Declaration Owner
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Product:
Small Diameter Valves

Functional Unit
1000 kg

EPD Number and Period of Validity
SCS-EPD-10462
EPD Valid July 24, 2025, through July 23, 2030
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Product Category Rule
Fabricated Metal Products, Except Construction Products. Product Category Classification: UN CPC 412, 414, 416, 42. Version 1.0.1 2023. International EPD System.

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Declaration owner:	Victaulic
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Product(s):	Small Diameter Valves
Functional Unit or Functional Unit:	1000 kg
Product RSL (if applicable):	N/A
Markets of Applicability:	North America, Europe, Asia
EPD Scope:	Cradle to Grave
Year(s) of Reported Manufacturer Primary Data:	2022
LCA Software & Version Number:	OpenLCA 2.2.0
LCI Database(s) & Version Number:	EcoInvent 3.9.1
LCIA Methodology & Version Number:	EN15804+A2, EF 3.1
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PCR review:	Hudai Kara. The Technical Committee of the International EPD® System. A full list of members is available at www.environdec.com. The review panel may be contacted via info@environdec.com.
LCA Practitioner:	Thomas Cygan, Sahil Akol
Independent critical review of the LCA and data, according to ISO 14044 and the PCR:	☐ internal ☒ external
LCA Reviewer:	Abby Martell
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Disclaimers: *An EPD should provide current information and may be updated if conditions change. The stated validity is therefore subject to the continued registration and publication.*

Conformity: *This EPD conforms to ISO 14025:2006.*

Ownership: *The EPD owner has the sole ownership, liability, and responsibility of the EPD.*

Accuracy of Results: *Due to PCR constraints, this EPD provides estimations of potential impacts that are inherently limited in terms of accuracy.*

Comparability: *The PCR this EPD was based on was not written to support comparative assertions. EPDs based on different PCRs, or different calculation models, may not be comparable. When attempting to compare EPDs or life cycle impacts of products from different companies, the user should be aware of the uncertainty in the final results, due to and not limited to, the practitioner's assumptions, the source of the data used in the study, and the specifics of the product modeled.*

The owner of the declaration shall be liable for the underlying information and evidence; SCS shall not be liable with respect to manufacturer information, life cycle assessment data, and evidence supplied or made available to SCS.

1. Victaulic

Since 1919, Victaulic continues to lead the industry with innovative pipe joining solutions, serving customers in more than 140 countries. Headquartered in Easton, Pennsylvania, USA,. Victaulic is a privately held, ductile iron company, specializing in mechanical pipe joining technologies, while providing additional services with a diverse product-line to address the most complex piping challenges faced by engineers, site owners, and contractors.

Victaulic is a vertically integrated company with direct control of all engineering, research, and product development to uphold strict quality standards across its global footprint. With 7 foundries and more than 50 strategically located facilities, Victaulic ensures proximity to its customer-base while sourcing raw materials and components, such as graded scrap iron used to make ductile iron. Engineered for confidence, Victaulic solutions enhance safety, ensure reliability, maximize efficiency, and accelerate project timelines.

Through innovation, manufacturing excellence, and a strong commitment to sustainability, Victaulic continues to set industry standards for mechanical pipe joining systems for a wide range of applications.

Victaulic operates globally and has four primary manufacturing facilities: the Forks foundry (USA), Alburtis foundry (USA), Drezdenko foundry (Poland), and DBMT foundry (China). No valves are produced at the Alburtis facility.

2. Product Information

2.1 PRODUCT IDENTIFICATION

This EPD is for Victaulic small diameter valves. The butterfly valve was determined to be the representative product. This is a base model that is updated with small design changes and new materials options over time, creating a new version. Please contact Victaulic for the most recent version. This EPD study is determined to be representative of future butterfly valve versions, as well as the other models listed in section 2.4, unless there is a major design change. This product, and all products found in section 2.4, correspond to UN CPC 412.

2.2 PRODUCT DESCRIPTION

Victaulic valves are mechanical devices used to control, direct, isolate mix or regulate the flow or pressure of a fluid. Victaulic valves can be installed in nearly any orientation in the piping system and are provided grooved. Designed to withstand system movement, including hanging loads and bending forces, these valves also offer flexibility for thermal expansion and contraction when required. Victaulic butterfly valves are designed for bi-directional flow from dead end services to full working pressure of the piping system. Victaulic check valves prevent backflow in a system, allowing fluids to only travel in the intended direction.

2.3 APPLICATION

These valves are designed for any pipe system of matching size and primarily used in industrial buildings. The product is applicable to any fluid. Different size and material options are available to suit the temperature and pressure needs of the system.

2.4 MULTIPLE PRODUCT EPD

This EPD is for the butterfly valve, but is inclusive of the following valve models:

Butterfly valve, check valve.

The butterfly valve was chosen primarily as it is the most materially complex valve and contains the most high impact materials.

2.5 GEOGRAPHIC SCOPE

This study includes manufacturing facilities in the United States of America, Poland, and China. Results for each facility were modeled, assuming use and end-of-life in country/region. The best datasets available were chosen for each region.

2.6 DECLARED/FUNCTIONAL UNIT

The functional unit is 1000 kg of valves.

