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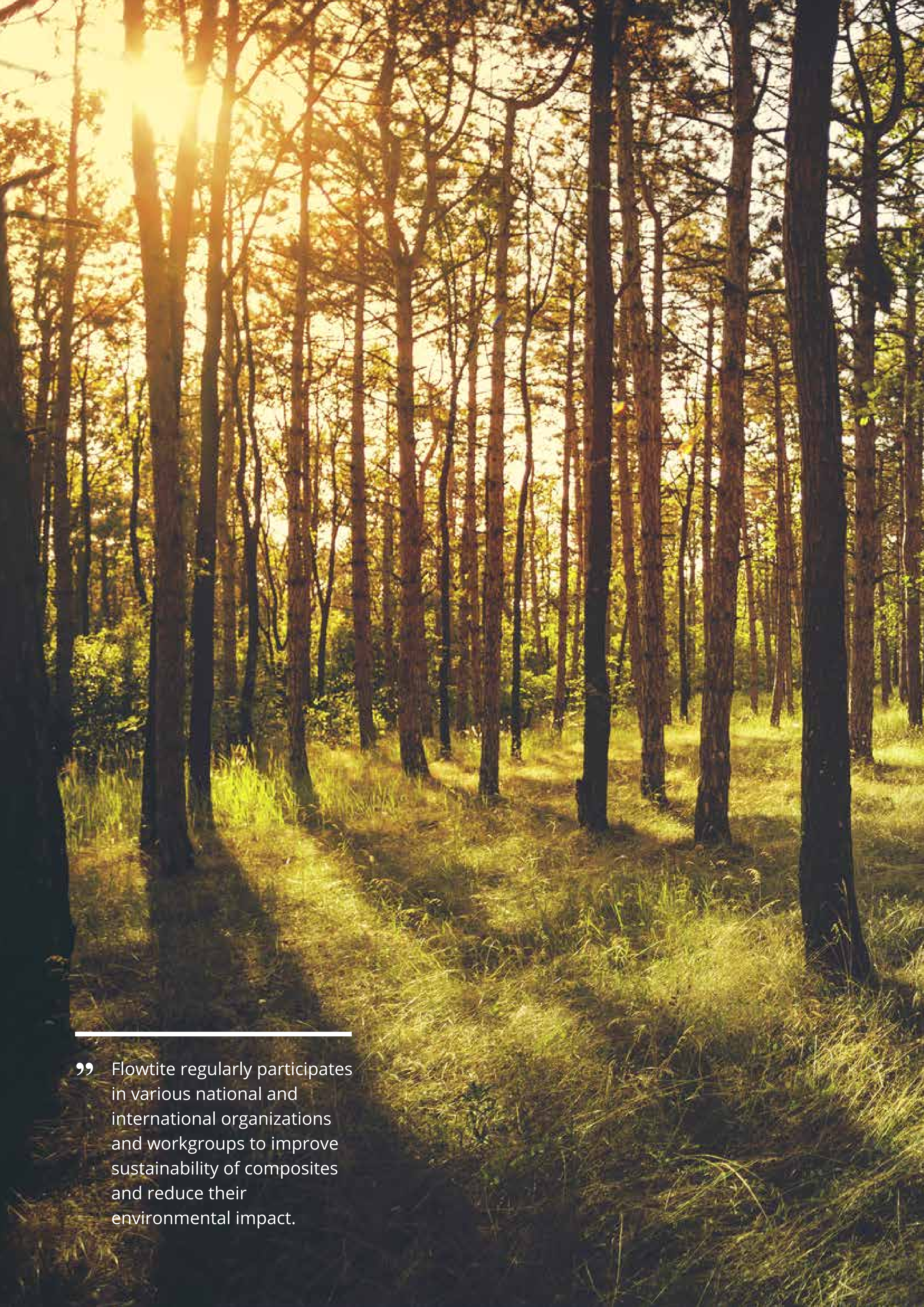
THE FIRST CHOICE OF ENGINEERS FLOWTITE WORLDWIDE

FLOWTITE ENVIRONMENTAL PRODUCT DECLARATION

LOW NEGATIVE IMPACT ON CLIMATE CHANGE



> Flowtite regularly participates in various national and international organizations and workgroups to improve sustainability of composites and reduce their environmental impact.

