the european **plastic pipes and fittings** association

European Communication Format – B2B

Environmental Product Declaration

Bi-oriented Polyvinylchloride (PVC-O), MRS 45 MPa pipe system for water distribution

1 DECLARATION OF GENERAL INFORMATION

Introduction

The European Plastics Pipes and Fittings Association (TEPPFA) deems it important to have an insight into the integral environmental impacts that are encountered during the life-span of particular pipe system applications. With this framework in mind, in 2010 TEPPFA has set up an LCA/EPD project with the Flemish Institute for Technological Research (VITO) which resulted in an EPD. The present EPD is the update of the EPD issued in 2011 – foreground data remained the same, with only the datasets being updated to the latest available version (Ecoinvent 3.3 and Industry 2.0 replaced Ecoinvent 2 datasets). It outlines the various environmental aspects, which accompany the Bi-oriented Polyvinylchloride (PVC-O), MRS 45 MPa pipe system for water distribution, from the primary extraction of raw materials up to and including the end of life (EoL) treatment after its reference service life time.

Name and address of manufacturers

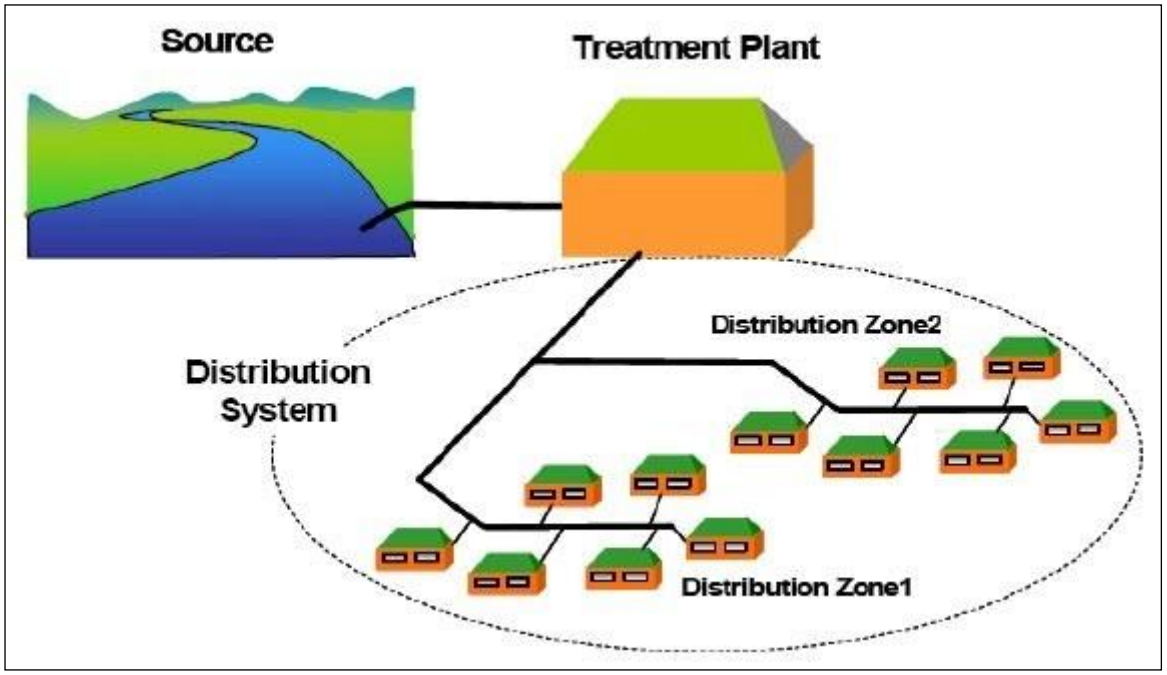
TEPPFA, Avenue de Cortenbergh, 71, B-1000 Brussels, Belgium, Tel: +32-2-736 24 06, Fax: +32-2-736 58 82, E-Mail: info@teppfa.eu, Website: www.teppfa.eu

