Concrete Volute Casing Pump Beveron I

1. Applications
2. Operation
3. Features
4. Hydraulic Design
5. Scale Model Tests
6. Pump Selection
7. Main Dimensions
8. Main Components
9. Technical Description
10. Materials
11. Tele Maintenance
12. Reference Projects
13. Concrete Elements
1. APPLICATION
- Irrigation
- Polder drainage
- Extraction in shrimps and fish farms
- Try docks (pumping station)
- Reservoir pumping

2. OPERATION
The Beveron I is suitable as much for new construction as for renovation of pumping stations, and is available in a series of 29 standard modules, covering a range of 4 to 30 m³/s for heads between 1 and 10 m.

3. FEATURES
The components of the Beveron pump are perfectly matched, and designed to ensure that flow losses are reduced to an absolute minimum. This results in the Beveron achieving a high level of hydraulic efficiency. Moreover, the required submersion depth has been minimised, thanks to the suction box, which has been developed specially for this pump.

A perfect match for minimal life cycle costs.

- Reduced maintenance costs
  - The pump is perfectly adapted to the customer’s demands on site. This can be tested and proofed with model tests, if requested.
  - Less mechanical wear because of low speed
  - Operation with long-lasting and maintenance-free Residur-Ceramic bearings
  - Corrosion and cavitation resistant casing
  - Easy removal of the mechanical part is possible
  - Seals and impeller easily accessible
  - No wet maintenance areas

- High efficiency
  - Operation with small motor
  - Perfect match of SEZ hydraulic and Bosman volute
  - Wide operating range (hydraulic)

- Reduced structure costs
  - Compact design, low lifting height
  - Shallow submersion as well as less volume thanks to purpose-built concrete casing
  - Possibility of prefabricated concrete casing segments
  - Pump casing part of site construction

- Low noise
4. HYDRAULIC DESIGN

The hydraulic design of the Beveron pump has been achieved through intensive cooperation between the research department of Bosman Watermanagement, KSB Aktiengesellschaft and the Technische Universiteit Eindhoven. The attention has been focussed on the proper matching of all hydraulic components: suction box, impeller and volute.

The suction box has a special design which ensures minimum hydraulic losses. Dedicated CFD flow calculations were used to prevent the boundary layers at the solid walls from separating prematurely. In the final design, the level of required submergence is minimised while preserving vortex free operation.

The casting process for the concrete volute and suction box has been carefully analysed by numerical simulations. Both strength analyses and transient temperature distributions during casting were established.
5. SCALE MODEL TESTS

Real world tests were conducted in-house by Bosman in a closed test rig specially built for this purpose. During these tests, precise measurements were recorded of the performance of the Beveron pump. The tests were carried out in compliance with the international standard ISO 5198. A unique feature of the test set-up is that it includes all the elements of the hydraulic design, including suction box and volute.

The following aspects were observed and recorded during the scale model tests, using calibrated measuring equipment:
- Capacity and head
- Axial torque and rotational speed
- Visible cavitation (by means of inspection window in pump casing)
- Barometric pressure
- Sound pressure
- Vibration level
- Pressure losses in the suction box
- Water temperature
- Air entraining vortices and submersion depth

6. PUMP SELECTION GRAPH

![Beveron Pump Selection Graph](image-url)
The optimal pump will be selected from a series of 29 pump sizes, with varying diameters and rotational speeds, depending on the operational purpose intended. Within the broad range of available possibilities, we use CAS (computer aided selection), a computer programme which allows the quick and easy selection of all applicable variants. The prerequisites include the broadest possible control range, the variation in the static head, the location of maximum efficiency, and the available NPSH.