INDEX

INTRODUCTION

For the past 10 years Flowtite has been strongly focusing on reduction of the environmental footprint of its pipe production technology. Great achievements have been made through optimization of the company's internal processes, innovation and constant improvement of the technologies, cooperation with major raw material suppliers and utilizing raw materials of high quality. In addition, Flowtite regularly participates in various national and international organizations and workgroups to improve sustainability of composites and reduce their environmental impact. According to an independent study conducted at the Norwegian University of Life Sciences in 2012, GRP pipes have a minimal negative environmental impact compared to other pipe materials due to the material efficiency. That is why Flowtite GRP pipes continue to be an excellent choice for the environment, which makes Flowtite the first choice of engineers worldwide.

SUMMARY

Flowtite Technology is proud to present this Environmental Product Declaration as a result of great efforts and intensive cooperation with our European license partners. The document summarizes Flowtite's extensive Life Cycle Assessment Study. The study was conducted according to international standards ISO 14040/ISO 14044 and reviewed by one of Europe's leading sustainability consultants – Thinkstep. The results show that the environmental footprint of Flowtite GRP pipes is dominated by the two major raw materials: polyester resin and glassfibre (in average 80% of cradle-to-gate results). This motivated Flowtite to strengthen existing cooperation with major raw material suppliers, ensure continuous improvement of the technologies and establish its position as a market leader in the GRP pipe industry. The ongoing efforts to find state-of-the-art solutions for the environment have contributed to the innovation and optimization of the processes, including sustainable recycling methods for the composite industry.

1 Declaration of general information

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Date of declaration:
21.05.2015

Valid until:
21.05.2020

EPD program, program operator:
Flowtite Technology participates in European Standardization organization (CEN-TS 155/WG27) which is currently developing Product Category Rules (PCR) for Plastic Pipes.
The EN 15804 has been used as guideline for this EPD.

Declared Building Product:
Flowtite® GRP Pipes

Declared unit of the construction product:
1 kg of GRP pipe

Reference service life (RSL):
Cradle-to-gate only

Geographical scope:
Europe*

*The data presented in this docoment can also be used as a guideline for Flowtite operations in other regions of the world.

❷ Description of the product

2.1 General product information

FLOWTITE® GRP PIPES are available in over six pressure classes and three stiffness classes. The diameters range from 100 mm to 4000 mm. Each type of pipe has its individual material composition. Possible fields of application are:

- Water transmission and distribution (potable and raw water)
- Sanitary sewerage collection systems and outfalls
- Storm sewers
- Hydroelectric penstock lines
- Sea water intake and outfalls
- Circulating cooling water, make-up and blowdown lines for power plants
- Industrial applications

GRP (glass fibre reinforced plastic) is a fibre reinforced polymer. Flowtite® GRP pipes mainly consist of a polymer matrix (polyester) which is reinforced by fine glass fibres.
The three basic raw materials are:

- Polyester resin (~25% mass)
- Glass fibre (~25% mass)
- Silica sand (~50 % mass)

NOTE » Composition is based on a product average – single products may differ based on the pipe specification used for a specific project.

Flowtite® pipes are manufactured using the continuous advancing mandrel process which represents the state of the art in GRP pipe production.

SIMPLY PUT, the manufacturing machine consists of a continuous steel band mandrel supported by beams in a cylindrical shape. As the beams turn, friction pulls the steel band around and a roller bearing allows the band to move longitudinally so that the entire mandrel moves continuously in a spiral path towards the exit assembly. As the mandrel rotates, all composite materials are metered onto it in precise amounts. Electronic sensors provide continuous production parameter feedback so that the various feeding systems apply the right amount of material. This ensures that the amount of material needed to build the different layers is applied throughout the manufacturing stage. Firstly, the mould release film is applied, which is followed by various forms and patterns of glass fibres, embedded in a polyester resin matrix. The structural layers are made of glass and resin only, whereas the core layer includes silica sand as well. It is the continuous application of these materials onto the mandrel which forms the pipe.

After the pipe has been formed on the mandrel, it is cured and later cut to the required length when leaving the machine. The ends of the pipe section are calibrated to fit the coupling.