PVC-O, MRS 45 MPa pipe system's use and functional unit

The EPD refers to a typical European Bi-oriented Polyvinylchloride (PVC-O), MRS 45 MPa, pipe system for water distribution, from the cradle to the grave, raw material extraction, transportation to converters, converting process, transport to trench, construction, use and end of life. Environmental indicators are expressed for the complete life cycle, from the cradle to the grave, so for an average European PVC-O, MRS 45 MPa pipe system. The functional unit is defined as "the below ground transportation of drinking water, over a distance of 100 m (from the exit of the water plant to the water meter of the building), by a typical public European PVC-O water distribution pipe system (Ø 110 mm) over its complete life cycle of 100 years, calculated per year".

Product name & graphic display of product

PVC-O, MRS 45 MPa pipe system for water distribution



Description of the PVC-O, MRS 45 MPa pipe system's components

The environmental burdens are calculated in relation to the functional unit, which resulted for the typical European PVC-O, MRS 45 MPa pipe system for water distribution in the following basic pipe system components: PVC-O pipes; PVC-U fittings, ductile iron fittings, bolts, rings, washers, nuts (made out of galvanized steel); cutter of stainless steel and EPDM gaskets.

The PVC-O pipe material consists of dark grey unplasticized polyvinylchloride MRS 45 MPa. The pipe has a diameter of 110 mm (as a representative for the average pipe diameter from the exit of the water plant to the water meter of the building). Standard dimension ratio: SDR 65 with wall thickness of 1,8 mm. The meter weight of the 110 mm pipe has been calculated as average weight per metre from actual sales across a market in sizes 20 mm to 1000 mm, this resulted in a meter weight of 0,951 kg. The service life time of 100 years is taken from Schulte and Hessel (2006). 2 types of fittings have been taken into account, PVC-U fittings and ductile iron fittings. The popularity of fittings in the "average" pipe of the functional unit has been calculated from actual sales data. The weight of fittings was calculated from company weight/piece data. For the PVC-O, MRS 45 MPa pipe system the same flow capacity has been taken into account as for a PVC-U pipe of a 110 mm SDR 26, of average roughness at a flow speed of 1,5 m per second (EN 805 advises that "in practice it will be desirable to avoid unduly high or low velocities. The range 0,5 m/s to 2,0 m/s may be considered appropriate).

The EPD is declared as the average environmental performance for a typical European PVC-O, MRS 45 MPa pipe system, over its reference service life cycle of 100 years, calculated per year, in accordance to ISO 16422, EN 805 and EN 1295-1.

EPD programme and programme operator
The present EPD is in line with the ongoing standardization work by CEN TC 350 (EN15804 and EN15942). A programme operator related to the CEN T350 has not been established yet.

Date of declaration and validity
June, 2018
The EPD has a 5 year validity period (June, 2023)

Comparability
Please note that EPDs of construction products may not be comparable if they do not comply with the CEN TC 350 (EN15804 and EN15942) standards.

Typical European PVC-O, MRS 45 MPa pipe system EPD
The present EPD outlines various environmental aspects, which accompany a typical European PVC-O, MRS 45 MPa, pipe system for water distribution, from the primary extraction of raw materials up to and including the end of life (EoL) treatment after its reference service life time of 100 years.

Group of manufacturers
The EPD for the PVC-O, MRS 45 MPa pipe system is representative for an anticipated European typical PVC-O, MRS 45 MPa pipe system for water distribution. The TEPPFA member companies represent more than 50% of the European market for extruded plastic pipes. For an overview of all members and national associations within TEPPFA we refer to the last page of this EPD.

Content of the product system
The product system does not contain materials or substances that can adversely affect human health and the environment in any stages of the life cycle.

Retrieve information
Explanatory material may be obtained by contacting TEPPFA (http://www.teppfa.eu)

2 DECLARATION OF THE MATERIAL CONTENT

The European Bi-oriented Polyvinylchloride (PVC-O), MRS 45 MPa pipe system for water distribution does not contain any substances as such or in concentration exceeding legal limits, which can adversely affect human health and the environment in any stages of its entire life cycle.

