User manual

Installation, Operation and Maintenance Manual

APP pumps (APP 5.1-10.2)
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Validity

This manual is valid for APP pumps with the following code numbers/serial numbers:

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<th>Pump Size</th>
<th>Code No.</th>
<th>Serial No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>APP 5.1</td>
<td>18083005</td>
<td>03</td>
</tr>
<tr>
<td>APP 6.5</td>
<td>18083006</td>
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<td>18083007</td>
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<td>APP 10.2</td>
<td>18083010</td>
<td>03</td>
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</tbody>
</table>
# EC Declaration of Conformity

**Danfoss A/S**
Danfoss High Pressure Pumps  
Nordborgvej 81  
6430 Nordborg  
Denmark

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Hiermit erklären wir, dass die Maschine gemäß 2006/42/EG entwickelt ist.</td>
<td>We hereby declare that the machine is designed according to the directive 2006/42/EC.</td>
<td>Par la présente, nous déclarons que la machine est concue conformément à la Directive 2006/42/CE.</td>
</tr>
<tr>
<td>Beschreibung der Maschine Hochdruck-Pumpe</td>
<td>Machine description High pressure pump</td>
<td>Description de la machine Pumpe haute pression</td>
</tr>
</tbody>
</table>
| Maschinentyp  
APP 0.6-1.0 / APP 1.5-3.5 / APP 5.1-10.2 / APP 11-13 / APP 16-22 / APP 21-38 | Machine designation  
APP 0.6-1.0 / APP 1.5-3.5 / APP 5.1-10.2 / APP 11-13 / APP 16-22 / APP 21-38 | Type de machine  
APP 0.6-1.0 / APP 1.5-3.5 / APP 5.1-10.2 / APP 11-13 / APP 16-22 / APP 21-38 |
| Seriennummer N/A | Serial number N/A | Numéro de série N/A |
| Technisches Dossier, Kontaktperson  
Leiter Qualitätsabteilung | Technical dossier, Contact person  
Manager Quality Department | Personne de contact pour le dossier technique  
Manager département qualité |
| Angewandte harmonisierte Normen  
DS/EN ISO 12100: 2011 | Used harmonised standards  
DS/EN ISO 12100: 2011 | Normes harmonisées appliquées  
DS/EN ISO 12100: 2011 |

Hersteller-Unterschrift / Titel:  
Welm Friedrichsen  
Leiter F&E

Manufacturers signature / Title:  
Welm Friedrichsen  
Director R&D

Signature du fabricant / Titre:  
Welm Friedrichsen  
Directeur R&D
1. Introduction

1.1 General
The APP pumps and pump units are manufactured by Danfoss A/S, and are sold and marketed by a net of authorized distributors world wide.

This manual contains the necessary instructions for the installation, operation and service of the pumps used in a Sea Water Reverse Osmosis (SWRO) or Brackish Water Reverse Osmosis (BWRO) system.

The APP pumps must not be used for other purposes than those recommended and specified without first consulting your local pump distributor.

Use of the pump in other applications not suitable for the pump unit can cause damages to the pump unit, with risk of personal injury.

All personnel being responsible for operation and maintenance of the pump unit must read and fully understand these instructions, especially the section “Safety” before:

- Transportation of the motor pump unit
- Lifting the unit
- Installing the pump unit
- Connecting the motor pump unit to the water system
- Connecting the electric motor and instrumentation
- Commissioning the unit
- Servicing the motor pump unit, mechanic and electric parts
- Decommissioning the motor pump unit

The pump must always be installed and used in accordance with existing national/local sanitary, safety regulations and laws.

It is the responsibility of the safety officer or the chief operator to assure compliance with all local regulations that are not taken into account in this manual.

Changing the pumps’ or motor pump units’ operational limits and hardware:

- Changes to the delivered pump or motor pump system may only be done with a written approval from Danfoss RO Solutions.
- Operation outside the Danfoss specifications requires a written approval from Danfoss RO Solutions.
- If any changes are made without written approval the warranty will automatically become void.

Ensure that these instructions are always readily available to all personnel concerned.

1.2 Symbols

- Indicates something to be noted by the reader
- Indicates a situation which will or could result in damage to the pump and its function
- Indicates a situation which will or could result in personal injury and/or damage to the pump
- Electrical hazard - Indicates a high-voltage warning
- Safety glasses required
- Hearing protection required
- Safety shoes required
- Safety helmet required

1.3 Manufacturer and customer service address:

Danfoss A/S
RO Solutions
Nordborgvej 81, D25
DK-6430 Nordborg
Denmark

Telephone:  +45 7488 4024
Fax: +45 7445 3831
Email: ro-solutions@danfoss.com
Homepage: www.ro-solutions.com

Your local Danfoss pump distributor can be found on our homepage.

Data sheets and instructions on all accessories are available on www.ro-solutions.danfoss.com

CE Declaration of Conformity can be found on page 5.
2. Safety

2.1 General information
Dangers that can arise from not following the instructions:

When the pump or pump system is managed by untrained personal, there is a danger of:

- Death or fatal injuries
- Costly damages and claims

Electrical hazard
All electrical installation work must only be carried out by authorized personnel in accordance with EN60204-1 and/or local regulations.

Install a lockable circuit breaker to avoid inadvertent starting.

Protect the motor and other electrical equipment from overloads with suitable equipment.

Protective garments must be worn
It is recommended to place a local safety switch near by the pump, enabling service personal to cut power for the electric motor. This prevents unintentionally starting the unit during servicing.

Always wear suitable safety clothing when handling the pump.

When working near the pump system, safety proof boot/shoes, safety glasses, ear protection and safety helmet must always be worn.

Danger Hot
Under certain operational conditions the surface of the pump can be above 60°C / 140°F. Under these conditions the pump must be labelled with a “Danger Hot” sign.

When using an electric motor, the motor must always be supplied with adequate cooling ventilation.

When using an electric motor together with a VFD, the motor must be designed for operation with VFD. VFD operation may increase the temperature inside the electric motor if the motor is not designed for VFD operation.

Before start-up, the settings for all protective devices, for example, sensors-switches and safety valves must be verified and free flow from safety valves must be ensured.

All pipe and hose connections must be stress-free mounted, securely fastened to the pumps and well supported. Improper installation will or could result in personal injury and/or damage to the pump.

Use of this manual does not relieve operation and maintenance personnel of the responsibility of applying normal good judgment in the operation and care of the pump and its components.

2.2 Preferred system design
Danfoss recommends building systems with a high degree of safety. See Danfoss preferred system design and PI&D in Data sheet and Instruction which are found in appendix 1 (Data sheet) and 2 (APP pump instruction).

It is always the system builders responsibility that the system design does not cause any kind of hazard and is adapted to local regulations and standards.

Proper installation, care of start up and shut-down devices and over-pressure protection equipment is essential.

2.3 Commissioning and servicing the unit
It is recommended that commissioning and servicing are carried out by a minimum of two people, where one is acting as a supervisor.

2.4 Adhere to the following important points
- Before using the pump/pump unit it is very important to read and understand this user manual.
- Do not try to lift the pump unit manually; most of the pumps weight more than 20 kilos, see specific weight for the pump in the Data sheet, which is found in appendix 1.
- Do not run the pump if it is completely dry and not bleeded.
- Do not mount the pump without the bell housing and a flexible coupling.
- Do not try to start the unit before the system components are mounted, bleeded and adjusted.

2.5 In case of doubt
Please contact Danfoss A/S in case of doubt. Contact information are listed in section 1.3, Manufacturer and customer service address.
3. Technical data

3.1 Approved applications and operational limits for the pumps

The pump and the pump units are designed for the use in a Sea Water Reverse Osmosis (SWRO) or Brackish Water Reverse Osmosis (BWRO) systems.

The APP pumps must not be used for other purposes than those recommended and specified without first consulting your local pump distributor.

Use of the pump in other applications not suitable for the pump unit can cause damages to the pump unit, with risk of personal injury.

For system integration of the pumps, please see Data sheet and Instruction which are found in appendix 1 (Data sheet) and 2 (APP pump instruction).

3.2 Application range

See Data sheet in appendix 1.

3.3 Electric motor data

See recommended motor in Data sheet, appendix 1 or IOM for motors, appendix 3. The motors mentioned are the most common used motors by Danfoss High Pressure Pumps.

3.4 Noise and vibration

Noise level for a motor pump unit with a "standard" motor measured according to EN ISO 3744:2010, see Data sheet in appendix 1. Possibilities to reduce noise and vibration are described in the same Data sheet.

3.5 General arrangement

Dimensions for the different pumps, see Data sheet in appendix 1.

3.6 Space requirement

For service and replacement of the complete motor pump unit, it is recommended having sufficient space around the unit.

For easy access to the unit, at least 1 meter/40 inches available space should be kept free around the pump. When working with high pressures, space demands should reflect the required safety requirements.

3.7 Filtration

(10µm absolute [β10 =5000]) Requirements are specified in Data sheet, appendix 1 and APP pump instruction, appendix 2.

Danfoss recommends not to build a filter bypass function or use filters with an integrated bypass. If the above recommendation is not followed the warranty for the pump will automatically become void.

It should be possible to monitor the condition of the filter via the differential/delta pressure across the filter.

Using insufficient filtration or a filter bypass can cause a failure or decreased service life of the pumps.

3.8 Properties of water

It is recommended NOT to use the pumps in feed water concentrations higher than 50,000 ppm TDS without consulting your local Danfoss pump distributor.

3.9 Air bubbles

Large bubbles in a pressurised RO system can result in damage to piping, equipment and the pumps.

