aspects which would be necessary for a complete sustainability assessment. Further, they do not imply a value judgment between environmental criteria. This EPD describes the production of the polymer precursors benzene, toluene, and xylenes (BTX) from cradle to gate (i.e. from crude oil extraction to liquid BTX at plant). **Please keep in mind that comparisons cannot be made on the level of the precursors:** it is necessary to consider the full life cycle of an application in order to compare the performance of different materials and the effects of relevant life cycle parameters. This EPD is intended to be used by member companies, to support product-orientated environmental management; by users of plastics, as a building block of life cycle assessment (LCA) studies of individual products; and by other interested parties, as a source of life cycle information.

Meta Data

Data Owner	PlasticsEurope & CEFIC/APPE
LCA Practitioner	IFEU – Institut für Energie- und Umweltforschung Heidelberg
Programme Owner	PlasticsEurope aisbl
Programme Manager, Reviewer	DEKRA Consulting GmbH
Number of plants included in data collection	50 steam cracker units; complemented by desktop study of subsequent steps.
Representativeness	Production in EU27 countries + Norway
Reference year	2010
Year of data collection and calculation	2007–2010
Expected temporal validity	2014
Cut-offs	None
Data Quality	Good
Allocation method	Mass allocation, except for: energy allocation for refinery

Description of the Product and the Production Process

This Eco-profile and EPD represents the average industrial production of several petrochemical polymer precursors from cradle to gate.

Production Process

Benzene, toluene, and xylenes are produced from three different feedstocks: (a) pyrolysis gasoline, a by-product of steam cracking of saturated hydrocarbons; (b) reformate, a product of catalytic reforming of naphtha; and (c) light oil, a condensate fraction of coke oven gas from coal pyrolysis. While benzene is predominantly (61 %) produced from pyrolysis gasoline, toluene and xylenes are mostly produced from reformate (70 and 86 %, respectively). This results in quite different environmental indicators. The model for this Eco-profile comprises extraction and refinery of crude oil and natural gas; steam cracking of hydrocarbons into lower olefins; catalytic reforming of naphtha; and the extraction of BTX from pygas and reformate. Additionally, hydrodealkylation of toluene is used for on-purpose production of benzene.

Data Sources and Allocation

The modelling of steam cracking, catalytic reforming, and petroleum refinery is based on confidential process and emission data from several sites. Recent data for energy consumption, feedstock mix and CO₂ emissions have been provided by APPE for the majority of European steam crackers. Representative literature data have been used for the modelling of the extraction and production of BTX from pygas and reformate. The processes for BTX extraction and production have been allocated by mass; the petroleum refinery has been allocated by energy.

Use Phase and End-of-Life Management

Disposal of waste from production processes is considered within the system boundaries this Eco-profile. The use phase and end-of-life processes of the polymer precursors are outside the system boundaries of this cradle-to-gate system.

Environmental Performance

The tables below show the environmental performance indicators associated with the production of 1 kg of each respective polymer precursor. Please see the Eco-profile report for explanations.

Input Parameters

Indicator	Unit	Benzene	Toluene	p-Xylene	o-Xylene	Mixed Xylenes
Non-renewable energy resources ¹⁾						
• Fuel energy	MJ	29.1	16.1	18.3	18.6	8.1
• Feedstock energy	MJ	50.8	49.5	49.2	49.2	49.2
Renewable energy resources (biomass) ¹⁾						
• Fuel energy	MJ	0.3	0.2	0.2	0.2	0.1
• Feedstock energy	MJ	0.0	0.0	0.0	0.0	0.0
Abiotic Depletion Potential						
• Elements	kg Sb eq	4.6×10^{-8}	3.8×10^{-8}	3.5×10^{-8}	3.6×10^{-8}	2.7×10^{-8}
• Fossil fuels	MJ	74.1	61.0	62.8	63.1	53.5
Renewable materials (biomass)	kg					
Water use	kg	33.0	31.3	23.5	23.9	13.3
• for process	kg	3.1	2.6	2.5	2.5	1.8
• for cooling	kg	26.7	25.9	18.2	18.5	9.0

¹⁾ Calculated as upper heating value (UHV)

Output Parameters

Indicator	Unit	Benzene	Toluene	p-Xylene	o-Xylene	Mixed Xylenes
GWP	kg CO ₂ eq	1.86	1.22	1.43	1.45	0.79
ODP	g CFC-11 eq	5.2×10^{-4}	4.1×10^{-4}	5.6×10^{-4}	5.7×10^{-4}	2.7×10^{-4}
AP	g SO ₂ eq	6.12	4.75	5.70	5.80	3.23
POCP	g Ethene eq	0.40	0.28	0.29	0.29	0.18
EP, terrestrial	g PO ₄ eq	0.42	0.33	0.37	0.38	0.25
EP, aquatic	g PO ₄ eq	0.84	0.73	0.77	0.77	0.66
Dust/particulate matter ²⁾	g PM10	0.27	0.24	0.24	0.25	0.18
Total particulate matter ²⁾	g PM10 eq	5.12	4.01	4.69	4.77	2.87
Waste	kg	4.3×10^{-5}	4.9×10^{-5}	5.7×10^{-5}	5.7×10^{-5}	5.1×10^{-5}

²⁾ Including secondary PM10

Additional Environmental and Health Information

Benzene has been classified as a human carcinogen by the International Agency for Research on Cancer (IARC). Not a consumer product in itself, it is used within the chemical industry to produce other chemicals. All handling of benzene must meet strict international standards to protect human health. Applied standards in industry are generally more stringent than required by regulations.

Additional Technical Information

BTX are single-ring aromatic compounds. They are colourless, flammable liquids at room temperature. The largest fraction of benzene is converted to

ethylbenzene, cumene, and cyclohexane, which are precursors for polystyrene, polycarbonates, epoxy resins, and polyamides, respectively; toluene is converted to toluene diisocyanate, a precursor for polyurethane foams; p-xylene is converted to terephthalic acid and dimethyl terephthalate, i.e. monomers for PET production; o-xylene is converted to phthalic anhydride, a precursor for phthalate plasticisers.

Additional Economic Information

BTX are used as starting materials for a wide range of consumer products: clothing, pharmaceuticals, cosmetics, computers, paints, vehicle components, sports equipment, and many others.

Information

Data Owner

PlasticsEurope

& CEFIC Sector Group Association of Petrochemicals Producers in Europe (APPE)

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Programme Manager & Reviewer

DEKRA Consulting GmbH

This Environmental Product Declaration has been reviewed by DEKRA Consulting GmbH. It was approved according to the Product Category Rules PCR version 2.0 (2011-04) and ISO 14025:2006.

Registration number: PlasticsEurope 2012-005, valid until 31 December 2015 (date of next revalidation review).

Programme Owner

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For copies of this EPD, for the underlying LCI data (Eco-profile); and for additional information, please refer to <http://www.plasticseurope.org/>.

References

PlasticsEurope: Eco-profiles and environmental declarations – LCI methodology and PCR for -uncompounded polymer resins and reactive polymer precursor (version 2.0, April 2011).