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

# Flexible Polyurethane (PU) Foam
# EUROPUR
# August 2015

EUROPUR
European Association of Flexible Polyurethane Foam Blocks Manufacturers

# Environmental Product Declaration

## Introduction

This Environmental Product Declaration (EPD) is based upon life cycle inventory (LCI) data from ISOPA [ISOPA 2012 TDI-MDI, ISOPA 2012 PP] and from the GaBi database 2014 [GABI 6], fulfilling the requirements on 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) [PLASTICSEUROPE 2011]. EPDs provide environmental performance data, but no information on the economic and social aspects which would be necessary for a complete sustainability assessment. EPDs do not imply a value judgement between environmental criteria.

This EPD describes the production of flexible polyurethane (PU) foam from cradle to gate in slabstock foam plants (from crude oil extraction to foam at plant). **Please keep in mind that comparisons cannot be made on the level of the polymer 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 | EUROPUR aisbl |
| LCA Practitioner | thinkstep AG |
| Programme Owner | PlasticsEurope aisbl |
| Programme Manager, Reviewer | DEKRA Assurance Services GmbH |
| Number of plants included in data collection | 9 |
| Representativeness | 60% |
| Reference year | 2013 |
| Year of data collection and calculation | 2014-2015 |
| Expected temporal validity | 2023 |
| Cut-offs | No significant cut-offs |
| Data Quality | Good |
| Allocation method | Price allocation |

## Description of the Product and the Production Process

Flexible polyurethane (PU) is a cellular polymer produced in the form of foam blocks.

It exists in multiple forms, depending on foam density, on the presence/absence of flame retardant (FR) or other additives, as well as on the isocyanate monomer used (Toluene diisocyanate-TDI or Methylene diphenyl diisocyanate – MDI).

This Eco-profile considers four representative flexible PU foam grades:

- TDI-based PU foam without FR, high density 35 to 40 kg/m³
- TDI-based PU foam without FR, low density 18 to 25 kg/m³
- TDI-based PU foam with FR, density 40 to 54 kg/m³
- MDI-based viscoelastic PU foam without FR, density 45 to 53 kg/m³.

After production and curing, foam blocks are transported to storage houses, ready for further transformation or incorporation into semi-finished or finished products.

### Production Process

Polyurethane is made by reacting diisocyanates and polyols. To generate PU foam, addition of water to the main reagents causes a side reaction producing carbon dioxide, which acts as a blowing agent. Flexible slabstock polyurethane foams are produced as large blocks using a continuous process with minimal human handling. Continuous foam machines are the standard in Europe today.

The reference flow for the four PU foam types considered, to which all data given in this Eco-profile refer, is 1 kg of flexible PU foam.

### Data Sources and Allocation

The main data source is a primary data collection from European producers of flexible PU foam blocks, providing site-specific gate-to-gate production data for processes under operational control

of the participating companies: nine plants of seven flexible PU foam producers in six different European countries.

These seven producers cover more than 60 % of the overall flexible PU foam blocks production (EU-27) in 2013 [EUROPUR 2014].

The life cycle inventory data for the three main precursors long-chain polyether polyol, TDI and MDI are from two 2012 ISOPA Eco-profile studies [ISOPA 2012 PP, ISOPA 2012 TDI-MDI]; further background data are taken from the database of the software system GaBi 6 [GABI 6].

All relevant background data, such as energy and auxiliary materials, is from the GaBi 6 database; the documentation is publicly available [GABI 6].

Most producers sell their foam trimmings co-products on the market for similar or different applications. A producer-specific price allocation is applied between main product and co-product, based on the ratio of their respective prices.

**Use Phase and End-of-Life Management**

Flexible polyurethane foam is used to manufacture mattresses, upholstered furniture and car seats, but also acoustic insulation boards, carpet underlays, household sponges, clothing and sportswear, packaging and many other applications. The bedding and furniture sector is the main market for slabstock foam. Around 48% of mattresses in the EU have a polyurethane foam core (EBIA, 2012) and around 90% of furniture upholstery is made out of PU foam.

Production block cut-offs (trim foam) are used in applications such as carpet underlay, gymnastic mats or headrests. Chemical recycling (transformation of clean production waste into new raw-materials) is also an option for production waste. The first chemical recycling plants have started to operate.

Today, the main process for treating end-of-life flexible polyurethane foam after it was used for several years or even decades) is energy recovery. Gasification or other technologies may become processing options in the future but still have to demonstrate economic and technical feasibility on an industrial scale. Finally, a proportion of products containing polyurethane foam is still being landfilled in Europe, although a phase-out of the landfilling of energy-rich waste is being foreseen by 2025 under the EU's proposals for a Circular Economy.

## Environmental Performance

The tables below show the environmental performance indicators associated with the production of 1 kg flexible PU foam.