2.7 REFERENCE SERVICE LIFE

Not applicable.

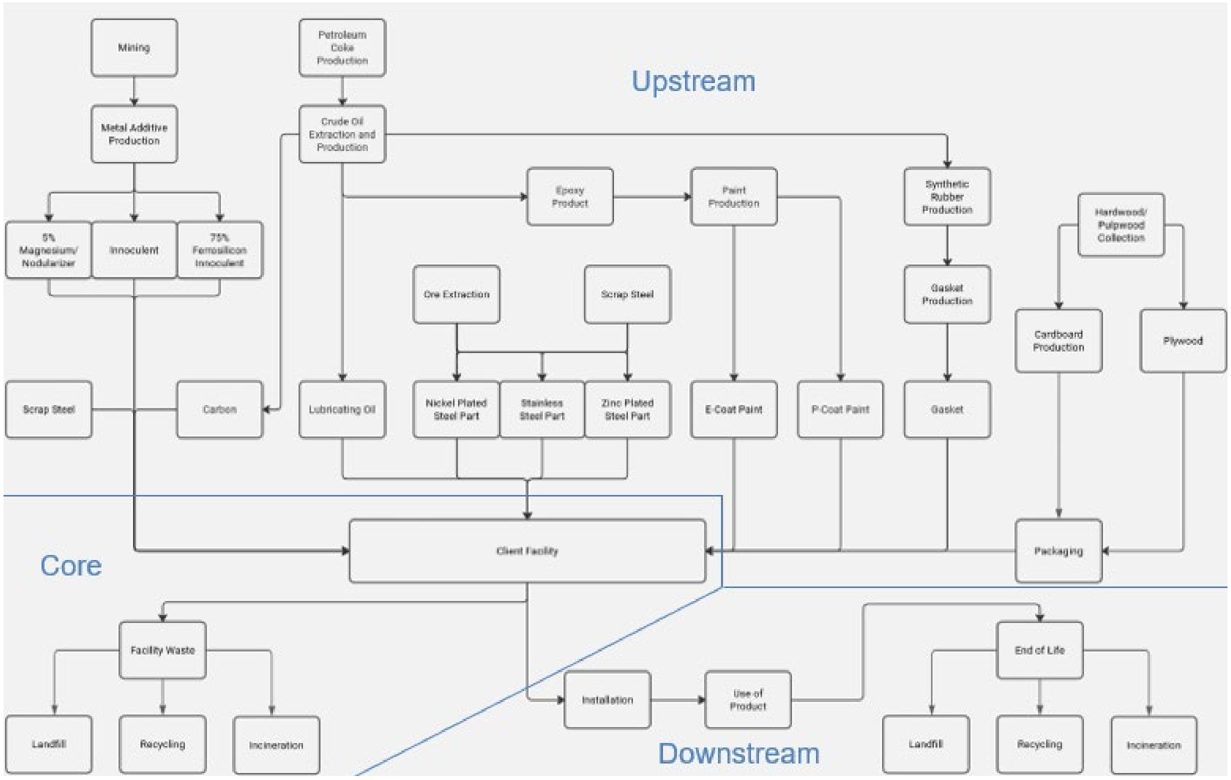
2.8 REFERENCE STANDARDS

The standard metal of all products included is ductile iron conforming to ASTM A-536, Grade 65-45-12.

2.9 FLOW DIAGRAM

This process is divided into three stages: upstream, core, and downstream.

Figure 1. Flow diagram for manufacturing 1000 kg of Victaulic product.



2.10 SYSTEM BOUNDARY

This LCA includes a Cradle-to-Grave scope of study. This includes the modules: raw material supply, inbound transport, manufacturing, transport to customer, use of the metal product, and end-of-life. All modules were included and all relative mass and energy flows from each process listed in the flow diagram were detailed in this study.

3. Methodological Framework

3.1 ALLOCATION

General principles of allocation were based on ISO 14040/14044. Since there are no other co-products, no allocation based on co-products is required.

To derive a per-unit for manufacturing inputs and outputs such as electricity, thermal energy, and waste streams, allocation based on Total Mass Production by unit was adopted. As a default, secondary Ecoinvent datasets use a mass basis for allocation.

The method in which recycled materials were handled is relevant to the defined system boundary. Throughout the study, recycled materials were accounted for via the cut-off method. In this method, impacts and benefits associated with the previous life of a raw material from recycled stock are excluded from the system boundary. Additionally, impacts and benefits associated with secondary functions of materials at the end of life are also excluded (i.e. production into a third life or energy generation from incineration). The study does include the impacts associated with reprocessing and preparation of recycled materials feed streams that are included in the studied product.

3.2 CUT-OFF RULES

Any material present at or above 1 wt% of the final product was included within the scope of this study. Material inputs less than 1% were included if sufficient data was available to warrant inclusion and/or the material input was thought to have significant environmental impacts. These materials include inoculant and pre-inoculant additives to the ductile iron products.

3.3 DATA SOURCES

All primary and secondary data was modelled in OpenLCA using Ecoinvent 3.9.1 datasets to calculate the potential environmental impacts during each stage of the product's life. No proxy data was used in this study.

