GF Piping Systems

Environmental Product Declaration

PVDF-System

According to EN 15804

Circling and distribution of purified water in a pharmaceutical plant

Georg Fischer Piping Systems Ltd.
Ebnatstrasse 111
CH-8201 Schaffhausen
+41 (0) 52 631 11 11
www.gfps.com/sustainability
sustainability.ps@georgfischer.com

1. Declaration of general information

1.1 Introduction

GF Piping Systems is one of the three divisions within Georg Fischer Corporation and a leading provider of plastic and metal piping systems with global market presence. The product portfolio includes pipes, fittings, valves and the corresponding automation and jointing technology for industry, building technology as well as water and gas utilities. Georg Fischer Piping Systems proactively incorporates its environmental responsibility into its everyday business activities. Because we understand environmental awareness as one of the corporation's core values, internal structures and processes are geared towards sustainability. In this context, life cycle assessments are the correct tool to gain insight in the different life cycle phases of our systems.

This EPD is based on a detailed background report written by the Flemish Institute for technological research (Vito). The report is in line with EN 15804 "Sustainability of construction works – environmental product declarations – Core rules for the product category of construction products". The data of the study complies with the quality requirements set out in EN 15804 (EN 15804 +A1:2013, Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products). Data regarding the production of the pipe system components is company specific and was provided by GF Piping Systems.

Declaration

Declaration owner & Program operator's name	Georg Fischer Piping Systems Ltd.
Validity	01.06.2014 – 31.05.2019
Declaration Number	GFPS-EPD_1406-5_4

EPD-Type	Cradle to grave
Data calculated by	Vito NV (Flemish Institute for technological research) www.vito.be
Life Cycle Inventory (LCI) source for generic background processes	Ecoinvent v 2.2 (2010, updated August 2012)
Software	SimaPro 7.3.3

Certified Management System SQS ISO 9001 / 14001 / OHSAS 18001

1.2 System

The analyzed case represents an exemplary system for the circling and distribution of purified water in a pharmaceutical plant. The system is designed in the dimension d63 and installed in Pratteln (Switzerland). The used jointing technology is bead and crevice free welding.
The picture below shows a comparable PVDF system from Georg Fischer Piping Systems.

Materials

The material of the main pipe system components (pipes and fittings) is PVDF. The whole system consists of the materials as listed below.

Material		Weight (kg)
PVDF		321
Plastics (other than PVDF)		14
Steel		60
Other materials		2
Rubber		1
Motor		9
Pump	Plastics	5
	Metals	2
	Other materials	2

Reference service life time

25 years

Please refer to chapter 2.3 for further information on the reference service life time of the system.

Functional unit (FU)

The circling and distribution of purified water in a pharmaceutical plant in a loop over the length of 267.3 meters by a piping system (d63) during the whole lifetime of the system. The loop starts at the outlet of the tank and ends at the outlet of each diaphragm valve.

Components of the system (number of pieces or meter)

The system mainly consists of Georg Fischer Piping Systems components. However, to complete the system also external components (Ext.) are necessary which are not produced by Georg Fischer Piping Systems. The calculation of the environmental impact of these products is based on publicly available data and assumptions.

	Product Code	Pieces or meter	Material
System components			
SYGEF Plus pipe, d63	175481208	267.3 m	PVDF-HP
SYGEF Plus bend 90°, d63	735018736	109	PVDF-HP
SYGEF Plus reducer d63/d50	735908609	3	PVDF-HP
SYGEF Plus diaphragm valve type 519, d63	180519330	10	PVDF-HP (body) and others
SYGEF Plus union, d63	735528631	2	PVDF-HP and others
Pump	Ext.	1	Various metals and others
Motor	Ext.	1	Various metals and others
Components for installation			
Clips	Ext.	86	PP
Pipe support tray	Ext.	81	Steel

1.3 Comparability

EPDs of construction products may not be comparable if they do not comply with the EN 15804.

