**OHH Process Pump**

The pump characterised in this EPD is inherently configurable. Configuration and efficiency depend on customer specification. The data given below are illustrative and only valid for the defined parameters (see chapter “Life cycle - coverage, assumptions, and exclusions”).

**Main applications:**
Hydrocarbon Processing Industry. The fluids pumped include sour water, gasoline, light hydrocarbons and vacuum bottoms.

**Type:**
Overhung, horizontal, centreline mounted, single stage, radially split process pump. Pump configured according to customer requirements.

**Rated power:**
40 kW

**Manufacturer:**
Sulzer Pumps Mexico, S.A. de C.V.

**CPC classification:**
4322

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**Key economic and environmental advantages**
- High availability of more than 98% (Customers typically buy two pumps for each service - one is standby)
- Design life of the pump is 20 years in accordance with API 610
- High efficiency and improved seal technology means lower energy consumption and hence lower emissions
- Variable frequency drives allow flexible performance and improved energy-efficiency
- Comprehensive training and professional service enable customers to operate the pump more reliably
- Retrofit service to re-establish the best efficiency point if operating conditions change
- Common API 610 materials are well suited for recycling.

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**Components included:**
- Pump including casing, baseplate, shaft, impeller, bearings
- Gearbox
- Motor
- Frequency inverter
- Piping system

**Electricity mix considered for usage:**
USA

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**Key economic and environmental indicators over life-cycle of 20 years**

**Costs**
- € 508 000
  - Procurement / manufacturing: 7.1%
  - Usage: electricity: 89.4%
  - Usage: service: 3.4%

**Energy consumption**
- 65 700 GJ-Eq
  - 1 641 GJ-Eq / kW
  - Procurement: 0.15%
  - Manufacturing: 0.11%
  - Usage: 99.74%

**CO₂ emissions**
- 3 951 tonnes CO₂-Eq
  - 98.8 tonnes CO₂-Eq / kW
  - Procurement: 0.14%
  - Manufacturing: <0.01%
  - Usage: 99.85%

**Weight & composition**
- 734 kg
  - 18.4 kg / kW
  - Cast iron: 68.0%
  - Alloyed / high alloyed steel: 31.8%
  - Oil: 0.2%
  - Others: <0.1%

1) e.g. varnishes, seals
Functional unit
The functional unit is defined as 1 kW hydraulic power of the pump at best efficiency point.

Composition of the product

<table>
<thead>
<tr>
<th>Material</th>
<th>kg</th>
<th>% 1)</th>
<th>kg / kW 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cast iron</td>
<td>499</td>
<td>68.0%</td>
<td>12.48</td>
</tr>
<tr>
<td>Steel (high alloyed)</td>
<td>234</td>
<td>31.8%</td>
<td>5.84</td>
</tr>
<tr>
<td>Oil</td>
<td>2</td>
<td>0.2%</td>
<td>0.05</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>734</td>
<td>100%</td>
<td>18.36</td>
</tr>
</tbody>
</table>

1) By weight.  2) Rated power.

The pump consists of 31.8% alloyed and high al-loyed steels and 68.0% cast iron.

The indicated quantity of oil refers to the initial fill of the pump, the oil is replaced every second year after installation.

Remaining components such as paints and seals amount to less than 0.01% of the total weight and have as such been omitted.

Material consumption during life cycle per pump3 (material balance sheet)

<table>
<thead>
<tr>
<th>Material</th>
<th>Procurement 2)</th>
<th>Manufacturing at Sulzer</th>
<th>Usage / end of life</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kg / kW</td>
<td>GJ-Eq</td>
<td>GJ-Eq / kW</td>
</tr>
<tr>
<td>Steel (alloyed), casting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>for pump</td>
<td>760</td>
<td>19.00</td>
<td>730</td>
</tr>
<tr>
<td>for spare parts</td>
<td>30</td>
<td>0.75</td>
<td>30</td>
</tr>
<tr>
<td>Oil</td>
<td>30</td>
<td>0.75</td>
<td>30</td>
</tr>
<tr>
<td>Waste production (total)</td>
<td>n.a.</td>
<td>n.a.</td>
<td>660</td>
</tr>
<tr>
<td>Hazardous waste</td>
<td>n.a.</td>
<td>n.a.</td>
<td>30</td>
</tr>
<tr>
<td>Municipal waste</td>
<td>n.a.</td>
<td>n.a.</td>
<td>120</td>
</tr>
<tr>
<td>Recyling (total)</td>
<td>n.a.</td>
<td>n.a.</td>
<td>510</td>
</tr>
<tr>
<td>metals (pump)</td>
<td>n.a.</td>
<td>n.a.</td>
<td>30</td>
</tr>
<tr>
<td>metals (spare parts)</td>
<td>n.a.</td>
<td>n.a.</td>
<td>0</td>
</tr>
<tr>
<td>others</td>
<td>n.a.</td>
<td>n.a.</td>
<td>480</td>
</tr>
<tr>
<td><strong>Renewable resources</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood (packaging)</td>
<td>50</td>
<td>1.25</td>
<td>50</td>
</tr>
<tr>
<td>Water consumption 4)</td>
<td>n.a.</td>
<td>n.a.</td>
<td>23 260</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

n.a.: not available, values per kW related to 40 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)