Victaulic provided quantities and specifications for its manufacturing facilities including utilities, waste, and process equipment. Transportation distances and installation specifications (the only notable source of emissions during the product's use/life) were also provided. Based on these specifications the most relevant dataset from Ecoinvent 3.9.1 was chosen. If no specifications were given, the most relevant dataset was worst case average data for each facility, in their respective regions.

Table 1 shows a summary of the datasets used and does not specify location; this would appear in the table as repeat entries with different locations. Frequently, the same dataset with a different specified location was used to model the differences for each facility. See the full LCA report for more information.

Table 1. *Data sources for valves.*

Flow	Dataset	Data Source	Publication Date
Raw Materials			
Carbon - Production	petroleum coke production, petroleum refinery operation	ecoinvent 3.9.1	2022
E-Coat Paint - Production	epoxy resin insulator, SiO2 production	ecoinvent 3.9.1	2022
Lubricating Oil - Production	market for lubricating oil production	ecoinvent 3.9.1	2022
Nickel - Production	smelting and refining of nickel concentrate, 16% Ni	ecoinvent 3.9.1	2022
Nylon - Plastic Forming	market for injection moulding	ecoinvent 3.9.1	2022
Nylon - Production	market for nylon 6-6	ecoinvent 3.9.1	2022
P-Coat Paint - Production	market for coating powder	ecoinvent 3.9.1	2022
Pig Iron - Production	pig iron production	ecoinvent 3.9.2	2022
Rubber - Production	synthetic rubber production	ecoinvent 3.9.1	2022
Stainless Steel - Production	steel production, chromium steel 18/8, hot rolled	ecoinvent 3.9.1	2022
Steel - Chromium Coating	hard chromium coating, chromium removed, electroplating, steel substrate, 0.14 mm thickness	ecoinvent 3.9.1	2024
Steel - Metal Working	deep drawing, steel, 10000 kN press, automode	ecoinvent 3.9.1	2022
Steel - Production	market for steel, low-alloyed, hot rolled	ecoinvent 3.9.1	2022
Steel - Zinc Coating	zinc coating, pieces	ecoinvent 3.9.1	2022
Utilities			
Forks/Alburtis Electricity	market for electricity, high voltage (US-RFC)	ecoinvent 3.9.1	2022
Drezdenko Electricity	market for electricity, medium voltage (PL)	ecoinvent 3.9.1	2022
DBMT Electricity	market for electricity, medium voltage (CN-NECG)	ecoinvent 3.9.1	2022
Facility Water	market for tap water	ecoinvent 3.9.1	2022
Natural Gas	market for heat, district or industrial, natural gas	ecoinvent 3.9.1	2022
Transportation			
Road Transportation	transport, freight, lorry 16-32 metric ton, EURO4	ecoinvent 3.9.1	2023
Sea Transportation	market for transport, freight, sea, container ship	ecoinvent 3.9.1	2022
Installation			
Electricity	market group for electricity, low voltage (RoW)	ecoinvent 3.9.1	2022
End of Life			
Steel Production Water Waste	treatment of wastewater from pig iron production, wastewater treatment	ecoinvent 3.9.1	2022
Municipal Waste - Landfill	treatment of municipal solid waste, sanitary landfill	ecoinvent 3.9.1	2022
Hazardous Waste - Incineration	treatment of hazardous waste, hazardous waste incineration	ecoinvent 3.9.1	2022
Zinc Waste - Landfill	treatment of zinc slag, residual material landfill	ecoinvent 3.9.1	2022
Zinc Waste - Incineration	treatment of zinc in car shredder residue, municipal incineration	ecoinvent 3.9.1	2022
Plastic Waste - Incineration	treatment of waste plastic, mixture, municipal incineration	ecoinvent 3.9.1	2022
Plastic Waste - Landfill	treatment of waste plastic, mixture, sanitary landfill	ecoinvent 3.9.1	2022
Steel Waste - Landfill	treatment of scrap steel, inert material landfill	ecoinvent 3.9.1	2022
Steel Waste - Incineration	treatment of scrap steel, municipal incineration	ecoinvent 3.9.1	2022
Rubber Waste - Incineration	treatment of waste rubber, unspecified, municipal incineration	ecoinvent 3.9.1	2022
Packaging			
Plywood	plywood production	ecoinvent 3.9.1	2022
Cardboard	corrugated board box production	ecoinvent 3.9.1	2022

3.6. DATA QUALITY

The data quality assessment addressed the following parameters: time-related coverage, geographical coverage, technological coverage, precision, completeness, representativeness, consistency, reproducibility, sources of data, and uncertainty.

