Environmental Product Declarations of the European Plastics Manufacturers

Polypropylene (PP)

PlasticsEurope
Association of Plastics Manufacturers

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 ISO 14025 and to PlasticsEurope's **Product Category Rules (PCR) for Uncompounded Polymer Resins and Reactive Polymer Precursors** (June 2006). EPDs provide environmental performance data, but no information on the economic and social aspects which would be necessary for a complete sustainability assessment. Furthermore, they do not imply a value judgment between environmental criteria.
This EPD describes the production of the PP polymer from cradle to gate (from crude oil extraction to pellets coming out the manufacturing plant). **It is important to note 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.

Description of the product and the production process

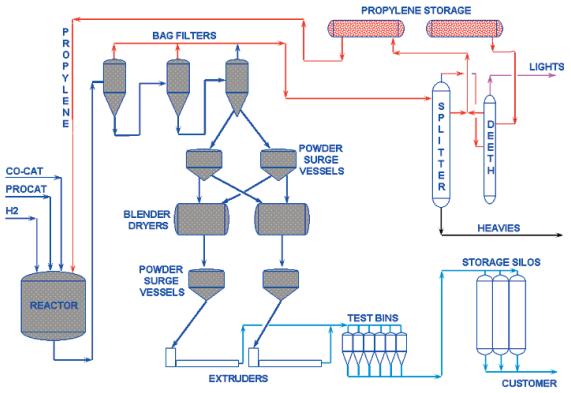
This EPD is designed for polypropylene (PP). PP is part of the polyolefins family. PP volumes in 2007 account for 42% (roughly 9.3 million tonnes) of Western Europe's total polyolefins production which is 22.1 million tonnes/year. Polyolefins represent 40% of total plastics production in Western Europe, which is 55 million tonnes/year. The functional unit, to which all data given in this EPD refers to, is **1kg of PP polymer**.

Production process

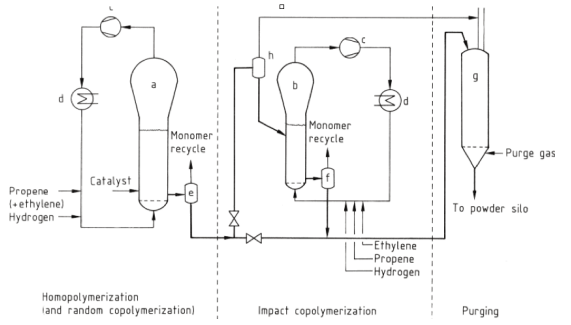
PP is a polyolefin with a density around 900 kg/m, produced by various low pressure processes.
Polyolefins are produced commercially from olefin (alkene) monomers because the olefins contain a reactive double bond. Starting material, propylene, is called the monomer and the final compound consisting of many thousands of bound propylene units is called the polymer. Co-monomers (ethylene, butene) are used to improve toughness, impact resistance and transparency (random co-polymers). Two main techniques are used for the production of polypropylene:
Liquid pool polymerisation: the polymer is produced in a liquid propylene medium. The polymer forms a suspension. The reaction medium is removed and the polymer is separated from the propylene. The obtained powder is mixed with stabilizers and generally extruded into pellets.
Gas phase polymerisation: a gas phase reactor is essentially a fluidised bed of dry polymer particles maintained either by stirring or by passing gas at high speeds through it. Pressures are usually relatively low at ~2MPa and temperatures are usually in the range 60-80°C. A variety of different configurations are used mainly to obtain an acceptable particle size and shape in the final product.

Data sources and allocation

All data refer to a European industry average (reference year 2005); all calculations were updated in 2006. PlasticsEurope's member companies supplied information on the production of hydrocarbon precursors and the polymerisation process itself. Information on the production of fuels, energy and the main hydrocarbon resources was derived from the reports of the *International Energy Agency*. Data for ancillary operations and transport were obtained from other manufacturers and operators as well as publicly available LCI databases. Mass allocation was used for multi-output processes. Vertical averaging was performed to take into account company- and site-specific production routes and to protect confidentiality.



Liquid pool polypropylene polymerisation process



Polypropylene fluidised bed gas phase process (EC 2006)

Use phase and end-of-life management

Because of its versatility, PP is one of the most popular plastics in use today. The many applications for PP include: carpet fibres and non-woven applications, food packaging,, garden furniture, medical packaging and devices, electric and electronic appliances, luggage, crates, kitchen appliances, automotive (such as bumpers, dashboards), and pipes.
For responsible end-of-life management, PlasticsEurope recommends recycling (whether mechanical or feedstock) as far as economically feasible and environmentally sensible. Alternatively, for residual streams energy recovery can be conducted in special designed plants.
In LCA studies, credits for recovered products should be awarded on the basis of substituted virgin materials, if functionally equivalent.

Environmental performance

The tables below show the environmental performance indicators associated with the production of 1 kg of polypropylene (PP).