7. MAIN DIMENSIONS

<table>
<thead>
<tr>
<th>Type (cm)</th>
<th>Type (cm)</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
<th>f</th>
<th>g</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>800</td>
<td>1675</td>
<td>1175</td>
<td>1870</td>
<td>1535</td>
<td>1175</td>
<td>1140</td>
<td></td>
</tr>
<tr>
<td>105</td>
<td>840</td>
<td>1760</td>
<td>1234</td>
<td>1944</td>
<td>1612</td>
<td>1234</td>
<td>1197</td>
<td></td>
</tr>
<tr>
<td>110</td>
<td>880</td>
<td>1843</td>
<td>1293</td>
<td>2018</td>
<td>1688</td>
<td>1293</td>
<td>1254</td>
<td></td>
</tr>
<tr>
<td>115</td>
<td>920</td>
<td>1926</td>
<td>1351</td>
<td>2090</td>
<td>1765</td>
<td>1351</td>
<td>1311</td>
<td></td>
</tr>
<tr>
<td>120</td>
<td>960</td>
<td>2010</td>
<td>1410</td>
<td>2164</td>
<td>1842</td>
<td>1410</td>
<td>1368</td>
<td></td>
</tr>
<tr>
<td>125</td>
<td>1000</td>
<td>2094</td>
<td>1469</td>
<td>2238</td>
<td>1919</td>
<td>1496</td>
<td>1425</td>
<td></td>
</tr>
<tr>
<td>130</td>
<td>1040</td>
<td>2178</td>
<td>1528</td>
<td>2310</td>
<td>1995</td>
<td>1528</td>
<td>1482</td>
<td></td>
</tr>
<tr>
<td>135</td>
<td>1080</td>
<td>2261</td>
<td>1586</td>
<td>2384</td>
<td>2072</td>
<td>1586</td>
<td>1539</td>
<td></td>
</tr>
<tr>
<td>140</td>
<td>1120</td>
<td>2345</td>
<td>1645</td>
<td>2458</td>
<td>2149</td>
<td>1648</td>
<td>1596</td>
<td></td>
</tr>
<tr>
<td>145</td>
<td>1160</td>
<td>2429</td>
<td>1704</td>
<td>2532</td>
<td>2225</td>
<td>1704</td>
<td>1653</td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>1200</td>
<td>2513</td>
<td>1763</td>
<td>2604</td>
<td>2302</td>
<td>1763</td>
<td>1710</td>
<td></td>
</tr>
<tr>
<td>155</td>
<td>1240</td>
<td>2596</td>
<td>1821</td>
<td>2778</td>
<td>2379</td>
<td>1821</td>
<td>1767</td>
<td></td>
</tr>
<tr>
<td>160</td>
<td>1280</td>
<td>2680</td>
<td>1880</td>
<td>2852</td>
<td>2456</td>
<td>1880</td>
<td>1824</td>
<td></td>
</tr>
<tr>
<td>165</td>
<td>1320</td>
<td>2764</td>
<td>1939</td>
<td>2924</td>
<td>2532</td>
<td>1939</td>
<td>1881</td>
<td></td>
</tr>
<tr>
<td>170</td>
<td>1360</td>
<td>2848</td>
<td>1998</td>
<td>3000</td>
<td>2609</td>
<td>1998</td>
<td>1938</td>
<td></td>
</tr>
<tr>
<td>175</td>
<td>1400</td>
<td>2931</td>
<td>2056</td>
<td>3072</td>
<td>2686</td>
<td>2056</td>
<td>1995</td>
<td></td>
</tr>
<tr>
<td>180</td>
<td>1440</td>
<td>3015</td>
<td>2115</td>
<td>3146</td>
<td>2763</td>
<td>2115</td>
<td>2052</td>
<td></td>
</tr>
<tr>
<td>185</td>
<td>1480</td>
<td>3099</td>
<td>2174</td>
<td>3220</td>
<td>2839</td>
<td>2174</td>
<td>2109</td>
<td></td>
</tr>
<tr>
<td>190</td>
<td>1520</td>
<td>3183</td>
<td>2233</td>
<td>3292</td>
<td>2916</td>
<td>2233</td>
<td>2166</td>
<td></td>
</tr>
<tr>
<td>195</td>
<td>1560</td>
<td>3266</td>
<td>2291</td>
<td>3366</td>
<td>2993</td>
<td>2291</td>
<td>2223</td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>1600</td>
<td>3350</td>
<td>2350</td>
<td>3440</td>
<td>3070</td>
<td>2350</td>
<td>2280</td>
<td></td>
</tr>
<tr>
<td>210</td>
<td>1680</td>
<td>3518</td>
<td>2468</td>
<td>3687</td>
<td>3223</td>
<td>2468</td>
<td>2394</td>
<td></td>
</tr>
<tr>
<td>220</td>
<td>1760</td>
<td>3685</td>
<td>2585</td>
<td>3834</td>
<td>3376</td>
<td>2585</td>
<td>2508</td>
<td></td>
</tr>
<tr>
<td>230</td>
<td>1840</td>
<td>3853</td>
<td>2703</td>
<td>3980</td>
<td>3530</td>
<td>2703</td>
<td>2622</td>
<td></td>
</tr>
<tr>
<td>240</td>
<td>1920</td>
<td>4020</td>
<td>2820</td>
<td>4128</td>
<td>3684</td>
<td>2820</td>
<td>2736</td>
<td></td>
</tr>
<tr>
<td>250</td>
<td>2000</td>
<td>4188</td>
<td>2938</td>
<td>4274</td>
<td>3837</td>
<td>2938</td>
<td>2850</td>
<td></td>
</tr>
<tr>
<td>260</td>
<td>2080</td>
<td>4355</td>
<td>3055</td>
<td>4422</td>
<td>3990</td>
<td>3055</td>
<td>2964</td>
<td></td>
</tr>
<tr>
<td>270</td>
<td>2160</td>
<td>4523</td>
<td>3173</td>
<td>4570</td>
<td>4144</td>
<td>3171</td>
<td>3078</td>
<td></td>
</tr>
<tr>
<td>280</td>
<td>2240</td>
<td>4690</td>
<td>3290</td>
<td>4716</td>
<td>4297</td>
<td>3290</td>
<td>3192</td>
<td></td>
</tr>
</tbody>
</table>