3 DECLARATION OF THE ENVIRONMENTAL PARAMETERS DERIVED FROM LCA

3.1 Life cycle flow diagram

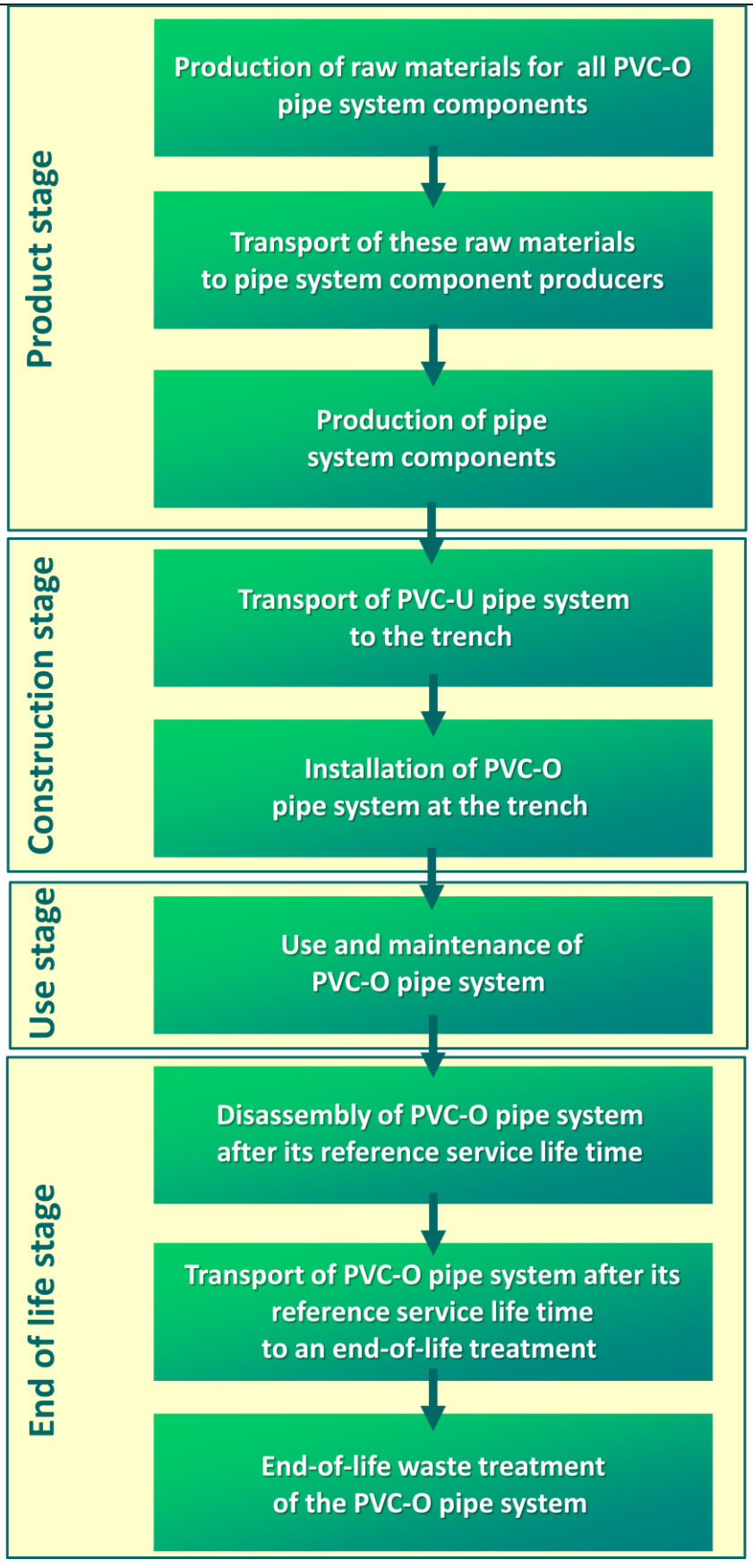
The EPD refers to a typical European PVC-O, MRS 45 MPa pipe system for water distribution, from the cradle to the grave, including product stage, transport to construction site and construction process stage, use stage and end of life stage.