## Input Parameters

| Indicator | Unit | TDI-based PU foam without FR, density 35 to 40 kg/m³ | TDI-based PU foam without FR, density 18 to 25 kg/m³ | TDI-based PU foam with FR, density 40 to 54 kg/m³ | MDI-based viscoelastic PU foam with-out FR, density 45 to 53 kg/m³ |
|---|---|---|---|---|---|
| | | | | | |
| Non-renewable energy resources[1)] | MJ | 85.67 | 82.56 | 89.38 | 82.45 |
| • Fuel energy | MJ | 52.20 | 49.09 | 55.91 | 48.98 |
| • Feedstock energy | MJ | 33.47 | 33.47 | 33.47 | 33.47 |
| Renewable energy resources (biomass)[1)] | MJ | 3.00 | 2.98 | 4.42 | 2.49 |
| • Fuel energy | MJ | 3.00 | 2.98 | 4.42 | 2.49 |
| • Feedstock energy | MJ | 0 | 0 | 0 | 0 |
| Abiotic Depletion Potential | | | | | |
| • Elements | kg Sb eq | 1.57E-05 | 1.55E-05 | 3.09E-05 | 1.00E-05 |
| • Fossil fuels | MJ | 74.97 | 72.03 | 77.91 | 72.62 |
| Renewable materials (biomass) | kg | 0 | 0 | 0 | 0 |
| Water use (key foreground process level) | kg | 1.86E-02 | 2.64E-02 | 8.70E-03 | 1.85E-01 |
| • for process | kg | n.a. | n.a. | n.a. | n.a. |
| • for cooling | kg | n.a. | n.a. | n.a. | n.a. |

[1)] Calculated as upper heating value (UHV); na= not available – details see

## Output Parameters

| Indicator | Unit | TDI-based PU foam without FR, density 35 to 40 kg/m³ | TDI-based PU foam without FR, density 18 to 25 kg/m³ | TDI-based PU foam with FR, density 40 to 54 kg/m³ | MDI-based viscoelastic PU foam with-out FR, density 45 to 53 kg/m³ |
|---|---|---|---|---|---|
| | | | | | |
| GWP | kg $CO_2$ eq | 3.22 | 3.18 | 3.56 | 2.95 |
| ODP | g CFC-11 eq | 3.83E-05 | 4.08E-05 | 3.53E-05 | 2.71E-03 |
| AP | g $SO_2$ eq | 6.48 | 6.31 | 7.40 | 6.17 |
| POCP | g Ethene eq | 1.18 | 1.12 | 1.22 | 1.11 |
| EP | g $PO_4$ eq | 0.99 | 0.99 | 1.16 | 0.89 |
| Dust/particulate matter[2)] | g PM10 | 1.15E-01 | 1.13E-01 | 1.40E-01 | 9.67E-02 |
| Total particulate matter[2)] | g | 2.66E-01 | 2.65E-01 | 4.77E-01 | 2.17E-01 |
| Waste | | | | | |
| • Radioactive waste | kg | 1.67E-03 | 1.70E-03 | 1.85E-03 | 1.42E-03 |
| • Non-radioactive waste [3)] | kg | 1.26E-01 | 1.24E-01 | 3.11E-01 | 7.40E-02 |

[2)] Including secondary PM10

[3)] Non-radioactive wastes include: spoil, tailings, and waste, deposited

## Additional Environmental and Health Information

The diisocyanate reagents used for flexible PU foam production have a highly reactive NCO group. This ensures that they are fully consumed during the chemical reaction with polyols yielding the polyurethane foam. Hence, they cannot be released into the air from the foam. That is why there cannot be any exposure of consumers to diisocyanates resulting from PU foam [SCOTT 2012].

Due to country-specific legislation, combustion–modified PU foam is used in upholstery and bedding for the UK and Irish markets or when required by fire regulations for public places (theatres, hospitals, schools, prisons…). As of today the main flame retarding-substances used in flexible PU foam are Tris(2-chloro-1-methylethyl) phosphate (TCPP) and Melamine. As for any substances used in polyurethane foam production, foam manufacturers closely monitor evolutions linked to flame retardants under the EU's REACH regulation.

## Additional Technical Information

The outstanding quality of flexible polyurethane foam lies in its performance (strength, cushion, …) to weight ratio. It is also a versatile and easy to process material.

## Information

**Data Owner**

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**DEKRA Assurance Services GmbH**
This Environmental Product Declaration has been reviewed by DEKRA Assurance Services GmbH. It was approved according to the Product Category Rules PCR version 2.0 (2011-04) and ISO 14025:2006 [ISO 14025: 2006].
Registration number: PlasticsEurope 2015-007, validation expires on 30 August 2018 (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 www.europur.org

**References**

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

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