Environmental Product Declaration - EPD

Environmental and economic life cycle performance including climate-related data

MD 150-360 - High Pressure Stage Casing Pump with Skid

The pump characterized in this EPD is configurable. Configuration and efficiency depends on customer specification. The data given below are illustrative and only valid for the defined parameters (see pages 4 ff).

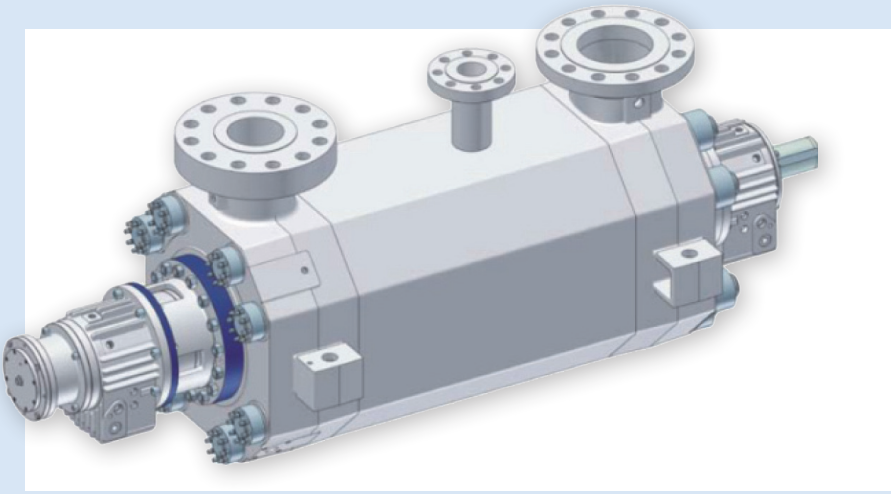
Main applications:
Power generation, i.e. boiler feed in industrial power plants and combined cycle power plants.

Type:
Horizontal, radially split, centerline mounted, multistage ring section pump. Pump configured according to customer requirements.

Rated power:
2 300 kW

Manufacturer:
Sulzer Pumpen (Deutschland) GmbH, Germany

CPC classification:
43220



Components included:

- [x] Pump including casing, baseplate, shaft, impeller, bearings
- [x] Skid including motor, valves and piping
- [ ] Gearbox
- [ ] Motor
- [ ] Frequency inverter
- [ ] Piping system

Electricity mix considered for downstream processes: Europe (UCTE)

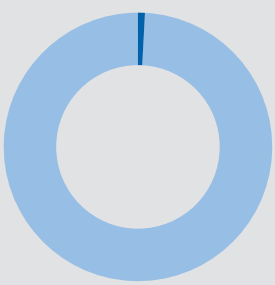
Key economic and environmental advantages

- High availability of more than 98%
- Life-time of 20 years
- High efficiency of the pump strongly contributes to lower energy consumptions and emissions
- Frequency inverter driver would allow flexible and energy efficient adaptation to the effective power used
- Comprehensive training and professional service enable customers to operate the pump cost and energy efficiently
- Retrofit service allows to reestablish the best efficiency point in case of changed operation conditions
- Simple to dismantle, best suited for recycling due to high quantity of high alloyed steels (> 95 weight %) that easily can be separated (metal parts marked to identify composition).

Key economic and environmental indicators over life cycle of 20 years

Costs

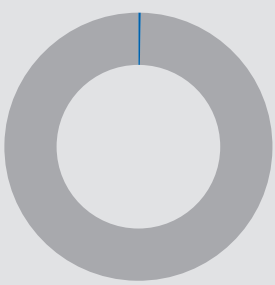
€ 30.5 million



Procurement / manufacturing	1%
Usage: electricity	98.6%
Usage: service	0.4%

Energy consumption

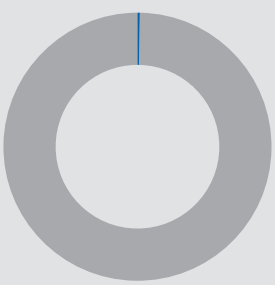
3.0 million GJ-Eq
1 310 GJ-Eq / kW



Procurement	0.02%
Manufacturing	<0.01%
Usage	99.98%

CO_2 emissions

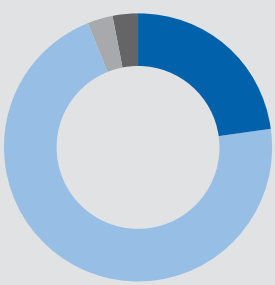
139 750 tonnes CO_2-Eq
61 tonnes CO_2-Eq/kW



Procurement	0.03%
Manufacturing	<0.01%
Usage	99.97%

Weight & composition

13 700 kg
5.96 kg / kW



Cast iron	23%
Steel	71%
Copper, aluminium	3%
Others[1)]	3%

1) e.g. oil, varnishes, seals

Functional unit

The functional unit is 1 kW of rated hydraulic power at best efficiency point.