- **Product stage**: raw material extraction and processing, recycling processes for recycled material input, transport to the manufacturer, manufacturing (including all energy provisions, waste management processes during the product stage up to waste for final disposal):
  - Production of raw materials for PVC-O (MRS 45 MPa) pipes;
  - Transport of PVC pipe raw materials to converter;
  - Converting process for PVC-O (MRS 45 MPa) pipes (extrusion);
  - Production raw materials for PVC-U fittings;
  - Transport of PVC-U fitting raw materials to converter;
  - Converting process for PVC-U fittings (injection moulding);
  - Production of ductile iron fittings (raw materials, transport and production process);
  - Production of galvanised steel components (raw materials + converting process) ;
  - Production of steel cutter;
  - Production of EPDM gaskets (raw materials + converting process)

- **Construction process stage**: including all energy provisions, waste management processes during the construction stage up to waste for final disposal
  - Transport of PVC pipe system to the trench
  - Installation of PVC pipe system in the trench

- **Use stage** (maintenance and operational use): including transport and all energy provisions, waste management processes up to waste for final disposal during this use stage
  - Use and maintenance of the complete PVC pipe system for water distribution during 100 years of reference service life time;

- **End of life stage**: including all energy provisions during the end of life stage
  - Disassembly of PVC pipe system for water distribution after 100 years of reference service life time at the trench
  - Transport of complete PVC pipe system for water distribution after 100 years reference service life time to an end-of-life treatment (in case the pipe system does not stay in the ground);
  - End-of-life waste treatment of complete PVC pipe system for water distribution after 100 years reference service life time (in case the pipe system does not stay in the ground).


Product stage
Production of raw materials for all PVC-O pipe system components
Transport of these raw materials to pipe system component producers
Production of pipe system components
Construction stage
Transport of PVC-U pipe system to the trench
Installation of PVC-O pipe system at the trench
Use stage
Use and maintenance of PVC-O pipe system
End of life stage
Disassembly of PVC-O pipe system after its reference service life time
Transport of PVC-O pipe system after its reference service life time to an end-of-life treatment
End-of-life waste treatment of the PVC-O pipe system

3.2 Parameters describing environmental impacts

The following environmental parameters are expressed with the impact category parameters of the life cycle impact assessment (LCIA).

Impact category	Abiotic depletion (non-fossil)	Abiotic depletion (fossil fuels)	Acidification	Eutrophication	Global warming	Ozone layer depletion	Photochemical oxidation
	kg Sb eq	MJ	kg SO2 eq	kg PO4--- eq	kg CO2 eq	kg CFC-11 eq	kg C2H4 eq
Product stage	1.69E-05	8.78E+01	1.50E-02	2.14E-03	4.28E+00	1.18E-06	1.16E-03
Construction process stage	4.91E-06	3.84E+01	1.63E-02	3.39E-03	2.50E+00	4.81E-07	5.09E-04
Use stage	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
End of life stage	5.02E-08	1.57E-01	4.88E-05	1.36E-05	4.75E-02	2.25E-09	1.81E-06
Total	**2.18E-05**	**1.26E+02**	**3.14E-02**	**5.54E-03**	**6.83E+00**	**1.66E-06**	**1.67E-03**

3.3 Parameters describing resource input

The following environmental parameters apply data based on the life cycle inventory (LCI).