(Type indicated in cm, dimensions in mm are subject to change)
8. MAIN COMPONENTS

- pump shaft
- Axial/radial bearing
- seal
- stator
- radial bearing
- impeller
- suction box
9. TECHNICAL DESCRIPTION

STATOR
The pump's stator comprises the following parts:
- upper bearing set
- shaft seals
- bearing column
- guide cone
- lower bearing set

The entire assembly is built-up from a welded construction, with a completely symmetric design. The lower bearing set of the stator is attached to the lower side of the central column with a flange connection. The upper bearing with sealing set is likewise attached by flanges to the upper side of the load-bearing support flange. The stator section serves as a water reservoir for the cooling and lubrication of the shaft seals.

PUMP SHAFT
The pump shaft is one complete unit, and is equipped with standard cylindrical shaft journals. The bottom section between the shaft seals and lower bearing is flushed with clean water from the shaft seals, and virtually never comes into contact with environmental water.
UPPER BEARING SET
The pump has its own bearing assembly, independent of the drive power source. To absorb the axial and minor radial forces exerted by the pump impeller, a bearing seat is built into the pump cover, with a combined self-aligning thrust bearing and radial guide bearing. The bearing combination is laid out spaciously, and with a modular design.

SHAFT SEALS
The shaft seal is a so-called "liquidyne seal", and is located on the pump cover in the bearing seat, where it is easily accessible. Lubrication is provided for by clean water, which is stored within the stator. The design comprises a 3 stage water-flushed seal with double rotating throttling. This is used in combination with a water flushing system in which the flush water pressure is higher than the process pressure at the point where the shaft passes through. The flush water is fed by means of a metering pump. Clean leakage water is re-used. The presence of an inflatable shaft seal makes it possible to replace the seals while pump under pressure.