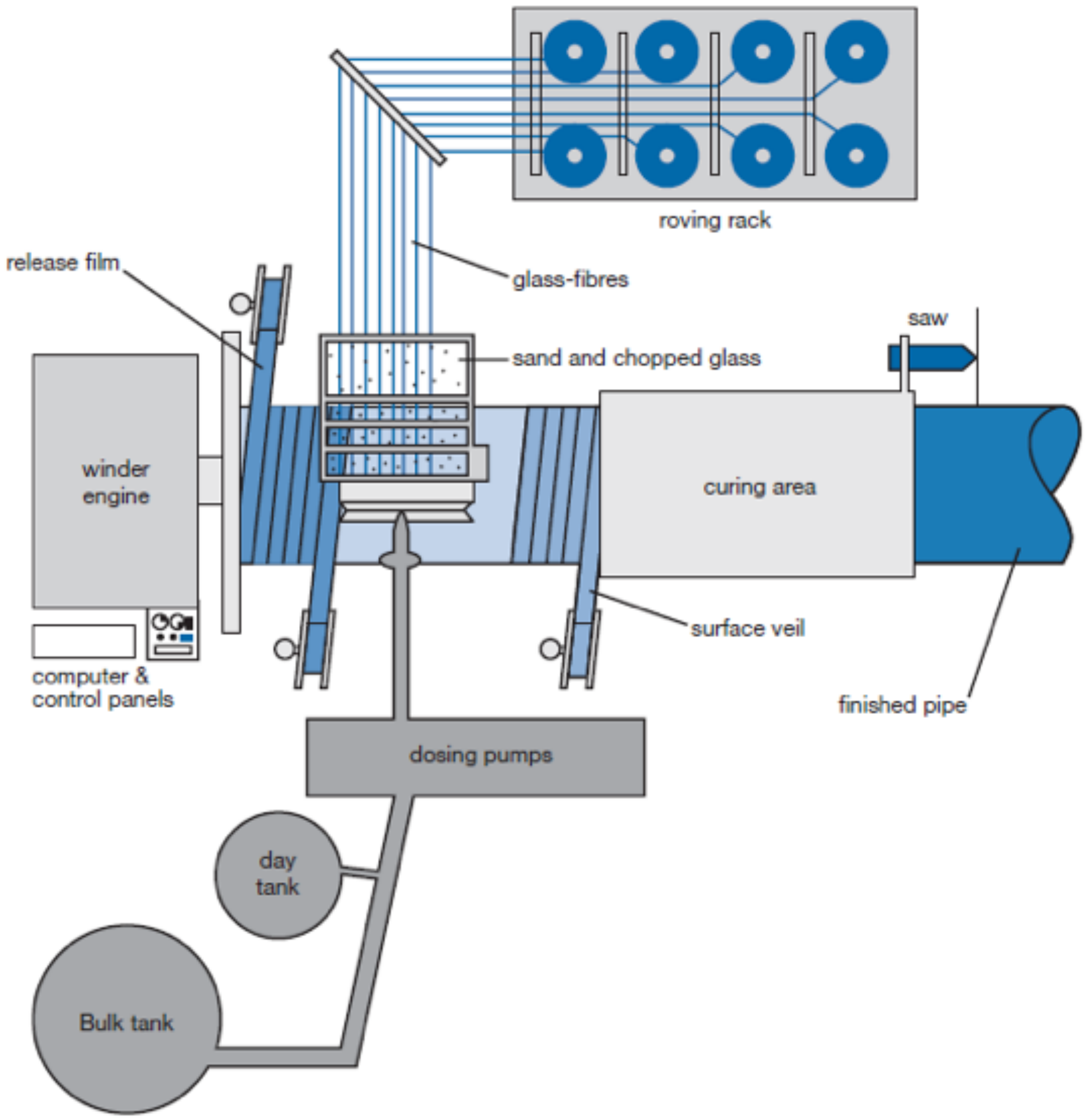
Flowtite® Pipe Systems are the first choice for the environment:

- Light weight and easy to install
- Corrosion resistance
- Outstanding service life
- Leak- and maintenance-free operation
- Low energy production process
- Recyclable

CompoCycle

2.2 Technical properties

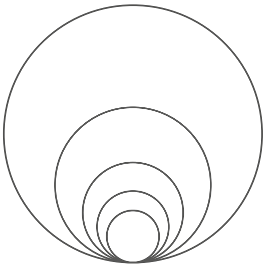
Figure 2.2: Principal of Flowtite® Continuous Winding Process



THE MANUFACTURING process allows the use of continuous glass-fibre reinforcements in the circumferential direction. For a pressure pipe or a buried conduit the principle stress is applied in circumferential direction. Thus, incorporating continuous reinforcements in this direction yields a higher-performing product at lower cost. Using the technology developed by material specialists, a very condensed laminate is created that maximizes the contribution from the three basic raw materials.