Environmental parameter	Use of renewable primary energy excluding renewable primary energy resources used as raw materials	Use of renewable primary energy resources used as raw materials	Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	Use of non renewable primary energy excluding non renewable primary energy resources used as raw materials	Use of non renewable primary energy resources used as raw materials	Total use of non renewable primary energy resources (primary energy and primary energy resources used as raw materials)	Use of secondary material	Use of renewable secondary fuels	Use of non renewable secondary fuels	Net use of fresh water
	MJ, net calorific value	MJ, net calorific value	MJ, net calorific value	MJ, net calorific value	MJ, net calorific value	MJ, net calorific value	kg	MJ, net calorific value	MJ, net calorific value	m3
Product stage	n.a.	n.a.	8,47E+00	n.a.	n.a.	1,03E+02	n.a.	n.a.	n.a.	2,42E-01
Construction process stage	n.a.	n.a.	1,59E+00	n.a.	n.a.	4,22E+01	n.a.	n.a.	n.a.	3,40E-01
Use stage	n.a.	n.a.	0,00E+00	n.a.	n.a.	0,00E+00	n.a.	n.a.	n.a.	0,00E+00
End of life stage	n.a.	n.a.	-2,61E-02	n.a.	n.a.	2,73E-02	n.a.	n.a.	n.a.	-9,64E-05
Total	**n.a.**	**n.a.**	**1,00E+01**	**n.a.**	**n.a.**	**1,45E+02**	**n.a.**	**n.a.**	**n.a.**	**5,81E-01**

3.4 Parameters describing different waste categories and further output material flows

The parameters describing waste categories and other material flows are output flows derived from the life cycle inventory (LCI):

Parameters describing different waste categories

Environmental parameter	Hazardous waste	Non-hazardous waste	Nuclear waste
	kg	kg	kg
Product stage	4,89E-01	2,37E-01	1,19E-04
Construction stage	2,47E-05	6,83E-01	3,20E-04
Use stage	0,00E+00	0,00E+00	0,00E+00
End of life stage	-7,63E-08	1,16E+00	5,95E-07
Total	**4,89E-01**	**2,08E+00**	**4,39E-04**

Parameters describing further output material flows

Parameter	Parameter unit expressed per functional unit
Components for re-use	1,104 kg
Materials for recycling	0,387 kg
Materials for energy recovery	0,032 kg

4 SCENARIOS AND TECHNICAL INFORMATION

4.1 Construction process stage

Transport from the production gate to the construction site (trench)

Parameter	Parameter unit expressed per functional unit
Fuel type consumption of vehicle or vehicle type used for transport e.g. long distance truck, boat etc.	The PVC-O pipe system is transported over an average distance of 330 km by means of a truck from the producers of the different pipe system components to the trench. The loading factor for PVC-U pipes is limited by volume. Environmental burdens associated with this kind of transport are calculated by means of the Ecoinvent V3.3 datarecord "Transport, freight, lorry 16-32 metric ton, EURO4 {RER}| transport, freight, lorry 16-32 metric ton, EURO4 | Alloc Rec, U".
Capacity utilisation (including empty returns)	
Bulk density	
Volume capacity utilisation factor (factor: =1 or <1 or ≥ 1 for compressed or nested packaged products)	

Construction (installation at trench)

Parameter	Parameter unit expressed per functional unit
Ancillary materials for installation	**0,1392 m³ of backfilling sand** trucked to trench over an average distance of 10 km. Environmental burdens associated with this kind of energy are calculated by means of the Ecoinvent V3.3 datarecords "Sand {CH}| gravel and quarry operation | Alloc Rec, U" and "Transport, freight, lorry >32 metric ton, EURO4 {RER}| transport, freight, lorry >32 metric ton, EURO4 | Alloc Rec, U" Building hall is excluded from the background dataset for sand due to irregularities related to the impact on abiotic depletion (non-fossil).
Other resource consumption	Not relevant