Table 2. *Data quality assessment for Victaulic valves.*

Data Quality Parameter	Data Quality Discussion
Time-Related Coverage: Age of data and the minimum length of time over which data is collected	Primary data was provided by the manufacturer and represents all data for 2022 calendar year. Time coverage of primary data is considered fully representative. Secondary dataset time coverage varies and is based on when the data was collected. Therefore, the most recent data set was chosen. Overall time coverage is considered to be 5.00/5.00 and meets the PCR requirements of being no older than 10 years. More specific time coverage can be seen in Appendix A.
Geographical Coverage: Geographical area from which data for unit processes is collected to satisfy the goal of the study	The geographical scope of the production stage of this study is threefold, The United States (US), Europe, and China. All primary data was collected from the manufacturer; therefore, the geographical coverage of primary data is considered to be fully representative. The geographical scope of all remaining stages is each respective market. In selecting secondary data from Ecoinvent, priority was given to technological representativeness of the data. Of the sets that were deemed of high enough quality, then the most representative geographical data was used. This led to Global, European, and Rest of World being used when North American data was not available for the two US sites. For the site in Poland priority was given to Polish, then European, and then Global or Rest of World datasets. For the site in China, priority was given to Chinese, then Global or Rest of World datasets. The geographical coverage of all secondary datasets can be seen in Appendix A. Overall geographical data quality is considered partially representative.
Technology Coverage: Specific technology or technology mix	Primary data provided by the manufacturer is specific to the technology that they use in their processes and products. Given that this study is for products manufactured at each respective facility, the technological coverage is completely representative. All facility data was allocated to the product using mass allocation. Secondary data was used to fill the gaps throughout the supply chain to address all inputs from Cradle-to-Gate. Technological coverage of these datasets is considered to be representative of the actual supply chain. Improving primary data in the supply chain would increase the technological coverage, but the use of secondary data sets for generic processes meets the goal and scope of the LCA.
Precision: Measure of the variability of the data values for each data expressed	The precision of the data is considered good. The Victaulic facility team provided the data for a full year of operations. Their team provided a list of suppliers and a Bill of Materials for all products in the scope of the study. All inbound transportation data is a weighted average of all suppliers for each material, which was determined by mass supplied by each supplier for a year. All outbound transportation data is as described in section 3.3.5 of the LCA report. No proxy data was used in this report. A sensitivity analysis was done on these processes.
Completeness: Percentage of flow that is measured or estimated	The data included is considered complete. The LCA model included all known materials and energy flows except for specified materials outlined in Section 3.4 of the LCA report. As stated, no known material flows above 1% were excluded and the sum of all exclusions is below 5% when evaluated against mass, energy, and environmental impact.
Representativeness: Qualitative assessment of the degree to which the data set reflects the true population of interest	The data used in the assessment represent typical or average processes as currently reported from multiple data sources to Ecoinvent and are therefore generally representative of the actual processes and technologies for production of these materials. Considerable deviation may exist among actual processes on a site-specific basis, though such a determination would require detailed data collection at each node upstream.
Consistency: Qualitative assessment of whether the study methodology is applied	The consistency of this model is considered high. Victaulic tracks all relevant inputs and outputs of their processes over a year, any other primary data used was collected with similar methods and time frame. Modelling assumptions are consistent across the model.

Data Quality Parameter	Data Quality Discussion
uniformly to the various components of the analysis	
Reproducibility: Qualitative assessment of the extent to which information about the methodology and data values would allow an independent practitioner to reproduce the results reported in the study	This study is considered to be reproducible. All assumptions and secondary datasets are described in this report and would allow an LCA practitioner to use an LCA tool to generate the results for the functional unit.
Sources of the Data: Description of all primary and secondary data sources	All primary and secondary data was modelled in OpenLCA using Ecoinvent 3.9.1 datasets to calculate the potential environmental impacts during each stage of the product's life. No proxy data was used in this study. Victaulic provided quantities and specifications for its manufacturing facilities including utilities, waste, and process equipment. Transportation distances and installation specifications (the only notable source of emissions during the product's use/life) were also provided. Based on these specifications the most relevant dataset from Ecoinvent 3.9.1 was chosen. If no specifications were given, the most relevant dataset was worst case average data for each facility, in their respective regions.
Uncertainty of the Information: Uncertainty related to data, models, and assumptions	Uncertainty of any primary data provided by Victaulic is dependent on how the data was allocated to each product. This allocation came from the yearly totals of product produced and utility data. Sub metered processes would decrease the uncertainty of the primary data. For secondary data, all uncertainty is outlined and published by Ecoinvent for Ecoinvent 3.9.1 datasets.

3.7 ESTIMATES AND ASSUMPTIONS

Throughout the report, choices and judgments that may have affected the LCA have been described. These decisions are summarized below:

- This LCA was conducted with an attributional approach.
- All primary and secondary data was modelled in openLCA using Ecoinvent datasets to calculate the potential environmental impacts during each stage of the product's life. For any processes that were not available in the Ecoinvent database, proxy data was used. Details for any proxy data used are outlined in Section 6.2.2.
- If multiple suppliers were identified for a material, then a weighted average of distance was determined based on mass supplied.
- Victaulic's energy usage was normalized to one (1) Kilogram based on the 2022 production data collected.
- Victaulic keeps track of all recycling and landfilled material over the data collection period. All waste transportation is determined by using EPA WARM data, which is estimated at 20 miles (32km).
- The fate of the product and packaging was determined using EPA Data (US) or BIR Data (EU, Asia)
- Type and distance of transportation was determined by developing a weighted average for all shipping data from calendar year 2022 based on sales.
- Any material present at or above 1 wt% of the final product was included within the scope of this study. Material inputs less than 1% were included if sufficient data was available to warrant inclusion and/or the material input was thought to have significant environmental impacts. No materials or energy inputs were excluded in this study.
- Steel and steel manufacturing datasets were found representative for the iron input material, iron processing, and end-of-life, and were used throughout this study.
- This product is powder coated or electrically coated with paint in its standard construction. This material was below 1% of the final product weight and was excluded.
- To derive a per-unit for manufacturing inputs and outputs such as electricity, thermal energy, and waste streams, allocation based on total mass by unit was adopted. As a default, secondary Ecoinvent datasets use a mass basis for allocation.
- The method in which recycled materials were handled is relevant to the defined system boundary. Throughout

the study, recycled materials were accounted for via the cut-off method. In this method, impacts and benefits associated with the previous life of a raw material from recycled stock are excluded from the system boundary.