Both continuous glass-fibre rovings and choppable rovings are incorporated for high hoop strength and axial reinforcement. A sand fortifier is used to provide increased stiffness by adding extra thickness, placed near the neutral axis in the core. With the Flowtite® dual resin delivery system, the equipment has the capability of applying a special inner resin liner for severely corrosive applications, while utilizing a standard type resin for the structural and the outer portion of the laminate.

**The Flowtite® GRP Pipe System offers an extensive range of pipe diameters and is completed by an outstanding range of fittings and accessories.
The range of standard diameters in mm:**



PIPE DIAMETERS

100 • 150 • 200 • 250 • 300 • 350 • 400 • 450

500 • 600 • 700 • 800 • 900 • 1000 1200 • 1400

1600 • 1800 • 2000 • 2400 • 2600 • 2800 • 3000

Other diameters up to 4000 mm are available on request.

Flowtite® pipes are available in standard stiffness classes SN 2500, SN 5000 and SN 10000. Additionally, custom-designed stiffness classes are available on request.

Dependent on diameters, the Flowtite® GRP pipes are available in nominal pressure classes between 1 bar and 32 bar. Flowtite® is committed to high quality standards and therefore ensures that all pipes with a pressure greater than PN1 are 100% pressure tested for twice their nominal pressure.

Our pipes are supplied in standard lengths up to 12 meters. For other, customized lengths please contact your local dealer.

2.3 Product standards

FLOWTITE® GLASSFIBRE PIPE systems are certified according to many national and international standards. Standards developed by ASTM, AWWA and the latest ISO and EN are applied to a variety of glassfibre pipe applications, including conveyance of sanitary sewerage, water and industrial waste.

EN 1796 and EN 14364 are the documents for water and sewer applications that have substituted many local standards in Europe.

The International Standards Organization (ISO) has issued two standards:

- ISO 10467 for drainage and sewerage
- ISO 10639 for water

Flowtite® is participating in the development of all these standards with representatives from its worldwide organization, thereby ensuring performance requirements that result in reliable products.

2.4 Product handling and installation

Flowtite® glassfibre pipe systems are lightweight products, that are easy to transport, handle and install. Detailed instructions and information can be found in various Flowtite® Installation Manuals covering different applications - please download the required information as needed:

[**http://www.flowtite.com/Downloads-Brochures.aspx**]

2.5 Product Lifetime, Disposal and Recycling

Flowtite® Pipe Systems are typically designed for a lifetime of minimum 50 years. Due to the outstanding performance and corrosion resistant material, many Flowtite® pipeline installations will operate much longer. Should a pipeline get out of operation, in most cases the pipeline owners decide to leave the pipes in the ground as they are not harmful to the environment.

For cases where pipelines are removed from the ground they can be disposed of following local regulations, which could specify normal landfill, incineration or recycling in a cement plant.

Recycling for composite materials in the cement industry have been introduced in Europe on Industrial scale from 2010, and is currently branded and promoted as COMPOCYLE®. This recycling concept is supported by AVK (Federation of Reinforced Plastics – Germany) and EuCIA (European Composites Industry Association);

At Flowtite Technology we are continuously improving the environmental impact of our pipe-systems and we are a participating member in different sustainability and standardization workgroups throughout Europe, i.e. Development of Product Category Rules (PCR) for Plastic Pipe System – European Standards – TC155/WG27, Sustainability of Composites – Workgroup of AVK, Workgroup for Life-Cycle Assessment of Composites – EuCIA.

❸ LCA calculation rules

The quantification of the environmental performance is based on a Life Cycle Assessment (LCA) study according to international standards ISO 14040/14044. The original LCA study has been performed in 2010 for Flowtite® GRP pipes, produced in Camarles (Spain). In an update the scope of the study has been extended to cover the European situation for Flowtite® GRP pipes.

