HPcp Barrel Casing Pumps

The Heart of Your Process
HPcp
Designation & Description

- API type BB5
  
  Between bearings, multistage, radially split, double casing.

- Sulzer designation HPcp xxx - yyy - n stages

  Number of stages
  Nominal impeller diameter. mm.
  Discharge branch diameter. mm.

- HPcp is a **diffuser** design, full pull-out cartridge barrel casing pump.
- It is available in alternate configurations to suit different applications and operating requirements
Main applications

- Seawater & Produced Water Injection
- Oil Export
- Pipeline
HPcp
Range coverage

- back to back, bolted delivery cover
- in-line, bolted delivery cover
- in-line, twist lock delivery cover

installed pumps
HPcp
Design Features – Hydraulics

- Well proven hydraulics in the NQ 13 to 36 range.

- Reliable suction performance backed up by life warranties if required – Sulzer were the first pump company to give 40,000 hour guarantees on suction impellers.

- Swirl break technology aids rotor stability even in the fully worn condition.
HPcp
Design Features – Hydraulics

- Thick shrouds provide high strength for high head duties
- Natural frequency away from resonance thus avoiding shroud breakage
- Continuous channel diffuser gives high efficiency
- Precision castings give high efficiency and low hydraulic unbalance
Shrink fit impellers driven by double keys and located by titanium thrust rings

Hydraulic fit balance piston

Hydraulic fit thrust collar

Absence of threads eliminates stress raisers

Component balance to ISO grade 1.0 and check rotor balance to grade 2.5
• Back to back design naturally balances axial thrust reducing bearing size

• Differential pressure across bushes reduced to 50% of full pressure

• Case cover only sees 50% discharge pressure

• Centre bush acts as a support allowing 8 stage+ construction
Center bush on back to back layout acts as a product lubricated bearing controlling shaft deflection and reducing vibration
HPcp
Design Features – Bearings

- 4 lobe arc journal bearings.

- 8 pad center pivoted thrust bearings, these may be specified to accommodate thrust loads in either direction if required.

- A self contained design not requiring a separate oil system is available for smaller size pumps.

- Full instrumentation of the bearings is possible.
The three main alternatives are

- **Flange**, traditional ANSI standard bolted flange. Heavy (expensive) and space consuming

- **Pad**, studded pad on the pump casing to accept a standard ANSI flange being bolted to it. Light but still requires a flange to connect with so space limitations may still apply

- **Techloc**, clamping arrangement, both light and space efficient
HPcp
Design Features – Pad Connections
HPcp
Design Features – Techloc Connections
HPcp

Design Features – Materials

- Standard Materials
  - Duplex or Super Duplex construction throughout.
  - Stellite overlay on all internal wear parts

- Enhanced wear parts for Produced Water and other abrasive applications
  - SUME® PUMP SA 30 3rd generation coating on all wear parts
Sulzer has developed advanced, well proven 3D FEA tools

Basic 3D model

Deformation in operation

Casing/cover contact on hydro-test
**HPcp**

**Full cartridge design**

**Advantage**
Quick and safe cartridge change including bearings and seals as a complete unit

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**Step 1**
Suspended and supported on rollers at DE

**Step 2**
Supported for re-rigging

**Step 3**
Final installation
In-line impeller arrangement with dry twist lock closure for up to 8 stages and design pressures below ~400 bar
**HPcp**  
**Design Features – Twistlock System**

- No heavy bolting required.

- Suitable for operation up to 400 bar depending on pump size.

- Minimizes barrel size (no heavy bolts to be accommodated).

- Minimizes cartridge size (no cover flange).

- Cartridge change out within a single shift.
Design Features – Twistlock System

- Cartridge assembled and ready for fitting.
- Initial line-up to the barrel.
HPcp

Design Features – Twistlock System

- Cartridge teeth turned to align with the slots in the barrel.