1.4 Demonstration of verification

CEN standard EN 15804 serves as core PCR.

Independent verification of the declaration, according to EN ISO 14025:2010

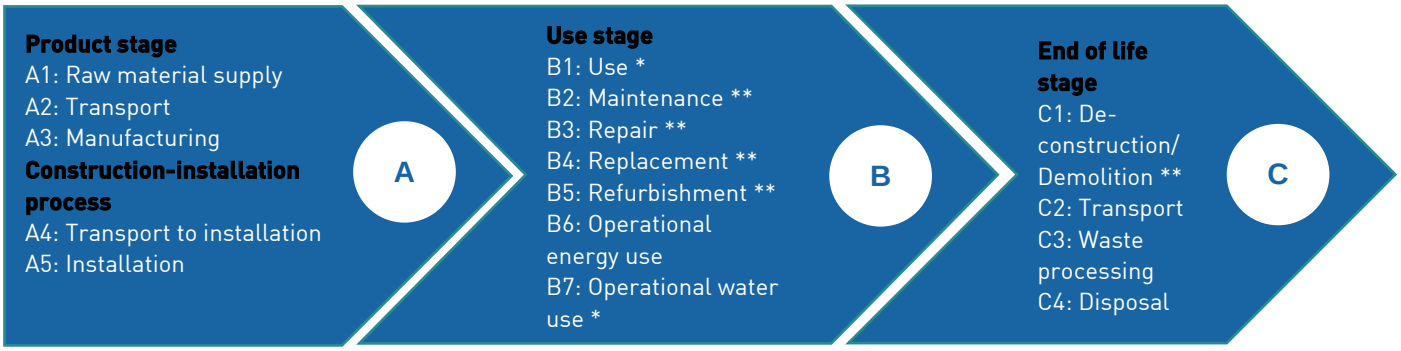
☐ internal ☒ external

Dr. Frank Werner

Company: Dr. Frank Werner Umwelt & Entwicklung, Zürich (Switzerland)

2. Declaration of environmental parameters derived from LCA

2.1 Flow diagram of the processes included in the LCA



* Stage not relevant, ** Environmental impact below cut-off criteria. Please refer to chapter 2.3 for details.

2.2 Parameters describing environmental impacts

The assessment of the environmental impact is based on the results of the calculation of the environmental impact for producing 1 kg PVDF raw materials provided by the raw material supplier. However, the provided results do not split the impact category abiotic depletion into abiotic depletion non fossil and fossil. Therefore these impact categories are disclosed as not available ("n.a").

	Impact category	Global warming	Ozone depletion	Acidification of soil and water	Eutro-phication	Photo-chemical ozone creation	Abiotic depletion - non fossil	Abiotic depletion - fossil
		kg CO_2 eq	kg CFC-11 eq	kg SO_2 eq	kg PO_4^{3-} eq	kg C_2H_4 eq	kg Sb eq	MJ
A1-3	Product stage	5.42E+03	8.20E-03	3.92E+01	2.84E+00	1.50E+00	n.a.	n.a.
A4	Transport to installation	1.51E+01	2.45E-06	8.67E-02	1.80E-02	2.46E-03	n.a.	n.a.
A5	Installation	1.48E+02	1.76E-06	6.47E-02	1.45E-02	8.76E-01	n.a.	n.a.
B1-5	Use, Maintenance, Repair, Replace-ment, Refurbish-ment	0	0	0	0	0	n.a.	n.a.
B6	Operational energy use	2.43E+04	3.24E-03	1.10E+02	1.96E+01	5.14E+00	n.a.	n.a.
B7	Operational water use	0	0	0	0	0	n.a.	n.a.
C1	De-construction/ demolition	0	0	0	0	0	n.a.	n.a.
C2	Transport to end-of-life treatment	2.71E+01	4.25E-06	1.49E-01	3.06E-02	4.47E-03	n.a.	n.a.
C3	Waste processing	4.08E+01	5.07E-08	6.40E-03	1.45E-03	2.06E-04	n.a.	n.a.
C4	Disposal	0	0	0	0	0	n.a.	n.a.