3.1 Declared unit

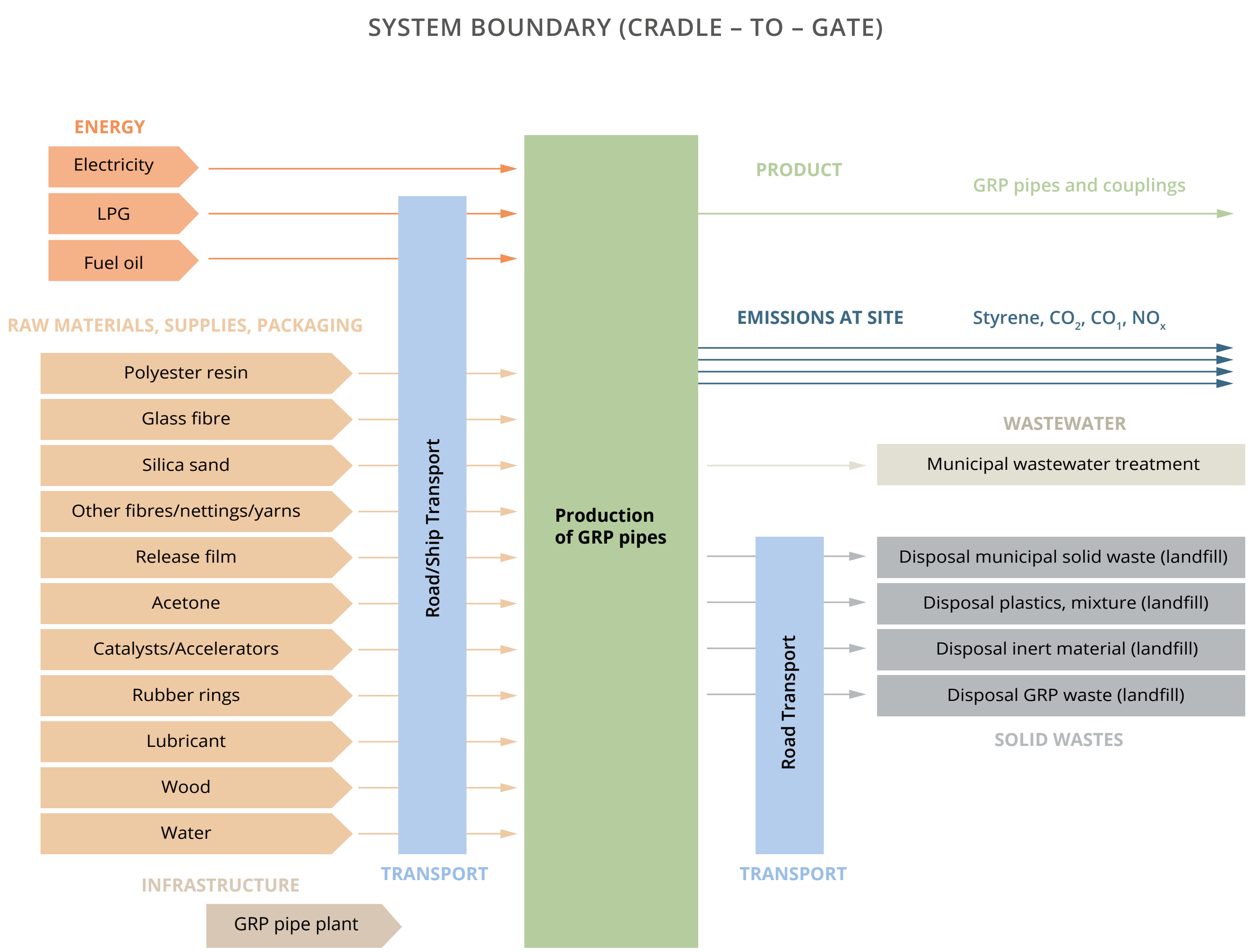
The declared unit of the EPD is the production of 1kg of GRP pipes.

The study considers pipes and couplings. Couplings are basically pipes of a slightly larger diameter, cut into short pieces. The production process of fittings (elbows, tees, reducers, flanges, etc.) is significantly different from the production of straight pipes and is not included.

Flowtite® produces a large variety of pipes (different diameters, pressure classes, stiffness classes, etc.). Each type has its individual material composition. This EPD does not focus on a single type of pipe but considers a representative production mix. Due to the individual material composition, the environmental impact of particular pipes can vary significantly from the production mix.

3.2 System boundaries

Figure 3.2: Main process modules of GRP pipe production (Cradle-to-Gate)



THE PRESENT EPD is a “cradle-to-gate” EPD, which means only the product stage information module groups (A1-A3) are included:

- **module A1:** raw material extraction and processing
- **module A2:** transport to the manufacturer
- **module A3:** manufacturing

The modules include the provision of all materials, products and energy, as well as waste processing up to the end of waste state or disposal of final residues during the product stage.

