

# **Vision Series**

# MC, CV



Fish-friendly flood control, drainage and irrigation submersibles.







- 1. General
- 2. Development
- 3. Fish-friendliness
- 4. Operating range
- 5. Main dimensions
- 6. Main components
- 7. Technical description
- 8. Example arrangements







# 1. GENERAL

### APPLICATION

As a result of market demand and based on many years of experience, Bosman Watermanagement has developed the Vision MC: a new fish-friendly and clog-free pump type with impressive performances. The Vision is suitable for both new construction and renovation of polder drainage and irrigation pumping stations, and is available as a series of standard modules suitable for a capacity range of about 12 to 360 m3/minute.

#### FUNCTIONING

The components of the Vision pump are hydraulic optimally matching and designed in such a way that fish and eels can pass through the pump easily and without being harmed. Together with a wide passage this also means that the Vision achieves a good hydraulic efficiency and has an incredibly wide control range. A major additional advantage of the pump design is the insensitivity to clogging by for example, aquatic plants or other objects. The inlet chamber, also ensures that the required immersion depth is very limited, resulting in construction cost savings.

#### FEATURES

#### Fish-Friendly

- Open impeller with only one blade
- Guide vane house with only three stator vanes on a wide distance of the impeller
- Field tests according to NEN8775 demonstrated the Vision-CV pump is extreme fish-friendly.

#### Hydraulic

- Extremely wide cavitation-free control range
- Compact design
- Shallow submergence

#### Mechanical

- Water-lubricated lower bearing with very long service life-time
- Shaft seal very easily accessible
- No oil or grease in the surface water
- Easy to disassemble

#### Economic

- Environmental-friendly design
- Good efficiency, low energy costs
- Low maintenance costs







# Fish-friendly pump

**VISION-MC** 

# 2. DEVELOPMENT

# **HYDRAULIC DESIGN**

For the hydraulic design of the Vision-MC pump, the research department of Bosman Watermanagement collaborated closely with Eindhoven University of Technology. Computer simulations (CFD) were used to achieve the optimum result. The focus was on matching all the hydraulic components, such as the impeller and guide vane house combined with suction bellmouth.

#### Impeller and guide vane house.

In our pump type Vision-MC we use the same fishfriendly shape impeller as in the Vision-CV type. An impeller with only one blade and a low speed. A guide vane house with only 3 vanes on wide distance of the impeller minimizes the chance of fish damage.







Fish-friendly pump



# **MODEL TESTS**

Bosman Watermanagement carried out model tests in house. During these tests the theoretical design has been tested in practice to demonstrate all the relevant properties of the Vision-MC.

The model tests were performed with a closed loop

laboratory setup, built especially for this purpose, which contained the entire hydraulic design.

During the model tests, the performance of the Vision-MC

pump were accurately measured and recorded.

The model tests were performed according to the international

standard: Centrifugal, mixed flow and axial pumps - Code for hydraulic performance tests - Precision class ISO 5198.

During the model tests, the following parameters were

- measured and recorded using calibrated measuring equipment:
  - Flow rate
  - Discharge head
  - Shaft torque
  - Speed
  - Visible cavitation (using a sight glass in the pump casing)
  - Vibration level
  - Radial forces
  - Pressure drop range
  - Air suction phenomena
  - · Water temperature
  - Barometric pressure
- · Required immersion depth due to air suction

### **TEST RESULTS**

The test results were processed using high-tech computer models and serve as the basis for the selection software of the Vision-MC pump.









Fish-friendly pump



# **3. FISH FRIENDLINESS**

#### **Field test**

In pumping station "Obdam" of Water Board "Hoogheemraadschap Hollands Noorderkwartier" has been installed a fish-friendly pump type "Vision 50MC".

The pump has a design capacity of 43 m<sup>3</sup>/minute at a manometric head of 4,19 meter.

At the request of the Water Board , a field test according to NEN 8775 has carried out by Ecological Consultant Visadvies, to check the fishfriendliness of the installed Vision-MC pump.

#### Execution

Two fish species, Silver Eel and Cyprinidae, have been used to carry out the test.

In total, no less than 800 eels and fishes were used (partly as a control group) with varying lengths between 17 and 103 cm.

The eels and fish have been guided to the suction of the pump by means of a funnel-shaped inlet. At the normal operating speed of approx. 438 min-1 the eels and fishes were pumped through the Vision 50MC pump to the discharge side where they were collected in a net. Subsequently they were inspected for damage and monitored for possible delayed mortality for 24-48 hours.