2.3 Scenarios and additional technical information

The analyzed case represents an exemplary system the circling and distribution of purified water in a pharmaceutical plant.

Product stage	
A1	Information on the PVDF raw material was provided by the raw material supplier. The production of other plastic raw material was modeled by generic European data (source: ecoinvent) and complemented by specific data from GF Piping Systems to consider the company specific formulation of the raw material.
A2	Wherever possible, the specific transport distances were taken into account. Data from ecoinvent with the respective parameters was used to model the transportation.
A3	The use of energy is the most important input for this process step. Pipes are extruded while fittings and valve parts are injection moulded. Each of GF Piping Systems' worldwide production sites is certified according to ISO 14001 (Environmental management systems) and to OHSAS 18001 (Occupational health and safety management systems) or is currently in the certification process. For the production of GF Piping Systems components, electricity mixes for the respective country/continent were used. The production of external products was modeled using generic ecoinvent data records for the process.

Construction process	
A4	The system is installed in Pratteln, Switzerland. All components, except the pump are first transported by truck to storage: Pipes, bows, reducing bushes and unions (129 km), valves (150 km), clips (678 km) and support trays (389 km). Afterwards they are transported by truck (90 km) to the installation site. The pump is directly transported by truck (253 km) to the installation site. For all transportations by truck the ecoinvent data record "Transport, lorry › 16t, fleet average/RER U" was used. Loading capacity is 60%.
A5	For the installation of the whole system 25 kWh welding energy (Swiss electricity mix) is needed. Furthermore, specific cleaner (2.2 kg/FU) is necessary. The cleaner is transported by truck (640 km) to the installation site. Outputs of the complete installation of the system are PVDF pipe left over (0.4 kg/FU) and packaging waste (59 kg/FU) whereof 74% is PE film. Cardboard is recycled. Other packaging material is incinerated. Transport distance to recycling is assumed to be 600 km, transport to incineration 150 km. Transport is carried out by truck.

Use stage	
B1	There are no further environmental impacts arising from the use of the system. This stage is considered as not relevant.
B2-B5	The system is designed to be operated without repair, maintenance, replacement or refurbishment during the reference service life time. This is subject to the condition that the system is operated according to the specifications given by GF Piping Systems. The lifetime of a valve is mainly influenced by the actuation cycles. The number of actuation cycles the valves are tested for is not reached during the life time of the evaluated system. It is possible that in individual cases components of the valve (e.g. seals) must be replaced. In this case the environmental impact is negligible compared to the impact of the whole system and below the cut-off criteria defined in EN 15804.
B6	The operational energy use of the system is an important stage because of the long reference service life time of 25 years. 163 800 kWh of energy (ecoinvent dataset: Electricity, low voltage, at grid/CH U) for the pump during the use stage is necessary per functional unit.
B7	No operational water use is necessary for the system. This stage is considered as not relevant.

End of life stage	
C1	A small energy input is needed to cut the pipe into smaller pieces. The environmental impact is negligible compared to the impact of the whole system and below the cut-off criteria defined in EN 15804.
C2	Transportation to the end of life treatment facilities is carried out by truck. Distances are 600 km for recycling and 150 km for incineration.
C3	It is assumed that all metal parts are recycled and all other parts are incinerated with energy recovery. The exported energy is in the form of electricity and thermal energy. Approximately 11.5% of the net energy content of the incinerated waste is converted to electricity and 23.4% is converted to heat. Both are sold to external consumers. These values reflect the situation in Swiss municipal waste incinerators about 10 years ago, as reported in ecoinvent documentation.
C4	It is assumed that all metal parts are recycled and all other parts are incinerated with energy recovery. Therefore module C4 is not relevant.