- It was assumed that it would take 1 minute to install a single coupling using an 18 V impact gun, and that the installation was on an average sized coupling (1.5 kg). This is the environmental worst case, all Victaulic products can be hand assembled.
- Tests provided by Victaulic indicate that using the impact gun for 1 hour uses 1.2 kWh of electricity.
- Secondary data sets used in the model are disclosed in Appendix A along with data quality indicators related to the geographical, time representation, and technological coverage of the datasets. If any proxy data was used, it is also included if applicable.
- Victaulic scrap in section 3.3.1 the LCA report was not included in the results. These inefficiencies in material use were calculated but excluded. Their impact if included was decided to be immaterial. The most impactful full material, iron and its scrap, is to Victaulic's knowledge re-melted and recycled completely back into forging process. Any loss of material was not separable from processed waste, its impact indistinguishable from the wastes' impact, and as such only the waste was included in the results. This is an area for improvement for future studies.
- LCIA Summary from Section 4:
    - Electrical, Fuels, and Water Consumption
        - Data was collected over 2022 calendar year. The totals over the collection period were divided by the mass of total production during that period to derive a usage-per-mass unit for use in this model.
    - Raw Materials and Purchasing
        - Victaulic provided all bills of materials and supplier names. Inbound shipping distances were calculated using Google Maps and Searoutes.
    - Waste amounts
        - Victaulic tracks all waste streams associated with manufacturing of the product over the data collection period. All waste was characterized, disposed of, and treated appropriately as outlined in Section 3.3.
    - Outbound Shipping Distance
        - A second-leg shipping distance of 1000 km was estimated after shipping to Victaulic's distribution centers.
    - End of Life (EoL) Scenarios
        - No primary data for the fate of the product was available. Waste from products and packaging was disposed of based on EPA Data. No credits were taken for energy recovery from waste. Cut-off criteria for recycling was applied.

Furthermore, additional decisions are summarized below:

- The use and selection of secondary datasets from Ecoinvent to represent an aspect of the supply chain is a significant value choice. These datasets were chosen by the LCA Practitioner after discussions with Victaulic and review of the Ecoinvent datasets. It should be noted that no generic data is a perfect fit. Obtaining primary data from the supply chain data would improve the accuracy of results, however, budget and time constraints were considered.
- All declared product systems were modelled using the same assumptions within this study and the results can be applied to all systems using the performance characteristics in Section 2.8.3 of the LCA report. All systems are made from the same materials and processed identically. The only variations of the systems are how the material composition of the systems.
- Specific Worldsteel and IAI/EAA LCA datasets were not used for steel and aluminum, respectively, as they

were not available to the practitioners at the time of the main study.

The following limitations to this study have been identified:

- Availability of more regionally appropriate data sets would improve accuracy.
- Since this LCA uses the cut-off approach to model recycled material in the product, no credit is given to the end of the product system. Instead, the manufacturer realized reduced environmental impacts through the absence of the burden of virgin material.
- Only known and quantifiable environmental impacts are considered.
- Due to the assumptions and value choices listed above, these results do not reflect the real-life impact scenarios and hence, they cannot assess actual and exact impacts. Instead, it only represents potential environmental impacts.

4. Content Declaration

4.1 MATERIAL COMPOSITION

The material compositions of the modeled Victaulic fittings are listed in the following tables. No known hazardous or dangerous substances are present in the finished product. This metal product is either powder or electrically coated by default. Those paint materials are excluded from this study; their impact on the results is less than 1%.

The recycled contents for the product were calculated according to EN 45557 definitions and mass balance methods. Additionally, steel and steel manufacturing datasets were found representative for the iron input material, iron processing, and end-of-life, and were used throughout this study. References to steel model iron scrap and ductile iron.

Table 3. *Material composition per functional unit (1000kg) of valves for the DBMT foundry.*

Material	Mass [kg]	Percent	Pre-consumer Recycled Content %	Post-consumer Recycled Content %
Iron Scrap	508.58	50.86%	90%	10%
Pig Iron	419.11	41.91%	0%	0%
Carbon	14.33	1.43%	0%	0%
Gaskets	24.66	2.47%	0%	0%
Injection Molded Nylon	10.17	1.02%	0%	0%
Zinc Plated Steel	15.26	1.53%	0%	8%
Nickel Plated Steel	0.00	0.00%	0%	8%
Stainless Steel	0.00	0.00%	0%	8%
Total	1000.00	100%	38%	5%

Table 4. *Material composition per functional unit (1000kg) of valves for the Forks foundry.*