All air must be bleded from both the low-pressure and high-pressure side before the RO system is pressurised. Special consideration should also be given to air bubbles in feed flow and continuously feed into the pumps as it else can give cavitation.

3.10 Chemicals

The pumps should not be exposed to any chemicals that can result in damage to piping, equipment and internal parts of the pumps.
4. Arrival inspection, transportation, handling, lifting and storage

4.1 Arrival inspection
The pump is packed in a cardboard or wood box with plugs in the port connections to protect the pumps from damage during transportation.

Immediately check the shipment for damage on arrival and make sure that the name plate/type designation is in accordance with the packing slip and your order.

Remove all packing materials immediately after delivery. In case of damage and/or missing parts, a report should be drawn up and presented to the carrier at once.

4.2 Warning
Before any lifting operation is performed, environmental conditions must be taken into consideration (Ex-rated areas, wind speed, wet/dry conditions, lifting height, etc.).

4.3 General safety information
Personnel involved in lifting and transporting the equipment (see Safety, chapter 2) must be trained in handling and safety procedures when lifting heavy loads. Many of the pumps and pump units weigh more than 20 kilos, which requires lifting slings and suitable lifting devices; e.g. an overhead crane or industrial truck to be used as minimum.

4.4 Transport and handling
Small pumps which have a weight below 20 kilos (weight can be found in the Data sheet in appendix 1) can be handled by hand if they are not mounted together with an electric motor.

The weight of a small pump with a motor will be above 20 kilos.

Pumps which have a weight above 20 kilos (see Data sheet, appendix 1) must be handled by using lifting eyes and slings.

Never use only one sling and make sure the slings does not slip off the pump.

When the pump is mounted together with an electric motor, the pump unit always weight more than 20 kilos and must be handled by using slings around the pump unit.
See below examples of where to/not to attach the lifting slings on the pump unit:

Correct lifting with 2 separate slings:

Incorrect lifting can result in personally injury and/or damage to the pump unit.

4.5 Return to supplier
Please see maintenance chapter 7.

4.6 Storage
Each pump is tested before shipment and therefore holds water, so for storage temperature and frost protection see Data sheet in appendix 1 or APP pump instruction in appendix 2.

The pumps are NOT delivered frost protected from the factory.

Wrong lifting:

When lifting the pump unit, one sling must be attached to the electric motor and one sling around the pump.

Only some motors and pumps have specific lifting eyes.

Do not use connections/nozzles for lifting!
Do not use only one sling!

Make sure that the unit/load is balanced before attempting to lift, as the centre of the mass is different from pump to pump and pump unit to pump unit.

How to mount the pump and the electric motor correctly together, see Data sheet in appendix 1 or APP pump instruction in appendix 2.
5. Installation and commissioning

5.1 Important dimensions
Physical dimensions and connections for the pump unit are described in Data sheet, appendix 1.

5.2 Cleanliness
It is very important that the tubes and pipes are completely clean: no dirt, chips or burrs are allowed. Flush all piping before connecting the high pressure pump to ensure the system is clean. Internal surfaces of the piping must not be corroded. If dirt or rust is not removed, the pump and the valves can be damaged and in the worst case damaged beyond repair!

5.3 Fluid temperature
Before start-up, the fluid and pump housing temperature must be above the minimum start-up temperature, see Data sheet, appendix 1.

5.4 Electrical data
Check voltage, current frequency and rated power on the electric motor and VFD setting name plate on both the motor and the VFD.

5.5 Local regulations
Commissioning must always be done in accordance with valid regulations and local standards.

5.6 Pre mounting checklist, based on Danfoss preferred system design

Schematic 1: Recommended system design

![Diagram of recommended system design](image-url)
### Table 1: Check points when assembling and commissioning system

<table>
<thead>
<tr>
<th>Check points</th>
<th>Comment</th>
<th>OK?</th>
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<tbody>
<tr>
<td>CP1</td>
<td>Ensure that the environmental conditions are safe. See Arrival inspection, transportation, handling, lifting and storage, chapter 4.</td>
<td></td>
</tr>
<tr>
<td>CP2</td>
<td>Minimum and maximum start-up temperature for fluid and pump. See Data sheet or Instruction, appendices 1 and 2.</td>
<td></td>
</tr>
<tr>
<td>CP3</td>
<td>Filtration condition (10µm absolute (ß10 = 5000) See Danfoss requirements in Data sheet and Instruction, appendices 1 and 2.</td>
<td></td>
</tr>
<tr>
<td>CP4</td>
<td>Power supply for electric motor and VFD. See Data sheet for the used motor and VFD, appendix 1.</td>
<td></td>
</tr>
<tr>
<td>CP5</td>
<td>Safety circuit / breaker must be sized for the motor and environment (corrosion and humidity) See Data sheet for the used safety circuit.</td>
<td></td>
</tr>
<tr>
<td>CP6</td>
<td>Bolts and screws must conform to environmental conditions as well as fluid and torque requirements.</td>
<td></td>
</tr>
<tr>
<td>CP7</td>
<td>Instrumentation, pressure switch should be designed to conform to the environment (corrosion and humidity). See Data sheet for the used equipment.</td>
<td></td>
</tr>
<tr>
<td>CP8</td>
<td>Check the factory settings of the safety/relief valves or pressure relief valves (8 &amp; 9). See Data sheets for the used valves.</td>
<td></td>
</tr>
<tr>
<td>CP9</td>
<td>Check the settings of the pressure transmitter/switch (3) set at min. inlet pressure. See Data sheet or Instruction, appendices 1 and 2.</td>
<td></td>
</tr>
<tr>
<td>CP10</td>
<td>Check that all pressure indicators (PI) are selected to be able to measure the system pressure range. Scaling should at least be 1 Bar or more precise.</td>
<td></td>
</tr>
<tr>
<td>CP11</td>
<td>Check coupling distance ( air gab – movement of the spider ) 3 – 5 mm</td>
<td></td>
</tr>
<tr>
<td>CP12</td>
<td>Check correct connections on the pump ( in &amp; outlet)</td>
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<tr>
<td>CP13</td>
<td>Check piping for possible air gaps.</td>
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### 5.7 Lifting and positioning

Lift the pump unit onto base (Remember vibration dampers, if needed). Fasten the motor to the base.

See also chapter 4, Arrival inspection, transportation, handling, lifting and storage.

### 5.8 Mount the different equipment (connections, pipes, tubes, check and safety/relief valves, etc.)

- The hard piping and flexible hoses used must be of proper design and must be installed in accordance with the manufacturer’s recommendations. (see also Data sheet for Hose and hose fittings and Instruction for Assembling Hose kit - both available on www.ro-solutions.danfoss.com).
- Misalignment of the hard pipes may place stress on the pump port connection and may damage the pump.
- Prevent excessive external pipe load.
- Do not connect piping by applying external force (use of wrenches, crane, etc.) Piping must be aligned without residual stress.
- Do not mount expansion joints so that their force applies internal pressure on the pump connections.

### 5.9 Electrics

All electrical installation work must be carried out by authorized personnel in accordance with EN60204-1 and/or local regulations. (see also Safety, chapter 2)

Mount the safety circuit breaker, turn the circuit off and lock it in the off position.

Mount the power cable on the electric motor.

If a VFD is used, adjust the protective motor switch/VFD to the current limits found on name plate of the electric motor.

### 5.10 Instrumentation

The pressure switch/sensor should be mounted as close to the pump as possible. It is recommended to test the pressure/sensor switch via an instrumentation manifold.

Mount the pressure switch/sensors according to the manufacturer’s instructions.

### 5.11 Connections

Mount connections and maybe check valve(s). Mount and tighten as specified.
5.12 Ensure free flow
Ensure that the flow from safety/relief valves 8 and 9 is completely unhindered. A blocked safety/relief valve can cause excessive build-up of pressure and thereby cause dangerous situations and damage to the whole system.

- Adjust the pressures to the specified inlet and outlet pressure for the system and let the pump unit run until the electric motor and pump temperature is stable.
- If the system is running within the system design limits, the system is released for operation.

5.13 Verify setting of safety/relief valves
Make sure, the safety/relief valves 8 and 9 are placed correctly.

- Check the pressure settings on the name plates of the safety/relief valves. If they are OK, continue. Otherwise replace the safety/relief valves.

5.14 Flush the pump
Fully open the pressure valve at the brine site.

- Close all the bleeding and draining plugs on the high pressure pump.
- Start the feed pump and ensure that the flow from the feed pump to the high pressure pump is unhindered.

5.15 Bleed and remove air from the pump
Open bleeding plugs. Keep the plugs open until only water leaves the high pressure pump.

5.16 Verify direction of rotation
An arrow can be found on the pump or pump unit. The direction of rotation must always follow the arrow.

- Unlock the safety circuit breaker. Start the motor for 1 second and observe the direction of rotation either looking on the fan of the motor or on the coupling true the hole in the bell housing (not available on all bell houses). If the motor is turning the wrong direction, switch two phases in the connection box of the motor or reprogram the direction in VFD.

5.17 Commissioning
- Close all the bleeding and draining plugs.
- Open the pressure valve at the brine site.
- Switch the safety circuit breaker on for both motor(s) and VFD(s).
- Start the feed pump.
- Start the high pressure pump.
- If a VFD or a soft starter is used a ramp up time of minimum 10 second is required to avoid damage of internal pump parts.
- Monitor the inlet pressure and outlet pressure of the high pressure pump and look for leakages.
- Check the pressure indicator function by slowly closing the valves. The pump unit should stop when the minimum inlet pressure and maximum outlet pressure has been reached.