Reference service life data

<table>
<tr><th>Parameter</th><th>Data</th></tr>
<tr><td>Reference Service Life</td><td>25 years</td></tr>
<tr><td>Declared product properties</td><td>System components are compliant with relevant international standards, e.g.
• EN (European Standards)
• ISO (International Organization for Standardization)
• ASTM (American Society for Testing and Materials)
• DVS (German Welding Society)

Most relevant standards are:
ISO 10931 Plastics piping systems for industrial applications -- Poly(vinylidene fluoride) (PVDF) -- Specifications for components and the system
ISO 16138 Industrial valves - Diaphragm valves of thermoplastics materials</td></tr>
<tr><td>Design application parameters</td><td>
<table>
<tr><th>PVDF characteristics</th><th>Value</th><th>Test standard</th></tr>
<tr><td>Operating temperature range</td><td>-20°C to + 140°C</td><td></td></tr>
<tr><td>Density</td><td>1.78 g/cm^3</td><td>EN ISO 1183-1</td></tr>
<tr><td>Yield stress 23°C</td><td>≥ 50 N/mm^2</td><td>EN ISO 527 - 1</td></tr>
<tr><td>Tensile e-module at 23°C</td><td>≥ 1700 N/mm^2</td><td>EN ISO 527 – 1</td></tr>
<tr><td>Charpy notched impact strength at 23°C</td><td>≥ 8 kJ/m^2</td><td>EN ISO 179-1/1eA</td></tr>
<tr><td>Charpy notched impact strength at 0°C</td><td>≥ 7 kJ/m^2</td><td>EN ISO 179-1/1eA</td></tr>
<tr><td>Heat distortion temperature HDT A 1.80 MPa</td><td>≥ 104 °C</td><td>EN ISO 72-2</td></tr>
<tr><td>Crystallite melting point</td><td>≥ 169 °C</td><td>DIN 51007</td></tr>
<tr><td>Heat conductivity at 23 °C</td><td>0.19 W/m K</td><td>EN 12664</td></tr>
<tr><td>Water absorption at 23 °C/24h</td><td>≤ 0.04 %</td><td>EN ISO 62</td></tr>
<tr><td>Limiting oxygen index (LOI)</td><td>≥ 43 %</td><td>ISO 4589-1</td></tr>
</table>
For more information, please refer to the planning fundamentals which are available at:
gfps.com › Support & Services › Planning Assistance › Planning Fundamentals › Industrial Piping Systems
</td></tr>
<tr><td>Assumed quality of work</td><td>• Completely controlled high-purity manufacturing processes
• High chemical and temperature resistance</td></tr>
<tr><td>Indoor environment</td><td>The system is installed in Pratteln, Switzerland. Standard indoor conditions apply.</td></tr>
<tr><td>Usage conditions</td><td>• SDR 21
• PN 16</td></tr>
<tr><td>Maintenance</td><td>The system is designed to be operated without repair, maintenance, replacement or refurbishment. This is subject to the condition that the system is installed and operated according to the specifications given by GF Piping Systems.</td></tr>
</table>

2.4 Parameters describing resource use

Parameters describing resource use, primary energy		Product stage	Construction process stage		Use stage			End of life			
		Total (of product stage)*	Transport	Construction installation process*	Use, Maintenance, Repair, Replacement, Refurbishment	Operational energy use	Operational water use	De-construction / Demolition	Transport	Waste processing	Disposal
		A1-3	A4	A5	B1-B5	B6	B7	C1	C2	C3	C4
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ, net calorific value	n.a.	3.14E+00	n.a.	0	2.45E+05	0	0	9.03E+00	1.67E-01	0
Use of renewable primary energy resources used as raw materials		n.a.	0	n.a	0	0	0	0	0	0	0
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)		n.a.	3.14E+00	n.a	0	2.45E+05	0	0	9.03E+00	1.67E-01	0
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials		n.a.	2.41E+02	n.a	0	1.53E+06	0	0	4.38E+02	6.29E+00	0
Use of non-renewable primary energy resources used as raw materials		n.a.	0	n.a	0	0	0	0	0	0	0
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials)		n.a.	2.41E+02	n.a	0	1.53E+06	0	0	4.38E+02	6.29E+00	0

*Impacts related to the PVDF materials are not available.