<table>
<thead>
<tr>
<th>Energy source</th>
<th>Procurement 2)</th>
<th>Manufacturing at Sulzer</th>
<th>Usage / end of life 3)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GJ-Eq</td>
<td>GJ-Eq / kW</td>
<td>GJ-Eq / kW</td>
<td>GJ-Eq / kW</td>
</tr>
<tr>
<td><strong>Electricity</strong></td>
<td>65.1</td>
<td>1.626</td>
<td>0.032</td>
<td>1 500</td>
</tr>
<tr>
<td><strong>Gases</strong> 1)</td>
<td>4.5</td>
<td>0.1127</td>
<td>0.006</td>
<td>0.1127</td>
</tr>
<tr>
<td>Fuel oils</td>
<td>0.1</td>
<td>0.003</td>
<td>0.006</td>
<td>0.006</td>
</tr>
<tr>
<td><strong>District heating</strong> 6)</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Materials</td>
<td>40</td>
<td>1.00</td>
<td>0.006</td>
<td>40</td>
</tr>
<tr>
<td><strong>Transports</strong></td>
<td>0.1</td>
<td>0.003</td>
<td>0.0893</td>
<td>0.0893</td>
</tr>
<tr>
<td>Disposal, waste water</td>
<td>n.a.</td>
<td>0.1</td>
<td>0.006</td>
<td>0.0161</td>
</tr>
<tr>
<td><strong>Non-renewable energies 5)</strong></td>
<td>103</td>
<td>2.579</td>
<td>0.0895</td>
<td>63 213</td>
</tr>
<tr>
<td>**Total renewable energies 4) 5)</td>
<td>7</td>
<td>0.177</td>
<td>0.00132</td>
<td>57</td>
</tr>
<tr>
<td><strong>Total energy sources 5)</strong></td>
<td>110</td>
<td>2.756</td>
<td>0.0909</td>
<td>65 624</td>
</tr>
</tbody>
</table>

1) Natural gas, butane, propane. 2) Including transportation to Sulzer.
3) Including transportation to customer. 4) Hydro power, solar power, wind power, biomass. 5) Including waste and waste water treatment.
6) Fully allocated to procurement. 7) Including credit from recycling of pump at end of life-time. 8) Imported as heat. 9) See p.3 of this EPD for more information.

Eq: equivalents, kW related to 40 kW rated power.

The USA is a representative market for this product; hence the USA national energy mix has been applied.
The construction of buildings, production machinery and transport infrastructure are all excluded.

Manufacturing and usage of the motor, frequency inverter, and the piping used to operate the pump are excluded from the functional unit.

**Procurement** includes the extraction of raw materials and production of semi-finished products, consumables, and energy by suppliers. Production data were converted into environmental effects via factors from the EcoInvent Database; based on the component parts for this product as assembled by Sulzer.

The consideration of externally sourced parts has been limited to the casing, baseplate, shaft, impeller and bearings; which together account for over 99% of the product weight.

Due to low masses or rates of usage, small components such as solvents, varnishes and plastics (for e.g. seals) have not been included.

**Manufacturing at Sulzer** covers all product manufacturing activities undertaken at the manufacturing site including engineering, welding, grinding, machining, painting and assembly. Data used are drawn from the yearly Sulzer SEED data collection which includes energy (e.g. electricity, natural gas, butane, propane, fuel oils, district heating, coal and coke etc.) water consumptions and waste water, emissions to air and waste production. The energy used includes both manufacturing and on-site office activities. The emissions to air from the use of paints and solvents are included, however related consumption of the varnishes and paints are excluded. The environmental burden from waste and wastewater treatment has been calculated using factors from the EcoInvent Database.

**Usage / End of Life** includes the usage and servicing of the pump. It also includes the production and disposal of spare parts and of oil.

The motor and frequency inverter are not part of the system. The electricity consumption of the pump has therefore been calculated assuming an efficiency of 100% for both. The pump is used in Texas (USA), the USA electricity mix was assumed. The price for electricity applied is € 0.07 per kWh and is quoted in Euros for comparability with similar EPDs.

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

4% of the total weight of the pump is typically replaced during the lifetime and includes bearings, seals, impeller, and wearing rings. For recycling purposes, a credit of 50% of the initial materials burden to produce the pump has been assumed. This conservative assumption was based on the fact that the use of recycled steel saves between 47% and 65% of energy compared to virgin steel (Volkshausen 2003; Wuppertal-Institut 2008).