Eel mortality that occurs after passing the Vision-50MC pump at design speed is set at 2%.

The roach mortality rate that occurs after passing the Vision-50MC pump at design speed is set at 4.7% For a relatively small pump with a suction diameter of approx. 500 mm, this is a good result and is better than predicted with the calculation model in accordance with NEN 8775.









# **4. OPERATING RANGE**



Standard operating range of Vision-MC pump series for information purposes. Graphs are generated for each object based on client specifications using our pump selection programme.







# **6. MAIN DIMENSIONS**

Vision-MC pump dimensions

Туре	A 2S Dim (mm)	A 3S Dim (mm)	B 2S Dim (mm)	B 3S Dim (mm)	DN
30	1360	1540	356	534	350
35	1560	1765	406	610	400
45	1965	2220	508	762	500
50	2370	2670	610	915	600
60	2770	3125	711	1070	700
70	3165	3570	813	1220	800
90	3955	4470	1016	1530	1000
105	4800	5410	1228	1840	1200
125	5600	6315	1430	2145	1400







# 7. MAIN COMPONENTS



- 1 axial-radial bearing
- 2 pump shaft
- 3 shaft seal
- 4 discharge elbow
- 5 guide vane house
- 6 radial bearing
- 7 impeller
- 8 suction bellmouth



Fish-friendly pump



# 7. TECHNICAL DESCRIPTION

### ASSEMBLY

The pump consists of the following parts:

- pump shaft
- thrust bearings
- shaft seal
- discharge elbow or diffusor
- set of lower bearings

All of these are assembled as a welded centric structure. The set of lower bearings is attached to the

bottom of the guide bearing house. The thrust bearing with the shaft sealing is attached to the top of the discharge elbow.

### **PUMP SHAFT**

The pump shaft is a single unit and provided with standard cylindrical shaft journals.

### THRUST BEARINGS

The pump has its own bearing system, independent of the drive unit. To absorb the axial and radial forces of the shaft coupling and pump impeller, a bearing stool with a combined axial and radial bearing is installed on the discharge elbow. The bearing combination has a standardised design.

### SHAFT SEAL

The standard shaft seal is a 'gland seal', and is located on the pump cover at the bottom of the bearing stool and is very easily accessible. It is lubricated by the pumped water, which is drained by a drain pipe. As an option, a 2-stage Liquidyne seal with rotating throttling is also available.

# LOWER BEARINGS

The lower bearing is a water lubricated rubber slide bearing with the following features:

- Long service life time
- Maintenance-free
- Environmentally-friendly
- No running dry during start up due to installation in the impeller casing
- Good heat transfer due to
  installation under water







Fish-friendly pump

bosman

### IMPELLER

To improve the fish-friendliness of the unit, an open mixed-flow impeller with only one vane was chosen. Characteristic features of this type of impeller are the wide opening and the low risk of hitting fish combined with a low speed. Furthermore, this impeller design has highly favourable cavitation properties and a wide control range. The impeller is casted, machined and balanced as a single unit.



### **GUIDE VANE HOUSE**

The guide vane house casing is specially designed for the impeller and has a high hydraulic efficiency. The guide vane house is characterised by a convex shape with a vertical discharge. The guide vane house is manufactured as a casted metal part.



### SUCTION CONFIGURATION

The Vision-MC pump has various setup variants, both with free flow from a pump cellar and with a preformed suction chamber like the Vision-CV pump.

For deviating intake situations, a CFD analysis can determine whether the flow conditions meet or need to be adjusted.







# MATERIALS

#### COMPONENT

Thrust bearing house: Cast Iron Bearing stool: Steel Welded Shaft seal Packing House: Cast Iron Packing Rings: Teflon/graphite Wear sleeves: Stainless Steel Guide vane house: Cast Iron Pump Shaft: Carbon Steel Discharge elbow/diffusor: Steel, welded Slide Bearing: Rubber/Bronze Impeller: Cast Iron Impeller wear ring: Cast Iron Connecting Materials: Steel hot-dip galvanised

For brackish and salt water, other materials like aluminium bronze and duplex stainless steel are available on request.

The standard shaft seal is a water lubricated gland seal. On request a 2-stage Liquidye heavy duty lipseal is available.

Coating to be determined. Material specification to be further determined based on the application.

### **PUMP SELECTION**

For a specific operating point, the optimum pump type must be selected from a series of pump types with different diameters and speeds. Within the broad range of these possibilities, CAS (computer-aided selection) is used; this is a computer programme that allows fast and accurate selection of all the available variations.