<table>
<tr><td>Quantitative description of energy type (regional mix) and consumption during the installation process</td><td>15 MJ of mechanical energy is needed for excavating the soil (dig up), for excavating the backfilling soil and sand, for the stamping process (compaction next pipe) and for the vibration plate (compaction top). Environmental burdens associated with this kind of energy are calculated by means of the Ecoinvent V3.3 datarecord "Diesel, burned in building machine {GLO}| processing | Alloc Rec, U"</td></tr>
<tr><td>Waste on the building site, generated by the product's installation</td><td rowspan="2">0,017 kg of PVC-O pipe left left over during installation: 80% to landfill, 15% to incineration and 5% to mechanical recycling. Transportation of PVC-O pipe left over to waste management treatment facilities is included: 600 km to recycling plant, 150 km to incineration with energy recovery and 50 km to landfill. Environmental burdens are calculated by means of the Ecoinvent V3.3 datarecord "Transport, freight, lorry 3.5-7.5 metric ton, EURO4 {RER}| transport, freight, lorry 3.5-7.5 metric ton, EURO4 | Alloc Rec, U".
0,0640 kg of packaging waste: treated according to European average packaging waste scenarios (Eurostat, 2006):
<table><tr><th></th><th>Recycling</th><th>Energy Recovery</th><th>Landfill</th></tr><tr><td>Plastic</td><td>27%</td><td>26%</td><td>47%</td></tr><tr><td>Paper and board</td><td>75%</td><td>10%</td><td>15%</td></tr><tr><td>Wood</td><td>38%</td><td>23%</td><td>39%</td></tr><tr><td>Metals</td><td>66%</td><td></td><td>34%</td></tr><tr><td>Total</td><td>57%</td><td>12%</td><td>31%</td></tr></table>
0,1488 m³ of soil that has to be transported over an average distance of 5 km to the nearest depot. Environmental burdens are calculated by means of the Ecoinvent V3.3 datarecord "Transport, freight, lorry 3.5-7.5 metric ton, EURO4 {RER}| transport, freight, lorry 3.5-7.5 metric ton, EURO4 | Alloc Rec, U".</td></tr>
<tr><td>Output materials as result of waste management processes at the building site e.g. of collection for recycling, for energy recovery, final disposal</td></tr>
<tr><td>Emissions to ambient air, soil and water</td><td>No direct emissions at the trench. Emissions are related to the upstream processes (mining of sand, transportation processes and mechanical energy) and downstream processes (waste management and treatment) and are included in the Ecoinvent datarecords that are used for modelling the environmental impacts.</td></tr>
</table>

4.2 Use stage: operation and maintenance

Operation and maintenance:

Operational use (pumping energy) is not relevant for the EPD, since it falls outside the system boundaries of the LCA project. Maintenance is not needed for the PVC-O pipe system for water distribution.

4.3 End of life

The following end of life scenarios have been taken into account:

- Estimated reference service life time of 100 years (Schulte and Hessel, 2006)
- EoL approach for landfill, incineration with energy recovery (impacts and credits are assigned to the life cycle that generates the waste flows)
- Recycled content approach for recycling and use of recyclates (= impact of recycling and credits for recyclates, because less virgin materials are needed is assigned to the life cycle that uses the recyclates)

<table>
<tr><th>Processes</th><th>Parameter unit expressed per functional unit</th></tr>
<tr><td>Collection process</td><td>After a reference service life time of 100 years the PVC-O pipe system for water distribution might be replaced. In most cases (95%) the pipe system will be left in the ground. In some cases (5%) the pipe system is taken out and treated (recycled, incinerated or landfilled).
<table>
<tr><th colspan="2">EOL scenario PVC-U pipes and fittings, EPDM gaskets</th></tr>
<tr><td>Mechanical recycling</td><td>2,5%</td></tr>
<tr><td>Incineration</td><td>2,5%</td></tr>
<tr><td>Left in ground</td><td>95%</td></tr>
<tr><th colspan="2">EOL scenario ductile iron fittings</th></tr>
<tr><td>Mechanical recycling</td><td>4%</td></tr>
<tr><td>Landfill</td><td>1%</td></tr>
<tr><td>Left in ground</td><td>95%</td></tr>
</table>
The transportation distance of the PVC-O pipe system from the trench to a waste treatment facility depends on the treatment option. For mechanical recycling we assumed an average transportation distance of 600 km and for incineration an average distance of 150 km. For the ductile iron parts a transportation distance of 50 km to both mechanical recycling and landfill has been assumed. Environmental burdens associated with transportation are calculated by means of the following Ecoinvent V3.3 datarecord “Transport, freight, lorry 3.5-7.5 metric ton, EURO4 {RER}| transport, freight, lorry 3.5-7.5 metric ton, EURO4 | Alloc Rec, U”</td></tr>
</table>

5 ADDITIONAL INFORMATION ON EMISSIONS TO INDOOR AIR, SOIL AND WATER DURING USE STAGE

Emissions to indoor air:
Since the PVC-O, MRS 45 MPa pipe system for water distribution is a buried system (in trench) we can confirm that emissions to indoor air are not relevant.