5.18 Check the filter condition
Evaluate dirt found in filter, replace filter elements, if necessary.

5.19 Instruct operator and maintenance personnel
Before using the pump/pump unit, the personnel must be instructed in using the pump/pump unit, its function, components, documentation and safety.

Danfoss offers commissioning and service at system manufacturer's location. Rate quotes are offered upon request.
6. Operation of motor pump unit

6.1 General safety information

Before inspecting the pump unit, read the Safety chapter 2 in this user manual.

6.2 What to listen and look for

If the following is observed, please act as indicated:

A) Re-check all bolts and, if necessary, contact the maintenance department in order to have all bolts tighten to the specified levels.

B) Leakage – if a small leak dripping from the bell housing is observed, contact the maintenance department.

C) Leakage – if there is a large leak, the unit should be stopped as soon as possible. Contact the maintenance department.

D) High frequency tones – safety/relief valves are either damaged or running very close to their cracking pressure, stop the unit immediately. Contact the maintenance department.

E) Non-standard noise or vibration from the pump requires the unit to be stopped immediately. Contact the maintenance department.

F) Very high temperatures – can indicate one or more damaged parts inside the pump. The pump then needs to be stopped immediately and inspected before running again. Contact the maintenance department.

G) Drop in flow and/or pressure - can indicate wear on one or more parts inside the pump. The pump needs to be stopped immediately and inspected before running again. Contact the maintenance department.

H) Other observations or troubles, please see appendix 7, Right and Wrong or the Trouble shooting guide, appendix 6. Both appendices give good advises on design, installation, wiring and trouble-shooting.

If the pump is not stopped for inspection, it can lead to damage of the pump. See also service and warranty section in the Data sheet, appendix 1; APP pump instruction or Instruction for recommended service intervals in appendix 2 and 4.

Danfoss offers service of the pump at the system manufacturer’s location as well as training in servicing the pump. Quotes are offered upon request.

Danfoss recommends at the same time also to check the filter and membrane condition and evaluate dirt found, replace filter and membrane elements if necessary.
7. Maintenance and service of the pump unit

7.1 General safety information
Before servicing the pump unit, it is necessary to read and understand this user manual, especially the Safety, chapter 2. Remember to wear suitable safety equipment according to Safety, chapter 2.

I) Carefully pull the pump out of the bell housing by using lifting equipment, if necessary.

7.2 Service and inspection interval for the pump
Maintenance and service intervals are depending on the cleanliness level of the water, hydraulic load and temperature of the pump unit. The most important parameter is the cleanliness of the water.

J) Hold the pump in different positions above a drip tray; this should allow most of the left-over water trapped in the pump to drip out. Clean and dry the pump surface and plug the bleeding and draining plugs.

See the section Service and warranty in the Data sheet, appendix 1, APP pump instruction and Instruction for recommended service intervals in appendix 2 and 4.

K) Move the pump to a clean and safe location where the pump can be inspected/servicesed.

7.3 Shut down of the system

A) Open the pressure valves at the brine site to release the pressure.

B) Stop the high pressure pump.

C) Stop the feed pump.

D) Turn on the motor safety circuit breaker for both the high pressure pump, the feed pump and the VDF if used and lock them. Only the employees servicing the pump unit should be able to unlock/activate the switch again.

E) Open bleeding and drain plugs. Wait until the pump and system are emptied for water.

F) Slowly unscrew and remove the bolts and gaskets from the in/out hoses or pipes, be careful about jets of water. Be aware that there still can be pressure in the system, which will be released when unscrewing and removing the bolts and gaskets.

G) Attach the lifting equipment to the pump unit. For instructions on lifting the complete pump unit, see chapter 4, Arrival inspection, transportation, handling, lifting and storage.

H) For the small pumps unscrew the bolts holding the pump to the bell housing and for the bigger pumps, unscrew the bolts holding the pump and bell housing to the motor and afterwards unscrew the bolts/nuts holding the pump and bell housing together.

I) Carefully pull the pump out of the bell housing by using lifting equipment, if necessary.

7.4 Disassembling and assembling the pump unit

A) Remove all connections from the pump.

B) Disassemble the pump according to the Disassembling and Assembling Instruction (available at www.ro-solutions.danfoss.com). At the website you can also find the Changing pistons instructions for APP 11-13 and APP 16-22 as well as for APP 21-38). Clean all the parts and surfaces with a fluid compatible with the materials found in the pump. Wipe the parts clean and dry with a dry and lint-free cloth.

C) Inspect all parts including shaft seal and if necessary, replace them; see Parts list, appendix 5 and APP pump instruction, appendix 2 or general instruction for Recommended service intervals, appendix 4.

D) If the pump is going to be returned to Danfoss for repair or a warranty claim, it is important that Danfoss, besides your contact information and reason for returning, gets the below information before shipping.

Product Information (see labeled on product)

<table>
<thead>
<tr>
<th>Product type</th>
<th>Location</th>
<th>Serial number</th>
</tr>
</thead>
</table>

Operational conditions

<table>
<thead>
<tr>
<th>Application</th>
<th>Unit pressure</th>
<th>Motor (pump, motor only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>hour of operation</td>
<td>Cold/pressure</td>
<td>Variable or static (motor only)</td>
</tr>
<tr>
<td>Elevation (p, absolute, meter)</td>
<td>Cold</td>
<td>Room temperature</td>
</tr>
<tr>
<td>Other type</td>
<td>TEC</td>
<td>Pump in parallel (system)</td>
</tr>
</tbody>
</table>

After Danfoss has been informed about the return, you will receive a return number and a template to fill out. One copy should be attached to the shipment and one copy should be sent to the E-mail address on the template.

Returns without a return number will be rejected !!!
7.5 Assembling the pump unit
Assemble the pump according to the Dis-assembling and Assembling Instruction (available at www.ro-solutions.danfoss.com).

7.6 Procedure for mounting pump back onto electric motor
Do always follow the procedure delivered with the instructions from the coupling manufacturer!

⚠️ Mount the flexible coupling and bell housing according to the Data sheet, appendix 1 and APP pump instruction, appendix 2.

7.7 Getting the pump unit back into operation
Find instructions of how to put the pump unit back into operation in chapter 4, Arrival inspection, transportation, handling, lifting and storage and Installation and commissioning, chapter 5.

7.8 Storage of the pump
If the pump has to be shut down for a longer period or put on the shelf, instructions can be found in Storage-chapter in Data Sheet, appendix 1 or APP pump instruction, appendix 2.
8. Troubleshooting and scrapping criteria

8.1 General safety information
Before inspecting the pump unit, it is necessary to read and understand this user manual, especially the Safety chapter 2.

Remember to wear suitable safety equipment according to Safety chapter 2.

8.2 Operational conditions which can cause pump failures
The following conditions can cause a pump failure:
- The pump is running dry.
- The inlet pressure is too high.
- The inlet pressure is too low.
- The viscosity of the fluid is too high.
- The temperature of the fluid being pumped is too high.
- The ambient temperature is too high.
- The pump is running against a blocked port/closed manual valve.
- The pump is operating at a pressure above the operational specification.
- The pump is running with a non-specified/approved fluid.
- The pump is running in the wrong direction.
- The filtration is insufficient.
- The pump is not being serviced according to Danfoss specifications (end of life).
- There is excessive mechanical load on the shaft coupling and piping.

If a VFD is used and wrongly programmed, it can damage the pump and lead to high temperatures or other dangers.

Therefore all electrical installation work must only be carried out by authorized personnel in accordance with EN60204-1 and/or local regulations.

8.3 Mechanical failure
If the pump is running dry, the temperature will quickly increase which can be dangerous, depending on how long time the pump is running dry.

If there is any leaking at start up or leaking arises during operation, the high pressure can lead to eye or skin damage.

Leaking can result in flooding, which again can cause a risk of slipping, tripping or falling.

If water is dripping into the electric motor; it can lead to electric shock, fire, short of circuit or even death. In order to avoid water dripping into the electric motor, see Installation and commissioning, chapter 5 and Operation, chapter 6.

8.4 Electrical failure
If the wiring/connection of the electric motor is not correct or the earth connection is missing, it can lead to electric shock, burn damages, fire or even death.

8.5 Responsibility
Danfoss takes no responsibility for any other abnormal injuries, risks or damages that could arise caused by abnormal conditions, vibrations, corrosion, abrasives, foreign objects or excessive temperatures and shall not be liable for any consequential or incidental damages.

8.6 Scrapping criteria
Whether the pump can be repaired or need to be scrapped depends on how damaged the internal parts are or how damaged the whole unit is.

Please use appendix 6, Trouble shooting guide as guideline or send the pump to Danfoss headquarter in Denmark for evaluation.

For other observations or troubles, please see appendix 7, Right and Wrong which gives good advises in design, installation, wiring and troubleshooting.
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APP pumps

APP 5.1-10.2
APP 5.1, APP 6.5, APP 7.2, APP 8.2 and APP 10.2 pumps are designed to supply low viscosity and corrosive fluids under high pressure, e.g. in seawater reverse osmosis filtration applications and for high pressure salt water pumping.

The APP pumps are based on the axial piston principle enabling a very light and compact design, and they are designed so that lubrication of the moving parts in the pumps is provided by the fluid itself. No oil lubrication is thus required.

All parts included in the APP pumps are designed to provide long service life, i.e. long service life with a constantly high efficiency and minimum of service required.