Material	Mass [kg]	Percent	Pre-consumer Recycled Content %	Post-consumer Recycled Content %
Iron Scrap	803.75	80.38%	90%	10%
Pig Iron	0.00	0.00%	0%	0%
Carbon	38.66	3.87%	0%	0%
Gaskets	63.41	6.34%	0%	0%
Injection Molded Nylon	16.07	1.61%	0%	0%
Zinc Plated Steel	24.11	2.41%	0%	8%
Nickel Plated Steel	32.15	3.21%	0%	8%
Stainless Steel	21.85	2.18%	0%	8%
Total	1000.00	100%	72%	8%

Table 5. *Material composition per functional unit (1000kg) of valves for the Drezdenko foundry.*

Material	Mass [kg]	Percent	Pre-consumer Recycled Content %	Post-consumer Recycled Content %
Iron Scrap	855.38	85.54%	90%	10%
Pig Iron	13.65	1.37%	0%	0%
Carbon	38.91	3.89%	0%	0%
Gaskets	49.21	4.92%	0%	0%
Injection Molded Nylon	17.11	1.71%	0%	0%
Zinc Plated Steel	25.66	2.57%	0%	8%
Nickel Plated Steel	0.00	0.00%	0%	8%
Stainless Steel	0.08	0.01%	0%	8%
Total	1000.00	100%	77%	9%

4.2 TRANSPORTATION

Includes the transportation of all raw materials to the facility, and the production of all fuels used. Does not include the manufacturing of transportation equipment. Type and distance of transportation was determined by mapping shipping distances to Victaulic's distribution centers.

Table 7. *Relevant transportation data for the product.*

Name	Unit	Value
Type of transport		Diesel, Low Sulfur (Truck)
Type of vehicle		EURO 4 Lorry
Type and amount of energy carrier	liters/kg-100 km	4.46E-03 (per kg shipped)

4.3 MANUFACTURE

Products are manufactured at Victaulic's facilities both by manual assembly and machine assembly. Electric induction furnaces and other equipment are used to melt and cast ductile iron. Some cast parts are further machined, and all are coated and painted to specification. Electricity and natural gas are used in these assembly processes, as well as lighting and building operations.

4.4 DISTRIBUTION

Products are shipped overland by truck. The EURO 4 Lorry was used in the model for all locations.

It was assumed for this study that the fittings are being sold from the region it was made in and shipped by truck. A scenario detailing product shipped overseas from China to the United States can be found in the LCA report. Average shipping distances from the foundries to known customers, retailers, and an EPA average shipping distance for truck (1000 km) are as follows:

1. North American Market (Forks Foundry) – 1010 km.
2. European Market (Drezdenko Foundry) – 1102 km
3. East Asian Market (DBMT Foundry) – 2658 km

4.5 PRODUCT USE

Includes the generation and use of any energy or materials for usage or maintenance of the product and does not account for replacement of the product. The only significant energy use identified was the installation of the product. Victaulic provided installation requirements for a valve, and it was determined to be representative for valves; see the full LCA report for more details.

4.6 END-OF-LIFE

Transportation distance to the final disposal location was determined to be 32 km as per the EPA WARM model. All waste treatment was classified based on US EPA Municipal Solid Waste for Durable Goods. There are no known hazardous or toxic properties regarding improper disposal of the product. Transport to disposal was assumed to be via a Euro 4 Lorry truck or similar vehicle.

Victaulic's products are made from various recyclable materials such as metals. The actual recyclability may depend on the availability of local infrastructure to accept quantity and state of the materials from the product, though Victaulic ensures that the products leaving its facilities are largely recyclable.

It was assumed disposal pathways align with US EPA Municipal Solid Waste for Durable Goods for all regions, and that the product is collected separately.

Table 8. *End-of-Life ratios of all materials used (NA)*

Material	Recycled %	Landfilled %	Incineration %
Iron	33%	55%	12%
Non-Ferrous/Non-Aluminum	67%	29%	3%
Plastics	9%	76%	16%
Rubber	18%	54%	27%

Table 9. *End-of-Life ratios of all materials used (NA)*

Material	Recycled %	Landfilled %	Incineration %
Iron	58%	34%	8%
Non-Ferrous/Non-Aluminum	0%	80%	20%
Plastics	0%	80%	20%
Rubber	0%	80%	20%

Table 10. *End-of-Life ratios of all materials used (NA)*

Material	Recycled %	Landfilled %	Incineration %
Iron	22%	62%	16%
Non-Ferrous/Non-Aluminum	0%	80%	20%
Plastics	0%	80%	20%
Rubber	0%	80%	20%

End-of-life datasets are listed in table 11; different localizations of the datasets were used corresponding to each region. Due to the cut-off rules the burden of all recycled material is zero, and all recycled material is captured under the elemental flow "output, material for recycling".