Input parameters

Indicator	Unit	Value
Non-renewable materials		
• Minerals	g	1.8
• Fossil fuels	g	1,564.5
• Uranium	g	0.005
Renewable materials (biomass)	g	5.129
Water use[1)]	g	4,788
Non-renewable energy resources[2)]		
• for energy	MJ	20.4
• for feedstock	MJ	52.6
Renewable energy resources (biomass)[2)]		
• for energy	MJ	0.4
• for feedstock	MJ	0

[1)] This indicator comprises only process water. Cooling water is not included.

[2)] Calculated as upper heating value (UHV).

Output parameters

Indicator	Unit	Value
GWP	kg CO_2 eq	2.00
ODP	g CFC-11 eq	n/a[3)]
AP	g SO_2 eq	6.13
POCP	g Ethene eq	0.92
NP	g PO_4 eq	0.74
Dust/particulate matter	g PM10	0.59
Total particulate matter	g	0.60
Waste		
• Non-hazardous	kg	0.024
• Hazardous	kg	0.005

[3)] Relevant LCI entries are below quantification limit.

Additional environmental and health information

PP has been very successful in light-weighting of cars by replacing steel for making bumpers, and a number of other automotive parts.

Foldable industrial crates take up much less space in transport.

LCA is the preferred tool to analyse and conclude about all environmental parameters for a specific PP application.

Additional technical information

PP, a highly corrosion resistant material at high temperature, possesses chemical resistance to organic solvents, degreasing agents and electrolytic attack. It has therefore found successful applications in packaging of chemicals, chemical processing, engineering and sterilization of medical devices.

Additional economic information

PP food packaging preserves the food integrity, extends the shelf life and prevents food spoilage

PP has been very successful in lowering costs when replacing traditional materials like paper, wood, metal, and glass.

Information

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Programme manager

Five Winds International
This Environmental Product Declaration has been reviewed by *Five Winds International*. It is approved according to the Product Category Rules PCR 2006-06 for Uncompounded Polymer Resins and Reactive Polymer Precursors and ISO FDIS 14025.
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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

Product photographs on cover with kind permission by PlasticsEurope.
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PlasticsEurope: Polypropylene (PP). Eco-profiles of the European Plastics Industry. Brussels, March 2005.
PlasticsEurope: Product Category Rules (PCR) for Uncompounded Polymer Resins and Reactive Polymer Precursors. Brussels, June 2006.
ISO FDIS 14025 : Environmental Labels and Declarations – Type III Environmental Declarations. Geneva, 2005.
European Commission (EC): IPPC Reference Document on Best Available Techniques in the Production of Polymers. Sevilla, October 2006.

Glossary

Acidification potential, AP — An environmental impact category ("acid rain"). Emissions (e.g. sulphur oxides, nitrous oxides, ammonia) from transport, energy generation, combustion processes, and agriculture cause acidity of rainwater and thus damage to woodlands, lakes and buildings. Reference substance: sulphur dioxide.
Environmental product declaration, EPD — A standardised method (ISO 14025) of communicating the environmental performance of a product or service based on LCA data.
Global warming potential, GWP — An environmental impact category ("greenhouse effect"). Energy from the sun drives the earth's weather and climate, and heats the earth's surface. In turn, the earth radiates energy back into space. Atmospheric greenhouse gases (water vapour, carbon dioxide, and other gases) are influencing the energy balance in a way that leads to an increased average temperature on earth's surface. Problems arise when the atmospheric concentration of greenhouse gases increases due to the "man-made" (or anthropogenic) greenhouse effect: this additional greenhouse effect caused by human activities may further increase the average global temperature. The index GWP is calculated as a multiple equivalent of the absorption due to the substance in question in relation to the emission of 1 kg of carbon dioxide, the reference substance, over 100 years.
Polypropylene (PP) — A thermoplastic polyolefin with a density around 900 kg/m . Thermoplastic consisting of bound propylene units. (C_3H_7)
Life cycle assessment, LCA — A standardised management tool (ISO 14040–44) for appraising and quantifying the total environment impact of products or activities over their entire life cycle of particular materials, processes, products, technologies, services or activities.
Nutrification potential, NP — An environmental impact category ("over-fertilisation"). Emissions such as phosphate, nitrate, nitrous oxides, and ammonia from transport, energy generation, agriculture (fertilisers) and wastewater increase the growth of aquatic plants and can produce algae blooms that consume the oxygen in water and thus smother other aquatic life. This is called eutrophication and causes damages to rivers, lakes, plants, and fish. Reference substance: phosphate.
Ozone depletion potential, ODP — An environmental impact category ("ozone hole"). The index ODP is calculated as the contribution to the breakdown of the ozone layer that would result from the emission of 1 kg of the substance in question in relation to the emission of 1 kg of CFC-11 as a reference substance.
Photochemical ozone creation potential, POCP — An environmental impact category ("summer smog"). The index used to translate the level of emissions of various gases into a common measure to compare their contributions to the change of ground-level ozone concentration. The index POCP is calculated as the contribution to ozone formation close to the ground due the substance in question in relation to the emission of 1 kg of ethene as a reference substance.
Product category rules, PCR — A set of rules for the preparation of LCA and EPD within a functionally defined class of products. A PCR document is a necessary component of any Type III Environmental Declaration programme (ISO 14025).

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