Aliphatic Isocyanates for Polyurethane Products ALIPA

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

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ALIPA
EUROPEAN ALIPHATIC ISOCYANATES PRODUCERS ASSOCIATION

Environmental Product Declaration

Introduction

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 aliphatic isocyanates from cradle to gate (from crude oil extraction to liquid at plant, i.e. aliphatic isocyanate production site output). **Please keep in mind that comparisons cannot be made on the level of the isocyanate material alone**: 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	ALIPA
LCA Practitioner	PE INTERNATIONAL AG
Programme Owner	PlasticsEurope AISBL
Programme Manager, Reviewer	DEKRA Consulting GmbH
Number of plants included in data collection	5 aliphatic isocyanates; 1 plant per product
Representativeness	Typical representative technology
Reference year	2010
Year of data collection and calculation	2012/2013
Expected temporal validity	2020
Cut-offs	No significant cut-offs
Data Quality	Good
Allocation method	Economic allocation (in foreground system)

Description of the Product and the Production Process

This EPD is for three aliphatic diisocyanate monomers, hexamethylene diisocyanate (HDI), isophorone diisocyanate (IPDI) and hydrogenated methylenediphenyl diisocyanate (H12MDI), and for the homologeous oligomers, hexamethylene diisocyanate trimer (HDI trimer) and isophorone diisocyanate trimer (IPDI trimer), which are predominantly used in the production of isocyanate hardeners for polyurethane coatings.

When a diisocyanate compound is reacted with a compound containing two or more hydroxyl groups (a polyol), long polymer chains are formed, known as polyurethanes.

Aliphatic diisocyanate monomers and their homologous oligomers are mainly used for lightfast, weatherproof and high-quality automotive and industrial coatings.

The reference flows, to which all data given in this EPD refer, is 1 kg of aliphatic isocyanate or corresponding oligomer.

Production Process

The aliphatic diisocyanate monomers HDI and IPDI are made from corresponding diamines by treatment with phosgene. The diamines stem from building blocks, such as butadiene, acetone and phenol.

H12MDI is produced via the urea route (reaction of Bis(para-aminocyclohexyl)methane (PACM) with urea).

In the production of homologeous oligomers of aliphatic diisocyanate, e.g. HDI trimer or IPDI trimer, monomeric diisocyanate is converted in oligomers by catalytic reaction. In a second step residual monomers are removed by a multi-stage distillation.

Data Sources and Allocation

The main data source for the average dataset was a primary data collection from European producers of HDI, IPDI, HDI-trimer, IPDI-trimer and H12MDI. Data of each aliphatic isocyanate are represented by the typical technological process chain. For each product one set of data has been provided. The partici-

pating companies represent about 80% of the European production capacity for the considered products. The data for the upstream supply chain and all relevant background data, such as energy and auxiliary materials are taken from the data base of the software system GaBi 5 [**Fehler! Verweisquelle konnte nicht gefunden werden.**].

Use Phase and End-of-Life Management

High quality polyurethane coatings help to preserve resources. They ensure effective protection of a substrate against corrosion, deterioration and mechanical damage and prolong the service life of goods like vehicles, industrial plants and buildings.

Post-consumer recycling of polyurethane products is common for applications where high volumes are available and no, or limited, sorting is necessary. A range of mechanical (regrinding, bonding, pressing, and moulding) and chemical (glycolysis, hydrolysis, pyrolysis) recycling technologies are available to produce alternative products and chemical compounds for subsequent domestic, industrial and chemical applications.

For all post-consumer polyurethane waste, for which recycling has not proven to be economically feasible due to complex collection and/or dismantling steps (e.g. automotive shredding), energy recovery is the option of choice.

Polyurethane coatings or adhesives are typically not separated in the end-of-life stage, but undergo the same procedure as the substrate.

Environmental Performance

The tables below show the environmental performance indicators associated with the production of 1 kg of aliphatic isocyanates.

Input Parameters

Indicator	Unit	Value
Non-renewable energy resources[3)]	MJ	141.8
• Fuel energy	MJ	107.5
• Feedstock energy	MJ	34.3
Renewable energy resources (biomass)[1)]	MJ	3.2
• Fuel energy	MJ	3.2
• Feedstock energy	MJ	0
Abiotic Depletion Potential		
• Elements	kg Sb eq	9.3E-06
• Fossil fuels	MJ	124.0
Renewable materials (biomass)	kg	0.0
Water use (key foreground process level)	kg	
• total input	kg	3444.5
• total consumption	kg	28.4
[1)] Calculated as upper heating value (UHV)		

Output Parameters

Indicator	Unit	Value
GWP	kg CO_2 eq	6.5
ODP	g CFC-11 eq	2.1E-05
AP	g SO_2 eq	9.8
POCP	g Ethene eq	2.2
EP	g PO_4 eq	1.6
Dust/particulate matter[2)]	g PM10	3.2E-01
Total particulate matter[2)]	g	4.4E-01
Waste	kg	1.3E-01
• Radioactive waste	kg	2.4E-03
• Non-radioactive waste [3)]	kg	1.3E-01
[2)] Including secondary PM10 [3)] Non-radioactive wastes include: spoil, tailings, and waste, deposited		

Additional Environmental and Health Information

The manufacturers of aliphatic diisocyanate monomers and their homologous oligomers are working through ALIPA to promote Product Stewardship and responsible practice in the value chain. The program "ALIPA Safeguard – We care that you care" provides safe handling information and training materials in many languages.

Additional Technical Information

Aliphatic diisocyanate monomers and their homologous oligomers are primarily used as raw materials for polyurethane coatings, but also for adhesives, sealants, elastomers and other applications.

Additional Economic Information

The main benefits of these polyurethane materials are outstanding adhesion, weather and corrosion resistance, elasticity and flexibility.

Polyurethane based on aliphatic isocyanates show exceptional durability and UV-light stability, chemical and mechanical performances which could not be achieved otherwise.

Information

Data Owner

European Aliphatic Isocyanates Producers Association (ALIPA)
Avenue E van Nieuwenhuyse 4,
B-1160 Brussels, Belgium
Tel.: +32 (0) 26767475, Fax: +32 (0) 26767479
E-mail: info@alipa.org.

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 2014-003, validation expires on 31 December 2017 (date of next revalidation review).

Programme Owner

PlasticsEurope AISBL
Avenue E van Nieuwenhuyse 4, Box 3
B-1160 Brussels, Belgium
Tel.: +32 (2) 675 32 97, Fax: +32 (2) 675 39 35
E-mail: info@plasticseurope.org.

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

References

- Cover image with kind permission by ALIPA.
- PlasticsEurope: Eco-profiles and environmental declarations – LCI methodology and PCR for uncompounded polymer resins and reactive polymer precursor (version 2.0, April 2011).