Table 11. *End-of-life data sources for valves.*

Flow	Dataset	Data Source	Publication Date
Raw Materials			
Wastewater from Pig Iron	treatment of wastewater from pig iron production, wastewater treatment	ecoinvent 3.9.1	2022
Municipal Solid Waste	treatment of municipal solid waste, sanitary landfill	ecoinvent 3.9.1	2022
Hazardous Waste for Incineration	treatment of hazardous waste, hazardous waste incineration	ecoinvent 3.9.1	2022
Zinc to Landfill	treatment of zinc slag, residual material landfill	ecoinvent 3.9.1	2022
Zinc for Incineration	treatment of zinc in car shredder residue, municipal incineration	ecoinvent 3.9.1	2022
Plastic for Incineration	treatment of waste plastic, mixture, municipal incineration	ecoinvent 3.9.1	2022
Plastic to Landfill	treatment of waste plastic, mixture, sanitary landfill	ecoinvent 3.9.1	2022
Steel to Landfill	treatment of scrap steel, inert material landfill	ecoinvent 3.9.1	2022
Steel to Incineration	treatment of scrap steel, municipal incineration	ecoinvent 3.9.1	2022
Rubber for Incineration	treatment of waste rubber, unspecified, municipal incineration	ecoinvent 3.9.1	2022

5. LCA: Results

Results of the Life Cycle Assessment are presented below. It is noted that LCA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks. The following environmental impact category indicators are reported using characterization factors based on EN15804+A2, the version 2.0 default list. Results reported in MJ are calculated using lower heating values. All values are rounded to three significant digits.

Table 12. *LCIA impact categories reported.*

Impact Category	Unit
Global Warming Potential, Fossil (GWPF)	kg CO_2 eq
Global Warming Potential, Biogenic (GWPB)	kg CO_2 eq
Global Warming Potential, Land Use and Land Change (GWPL)	kg CO_2 eq
Global Warming Potential, Total (GWPT)	kg CO_2 eq
Acidification Potential (AP)	mol H^+ eq
Photochemical Ozone Creation Potential (POCP)	kg NMVOC eq
Eutrophication Potential, Aquatic Freshwater (EPF)	kg P eq
Eutrophication Potential, Aquatic Marine (EPM)	kg N eq
Eutrophication Potential, Terrestrial (EPT)	mol N eq
Ozone Depletion Potential (ODP)	kg CFC^{-11} eq
Water Deprivation Potential (WDP)	m^3
Abiotic Depletion Potential, Fossil (ADPF)	MJ, LHV
Abiotic Depletion Potential, Elements (ADPE)	MJ, LHV

These impact categories are globally deemed mature enough to be included in Type III environmental declarations. Other categories are being developed and defined and LCA should continue making advances in their development. However, the EPD users shall not use additional measures for comparative purposes. The following inventory parameters, specified by the PCR, are also reported.

Table 13. *LCI parameters reported.*

Resources	Unit
Renewable Primary Energy Used as Energy Carrier (PERE)	MJ, LHV
Renewable Primary Energy Resources Used as Raw Materials (PERM)	MJ, LHV
Renewable Primary Energy Total (PERT)	MJ, LHV
Non-renewable Primary Energy Used as Energy Carrier [$NRPR_E$]	MJ, LHV
Non-renewable Primary Energy Resources Used as Raw Materials (PENRM)	MJ, LHV
Non-renewable Primary Energy Total (PENRT)	MJ, LHV

All LCA results are stated to three significant figures in agreement with the PCR for this product and therefore the sum of the total values may not exactly equal 100%.

Table 14. *DBMT foundry environmental indicator results for Victaulic small diameter valves.*

Impact Category	Units	Life cycle stage			
		Upstream	Core	Downstream	Total
ADPE	MJ, LHV	3.98E-03	2.16E-03	1.70E-03	7.84E-03
ADPF	MJ, LHV	1.19E+04	2.42E+04	7.63E+03	4.37E+04
AP	mol H^+ eq	3.81E+00	1.29E+01	2.34E+00	1.91E+01
EPF	kg P eq	3.16E-01	4.99E-01	4.43E-02	8.60E-01
EPM	kg N eq	9.07E-01	3.66E+00	9.13E-01	5.48E+00
EPT	mol N eq	8.76E+00	3.20E+01	9.21E+00	5.00E+01
GWPB	kg CO_2 eq	-3.74E+00	1.82E+02	2.41E+01	2.02E+02
GWPF	kg CO_2 eq	9.52E+02	2.59E+03	5.55E+02	4.10E+03

Impact Category	Units	Life cycle stage			
		Upstream	Core	Downstream	Total
GWPL	kg CO_2 eq	3.57E-01	9.93E-01	2.75E-01	1.62E+00
GWPT	kg CO_2 eq	9.49E+02	2.78E+03	5.70E+02	4.29E+03
ODP	kg CFC^{-11} eq	1.97E-05	6.68E-06	8.49E-06	3.49E-05
PENRE	MJ, LHV	1.14E+04	2.40E+04	6.97E+03	4.24E+04
PENRM	MJ, LHV	4.36E+02	1.96E+02	6.54E+02	1.29E+03
PENRT	MJ, LHV	1.19E+04	2.42E+04	7.63E+03	4.37E+04
PERE	MJ, LHV	4.12E+02	2.84E+03	9.49E+01	3.35E+03
PERM	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ, LHV	4.12E+02	2.84E+03	9.49E+01	3.35E+03
POCP	kg NMVOC eq	4.66E+00	8.60E+00	3.17E+00	1.64E+01
WDP	m^3	2.33E+02	3.28E+02	3.95E+01	6.01E+02