LOWER BEARING SET
The lower bearing has many positive features, such as,
- non-wearing
- very long service life, and requiring no maintenance
- chemically resistant in all fluids
- no external lubrication required, environment-friendly
- dry-running permitted during pump start-up
- positioned in the impeller boss, close to the point of action of radial forces
- good heat transfer due to submerged position
IMPELLER
The impeller can be manufactured from various materials. This enables the impeller characteristics to be made to correspond with the specified requirements for strength and corrosion resistance. The impeller is manufactured as 3-bladed, half-open type, cast in one piece, machined and balanced.

VOLUTE
The volute has been designed specially to match the impeller, and has a very high hydraulic efficiency. It features a flat floor, and a trapezoidal flow cross-section. The volute is produced in concrete, and on request can also be manufactured as prefabricated elements, either constructed on- or off-site.

SUCTION BOX
Special attention has been given to the design of the intake box. The shape has been carefully calculated to reduce friction losses to the absolute minimum, and reduce the chance of formation of vortices that take air into the pump. The provision of a streamlining cone in the suction box contributes to this vortex reduction. Extensive computer simulations of the flow through the suction box have led to this optimised design. Subsequent trials in the test rig have proven the high performance of this design.
10. MATERIALS

<table>
<thead>
<tr>
<th>Component</th>
<th>Fresh water</th>
<th>Brackish water</th>
<th>Salt water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper bearing casing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- bearing seat</td>
<td>Steel</td>
<td>Stainless steel</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>Shaft seal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- casings</td>
<td>Bronze</td>
<td>Bronze</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>- sealing rings</td>
<td>Perbunan</td>
<td>Perbunan</td>
<td>Perbunan</td>
</tr>
<tr>
<td>- grooved wear bushes</td>
<td>Stainless steel</td>
<td>Stainless steel</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>Stator</td>
<td>Steel</td>
<td>Stainless steel</td>
<td>Duplex stainless steel</td>
</tr>
<tr>
<td>Pump shaft</td>
<td>Steel</td>
<td>Duplex stainless steel</td>
<td>Duplex stainless steel</td>
</tr>
<tr>
<td>Lower bearing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- bearing casing</td>
<td>C 22.8</td>
<td>Duplex stainless steel</td>
<td>Duplex stainless steel</td>
</tr>
<tr>
<td>- bearing bush seating</td>
<td>Elastomer</td>
<td>Elastomer</td>
<td>Elastomer</td>
</tr>
<tr>
<td>- sleeve bearing</td>
<td>Ceramic</td>
<td>Ceramic</td>
<td>Ceramic</td>
</tr>
<tr>
<td>Impeller, nut and key</td>
<td>Aluminium bronze</td>
<td>Stainless steel</td>
<td>Duplex stainless steel</td>
</tr>
<tr>
<td>Impeller wear ring</td>
<td>Cast iron</td>
<td>Stainless steel</td>
<td>Duplex stainless steel</td>
</tr>
<tr>
<td>Fasteners</td>
<td>Hot-dip galvanised</td>
<td>Stainless steel</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>Pump housing and intake box</td>
<td>Concrete</td>
<td>Concrete</td>
<td>Concrete</td>
</tr>
</tbody>
</table>

Conservation system to be determined. Material specification of pumps depends on the application.

11. TELEMAINTENANCE

The pump configuration is particularly suitable for fully automatic operation. The necessary sensors for remote monitoring can of course be built into each relevant component.

Some examples:

- Temperature: lower bearing / upper bearing
- Vibration sensors: pump stator, axial/radial bearing
- Tachometer: pump shaft
- Back-flow detector: impeller
12. Reference Projects

Lijnden Pumping Station
Client: Waterschap Groot Haarlemmermeer
Pumps: 2x Beveron 145
Capacity: 2 x 8.75 m³/s
Hstatic: 5.7 m.w.c.
Power: 2 x 800 kW
St Germans Pumping Station
Client: Middle Level Commissioners
Pumps: 6 x Beveron 210
Capacity: 6 x 16.67 m³/s
Hstatic: 4.25 m.w.c.
Power: 6 x 1250 kW
13. VOLUTE, SUCTION BOX AND WEAR RING PRODUCED AS PREFAB CONCRETE ELEMENTS