3.3 Data sources

DATA COLLECTION PROCEDURES have been defined in cooperation with Flowtite Technology AS. Primary data has been collected for the production of GRP pipes at the Amiantit production site in Camarles (Spain, 2009). In an update the scope of the study has been extended to cover the European situation for Flowtite® GRP pipes.

The LCI data for glass fibres is based on a LCA-study performed by PwC for GlassFibreEurope [GlassFibreEurope, 2011]. The data set is based on average site-specific data of the European glass-fibre industry.The LCI data for polyester resin is based on a LCA-study performed by Ernst & Young Accountants LLP for AVK (Industrievereinigung Verstärkte Kunststoffe e.V.) [AVK, 2014]. The data set is based on average site-specific data of the European resin industry. Generic data from the ecoinvent database, version 2.2 has been used for other upstream (material production, energy generation, transportation, etc.) and downstream processes (e.g. disposal of production waste).

For some materials (additives) LCA-data was not available. These inputs have been approximated, based on general modules for organic chemicals. Sensitivity analysis indicated an insignificant impact on the results.

For the calculation of the LCI for GRP-waste and the wastewater treatment of GRP production, the corresponding Ecoinvent tools have been used.

3.4 Temporal coverage/scope

The base period for data collection of the production process is 2009.

3.5 Geographical coverage/scope

THE GEOGRAPHIC SCOPE is the production of GRP pipes within Europe*. Primary data for pipe production has been collected at a production site in Spain. Since the technology and the production processes are identical in every European site, these data can be regarded as representative for the European production situation. Furthermore generic data which covers the European situation (raw materials, electricity mix, typical transport distance and technologies, typical waste and wastewater treatment) has been used in the LCA.

3.6 Cut-off Criteria

FOR THE INPUT AND OUTPUT data collection of the pipe production process all material flows higher than 1% of the total mass flow and all energy flows higher than 1% of the total energy input have been required. For hazardous and toxic substances the 1% cut-off rule did not apply. All available inputs and outputs have been considered in the LCA, even if they were below the 1% threshold. Some incoming packaging materials have not been recorded. Their estimated mass is significantly below the 1% threshold. The sum of all excluded inputs accounts for less than 5 % of the total mass and of the LCA results.

*The data presented in this docoment can also be used as a guideline for Flowtite operations in other regions of the world.

3.7 Allocation principles

THE FACTORY IN CAMARLES produces regular pipes and couplings as well as fittings (elbows, tees etc.). Since fittings are excluded from the study, the overall inputs and outputs of the factory had to be allocated. For the raw material input and energy consumption allocation has been avoided, since the inputs are recorded separately. Other inputs/outputs (waste, infrastructure etc.) have been allocated to the production of straight pipes. This approach can be justified since the overall impact of production wastes and infrastructure is low. Thus the LCA results of straight pipes are not significantly changed by the allocation assumptions. Since upstream processes have been modeled by the ecoinvent database, the ecoinvent allocation principles have been implicitly implemented.

3.8 Life Cycle Impact Assessment (LCIA)

CML 2001 method has been chosen for Life Cycle Impact Assessment (LCIA). The CML method has been developed by the Centre of Environmental Science of Leiden University and is one of the most acknowledged methods for impact assessment. The reported impact categories are:

- **Abiotic depletion, ADP in [kg Sb-Eq]**
- **Acidification, AP in [kg SO2-Eq]**
- **Eutrophication, EP in [kg PO4-Eq]**
- **Global warming, GWP100 in [kg CO2-Eq]**
- **Photochemical oxidation, PCOP in [kg C2H4-Eq]**

The contributing flows to the above impact categories and their characterization factors are given in [Guinée et al., 2001].

The use of renewable and non-renewable primary energy has been considered by means of the cumulative energy demand (CED) according to [Hischier et al., 2010].