The pumps are fixed displacement pumps in which the flow is proportional to the number of revolutions of the input shaft and the pump displacement, regardless of any counter-pressure.
APP pumps - APP 5.1-10.2

2. Benefits

- One of the smallest and lightest pumps on the market.
- Can be powered by a combustion engine provided that a special coupling is used.
- Generates insignificant pulsations in the pressure line.
- No preventive maintenance required (no periodic service like e.g. change of lubricant and wearing parts).
- Long service life. Danfoss guarantees 8,000 hours maintenance-free operation.
- All parts of the pump are made of non-corrosive materials e.g. Duplex (SAF 2205/EN1.4462) and Super Duplex (SAF 2507/EN1.4410) stainless steel and carbon reinforced PEEK.
- High efficiency.

3. Technical data

<table>
<thead>
<tr>
<th>Code number</th>
<th>180B3005</th>
<th>180B3006</th>
<th>180B3007</th>
<th>180B3008</th>
<th>180B3010</th>
</tr>
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<tbody>
<tr>
<td>APP pumps</td>
<td>APP 5.1</td>
<td>APP 6.5</td>
<td>APP 7.2</td>
<td>APP 8.2</td>
<td>APP 10.2</td>
</tr>
<tr>
<td>Geometric displacement</td>
<td>cm³/rpm</td>
<td>50</td>
<td>63</td>
<td>70</td>
<td>80</td>
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<tr>
<td></td>
<td>in³/rpm</td>
<td>3.05</td>
<td>3.84</td>
<td>4.27</td>
<td>4.88</td>
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<tr>
<td>Flow (1800 rpm)</td>
<td>m³/h</td>
<td>5.0</td>
<td>6.4</td>
<td>7.2</td>
<td>8.2</td>
</tr>
<tr>
<td></td>
<td>gpm</td>
<td>22.0</td>
<td>28.2</td>
<td>31.7</td>
<td>36.1</td>
</tr>
<tr>
<td>Min. pressure</td>
<td>bar</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
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<tr>
<td></td>
<td>psi</td>
<td>290</td>
<td>290</td>
<td>290</td>
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<tr>
<td>Max. pressure, cont.</td>
<td>bar</td>
<td>80</td>
<td>80</td>
<td>80</td>
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</tr>
<tr>
<td></td>
<td>psi</td>
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<tr>
<td>Max. pressure, intermittent</td>
<td>bar</td>
<td>100</td>
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<td></td>
<td>psi</td>
<td>1450</td>
<td>1450</td>
<td>1450</td>
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</tr>
<tr>
<td>Max. speed cont.</td>
<td>rpm</td>
<td>1800</td>
<td>1800</td>
<td>1800</td>
<td>1800</td>
</tr>
<tr>
<td>Min. speed cont.</td>
<td>rpm</td>
<td>700</td>
<td>700</td>
<td>700</td>
<td>700</td>
</tr>
<tr>
<td>Power requirement at 80 bar and 1800 rpm</td>
<td>kW</td>
<td>13.7</td>
<td>17.3</td>
<td>19.2</td>
<td>21.7</td>
</tr>
<tr>
<td></td>
<td>hp</td>
<td>18.4</td>
<td>23.2</td>
<td>25.7</td>
<td>29.1</td>
</tr>
<tr>
<td>Weight</td>
<td>kg</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>lb</td>
<td>66</td>
<td>66</td>
<td>66</td>
<td>66</td>
</tr>
</tbody>
</table>

1) Typical average flow at 80 bar.
2) For lower pressure, please contact Danfoss RO Solutions Sales Organization.
3) For higher pressure, please contact Danfoss RO Solutions Sales Organization.
4) Intermittent pressure is acceptable for less than 10 seconds per minute.
5) For speeds above 1500 rpm the APP pump must be boosted at a pressure of 2-5 bar (29-72.5 psi).
4. **Flow at different rpm**  

Using the diagram shown below, it is easy to select the APP pump which fits the application best if the flow required and the rotation speed (rpm) of the pump are known.

![Diagram showing flow vs rpm for different APP pumps](image)

Furthermore, this diagram shows that the flow can be changed by changing the rotation speed of the pump. The flow/rpm ratio is constant, and the “desired” flow can be obtained by changing the rotation speed to a corresponding value.

Thus, the required rpm can be determined as:

\[
\text{Required rpm} = \frac{\text{Desired flow} \times \text{Rated rpm}}{\text{Rated flow}}
\]

5. **Power requirements**

<table>
<thead>
<tr>
<th>Pump model</th>
<th>Flow at different rpm</th>
<th>Pressure</th>
<th>rpm</th>
<th>Calc. factor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>l/min</td>
<td>m³/h</td>
<td>gpm</td>
<td>60 bar</td>
</tr>
<tr>
<td>APP 5.1</td>
<td>66</td>
<td>4.0</td>
<td>17.4</td>
<td>8.3 kW</td>
</tr>
<tr>
<td>APP 5.1</td>
<td>79</td>
<td>4.7</td>
<td>20.9</td>
<td>10.0 kW</td>
</tr>
<tr>
<td>APP 6.5</td>
<td>83</td>
<td>5.0</td>
<td>22.0</td>
<td>10.5 kW</td>
</tr>
<tr>
<td>APP 6.5</td>
<td>100</td>
<td>6.0</td>
<td>26.4</td>
<td>12.6 kW</td>
</tr>
<tr>
<td>APP 7.2</td>
<td>93</td>
<td>5.6</td>
<td>24.6</td>
<td>11.6 kW</td>
</tr>
<tr>
<td>APP 7.2</td>
<td>112</td>
<td>6.7</td>
<td>29.5</td>
<td>13.9 kW</td>
</tr>
<tr>
<td>APP 8.2</td>
<td>106</td>
<td>6.4</td>
<td>28.1</td>
<td>12.7 kW</td>
</tr>
<tr>
<td>APP 8.2</td>
<td>128</td>
<td>7.7</td>
<td>33.7</td>
<td>15.3 kW</td>
</tr>
<tr>
<td>APP 10.2</td>
<td>133</td>
<td>8.0</td>
<td>35.1</td>
<td>16.0 kW</td>
</tr>
<tr>
<td>APP 10.2</td>
<td>159</td>
<td>9.6</td>
<td>42.1</td>
<td>19.3 kW</td>
</tr>
</tbody>
</table>

The power requirements can be determined using one of the following guiding equations:

\[
\text{Required power} = \frac{l/min \times \text{bar}}{\text{Calc. factor}} \quad \text{kW} \quad \text{or} \quad \frac{16.7 \times m^3/h \times \text{bar}}{\text{Calc. factor}} \quad \text{kW} \quad \text{or} \quad \frac{0.26 \times \text{gpm} \times \text{psi}}{\text{Calc. factor}} \quad \text{kW}
\]

\[
\begin{align*}
1 \text{ hp} & = 0.75 \text{ kW} \\
1 \text{ kW} & = 1.34 \text{ hp} \\
1 \text{ gpm} & = 3.79 \text{ l/min} \\
1 \text{ l/min} & = 0.26 \text{ gpm} \\
1 \text{ m}^3/\text{h} & = 4.40 \text{ gpm} \\
1 \text{ gpm} & = 0.23 \text{ m}^3/\text{h}
\end{align*}
\]
6. **Inlet pressure**

Water supply to the APP pump is either made from a tank placed above the pump or directly from a feed pump. The pressure at the pump inlet (I) must be in the range: 0.5 - 5 bar (7.3 - 72.5 psi).

7. **Temperature and corrosion**

7.1 **Operation**

Fluid temperature:  
+3°C to +50°C (+37.4°F to 122°F) - dependent on the NaCl concentration

Ambient temperature:  
+3°C to +50°C (+37.4°F to 122°F)

The chart below illustrates the corrosive resistance of different types of stainless steel related to NaCl concentration and temperature. All critical parts of the APP pump are made of SAF 2507. If the APP pump is operated at high salinity, always flush the pump with fresh water at operation stop in order to minimise the risk of crevice corrosion.

7.2 **Storage**

Storage temperature:  
-40°C to +70°C (+37.4°F to 122°F) – provided that the APP pump is drained of fluid and stored “plugged”.

Antifreeze protection is required at temperatures below 2°C. Danfoss recommends using Dowcal N from Dow Chemical Company or Chillsafe mono propylene glycol from Arco Chemical Company.

8. **Noise level**

The chart indicates the noise level in dB(A) measured at a distance of 1 m from the APP pump in a reverberation room.

<table>
<thead>
<tr>
<th>Type</th>
<th>60 bar (580 psi) 1500 rpm</th>
<th>60 bar (580 psi) 1800 rpm</th>
<th>80 bar (2000 psi) 1500 rpm</th>
<th>80 bar (2000 psi) 1800 rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>APP 5.1</td>
<td>74</td>
<td>79</td>
<td>73</td>
<td>78</td>
</tr>
<tr>
<td>APP 6.5</td>
<td>74</td>
<td>79</td>
<td>73</td>
<td>78</td>
</tr>
<tr>
<td>APP 7.2</td>
<td>74</td>
<td>79</td>
<td>73</td>
<td>78</td>
</tr>
<tr>
<td>APP 8.2</td>
<td>74</td>
<td>79</td>
<td>73</td>
<td>78</td>
</tr>
<tr>
<td>APP 10.2</td>
<td>74</td>
<td>79</td>
<td>73</td>
<td>78</td>
</tr>
</tbody>
</table>

Generally, noise will be reduced if speed is reduced and vice versa. Use flexible hoses in order to minimise vibrations and noise.

Since the APP pump is typically mounted on a bell housing or frame, the noise level can only be determined for the complete unit (system).
The noise level is influenced by:

- The speed of the pump; high rpm create more noise than low rpm
- Rigid mounting of the pump generates more noise than flexible mounting
- Pipe mounting direct to the pump increases the noise level compared to a flexible hose

9. Filtration

As water has very low viscosity, the APP pumps have been designed with very narrow clearance in order to control internal leakage rates and improve component performance. Therefore it is important that the inlet water is filtered properly to minimize the wear of the pump.