Composition of the product

Material	kg	%[1]	kg / kW [3]
Cast iron	3'150	23%	1.37
Steel (high alloyed)	7'345	54%	3.19
Other steel	2'350	17%	1.02
Aluminium (motor)	120	1%	0.05
Copper (motor)	344	3%	0.15
Paint and impregnation resin (motor)	35	0%	0.02
Insulation material (motor)	90	1%	0.04
Oil	170	1%	0.07
Parts not included [2]	100	1%	0.04
Total	**13'704**	**100%**	**5.96**

[1] By weight. [2] Weight not included in assessment. [3] Rated power.

More than 50% of the pump consists of high alloyed steels, 40% of cast iron and other steels. The indicated quantity of oil refers to the initial fill of the pump, the oil is replaced every second year during the downstream processes.

Not included parts are e.g. seals. They amount to less than 1% of the total weight.

Material consumption during life-cycle per pump[1] (material balance sheet)

Non-renewable resources	Procurement [2]		Manufacturing at Sulzer		Usage / end of life	
	kg	kg / kW	kg	kg / kW	kg	kg / kW
Steel (alloyed), casting			[3]	[3]		
for pump	7 100	3.09	6 800	2.96	6 800	2.96
for spare parts	300	0.13	290	0.13	290	0.13
Oil	5 490	2.39	5 490	2.39	5 490	2.39
Lubricants	1 900	0.83	1 900	0.83	1 900	0.83
Waste production (total)	n.a.	n.a.	1 220	0.53	8 990	3.91
Hazardous waste	n.a.	n.a.	150	0.07	1 900	0.83
Municipal waste	n.a.	n.a.	270	0.12	n.a.	n.a.
Recycling (total)	n.a.	n.a.	800	0.348	7 090	3.08
metals (pump)	n.a.	n.a.	300	0.130	6 800	2.96
metals (spare parts)	n.a.	n.a.	10	0.004	290	0.13
others	n.a.	n.a.	490	0.213	n.a.	n.a.
Renewable resources	**kg**	**kg / kW**	**kg**	**kg / kW**	**kg**	**kg / kW**
Wood (packaging)	20	1.18	20	1.18	20	20
Water consumption [4]	n.a.	n.a.	24 100	1417.6	n.a.	n.a.

n.a.: not available, values per kW related to 10 700 kW rated power. [1] Material resources related to supply of energy to site are not considered. [2] Covers all resources procured during the life cycle by Sulzer, including the oil used to operate the pump. [3] Machining during the manufacturing produces recyclable waste of around 4% by mass of the metals bought in. [4] In manufacturing: used for testing purposes.

Primary energy consumption during life cycle (primarily from usage / end of life)

	Procurement [2]		Manufacturing at Sulzer		Usage / end of life [3]		Total	
	GJ-Eq	GJ-Eq/kW	GJ-Eq	GJ-Eq/kW	GJ-Eq	GJ-Eq/kW	GJ-Eq	GJ-Eq/kW
Electricity	94.6	0.0411	[6]	[6]	3 009 630	1 310	3 009 720	1 309
Gases [1]	7.0	0.0030	[6]	[6]	0	0	7.0	0.0030
Fuel oils	32.6	0.014	[6]	[6]	0	0	32.6	0.014
Fuels	n.a.	n.a.	0	0	0	0	0.0	n.a.
District heating [8]	n.a.	n.a.	0	0	0	0	0.0	n.a.
Materials	740	0.32	0	0	0	0	740	0.32
Transports	15.8	0.007	36.5	0.016	459	0.20	511	0.222
Disposal, waste water [7]	n.a.	n.a.	0.4	0.000	-450	-0.195	-449	-0.195
Non-renewable energy sources [5]	**815**	**0.355**	**36.3**	**0.0158**	**2 824 850**	**1 230**	**2 825 700**	**1 229**
Total renewable energies [4] [5]	**75**	**0.0324**	**0.5**	**0.0002**	**184 780**	**80**	**184 860**	**80**
Total energy sources [5]	**890**	**0.3870**	**36.8**	**0.0160**	**3 009 640**	**1 310**	**3 010 567**	**1 309**

[1] Natural gas, butane, propane. [2] Including transportation to Sulzer (< 1%). [3] Including transportation to customer (< 1%). [4] Hydro power, solar power, wind power, wood. [5] Including waste and waste water treatment. [6] Fully allocated to upstream processes.