4 LCA Results

4.1 Declared information modules

PRODUCT stage			CON-STRUCTION PROCESS stage		USE STAGE							END OF LIFE stage				Suppl. Information
Raw material supply	Transport	Manufacturing	Transport	Construction- installation process	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction	Transport	Waste-processing	Disposal	Benefits/loads beyond system boundary
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
D	D	D	-	-	-	-	-	-	-	-	-	-	-	-	-	-

D information module declared
- information module not declared

4.2 Parameters describing environmental impacts

Environmental impacts: 1 kg GRP pipes (production mix – complies with a DN 1200 SN 5000 PN 10 pipe)					
Parameter	Unit	A1 Raw material supply	A2 Transport	A3 Manufacturing	Production (total A1-A3)
Abiotic depletion	kg Sb eq	1,46E-02	8,85E-04	8,17E-04	1,63E-02
Acidification	kg SO2 eq	5,97E-03	6,56E-04	9,64E-04	7,59E-03
Eutrophication	kg PO4--- eq	8,79E-04	1,07E-04	1,13E-04	1,10E-03
Global warming (GWP100)	kg CO2 eq	1,56E+00	1,26E-01	1,43E-01	1,83E+00
Photochemical oxidation	kg C2H4	5,47E-04	2,40E-05	1,73E-04	7,43E-04

4.3 Parameters describing primary energy consumption

Primary energy consumption: 1 kg GRP pipes (production mix – complies with a DN 1200 SN 5000 PN 10 pipe)					
Parameter	Unit	A1 Raw material supply	A2 Transport	A3 Manufacturing	Production (total A1-A3)
CEDren	MJ	0,78	0,03	0,17	0,97
CEDnon-r	MJ	31,36	2,08	2,02	35,46
CED	MJ	32,13	2,11	2,19	36,43

NOTE » Specific Environmental Impact Information for Flowtite® products is available for most standard Flowtite® pipe systems. For further information please contact us.

5 LCA Interpretation

The cradle-to-gate analysis shows that the two main raw materials, polyester resin and glass fibres, are responsible for the main part of the environmental impact. Their contribution to the overall impact is between 72 % (Photochemical oxidation) and 85 % (Abiotic depletion).

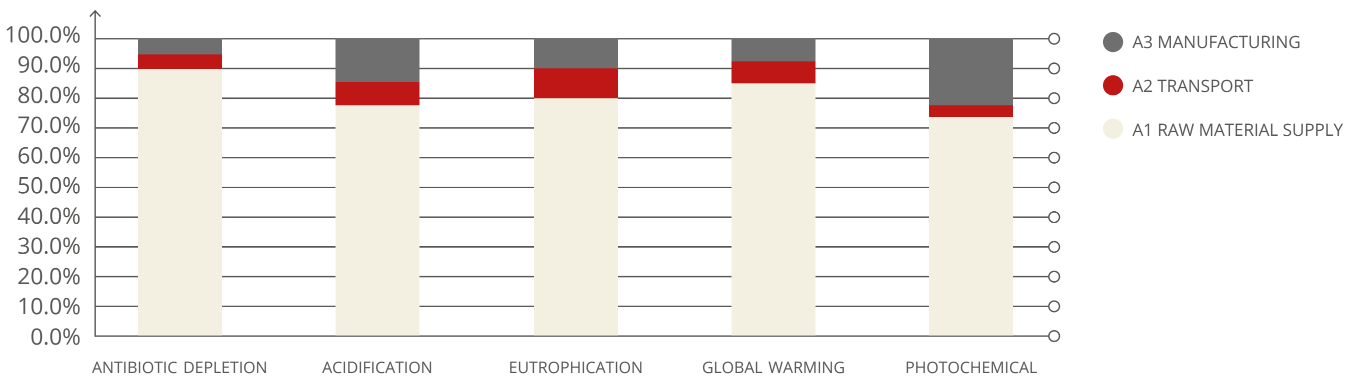
Energy consumption at the production site, which is mainly electricity, but also LP gas and fuel oil, does not have a very large influence on the results. The contribution to the overall impact is between 4 % (Photochemical oxidation) and 10 % (Acidification).

The transport of raw materials to the factory and wastes from the factory also does not have a very large influence on the results. The contribution to the overall impact is between 3 % (Photochemical oxidation) and 10 % (Eutrophication).

Process emissions at the factory (mainly styrene emissions) are responsible for 19% of the photo chemical oxidant formation potential and hence play a significant role for this impact category. In all other impact categories they only play a minor role.

The contribution of other raw materials and supplies (silica sand, chemicals etc.) is between 2 % (Photochemical oxidation) and 5 % (Abiotic depletion) and therefore they only play a minor role.

Figure 5.1: Relative contribution of the information modules to the environmental impact categories



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THE BEST PIPE SOLUTION FOR THE ENVIRONMENT

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