The main filter must have a filtration efficiency of 99.98% at 10 μm. We recommend that you use precision depth filter cartridges rated 10 μm abs. (β10>5000 (equivalent to a filtration efficiency of 99.98%). Bag filters and string wound filter cartridges typically have only 90% filtration efficiency. This means that for each 100,000 particles reaching the filter, 10,000 particles pass through it compared to only 20 particles in a filter with an efficiency of 99.98%.

For more information on the importance of proper filtration, please consult our publication “Filtration” (code number 521B0861), which also will provide you with an explanation of filtration definitions and a guidance on how to select the right filter.

10. Dimensions

10.1 APP pump

![APP pump dimensions diagram]

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10. Dimensions 10.1 APP pump

<table>
<thead>
<tr>
<th>Description</th>
<th>APP 5.1 and APP 10.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>C Bleeding</td>
<td>M6, Hexagon AF = 5 mm</td>
</tr>
<tr>
<td>D Parallel key, DIN 6885</td>
<td>mm 10 x 8 x 45</td>
</tr>
<tr>
<td></td>
<td>inches 0.39 x 0.31 x 1.77</td>
</tr>
<tr>
<td>I Inlet connection</td>
<td>M42 x 1.5 x 13 mm (0.51 inch) depth</td>
</tr>
<tr>
<td>O Outlet connection</td>
<td>M42 x 1.5 x 13 mm (0.51 inch) depth</td>
</tr>
<tr>
<td>Pump mounting flange</td>
<td>125 A2</td>
</tr>
</tbody>
</table>

10.2 Complete unit

<table>
<thead>
<tr>
<th>Pump</th>
<th>A (mm)</th>
<th>B (mm)</th>
<th>C (mm)</th>
<th>D (mm)</th>
<th>E (mm)</th>
<th>F (mm)</th>
<th>IEC Electric motor</th>
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</thead>
<tbody>
<tr>
<td>APP 5.1</td>
<td>350</td>
<td>437</td>
<td>160</td>
<td>254</td>
<td>210</td>
<td>498</td>
<td>11 kW, HUC2 160 M-4</td>
</tr>
<tr>
<td>APP 6.5</td>
<td>350</td>
<td>437</td>
<td>160</td>
<td>254</td>
<td>254</td>
<td>542</td>
<td>15 kW, HUC2 160 L-4</td>
</tr>
<tr>
<td>APP 7.2</td>
<td>350</td>
<td>473</td>
<td>180</td>
<td>279</td>
<td>241</td>
<td>578</td>
<td>15 kW, HUC2 160 L-4</td>
</tr>
<tr>
<td>APP 8.2</td>
<td>350</td>
<td>473</td>
<td>180</td>
<td>279</td>
<td>279</td>
<td>616</td>
<td>18.5 kW, HUC2 180 M-4</td>
</tr>
<tr>
<td>APP 10.2</td>
<td>350</td>
<td>473</td>
<td>180</td>
<td>279</td>
<td>279</td>
<td>659</td>
<td>22 kW, HUC2 180 L-4</td>
</tr>
<tr>
<td>APP 10.2</td>
<td>400</td>
<td>513</td>
<td>200</td>
<td>318</td>
<td>305</td>
<td>659</td>
<td>30 kW, HUC2 200 L-4</td>
</tr>
</tbody>
</table>

For inlet and outlet connections data, see “Accessories catalogue” (521B0903).
11. Installation

11.1 Mounting
The figure below illustrates how to mount the APP pump and connect it to an electric motor/combustion engine.

A: Flexible coupling
B: Bell housing
C: Motor shaft

If alternative mounting is required, please contact Danfoss Sales Organization for further information.

To ensure easy mounting of the flexible coupling without using tools, the tolerances must be dimensioned accordingly.

Note: Any axial and/or radial loads on the shaft must be avoided

The APP pump should be connected to the rest of the plant with a flexible hoses.

11.2 Open-ended systems with water supply from tank
In order to eliminate the risk of cavitation, a positive inlet pressure should always be maintained by observing the following guidelines:

1. Place the tank (1) above the APP pump inlet (water level in tank should always be above the pump).

2. Place a filter (2) in the water supply line in front of the tank.

3. Dimension the inlet line (3) with minimum pressure drop (large internal diameter, minimum length of pipe, avoid bends and fittings with small internal diameter).

11.3 Open-ended system with direct water supply
In order to eliminate the risk of cavitation, a positive inlet pressure is always to be maintained at min. 0.5 bar (7.3 psi) and max. 5 bar (72.5 psi).

1. Place the filter (1) in the water supply line in front of the APP pump.

2. Place a monitoring pressure switch (2) set at min. 1 bar (14.5 psi) between filter and pump inlet. The monitoring switch must stop the pump at pressures lower than 1 bar (14.5 psi) At speeds above 1500 rpm - use 2 bar (29 psi) as set point.
11.4 RO system with APP pump
1. For easy system bleeding and flushing, apply a bypass non-return valve (1) in parallel with the APP pump.
2. Place an inlet filter (2) in front of the APP pump (3). Please consult section 9, “Filtration” for guidance on how to select the right filter. Thoroughly clean pipes and flush system prior to start-up.
3. Place a monitoring pressure switch (6) set at min. 1 bar between filter and pump inlet. The monitoring switch must stop the pump at pressures lower than 1 bar (14.5 psi). Above 1500 rpm - use 2 bar (29 psi) as set point.
4. Dimension the inlet line to obtain minimum pressure loss (large flow, minimum pipe length, minimum number of bends/connections, and fittings with small pressure losses).
5. In order to eliminate the risk of damage and cavitation, a positive pressure at the inlet (4) is always to be maintained at min. 0.5 bar (7.3 psi) and max. 5 bar (72.5 psi). At speeds above 1500 rpm the pressure at the inlet of the APP pump must be min. 2 bar (29 psi).
6. Use flexible hoses (5) to minimize vibrations and noise.
7. Install a safety valve (7) in order to avoid system damage as the APP pump creates pressure and flow immediately after startup, regardless of any counter-pressure.

12. Service

Provided that the APP pump has been running according to the Danfoss specifications on pre-filtration, pressure, and rotation speed, Danfoss guarantees minimum 8,000 hours operation, however max. 18 months from date of sale.

To prevent a total and disastrous breakdown, Danfoss recommends a pump inspection after max. 8,000 hours – at which any worn parts must be replaced.

Note: It is always recommended to replace pistons and shaft sealing if another service-free period is to be obtained.

If the pistons are not replaced, more frequent inspection is recommended.

The shaft sealing in the APP pump is made of Hastelloy C. At high TDS and high water temperature, the service life of the shaft sealing will be reduced. For these applications it is recommended to replace the shaft sealing after approx. 4,000 hours operation.

12.1 Periodic maintenance
Water acts as lubricant in the APP pump. Thus there is no oil in the pump.

By operation below the curve for SAF 2507 in the figure in section 7.1, no parts are expected to be replaced within the first 8,000 hours of operation.

12.2 Repair
In case of irregular function of the APP pump, please contact the Danfoss RO Solutions Sales Organisation.
Danfoss A/S
High Pressure Pumps
DK-6430 Nordborg
Denmark

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Instruction

APP pump instruction

APP 5.1-10.2
## 1. Identification

![Image of pump identification label]

## 2. System design

The design of the system must ensure that self-emptying of the pump during standstill is avoided.

The inlet pressure of the pump must never exceed the outlet pressure. This may typically occur in boosted or open-ended systems with direct water supply.

In order to avoid this, it is recommended to install a prestressed check valve or a pressure switch in the pump inlet.

The opening pressure of the check valve must be bigger or equal to the inlet pressure.

---

APP pump instruction
APP 5.1-10.2 (180R9072)

Table of Contents

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2. System design
2.1 Open-ended systems with water supply from tank
2.2 Open-ended systems with direct water supply
2.3 Reversible pumps
2.4 General guidelines for calculation of pressure losses
2.5 General comments on
3. Building up the pump unit
3.1 Mounting
3.2 Direction of rotation
3.3 Orientation
3.4 Protection from too high pressures
3.5 Connections
4. Initial start-up
5. Operation
5.1 Temperature
5.2 Pressure
5.3 Dry running
5.4 Disconnection
5.5 Storage
5.5.1 Open-ended systems with water supply from tank
5.5.2 Open-ended systems with direct water supply
6. Service
6.1 Periodic maintenance
6.2 Repair
7. EC Declaration of Conformity
2.1 Open-ended systems with water supply from tank

(The numbers 1-3 refer to the drawing below)

In order to eliminate the risk of cavitation, observe the following guidelines:

1) Place the tank above the pump (water level in the tank should always be above the pump).

2) Place the inlet filter before the tank.

3) Dimension the inlet line to obtain minimum pressure loss (large flow area, minimum pipe length, minimum number of bends/connections, fittings with small pressure losses).

4) If noise has to be considered, the inlet line must be a flexible soft hose.

![Diagram of 2.1 Open-ended systems with water supply from tank]

2.2 Open-ended systems with direct water supply

The pump is supplied with water direct from a booster pump. The water pressure must not exceed 5 bar abs. (72.5 psi).

![Diagram of 2.2 Open-ended systems with direct water supply]

2.3 Reversible pumps

If exposed to high pressure in the outlet while the electric motor is not energized, the pumps will start spinning backwards. This will not harm the pumps as long as the pressure in the inlet does not exceed the max. pressure of 5 bar.

If a non-return valve is mounted in the inlet line, a low-pressure relief valve will also be required.