Eq: equivalents, kW related to 10 700 kW rated power.

The pump is used in Europe, the European energy mix was applied (UCTE mix).

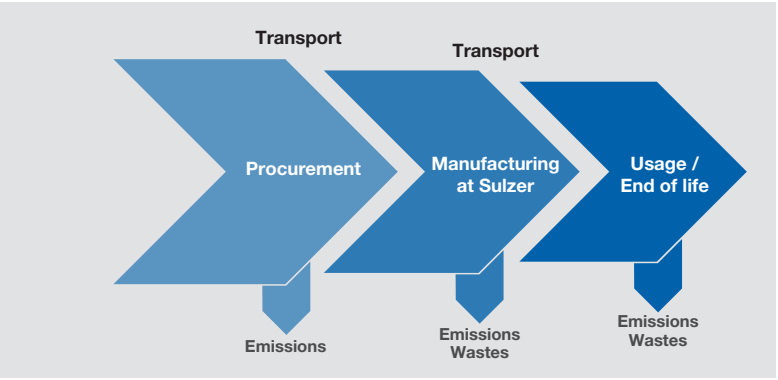
Emissions during life cycle (primarily from usage / end of life)

	Procurement		Manufacturing at Sulzer		Usage / end of life [1]		Total	
	t	kg / kW	t	kg / kW	t	kg / kW	t	kg / kW
Greenhouse Gas Potential (CO_2-equivalents)	54.7	23.76	2.40	1.04	139 690	60 735	139 750	60 761
Acidification potential (SOx-equivalents - AP)	2.3	0.979	0.101	0.044	2 263	984	2 265	985
Photosmog potential (ethylene equivalents)	0.022	0.009	<0.001	<0.001	5.6	2.41	5.6	2.42
Ozone depleting potential (CFC11-equivalents)	<0.001	<0.001	0[2]	0[2]	0.008	0.003	0.008	0.003
Biological Oxygen Demand (O_2-equivalents)	0.41	0.180	n.a.	n.a.	53.6	23.3	54.0	23.5

n.a.: not available, kW related to 10 700 kW rated power. [1] Emissions are dominated by emissions in usage from electricity consumption.
[2] Ozone depleting substances are not in use at the manufacturing site.

Life-cycle – coverage, assumptions, and exclusions

System boundary: The EPD covers all relevant environmental aspects in relation to the below described life-cycle phases.



The construction of buildings, machines to manufacture products, means of transport, (including roads or railways) are excluded.

Procurement comprise the extraction of raw materials and production of semi-finished products, consumables, and energies by suppliers. Production data were adopted from the EcoInvent Database based on parts lists of Sulzer.

Considered parts externally sourced have been limited to casing, baseplate, shaft, impeller, motor, gearbox, and bearings that cover more that 99% of the product weight.

Due to minor importance solvents, varnishes and plastics (for e.g. seals) have not been included.

Manufacturing at Sulzer comprises all activities conducted at the manufacturing site in relation to the product manufacturing (engineering, welding, grinding, machining, painting, assembly). Considered data origin from the yearly Sulzer SEED data collection and comprise energy (e.g. electricity, natural gas, butane, propane, fuels, fuel oils, district heating, coal coke, district heating) and water consumptions, emissions, waste water and waste production. The energy used includes manufacturing as well as office activities. The emissions from the use of varnishes and solvent are included, related consumption of the varnishes and colors are excluded. The environmental burden caused by waste and wastes water treatment has been adopted from the EcoInvent Database.

The pump is assembled in Germany, the European electricity mix has been considered.

The packaging of the pump for the transport to the customer is included (wooden box).

Usage / end of life comprise the usage and servicing of the product. It includes the manufacturing and disposal of spare parts and the oil.

The pump is used in Europe, the European energy mix was applied (UCTE mix). The price for electric

The performance of the motor is 96.8% and has been adotpte from an EPD of ABB (AC machine type AMA 450, 1600 kW power).

The yearly costs for maintenance are at 2% of the purchase price of the pump, the assumed average increase in prices is at 2% per year.

4% of the total weight of the pump is to be replaced during the lifetime what includes bearings, seals, impeller, and wearing rings.

During the life-time and including the initial fill, totally 1 700 kg of oil is used to operate the pump.

For recycling a benefit of 50% of the initial environmental burden to produce the pump has been applied.

Costs for dismantling are not considered (minor compared to energy costs during usage). Monetary benefits through selling the pump as scrap have not been considered (life-time of product too long for appropriate estimation).