Preconditions include the largest possible control range, the variation in static discharge head, the

location of the maximum efficiency and the available NPSH. Once a choice has been made, CAS calculates the shape of the pump characteristic and generates all the performance characteristics. A data sheet with all the relevant information is then automatically generated.

### MONITORING

The pump configuration is especially suitable for fully automatic functioning. Naturally, the sensors required for monitoring can be included in the relevant component. A few examples:

- Temperature sensor and/or vibration detectors in guide bearing
- · Tachometer and/or reversal detection in pump shaft

### QUALITY

During the development of the Vision pump, it was decided to use the latest technology and top-quality materials. Bosman Watermanagement secures the quality of the Vision-MC pump by ISO 9001 standard.



VISION-MC Fish-friendly pump



# 8. EXAMPLE ARRANGEMENTS

# Pumps in open cellar, wet arrangement

Pumping Station Oosterboer Client : Waterschap Drents Overijsselse Delta Pumps : 2 x Vision 45MC Capacity : 2 x 25 m3/min Hstatic : 1,50 m Power : 15 kW









## Pump in dry cellar with formed suction intake

Pumping Station Obdam Client : Hoogheemraadschap Hollands Noorderkwartier Pump : 1 x Vision 50MC Capacity : 1 x 50 m3/min Hstatic : 2,92 m Power : 1 x 75 kW









VISION-MC





# Open pump in wet pump cellar

Pumping Station Burgvlietkade Client : Hoogheemraadschap van Rijnland Pump : 1 x Vision 70MC Capacity : 1 x 90 m3/min Hstatic : 1,84 m Power : 1 x 75 kW











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# 1. GENERAL

#### **APPLICATION**

As a result of market demand, and based on many years of experience, Bosman Watermanagement has developed the Vision-CV: a fish-friendly and clog-free pump type with impressive performances. The Vision is suitable for both new construction and renovation of polder and drainage an irrigation pumping stations, and is available as a series of standard modules suitable for a capacity range of about 12 to 360 m<sup>3</sup>/minute.

#### **FUNCTIONING**

The components of the Vision pump are hydraulic optimally matching and designed in such a way that fish and eels can pass through the pump easily and without being harmed. Together with a wide passage this also means that the Vision achieves a good hydraulic efficiency and has an incredibly wide control range. A major additional advantage of the pump design is the insensitivity to clogging by for example, aquatic plants or other objects. The inlet chamber, also ensures that the required immersion depth is very limited, resulting in construction cost savings.

#### **FEATURES**

#### Fish-friendly

- Open impeller with only one blade
- No guide vanes, but a wide volute
- Field tests according to NEN8775 demonstrated the Vision-CV pump is 100% fishfriendly

#### Hydraulic

- Extremely wide cavitation-free control range
- Compact design
- Shallow submergence

#### Mechanical

- Water-lubricated lower bearing with very long service life-time
- Shaft seal very easily accessible
- Very low noise level
- Maintenance free concrete pump casing
- No oil or grease in the surface water
- Easy to disassemble
- Low-maintenance and environmentalfriendly design

#### Economic

- Good efficiency, low energy costs
- Lower construction costs due to limited installation depth
- Low maintenance costs





VISION-CV Fish-friendly pump



# 2. DEVELOPMENT

# **HYDRAULIC DESIGN**

For the hydraulic design of the Vision pump, the research department of Bosman Watermanagement collaborated closely with Eindhoven University of Technology. Computer simulations (CFD) were used to achieve the best results. The focus was on matching all the hydraulic components, such as the inlet casing, impeller and screw casing.

#### Inlet chamber

The inlet chamber has a special design with a large opening to make it fish-friendly while minimising hydraulic losses.

#### Impeller and volute

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An extensive literature study by our engineers, combined with our pump expertise, has led to the choice for a screw centrifugal impeller with a fish-friendly nonclogging shape that has only one blade and which operates at low speed.

This impeller is subsequently installed in a large volute without guide vanes, minimising the risk of hitting fish, and therefore the risk of harming them.

VISION





# VISION-CV





# **MODEL TESTS**

Bosman Watermanagement carried out model tests in house. During these tests the theoretical design has been tested in practice to demonstrate all the relevant properties of the Vision-CV.

The model tests were performed with a closed loop laboratory setup built especially for this purpose, which contained the entire hydraulic design, including the suction chamber.

During the model tests, the performance of the Vision pump including the inlet chamber were accurately measured and recorded.