Alternatively a high-pressure check valve could be mounted in the pump discharge line to prevent the pump from reversing.

The dotted setup ensures that the inlet pressure does not exceed the 5 bar abs., when a non-return valve is mounted in the inlet.

![Diagram of 2.3 Reversible pumps]
2.4 General guidelines for calculation of pressure losses

In order to avoid the risk of cavitation, the inlet pressure at the pump must be min. 0.9 bar (13 psi) abs.

The inlet line connection must be properly tightened, as possible entrance of air will cause cavitation.

The suction conditions can be optimized according to below guidelines.

![Graph of pressure losses in smooth pipes and hoses](image)

![Graph of pressure losses in 90° bends](image)

2.5 General comments on Filtration

A good filtration is vital to ensure a long and trouble free life of the pump.

When selecting a filter or strainer, please note that filter materials should be compatible with water, i.e. should neither corrode nor dissolve. Also be aware of the electrochemical series of the applied materials. Main filter must have a fineness of 10 μm abs. B ≥ 5000. The pressure loss across the filter should be monitored.

Water tank

Must be made of corrosion-proof material such as stainless steel or plastic and must be sealed to prevent entrance of impurities from the environment.

Automatic pressure equalization between tank and surroundings must be ensured.

Inlet from the water supply and inlet to the pump should be placed in opposite ends of the tank to calm and deaerate the water, and to ensure optimum opportunity for particles to settle.
Pump suction line should be placed relatively high above the tank bottom in order to prevent settled particles from being led into the pump.

We recommend a separation ("wall") to separate the inlet from the outlet end of the tank.

**Monitoring**

It is recommended to continuously monitor the following conditions:
- Water level in the tank
- Filter contamination
- Pressure (inlet- and outlet side of the pump)

### 3. Building up the pump unit

#### 3.1 Mounting

(Please see also hints in “Right and Wrong”)

If alternative mounting is desired, please contact the Danfoss Sales Organization.

Choose proper tolerances to ensure an easy mounting of the elastic coupling without use of tools.

Please take care to observe the recommended length tolerances of the chosen coupling, as an axial force on the pump will damage the pump.

A: Elastic coupling  
B: Bell housing  
C: Motor shaft

#### 3.2 Direction of rotation

Is indicated by an arrow on the pump label.

---

The pump can be mounted/orientated in any horizontal direction.

Vertically only with the shaft pointing upwards.
3.4 Protection from too high pressures
The pump should be protected against too high pressure by means of a pressure relief valve or a bypass/unloading valve placed on the pressure side.

The valve should be placed as close to the pump as possible. The opening characteristics of the valve must not result in peak pressures higher than 100 bar (1450 psi).

If noise has to be considered, the inlet line must be a flexible soft hose.

The valve outlet must not be connected directly to the pump suction line. It shall be connected directly to the tank.

3.5 Connections

I: Inlet
O: Outlet
C: Bleeding
D: Parallel key 5 × 5 × 20, DIN 6885

Recommended torque values refer to steel washers containing a rubber sealing element. Victualic® is a registered trademark of Victualic.

<table>
<thead>
<tr>
<th>Thread connections</th>
<th>Victualic connections</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>O</strong></td>
<td><strong>I</strong></td>
</tr>
<tr>
<td>Thread size</td>
<td>M 42 × 1,5 × 13 mm (0.51 inch) depth</td>
</tr>
<tr>
<td>Max tightening torque</td>
<td>25 Nm 18 (LBF-FT)</td>
</tr>
</tbody>
</table>
4. Initial start-up
Before start-up, loosen the top bleeding plug “C”. When water appears from the bleeding plug, retighten the plug. With its inlet line connected to the water supply or the tank, the pump is now started with open outlet port.

At the initial start of the system, the pump should be run without pressure for about 5 minutes, thus removing possible impurities from pipes, hoses, etc. However, the system should be flushed before start-up – without the connected pump.

WARNING
Make sure that the direction of rotation of the electric motor corresponds to the direction of rotation of the pump. Otherwise the pump will be damaged if a check valve is placed between pump and tank.

Note: The pumps are preserved with antifreeze Dowcal N.

5. Operation

5.1 Temperature

<table>
<thead>
<tr>
<th>Fluid temperature:</th>
<th>Min. +3°C to max. +50°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient temperature:</td>
<td>Min. 0°C to max. 50°C</td>
</tr>
</tbody>
</table>

In case of lower operating temperatures, please contact the Danfoss Sales Organization.

5.2 Pressure
The inlet pressure must be min. 0.9 bar (13 psi) and max. 4 bar (58 psi) abs. At lower pressures the pump will cavitate, resulting in damage of the pump.

Max. pressure on the pump’s outlet line should be limited at 80 bar (1160 psi) continuously.

Short-term pressure peaks (e.g. in connection with closing of a valve) of up to 100 bar (1450 psi) are acceptable.

Note: The pump unit should include a pressure gauge on the high pressure side.

5.3 Dry running
When running, the pump must always be connected to the water supply in order to avoid damage if it should run dry.

In systems with water tank it is recommended to build in a level gauge in the tank to avoid the risk of running dry.

5.4 Disconnection
If the inlet line is disconnected from the water supply, the pump will be emptied of water through the disconnected inlet line.

5.5 Storage

| Storage temperature: | Min. -40°C to max. +70°C |

When preparing the pump for long-term storage or for temperatures below the freezing point, flush the pump with an anti-freeze medium type monopropylene glycol to prevent internal corrosion or frost in the pump.

For further information on anti-freeze media, please contact the Danfoss Sales Organization.

Recommended procedure:

5.5.1 Open-ended systems with water supply from tank
1. Empty the tank of water and empty the pump housing through the lower bleeding plug. When the pump is empty, retighten the plug.
2. Through the upper bleeding plug, fill the pump housing with anti-freeze medium. Pour anti-freeze medium into the tank. Connect a hose to the outlet of the pump and lead the other end of the hose back to tank.
3. Quickly start and stop the pump. Make sure that the pump does not run dry. The pump is now protected against internal corrosion and frost.
### 5.5.2 Open-ended systems with direct water supply

1. Disconnect the water supply to the pump.
2. Through the lower bleeding plug, empty the pump housing of water and close it again.
3. Connect the pump to a tank of e.g. 25 litre/6 gal. of anti-freeze additive. Connect a hose to the inlet port of the pump and via another hose return the flow from the outlet port to the tank with anti-freeze additives.
4. Quickly start and stop the pump. **Make sure that the pump does not run dry.** The pump is now protected against internal corrosion and frost.

### 6. Service

#### 6.1 Periodic maintenance
The APP pump is designed so that lubrication follows from the water itself and there is thus no oil in the pump.

The pump requires no periodic replacements of seals and valve parts.

#### 6.2 Repair
In case of irregular function in the pump, please contact the Danfoss Sales Organisation.

---

Danfoss A/S  
High Pressure Pumps  
DK-6430 Nordborg  
Denmark

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5.5.2 Open-ended systems with direct water supply

1. Disconnect the water supply to the pump.
2. Through the lower bleeding plug, empty the pump housing of water and close it again.
3. Connect the pump to a tank of e.g. 25 litre/6 gal. of anti-freeze additive. Connect a hose to the inlet port of the pump and via another hose return the flow from the outlet port to the tank with anti-freeze additives.
4. Quickly start and stop the pump. Make sure that the pump does not run dry.

The pump is now protected against internal corrosion and frost.

6.1 Periodic maintenance

The APP pump is designed so that lubrication follows from the water itself and there is thus no oil in the pump. The pump requires no periodic replacements of seals and valve parts.

6.2 Repair

In case of irregular function in the pump, please contact the Danfoss Sales Organisation.

6. Service

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1. General
This manual concerns the following types of standard induction motors from Hoyer:
HMA2, HMC2, HMD, HMT, MS, Y2E1, Y2E2, YDT
These motors are manufactured in accordance with IEC/EN 60034-4 and IEC/EN 60072.
Motors are rated for the ambient temperature range -20°C to +40°C and site altitudes ≤1000 m above sea level.
Low-voltage motors are components for installation in machinery. They are CE marked according to the Low Voltage Directive 2006/95/EC

2. Transport and storage
Check the motor for external damage immediately upon receipt and, if found, inform the forwarding agent right away. Check all rating plate data, and compare it with the requirement of the motor.
Turn the shaft by hand to check free rotation, remove transport locking if used.
Transport locking must be used again for internal transport also. It is also important that transport locking is used when motors are transported mounted on equipment.
All motors should be stored indoors, in dry, vibration- and dust-free conditions.
Lifting eyebolts must be tightened before use. Damaged eyebolts must not be used, check before use. Lifting eyes at motor must not be used to lift the motor when it is attached to other equipment.
Before commissioning, measure the insulation impedance. If values are ≤ 10MΩ at 25°C, the winding must be oven dried.

3. Installation
The motor must be fixed on a stable, clear and flat foundation. It must be sufficiently rigid to withstand possible short circuit forces.
It is important to ensure that the mounting conditions do not cause resonance with the rotational frequency and the doubled supply frequency.
Only mount or remove drive components (pulley, coupling, etc.) using suitable tools, never hit the drive components with a hammer as this will cause damage to the bearing.
The motor are balancing with half key, ensure that the drive components are also the same.
Correct alignment is essential to avoid bearing, vibration and shaft failure.
Use appropriate methods for alignment.
Re-check the alignment after the final tightening of the bolts or studs.
Check that drain holes and plugs face downwards. We recommend opening the drain hole for motors placed outdoors and not running 24 hours / day, so that the motor can breathe, thus ensuring a dry motor.