Parameters describing resource use, secondary materials and fuels, and use of water		Product stage	Construction process stage		Use stage			End of life			
		Total (of product stage)	Transport	Construction installation process	Use , Maintenance, Repair, Replacement, Refurbishment	Operational energy use	Operational water use	De-construction / Demolition	Transport	Waste processing	Disposal
		A1-3	A4	A5	B1-B5	B6	B7	C1	C2	C3	C4
Use of secondary material**	kg	n.a.	0	n.a.	0	0	0	0	0	0	0
Use of renewable secondary fuels**	MJ, net calorific value	n.a.	0	n.a.	0	0	0	0	0	0	0
Use of non-renewable secondary fuels*	MJ, net calorific value	n.a.	0	n.a.	0	0	0	0	0	0	0
Net use of fresh water	m^3	n.a.	6.08E-02	n.a.	0	8.66E+02	0	0	1.19E-01	2.45E-02	0

* Impacts related to the PVDF materials are not available.

**Only for foreground process from which LCI data are made available by GF Piping Systems - the number does not include processes and materials modelled by means of background data, e.g. transportation, electricity, ancillary materials, etc.

2.5 Environmental information describing output flows

Other environmental information describing output flows		Product stage	Construction process stage		Use stage			End of life			
		Total (of product stage)	Transport	Construction installation process	Use, Maintenance, Repair, Replacement, Refurbishment	Operational energy use	Operational water use	De-construction / Demolition	Transport	Waste processing	Disposal
		A1-3	A4	A5	B1-B5	B6	B7	C1	C2	C3	C4
Components for re-use*	kg	0	0	0	0	0	0	0	0	0	0
Materials for recycling*	kg	4.83E+01	0	1.19E+01	0	0	0	0	0	3.94E+02	0
Materials for energy recovery*	kg	0	0	0	0	0	0	0	0	0	0
Exported energy - electricity*	MJ per energy carrier	1.24E+01	0	1.88E+02	0	0	0	0	0	6.59E+01	0
Exported energy - thermal energy*	MJ per energy carrier	8.03E+00	0	2.80E+02	0	0	0	0	0	1.33E+02	0

*Only for foreground process from which LCI data are made available by GF Piping Systems - the number does not include processes and materials modelled by means of background data, e.g. transportation, electricity, ancillary materials, etc.

Other environmental information describing waste categories		Product stage	Construction process stage		Use stage			End of life			
		Total (of product stage)*	Transport	Construction installation process*	Use , Maintenance, Repair, Replacement, Refurbishment	Operational energy use	Operational water use	De-construction / Demolition	Transport	Waste processing	Disposal
		A1-3	A4	A5	B1-B5	B6	B7	C1	C2	C3	C4
Hazardous waste disposed	kg	n.a.	2.60E-04	n.a.	0	6.93E-01	0	0	4.35E-04	5.03E-05	0
Non-hazardous waste disposed		n.a.	1.72E+00	n.a.	0	2.88E+03	0	0	2.84E+00	5.78E+00	0
Radioactive waste disposed		n.a.	1.90E-04	n.a.	0	1.69E+01	0	0	5.81E-04	1.11E-05	0

* Impacts related to the PVDF materials are not available.

GF Piping Systems

Your contact

Georg Fischer Piping Systems Ltd.
Ebnatstrasse 111
CH-8201 Schaffhausen
Switzerland

Phone +41 (0) 52 631 11 11
www.gfps.com/sustainability
sustainability.ps@georgfischer.com