The model tests were performed according to the international standard: Centrifugal, mixed flow and axial pumps - Code for hydraulic performance tests - Precision class ISO 5198.

The unique aspect of this is that the pump and suction chamber were tested as a combined unit.

During the model tests, the following parameters were measured and recorded using calibrated measuring equipment:

- Flow rate
- Discharge head
- Shaft torque
- Speed
- Visible cavitation (using a sight glass in the pump casing)
- Vibration level
- Radial forces
- Pressure drop range
- Flow losses in the inlet chamber
- Air suction phenomena
- Water temperature
- Barometric pressure
- Required immersion depth due to air entrainment

# TEST RESULTS

The test results were processed using high-tech computer models and serve as the basis for the selection software of the Vision-CV pump.











**VISION-CV** Fish-friendly pump



# **3. FISH FRIENDLINESS**

#### **Field test**

In pumping station "De Nesse" of Water Board "Hoogheemraadschap van Schieland en de Krimpenerwaard" has been installed a fish-friendly pump type "Vision-CV".

The pump has a design capacity of 40 m<sup>3</sup>/minute at a manometric head of 4,72 meter. At the request of the Water Board, a field test according to NEN 8775 has carried out in the autumn of 2015 by Ecological Consultant ATKB, to provide insight in the fish-friendliness of the installed Vision-CV pump.



#### Execution

Two fish species, Silver Eel and Cyprinidae, have been used to carry out the test.

In total, no less than 600 eels and fishes were used (partly as a control group) with varying lengths between 10 and 78cm.

The eels and fish have been guided to the suction of the pump by means of a funnel-shaped inlet. At the normal operating speed of approx. 430 min-1 the eels and fishes were pumped through the Vision 50 pump to the discharge side where they were collected in a net. Subsequently they were inspected for damage and monitored for possible delayed mortality for 24-48 hours.



#### "The best pump ever tested"

All pumped eels and fishes survived the extensive test without lethal damage and/or (delayed) mortality. Never before a pump has been tested that has achieved a test result of 100% fish-friendliness. The Vision pump has come out with this great result as "the best pump ever tested"!!

Table 4.4 Sum	mary mort	ality per	specie an	d length c	lass
Fich	Length class (cm)	N passed fish	N damage serious/ terminally	% damage serious/ terminally	
FISH	(CIII)	11011	communy	communy	
Silver Eel	43-78	200	0	0	
Silver Eel Cyprinidae small	43-78 10-20	200 100	0 0	0 0	
Silver Eel Cyprinidae small Cyprinidae big	43-78 10-20 16-29	200 100 94	0 0 0	0 0 0	





# **4. OPERATING RANGE**



Standard operating range of Vision pump series for information purposes. Graphs are generated for each object based on client specifications using our pump selection programme.





# **6. MAIN DIMENSIONS**

Vision pump dimensions

													Mass	Mass Lower	Mass
Туре	A	В	С	D	E	F	G	н	I	J	К	NW	upper part	part	pump
35	1300	1500	1100	965	585	665	345	530	815	000	000	400	1700	1750	425
45	1650	1850	1300	1215	717	811	434	660	1027	804	253	500	3450	3650	850
50	2055	2300	1713	1465	890	980	523	800	1240	1038	305	600	7950	6750	1200
60	2400	2680	2000	1710	1040	1140	611	900	1445	1207	356	700	12550	11050	1450
70	2500	3000	2100	1960	1060	1310	700	1050	1655	1312	408	800	13400	14700	2000
90	3300	3800	2625	2450	1420	1637	875	1290	2070	1690	510	1000	19800	24200	3200
105	4000	4500	3160	2950	1742	1968	1053	1550	2490	1962	614	1200	10625/ 8175+1350	10150	5750
125	4700	5245	3680	3435	2050	2295	1227	1850	2905	2285	715	1400	17250/ 12650+1900	14300	8500



Horizontale doorsnede over midden van de slak





**VISION-CV** Fish-friendly pump



# **7. MAIN COMPONENTS**



- 2 axial-radial bearing
- 3 pump shaft seal
- 4 stator
- 5 radial bearing
- 6 pump impeller





# 7. TECHNICAL DESCRIPTION

# STATOR

The stator of the pump consists of the following parts:

- pump shaft
- set of guide bearings
- shaft seal
- bearing column with guide cone
- set of lower bearings

All of these are assembled as a welded centric structure. The set of lower bearings is attached to the bottom of the central column. The guide bearing with the shaft sealing is attached to the top of the support flange.