4. Electrical connection
Work is only permitted to be carried out by qualified specialists and must to be carried out in accordance with local regulations.
Before work commences, ensure that all power is switched off and cannot be switched on again. This also applies to the auxiliary power circuits, e.g. anti-condense heaters.
Check that supply voltage and frequency are the same as rated data.
Motors can be used with a supply deviation of ± 5% voltage and ± 2% frequency, according to IEC60034-1
Connection diagrams for main supply and accessory as PTC or heater are located inside the terminal box.
Connections must be made in such a way as to ensure that a permanently safe electrical connection is maintained, both for the main supply and the earth connection.
We recommend that crimped connections are made in accordance with IEC 60352-2.
Tightening torques for terminal board screws:

<table>
<thead>
<tr>
<th>Thread</th>
<th>M5</th>
<th>M6</th>
<th>M8</th>
<th>M10</th>
<th>M12</th>
<th>M16</th>
<th>M20</th>
</tr>
</thead>
<tbody>
<tr>
<td>T.(Nm)</td>
<td>2.5</td>
<td>3.5</td>
<td>7</td>
<td>12</td>
<td>18</td>
<td>35</td>
<td>55</td>
</tr>
</tbody>
</table>
Ensure that the terminal box is clean and dry. Unused glands must be closed.
Check the terminal box gasket before it is remounted.

5. Maintenance
Inspect the motor at regular intervals, keep it clean and ensure free ventilation air flow, check the condition of shaft seals and replace if necessary. Both electrical and mechanical connections must be checked and tightened if necessary.
Bearing size and type are specified on the rating plate.
Motor types HMA2 and HMC2 is as standard with lifetime greased bearing with motor size ≤225.
Motor types MS and Y2E is as standard with lifetime greased bearing with motor size ≤160.

Typical duty hours for lifetime lubricated bearings.

<table>
<thead>
<tr>
<th>Frame size</th>
<th>Poles</th>
<th>Typical lifetime</th>
</tr>
</thead>
<tbody>
<tr>
<td>56 – 160</td>
<td>2 – 8</td>
<td>40.000h</td>
</tr>
<tr>
<td>180</td>
<td>2</td>
<td>35.000h</td>
</tr>
<tr>
<td>200</td>
<td>2</td>
<td>27.000h</td>
</tr>
<tr>
<td>225</td>
<td>2</td>
<td>23.000h</td>
</tr>
<tr>
<td>180 – 225</td>
<td>4 – 8</td>
<td>40.000h</td>
</tr>
</tbody>
</table>

Motors with a re-greasing system must be lubricated with high quality lithium complex grease, NLGI grade 2 or 3, with a temperature range of between -40°C to +150°C.

Motors are normal fitted with a data plate with greasing information; if it is missing use the following re-greasing intervals.

<table>
<thead>
<tr>
<th>Frame size</th>
<th>Grease (g)</th>
<th>2 pole (h)</th>
<th>4 pole (h)</th>
<th>6 pole (h)</th>
<th>8 pole (h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>160</td>
<td>20</td>
<td>4200</td>
<td>7000</td>
<td>8500</td>
<td>8500</td>
</tr>
<tr>
<td>180</td>
<td>20</td>
<td>4200</td>
<td>7000</td>
<td>8500</td>
<td>8500</td>
</tr>
<tr>
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<td>6500</td>
<td>8500</td>
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</tr>
<tr>
<td>225</td>
<td>25</td>
<td>3100</td>
<td>6500</td>
<td>8500</td>
<td>8500</td>
</tr>
<tr>
<td>250</td>
<td>35</td>
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<td>6000</td>
<td>7000</td>
<td>7000</td>
</tr>
<tr>
<td>280</td>
<td>35</td>
<td>2000</td>
<td>6000</td>
<td>7000</td>
<td>7000</td>
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<td>315</td>
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<td>400</td>
<td>80</td>
<td>800</td>
<td>3000</td>
<td>4000</td>
<td>6000</td>
</tr>
</tbody>
</table>

Grease the motor while running, open the grease outlet plug and let the motor run 1-2 hours before the outlet grease plug is closed again.

Grease the motor for the first time during commissioning.

The following applies in general for both lifetime lubricated and re-lubricated bearings:
At 60Hz the time will be reduced by app. 20%.
Data for vertically mounted motors are half of the above values.

The table values are based on an ambient temperature of 25°C. The values must be halved for every 15K increase in bearing temperature.
Higher speed operations, e.g. frequency converter drive will require shorter greasing intervals. Typically, doubling the speed will reduce the values by 50%.

6. Special note for Atex Zone 22 motors.

Notice for the use of electrical equipment in areas with combustible dust.
Designation of motor according to EC directive: Ex II 3D T125°C, IP55.

The dust hazardous 3-phase asynchronous motors are in accordance with European standard EN 50281-1-1. Combustible dust areas will be found in agricultural areas and in industrial environments.
Only one electrical installation may be installed in one specified area (zone).

Only certificated cable glands for category 2D may be used. Unused glands must be closed. Connections must be made in such a way as to ensure that a permanently safe electrical connection is maintained, both for the main supply and earth connection. Installations must be in accordance with actual standards for installation in the Zone 22 area.

It is recommended that EN 50281-2 is followed according temperature and dust on the motor surface. The use of motors with so much surface dust that the motor temperature increases is not permitted. Regularly cleaning is recommended. The radial shaft sealing ring is part of the ATEX certification. It is important that the ring is always intact. The shaft sealing must be regularly checked, and if dry it must be lubricated. It is recommended that the seal is re-lubricated regularly. Always use the original seal ring when replaced. Replacing bearings also means replacing the seals.

All machines must be inspected regularly for mechanical damage. The user is responsible for changing parts in accordance with the lifetime of parts, in particular: bearings, grease and lubrication of shaft sealing.

Maintenance, repairs and replacement on zone 22 motors must only be carried out by qualified specialists.
1. General

This manual concerns the following types of standard induction motors from Hoyer:

HMA2, HMC2, HMD, HMT, MS, Y2E1, Y2E2, YDT

These motors are manufactured in accordance with IEC/EN 60034-4 and IEC/EN 60072.

Motors are rated for the ambient temperature range -20°C to +40°C and site altitudes ≤ 1000 m above sea level.

Low-voltage motors are components for installation in machinery. They are CE marked according to the Low Voltage Directive 2006/95/EC.

2. Transport and storage

Check the motor for external damage immediately upon receipt and, if found, inform the forwarding agent right away. Check all rating plate data, and compare it with the requirement of the motor.

Turn the shaft by hand to check free rotation, remove transport locking if used.

Transport locking must be used again for internal transport also. It is also important that transport locking is used when motors are transported mounted on equipment.

All motors should be stored indoors, in dry, vibration- and dust-free conditions.

Lifting eyebolts must be tightened before use. Damaged eyebolts must not be used, check before use. Lifting eyes at motor must not be used to lift the motor when it is attached to other equipment.

Before commissioning, measure the insulation impedance. If values are ≤ 10MΩ at 25°C, the winding must be oven dried.

The insulation resistance reference is halved for each 20°C rise in motor temperature.

It is recommended that shafts are rotated periodically by hand to prevent grease migration.

3. Installation

The motor must be fixed on a stable, clear and flat foundation. It must be sufficiently rigid to withstand possible short circuit forces.

It is important to ensure that the mounting conditions do not cause resonance with the rotational frequency and the doubled supply frequency.

Only mount or remove drive components (pulley, coupling, etc.) using suitable tools, never hit the drive components with a hammer as this will cause damage to the bearing.

The motor are balancing with half key, ensure that the drive components are also the same.

Correct alignment is essential to avoid bearing, vibration and shaft failure.

Use appropriate methods for alignment. Re-check the alignment after the final tightening of the bolts or studs.

Check that drain holes and plugs face downwards. We recommend opening the drain hole for motors placed outdoors and not running 24 hours / day, so that the motor can breathe, thus ensuring a dry motor.

4. Electrical connection

Work is only permitted to be carried out by qualified specialists and must to be carried out in accordance with local regulations.

Before work commences, ensure that all power is switched off and cannot be switched on again. This also applies to the auxiliary power circuits, e.g. anti-condense heaters.

Check that supply voltage and frequency are the same as rated data.

Motors can be used with a supply deviation of ± 5% voltage and ± 2% frequency, according to IEC60034-1.

Connection diagrams for main supply and accessory as PTC or heater are located inside the terminal box.

Connections must be made in such a way as to ensure that a permanently safe electrical connection is maintained, both for the main supply and the earth connection.

We recommend that crimped connections are made in accordance with IEC 60352-2.

Tightening torques for terminal board screws:

Ensure that the terminal box is clean and dry.

Unused glands must be closed.

Check the terminal box gasket before it is remounted.

5. Maintenance

Inspect the motor at regular intervals, keep it clean and ensure free ventilation air flow, check the condition of shaft seals and replace if necessary. Both electrical and mechanical connections must be checked and tightened if necessary.

Motor Manual

Connection diagram
Anschlußdiagram
Anslutningdiagram
Forbindelsesdiagram
Aansluitdiagram
Connection
Conexión
Collegamento
Схема соединений
Schemat polaczeń
Recommended service intervals for APP pumps
Table of Contents

1. General information

This guideline provides information on the recommended service intervals. The recommendation is based upon good engineering practice and on experience gained from operation even under extreme conditions.

The recommendation is for guidance only.

2. Design/features

Danfoss APP pumps are designed for long operation and low maintenance and life cycle costs.

Danfoss guarantees 8,000 hours service free operation, however max. 18 months from date of production. After 8,000 operation hours it is recommended to inspect the pump and replace worn parts, if any.