Emissions to soil and water:
Despite there is no approved European measurement method available, we can confirm that the PVC-O, MRS 45 MPa pipe system for water distribution does not contain any substances mentioned on the REACH-list.

6 OTHER ADDITIONAL INFORMATION

Product certification, conformity, marking

ISO 16422, Pipes and joints made of oriented unplasticized poly(vinyl chloride) (PVC-O) for the conveyance of water under pressure — Specifications

EN 805, Water supply. Requirements for systems and components outside buildings

EN 1295-1, Structural design of buried pipelines under various conditions of loading. Part 1: General requirements

Other technical product performances

For the full overview of the environmental benefits of plastic pipe systems we will refer to the TEPPFA website: http://www.teppfa.eu

List of names and logos of TEPPFA member companies

Aliaxis	**Aliaxis**
GEBERIT	**Geberit International**
+GF+	**Georg Fischer Piping Systems**
PIPELIFE	**Pipelife International**
Polypipe	**Polypipe**
REHAU Unlimited Polymer Solutions	**Rehau**
RADIUS Systems	**Radius Systems**
Tessenderlo Group EVERY MOLECULE COUNTS	**Tessenderlo Group**
uponor	**Uponor**
wavin CONNECT TO BETTER	**Wavin**

List of National Associations of TEPPFA

ADPP	-	Czech Republic plastic pipes association
ASETUB	-	Asociación Española de Fabricantes de Tubos y Accesorios Plásticos
BPF	-	Plastic Pipes Group
BureauLeiding	-	Dutch Plastic Pipes Association
DPF	-	Danish Plastics Federation
FCIO	-	Fachverband der Chemischen Industrie Österreich
Federplast	-	De Belgische producenten van kunststof-en rubberartikels, lid bij Agoria of essenscia.
FIPIF	-	Finnish Plastics Industries Federation
KRV	-	Kunstoffrohrverband e.V.- Fachverband der Kunstoffrohr-Industrie
MCsSz	-	Műanyag Csőgyártók Szövetsége
IKEM	-	Swedish Plastics and Chemical Federation
PRiK	-	Polish Association of Pipes and Fittings
STR	-	Syndicat des Tubes et Raccords
VKR	-	Verband Kunststoffrohre und Rohrleitungstelle
Unionplast	-	Federazione Gomma Plastica – Pipes Sector Group

List of names and logos of TEPPFA Associated Members

Borealis

LyondellBasell

Vynova

Lubrizol

List of names and logos of TEPPFA Supporting Members

Rollepaal

Molecor

REFERENCES

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ISO 16422 Pipes and joints made of oriented unplasticized poly(vinyl chloride) (PVC-O) for the conveyance of water under pressure — Specifications

EN 805, Water supply. Requirements for systems and components outside buildings

EN 1295-1, Structural design of buried pipelines under various conditions of loading. Part 1: General requirements

EN 15804:2012+A1:2013: Sustainability of construction works – Environmental product declarations – core rules for the product category of construction products (2013)

EN 15942: Sustainability of construction works – Environmental product declarations – Communication format – Business to Business

Eurostat, 2006. Packaging waste scenarios (EU27, 2006)

*ISO 14025, (2006), Environmental labels and declarations -- General principles.
*ISO 14040, (2006), Environmental management – Life cycle assessment – Principles and framework.
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Schulte U. and Hessel J., 2006. Remaining service life of plastic pipes after 41 years in service. Fachberichte. 3R International (45), Heft 9/2006. 5 p

Background LCA report (ISO 14040 and ISO 14044) prepared by

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