- Cartridge is then inserted into the barrel.
HPcp
Design Features – Twistlock System

- Suction end retaining plates ready for fitting.
Suction end retaining plates being fitted to lock the cartridge from the suction end.
The suction end is now assembled, work now commences at the discharge end.
HPcp
Design Features – Twistlock System

- The cartridge end block is now rotated to lock the teeth into position.
HPcp
Design Features – Twistlock System

- Discharge end retaining screws are now fixed in place. The cartridge is now locked from the suction and discharge end of the barrel.
Assembly is now complete and the pump ready to be put into service.
Twistlock Cartridge Closure System
HPcp
Design Features – Twistlock System

- Twistlock cartridges and barrel
Inline impeller arrangement with bolted delivery cover for up to 8 stages and design pressure above ~400 bar
Back to back impeller arrangement with bolted delivery cover for more than 8 stages
HPcp
Design Features – Bolted End Cover

- Bolted design for pressures above 400 bar depending on pump size.

- Casing cover seal leakage instrumentation available.

- Worlds highest pressure centrifugal injection pump built using this layout (606 bar operating pressure, 909 bar test pressure).
**Sulzer Pumps**

**HPcp**

**Design Features – Superbolt Nut**

**Superbolt Nut**

- Proven design
- No heavy hydraulic jack required
- No special tools required
- Smaller barrel casing OD
- Hydrotest
- Equivalent Stress
Design Features – Cartridge Types

- Cartridge with bolted end cover
Physically testing pumps under all conditions verifies the correlation between theoretical and actual rotor dynamic behaviour.

<table>
<thead>
<tr>
<th>Thunder Horse</th>
<th>New Condition</th>
<th>Worn Condition 2 X new clearances</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DE</td>
<td>NDE</td>
</tr>
<tr>
<td><strong>Shaft Displacement</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calculated (Microns Pk)</td>
<td>1.9</td>
<td>5.8</td>
</tr>
<tr>
<td>Max. achieved on test. (Microns Pk)</td>
<td>2.0</td>
<td>6.0</td>
</tr>
<tr>
<td>Max. achieved on test. (Mils Pk – Pk)</td>
<td>0.16</td>
<td>0.48</td>
</tr>
<tr>
<td>Allowable per API (Mils Pk – Pk)</td>
<td>1.159</td>
<td>1.159</td>
</tr>
</tbody>
</table>
Velocities
A: high
B: medium to high
C: high (90° impact, jet)
Influencing factors

Quality of pumped liquid, sea and/or produced water.

Velocity of pumped liquid.

\[ \delta = \text{constant} \times (1 + 10 \sin 2\varepsilon) \times c_{sq,eq} \times w^{3.4} \times GSF \times F_{mat} \]

- where:
  - \( \delta \) material loss rate \([\mu m/h]\)
  - \( \varepsilon \) impact angle \([^{\circ}]\)
  - \( c_{sq,eq} \) equivalent quartz concentration \([kg/m^3]\)
  - \( w \) relative flow velocity of fluid \([m/s]\)
  - \( GSF \) grain size factor \([-]\)
  - \( F_{mat} \) Material factor \([-]\)

Pump selection/operation

- Operation close to BEP reduces internal velocities

Pump selected and designed to give:

- Optimum speed, high number of stages, high specific speed,
- all of which reduce internal velocities in wear sensitive areas.

Materials of wear parts
Material Testing – Erosion/corrosion test Rig

- Rotor velocity up to 40 m/s
- 6 specimens in stator
- Corrosive media with solids

Electro-chemical monitoring to determine transition points
HPcp

References

- **1975. World’s first duplex injection pump.**
  Sonatrach – Algeria – 13 units

- **1977. World’s largest injection pumps.**
  Saudi Aramco - 15.7 MW - 2 units

- **1981. World’s largest injection pumps**
  Sohio – Alaska – 18.8 MW – 2 units

- **1984. World’s Largest Offshore Injection Pump**
  Zadco - Abu Dhabi - 14.2 MW - 1 unit

- **1992. World’s Largest Vertical Injection Pumps**
  Statoil - Norway - 6.7 MW - 2 units

- **2001. World’s Highest Pressure Injection Pump**
  BP - Gulf of Mexico - 605 Bar - 4 units

- **2002. World’s largest Injection Pumps**
  AIOC – Caspian Sea – 27 MW – 4 units
Sulzer HPcp injection pumps

> 1,250 MW installed power.
> > 120,000,000 operating hours
> > 99% availability