Spent oil is disposed as hazardous waste and incinerated accordingly; its environmental burden has been adopted from the EcoInvent Database based.

Transports to Sulzer (depending on the location of the supplier by truck, train, ship, or airplane) are included in the upstream processes phase, transports to the customer in the manufacturing phase (by truck), and transports for service activities in the downstream processes (by van for service at the customer site, by truck if pump is serviced at Sulzer). Transports of the dismantled pump are not considered.

Allocation: In the manufacturing the yearly collected consumption of energy and water, emissions, waste water and waste production (SEED data collection), have been divided by the total number of pumps produced by the site to estimate the resource consumption per pump. For upstream processes and usage all resources, emissions, and wastes have been fully allocated to the product.

Applied load levels of pump during life cycle

The applied load levels are summarized in the table below. The pump is operated in three sequential load level phases that differ from duration, yearly operating hours, efficiency, and power consumption.

Phases of load level	Duration of phase	Operating hours per year	Efficiency η	Effective Rating
	years	hours / year	%	kW
Phase 1: full load	10	8 000	81.5%	2 300
Phase 2: middle load	5	5 000	79%	2 000
Phase 3: low load	5	3 000	70%	1 620

Glossary

Life cycle assessment, LCA is a management tool for appraising and quantifying the total environment impact of products or activities during the entire life cycle.

Life cycle costs are based on LCAs and cover the total costs of a product during the entire life cycle from the extraction of resources to the disposal of the product.

A **Functional Unit** is a concept that is used to compare the life cycle costs of different products on a like-for-like basis.

CPC (Central Product Classification) is a UNbased scheme for statistical division of product categories and service types.

EcoInvent Database contains international industrial life cycle inventory data.

Acidification occurs through deposition of soluble sulphur and nitrogen compounds from agricultural and combustion processes. Acidification can be harmful to sensitive ecosystems.

Eutrophication is the often anthropogenic enrichment of bodies of water by nitrates and phosphates. This increases the growth of aquatic plants that deoxygenate water and outcompete other aquatic life.

Global warming potential, GWP is the potency of 1 kg of a gas as a radiative forcing agent relative to an emission of 1 kg of carbon dioxide over 100 years.

Ozone depletion potential, ODPs are calculated as the change that would result from the emission of 1 kg of a substance compared to that from the emission of 1 kg of CFC-11 (trichlorofluoromethane).

Photochemical ozone creation potential, POCP refers to the change in of ground level ozone concentration potentially caused by the emission of 1 kg of a gas compared to that from the emission of 1 kg of ethene.

SEED is the database that Sulzer uses to collect, validate, and report on social, economic, and ecological data.

EPD related information

The document was prepared based on the EPD General Program Instruction, the ISO 14025:2010 standard, and the Product Category Rules for Submersible pumps and mixers.

The EPD has not been externally verified. It is valid for 3 years until November 2013.

The EPD is published by Sulzer Ltd, Corporate QESH, 8401 Winterthur, Switzerland, © December 2010. For questions and feedback please contact sustainability@sulzer.com

Sulzer Pumps

Sulzer Pumps is a world leader in reliable products and innovative pumping solutions. The global network of modern manufacturing and packaging facilities together with sales offices, service centers and representatives located close to major markets provide fast responses to customer needs.

Sulzer Pumps has a long history of providing innovative pumping solutions to business partners in the following industries: Oil and Gas, Hydrocarbon Processing, Pulp and Paper, Power Generation, General Industry, Chemical Process Industry, Water and Wastewater

All manufacturing sites dispose on managements systems certified against ISO 9001, ISO 14001, and OHSAS 18001.

Further information about Sulzer Pumps: can be found at www.sulzerpumps.com.

References

The International EPD Cooperation, EPD General Instructions for Environmental Product Declaration, EPD Version 1.0; 2008-02-29.

The Swedish Environmental Management Council;
Product Specific Requirements for Submersible pumps and mixers; PSR 2002:5; 2002

Swiss Center for Life Cycle Inventories, EcoInvent Database 2.2, St. Gallen, 2009

Environmental labels and declarations – Type III environmental declarations – Principles and English version EN ISO 14025:2010, Berlin 2010

Environmental Product Declaration ABB; AC machine type AMA 450, 1600 kW power; ABB Industry Oy, Helsinki.

Further information about products of Sulzer Pumps can be found at www.sulzerpumps.com/products

This and other EPDs are available online at:
www.sulzer.com/sustainability.

Further information about Sulzer: www.sulzer.com

Further information about the Sulzer sustainability program:
www.sulzer.com/sustainability