Costs and effects of dismantling are not considered and are assumed minor compared with the usage phase. Monetary benefits through selling the pump as scrap have not been considered, as the lifetime of the product is too long to make a robust estimate. Spent oil is disposed as hazardous waste and incinerated accordingly; its environmental effects have been calculated based on factors from the EcoInvent Database.

**Transport** to Sulzer (depending on the location of the supplier, variably by truck, train, ship or airplane) is included in the procurement phase. Transportation to the customer following the manufacturing phase is by truck, and transportation for service activities in usage is by van for service at the customer site, or by truck if the pump is serviced at Sulzer's site. Transportation of the dismantled pump at the end of its working life is not considered.

**Allocation:** For manufacturing, data collected on the annual consumption of energy and water, emissions to air, waste water and waste production (from SEED) have been divided by the total number of pumps produced by the site to estimate the resource consumption per pump. For procurement and usage all resources, emissions, and wastes have been fully allocated to the pump.

**Referenced period for underlying data:** Data taken from the Sulzer SEED database and EcoInvent v.2 database, 2010.

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

<table>
<thead>
<tr>
<th></th>
<th>Procurement</th>
<th>Manufacturing at Sulzer</th>
<th>Usage / end of life</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t</td>
<td>kg / kW</td>
<td>t</td>
<td>kg / kW</td>
</tr>
<tr>
<td>Greenhouse Gas Potential (CO₂-equivalents)</td>
<td>5.7</td>
<td>142.13</td>
<td>0.30</td>
<td>7.404</td>
</tr>
<tr>
<td>Acidification potential (SOx-equivalents - AP)</td>
<td>0.2</td>
<td>4,243</td>
<td>0.010</td>
<td>0.254</td>
</tr>
<tr>
<td>Photosmog potential (ethylene equivalents)</td>
<td>0.001</td>
<td>0.020</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Ozone depleting potential (CFC11-equivalents)</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Biological Oxygen Demand (O₂-equivalents)</td>
<td>&lt;0.001</td>
<td>0.063</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

n.a.: not available/applicable, kW related to 40 kW rated power. 1) Emissions are dominated by emissions from electricity consumption.

2) Ozone depleting substances are not in use at the manufacturing site. 3) No related substances used in production.
Applied load levels of pump during life cycle

The applied load levels are summarized in the table below. Based on expected usage characteristics advised by customers, the pump is expected to be operated at full load throughout its life.

<table>
<thead>
<tr>
<th>Phases of load level</th>
<th>Duration of phase</th>
<th>Operating hours per year</th>
<th>Efficiency $\eta$</th>
<th>Effective Rating $kW$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1: full load</td>
<td>10 years</td>
<td>8 000</td>
<td>65%</td>
<td>40</td>
</tr>
<tr>
<td>Phase 2: middle load</td>
<td>6</td>
<td>6 000</td>
<td>59%</td>
<td>38</td>
</tr>
<tr>
<td>Phase 3: low load</td>
<td>4</td>
<td>4 000</td>
<td>45%</td>
<td>31</td>
</tr>
</tbody>
</table>

Sustainability program of Sulzer

Sustainability is a key factor for the success of Sulzer. The company is committed to creating long term economic value, while proactively assuming its social and environmental responsibility. Sulzer continuously assesses its sustainability activities. Extensive programs have been initiated to meet the expectations of Sulzer’s stakeholders.

Applied standards and limitations

The document was prepared based on the EPD General Program Instructions, the PCR for pumps for liquids, liquid elevators and mixers (4322), and the ISO 14025:2010 standard. Environmental product declarations from different programs with different product category rules may not be comparable.

Verification

The EPD has been externally verified by Atkins Ltd, United Kingdom. The verification was undertaken in two sections: a review of the relevant documentation followed by a review of underlying data using a combination of a desk based review, a site visit and information exchange with Sulzer. This EPD has been verified against the updated PCR for Pumps for Liquids; Liquid Elevators and Mixers (CPC Class 4322), valid until 2014-12-05.

References

Product Category Rule (PCR), CPC Class 4322, Pumps for Liquids; Liquid Elevators and Mixers, PCR 2011:22, Version 1.0, 2011-12-05
Swiss Centre for Life Cycle Inventories, EcoInvent Database 2.1, St. Gallen, 2009
The International EPD Cooperation, EPD General Instructions for Environmental Product Declaration, EPD Version 1.0; 2008-02-29.
Further information about products of Sulzer Pumps can be found at: www.sulzerpumps.com/products
Further information about Sulzer: www.sulzer.com
Further information about the Sulzer sustainability program: www.sulzer.com/sustainability

Disclaimer

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