Table 15. *Forks foundry environmental indicator results for Victaulic small diameter valves.*

Impact Category	Units	Life cycle stage			
		Upstream	Core	Downstream	Total
ADPE	MJ, LHV	2.22E-01	1.09E-03	5.96E-04	2.23E-01
ADPF	MJ, LHV	1.54E+04	3.62E+04	2.93E+03	5.45E+04
AP	mol H^+ eq	2.01E+01	2.83E+00	8.40E-01	2.38E+01
EPF	kg P eq	1.45E+00	1.90E-01	1.55E-02	1.65E+00
EPM	kg N eq	1.56E+00	1.59E+00	4.04E-01	3.56E+00
EPT	mol N eq	1.76E+01	7.40E+00	3.44E+00	2.84E+01
GWPB	kg CO_2 eq	4.94E+00	2.62E+02	3.36E+01	3.00E+02
GWPF	kg CO_2 eq	8.97E+02	1.48E+03	2.61E+02	2.64E+03
GWPL	kg CO_2 eq	1.12E+00	1.08E+00	9.45E-02	2.29E+00
GWPT	kg CO_2 eq	9.03E+02	1.74E+03	2.85E+02	2.93E+03
ODP	kg CFC^{-11} eq	1.39E-05	7.81E-06	4.48E-06	2.62E-05
PENRE	MJ, LHV	1.45E+04	3.52E+04	2.67E+03	5.24E+04
PENRM	MJ, LHV	8.89E+02	9.51E+02	2.54E+02	2.09E+03
PENRT	MJ, LHV	1.54E+04	3.62E+04	2.93E+03	5.45E+04
PERE	MJ, LHV	1.61E+03	2.13E+03	4.34E+01	3.78E+03
PERM	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ, LHV	1.61E+03	2.13E+03	4.34E+01	3.78E+03
POCP	kg NMVOC eq	6.04E+00	3.80E+00	1.24E+00	1.11E+01
WDP	m^3	5.98E+02	3.31E+02	1.95E+01	9.49E+02

Table 16. *Drezdenko foundry environmental indicator results for Victaulic small diameter valves.*

Impact Category	Units	Life cycle stage			
		Upstream	Core	Downstream	Total
ADPE	MJ, LHV	1.74E-02	3.95E-03	1.90E-03	2.33E-02
ADPF	MJ, LHV	2.77E+04	9.07E+03	3.80E+04	7.48E+04
AP	mol H^+ eq	2.25E+00	1.42E+01	8.41E-01	1.73E+01
EPF	kg P eq	2.38E+00	2.51E+00	1.83E-02	4.91E+00
EPM	kg N eq	6.10E-01	6.35E+00	1.08E+00	8.04E+00
EPT	mol N eq	6.56E+00	3.17E+01	1.71E+01	5.54E+01
GWPB	kg CO_2 eq	-1.01E+00	2.75E+02	3.66E+01	3.11E+02
GWPF	kg CO_2 eq	4.34E+02	2.13E+03	2.42E+02	2.81E+03
GWPL	kg CO_2 eq	2.30E-01	9.89E-01	9.81E-02	1.32E+00
GWPT	kg CO_2 eq	4.33E+02	2.41E+03	2.69E+02	3.11E+03
ODP	kg CFC^{-11} eq	1.16E-05	4.69E-05	5.63E-06	6.42E-05
PENRE	MJ, LHV	4.47E+04	2.67E+04	1.92E+02	7.16E+04
PENRM	MJ, LHV	1.51E+03	9.09E+02	1.50E+01	2.44E+03
PENRT	MJ, LHV	2.74E+04	4.57E+04	6.24E+02	7.38E+04
PERE	MJ, LHV	4.29E+03	3.38E+02	1.40E+03	6.02E+03
PERM	MJ, LHV	8.29E-10	5.87E-12	0.00E+00	8.35E-10
PERT	MJ, LHV	4.29E+03	3.38E+02	1.40E+03	6.02E+03
POCP	kg NMVOC eq	2.97E+00	1.27E+01	4.96E+00	2.06E+01
WDP	m^3	1.35E+03	2.27E+02	3.51E+01	1.61E+03

6. LCA: Interpretation

The potential environmental impacts associated with Victaulic's small diameter valves are largely driven by electricity consumption. Victaulic could significantly reduce the impact of this by sourcing renewable energy for its operations across its production sites. The pig iron used in the Asian market is a significant driver at the DBMT facility. This addition is used to offset poor quality scrap and achieve regular product chemistry; Victaulic should minimize pig iron use and pursue high quality scrap where possible to reduce its impact.

7. Additional Environmental Information

7.1 ENVIRONMENTAL ACTIVITIES AND CERTIFICATIONS

4. Victaulic manufacture close to the markets it serves, allowing them to quickly serve customers while cutting transportation emissions.
5. Electric induction furnaces utilized at all facilities produce over 85% less CO2 per ton of metal than the basic blast furnaces.
6. Resource conservation is integral to Victaulic's production. Its ductile iron products are made using up to 100% high-quality, graded iron scrap when the scrap is available. This reduces facility waste and allows them to reuse existing materials rather than new natural resources.

8. References

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