# **PUMP SHAFT**

The pump shaft is a single unit and provided with standard cylindrical shaft journals.

# THRUST BEARINGS

The pump has its own bearing system, independent of the drive unit. To absorb the axial and radial forces of the shaft coupling and pump impeller, a bearing seat with a combined axial and radial bearing is installed on the stator. The bearing combination has a standardised design.

# SHAFT SEAL

The standard shaft seal is a 'gland seal', and is located on the pump cover at the bottom of the bearing stool and is very easily accessible. It is lubricated by the pumped water, which is drained by a drain pipe. As an optional extra, a 2-stage Liquidyne seal with rotating throttling is also available.

# LOWER BEARINGS

The lower bearing is a water lubricated rubber slide bearing with the following features:

- long service life time
- maintenance-free
- environmentally-friendly
- no running dry during start up due to installation in the impeller casing
- good heat transfer due to installation under water









### IMPELLER

**VISION-CV** 

Fish-friendly pump

To improve the fish-friendliness of the unit, an open mixed-flow impeller with only one vane was chosen. Characteristic features of this type of impeller are the wide opening and the low risk of hitting fish combined with a low speed. Furthermore, this impeller design has highly favourable cavitation properties and a wide control range. The impeller is casted, machined and balanced as a single unit.

### VOLUTE

The volute casing is specially designed for the impeller and has a high hydraulic efficiency. The volute is characterised by a flat bottom with a trapezoidally shaped flow surface. The volute is constructed as a prefabricated concrete element.





### SUCTION CHAMBER

Special attention has been paid to the design of the inlet chamber. Its shape has been determined so that a large fish-friendly flow to the impeller is realised with limited hydraulic losses. This also limits the required installation depth. Tests in the pilot setup have demonstrated its good performance.









# MATERIALS

	Standard
Component	Materials
Guide bearing house	
Bearing seat	Steel
Shaft seal	
Packing house	Cast iron
Packing rings	Teflon/graphite
Wear sleeves	Stainless steel
Stator	Steel welded
Pump shaft	Carbon steel
Sleeve bearing	Rubber/bronze
Impeller	Cast iron
Impeller wear ring	Cast iron
Connecting materials	Steel hot-dip galvanised
Pump volute	Concrete

Preservation to be determined. Material specification to be further determined based on the application.

# **PUMP SELECTION**

For a specific operating point, the optimum pump type must be selected from a series of pump types with different diameters and speeds. Within the broad range of these possibilities, CAS (computer-aided selection) is used; this is a computer programme that allows fast and accurate selection of all the available variations.

Preconditions include the largest possible control range, the variation in static discharge head, the location of the maximum efficiency and the available NPSH. Once a choice has been made, CAS calculates the shape of the pump characteristic and generates all the performance characteristics. A data sheet with all the relevant information is then automatically generated.

### MONITORING

The pump configuration is especially suitable for fully automatic functioning. Naturally, the sensors required for monitoring can be included in the relevant component. A few examples:

- temperature sensor and/or vibration detectors in guide bearing
- tachometer and/or reversal detection in pump shaft

### QUALITY

During the development of the Vision pump, it was decided to use the latest technology and top-quality materials. Bosman Watermanagement secures the quality of the Vision-CV pump by ISO 9001 standard.







# PREFAB CONCRETE VOLUTE

Vision-CV volute, designed as a prefab concrete element







# 8. EXAMPLE ARRANGEMENTS

Pump in enclosed cellar below ground level

De Nesse pumping station

Client : Hoogheemraadschap van Schieland en de Krimpenerwaard

Pump	:	1 x Vision 50
Capacity	:	1 x 40 m³/min
H <sub>static</sub>	:	4.12 m.w.c.
Power	:	75 kW





Doorsnede A-A





VISION-CV Fish-friendly pump



# Pumps in cellar, drives one machine floor

Pumping St	ation Putten
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Client	:	Waterschap Hollandse Delta
Pumps	:	2 x Vision 90 en 1 x Vision 50
Capacityt	:	2 x 200 m <sup>3</sup> /min en 1 x 50 m <sup>3</sup> /min
H <sub>static</sub>	:	4,00 m.w.k.
Power	:	2 x 288 kW en 1 x 67 kW











# Pumps and drives in machine room

#### Pumping Station De Schans

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Client	:	HH Hollands Noorderkwartier
Pumps	:	2 x Vision 105
Capacity	:	2 x 150 m³/min
H <sub>static</sub>	:	2,03 m.w.k.
Power	:	2 x 110 kW





# Available in New Zealand from:

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