If the Danfoss recommendations concerning system-design (see our data sheet) are not followed, the service life of the APP pumps might be affected.

The recommended service intervals on the different parts in the APP pumps appear from the table below:

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Qty.</th>
<th>Description</th>
<th>Material</th>
<th>Service interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Housing, main bearing</td>
<td>Duplex, PEEK</td>
<td>No need for service</td>
</tr>
<tr>
<td>11, 125, 211*</td>
<td>1</td>
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<td>Wetted part: Duplex Dry part: AISI 316L</td>
<td>No wear part</td>
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<td>No wear part</td>
</tr>
<tr>
<td>31</td>
<td>1</td>
<td>Swash plate</td>
<td>Super Duplex</td>
<td>40,000 hours</td>
</tr>
<tr>
<td>66</td>
<td>5/7/9</td>
<td>Piston</td>
<td>Super Duplex and PEEK</td>
<td>Recommended inspection on a yearly basis and evaluated acc. to app. 1</td>
</tr>
<tr>
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<td>1</td>
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<td>Super Duplex</td>
<td>24,000 hours</td>
</tr>
<tr>
<td>91</td>
<td>1</td>
<td>Port plate</td>
<td>Super Duplex, PEEK</td>
<td>24,000 hours</td>
</tr>
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<td>61</td>
<td>1</td>
<td>Cylinder barrel</td>
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<td>40,000 hours</td>
</tr>
<tr>
<td>65</td>
<td>1</td>
<td>Retaining plate</td>
<td>Super Duplex</td>
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</tr>
<tr>
<td>64</td>
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<td>40,000 hours</td>
</tr>
<tr>
<td>71</td>
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<td>40,000 hours</td>
</tr>
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<tr>
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<td></td>
<td>O-ring (overall)</td>
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<td></td>
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* depends on pump size
### 3. Appendix 1

**Recommended service intervals for APP pumps**

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<th>Nr.</th>
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<th>Service interval</th>
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<tr>
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<td>Super Duplex and PEEK</td>
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<tr>
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<td>1</td>
<td>Port plate</td>
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<td>40,000 hours</td>
</tr>
<tr>
<td>65</td>
<td>1</td>
<td>Retaining plate</td>
<td>Super Duplex</td>
<td>24,000 hours</td>
</tr>
<tr>
<td>64</td>
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<td>Retaining ball</td>
<td>Super Duplex</td>
<td>40,000 hours</td>
</tr>
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<tr>
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<td>40,000 hours</td>
</tr>
<tr>
<td>63</td>
<td>1</td>
<td>Spring guide</td>
<td>Duplex or PP</td>
<td>40,000 hours</td>
</tr>
<tr>
<td>142</td>
<td>1</td>
<td>Stop for shaft seal</td>
<td>PP</td>
<td>No wear part</td>
</tr>
<tr>
<td>124,</td>
<td>215*</td>
<td>Shaft seal</td>
<td>Hasteloy and NBR</td>
<td>It is good practice to change the seal after each disassembly of the pump</td>
</tr>
<tr>
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<td>93</td>
<td>5/7/9</td>
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<td>24,000 hours</td>
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<tr>
<td>*</td>
<td></td>
<td>O-ring (overall)</td>
<td>NBR</td>
<td>24,000 hours</td>
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<tr>
<td>*</td>
<td></td>
<td>Screw (overall)</td>
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<td>No wear part</td>
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<td>Pin (overall)</td>
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<tr>
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<td>1</td>
<td>Parallel key</td>
<td>AISI 302</td>
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</tr>
</tbody>
</table>

**Instruction**

Pistons:
The pistons are the heart of the pump regarding service.

If the pistons break down, the pump will suffer a breakdown.

In case of doubt - the pistons must be replaced.

The pictures below is ment as a guideline for evaluating the wear of the sliding surface.

- Cavitation of the piston shoes.
  New inspection is required in 3,000-4,000 hours.

- Cavitation of the piston shoes.
  All pistons must be replaced within the next 500-1,000 hours.

- Cavitation of the piston shoes.
  All pistons must be replaced within the next 100-200 hours.

- Cavitation of the piston shoes.
  All pistons must be replaced immediately.

- Abrasive wear of the piston shoes.
  All pistons must be replaced immediately.
<table>
<thead>
<tr>
<th>Instruction</th>
<th>Recommended service intervals for APP pumps</th>
</tr>
</thead>
</table>

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Parts list

APP Pumps

APP 5.1-10.2
APPW 5.1-10.2
## APP 5.1 - 10.2

**Note:**
The parts listed are not sold separately, only in various kits.

Exploded view, see next page.

### Parts list

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<th>Qnt.</th>
<th>Designation</th>
<th>Material</th>
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<td>Housing</td>
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</tr>
<tr>
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<td>1</td>
<td>Pin (Ø6x10)</td>
<td>AISI 316</td>
</tr>
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<td>2</td>
<td>Bleeding plug</td>
<td>Duplex</td>
</tr>
<tr>
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<td>NBR</td>
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<tr>
<td>31</td>
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<td>Super Duplex</td>
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<td>1</td>
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<td>Super Duplex / PEEK</td>
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<tr>
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<td>1</td>
<td>Valve plate</td>
<td>Super Duplex</td>
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<td>9</td>
<td>Back-up ring</td>
<td>PTFE</td>
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<td>9</td>
<td>O-ring (Ø18.3x2.4)</td>
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<tr>
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### Instruction

x x x x x x x x x
Exploded view
APP 5.1 - 10.2
APPW 5.1 - 10.2
APPW 5.1 - 10.2

Note: The parts listed are not sold separately, only in various kits.

Exploded view, see next page.

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<th>Pos.</th>
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<th>Designation</th>
<th>Material</th>
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Instruction x x x x x x x x x x x
### Exploded View

#### APP 5.1 - 10.2

APPW 5.1 - 10.2

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### Parts List

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<tr>
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<td>Retainer plate</td>
<td>Super Duplex / DLC</td>
</tr>
<tr>
<td>66</td>
<td>Piston</td>
<td>Super Duplex / PEEK</td>
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<tr>
<td>67</td>
<td>Key</td>
<td>10x8x45 AISI 316</td>
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<td>91</td>
<td>Port plate</td>
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<td>Valve plate</td>
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<tr>
<td>93</td>
<td>Back-up ring</td>
<td>PTFE</td>
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<tr>
<td>94</td>
<td>O-ring (Ø18.3x2.4)</td>
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<td>Port flange</td>
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<td>182</td>
<td>O-ring (Ø135x3)</td>
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<tr>
<td>183</td>
<td>Guide pin</td>
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<tr>
<td>184</td>
<td>Pin (Ø6x10)</td>
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</tr>
<tr>
<td>185</td>
<td>Pin (Ø6x10)</td>
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<tr>
<td>186</td>
<td>Screw M8x20</td>
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<td>211</td>
<td>Mounting flange</td>
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<td>212</td>
<td>O-ring (Ø135x3)</td>
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<tr>
<td>213</td>
<td>Sealing ring</td>
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<td>214</td>
<td>O-ring (Ø58x2)</td>
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<td>215</td>
<td>Shaft seal</td>
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<tr>
<td>216</td>
<td>Stop bush</td>
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</tr>
<tr>
<td>217</td>
<td>Bush</td>
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<td>218</td>
<td>Screw M8x20</td>
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<tr>
<td>219</td>
<td>Screw</td>
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</tbody>
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Note:
The parts listed are not sold separately, only in various kits.

Exploded view, see next page.
### Tool sets

Note: The parts listed are not sold separately, only in various kits.

<table>
<thead>
<tr>
<th>Designation</th>
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<th>APP 0.6-1.0</th>
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<td>Press bush Ø35</td>
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<td>Adjustable pin wrench</td>
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<td>Press bush for valve plate</td>
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Danfoss A/S
High Pressure Pumps
DK-6430 Nordborg
Denmark
Guideline

Trouble shooting guide for APP pumps
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<td></td>
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<td>6.1 Valve plate</td>
<td></td>
</tr>
<tr>
<td>6.2 Port plate</td>
<td></td>
</tr>
<tr>
<td>6.3 Swash plate</td>
<td></td>
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</table>
Trouble shooting fish bone chart

1. No flow/pressure
   - 1.1 Dry running
   - 1.2 Pump reversing
   - 1.3 No rotation of electric motor
   - 1.4 No rotation of pump
   - 1.5 Axial force on pump shaft
   - 1.6 Pump damage

2. Reduced flow/pressure
   - 2.1 Low inlet pressure
   - 2.2 Low fluid pressure
   - 2.3 RPM
   - 2.4 Low fluid temperature
   - 2.5 Inlet/outlet connections
   - 2.6 Main filtration
   - 2.7 Wear in pump (internal leakage)
   - 2.8 Type of fluid
   - 2.9 High fluid temperature

3. High torque on electric motor
   - 3.1 Too high inlet pressure from pump
   - 3.2 Pump starts against pressure
   - 3.3 Pump starts against pressure
   - 3.4 Water pump damage
   - 3.5 Constant torque
   - 3.6 Water pump damage

4. Noise from pump
   - 4.1 Air in fluid
   - 4.2 Bleeding conditions of pump
   - 4.3 Min/max nominal inlet pressure
   - 4.4 Pump reversing
   - 4.5 High rotation speed (RPM)

5. Noise from installation
   - 5.1 Inlet/outlet connections
   - 5.2 Main filtration
   - 5.3 Wear in pump (internal leakage)
   - 5.4 Type of fluid
   - 5.5 Vibration damper under the electric motor

PUMP FAILED

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- Trouble shooting fish bone chart
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  - 1.1 Dry running
  - 1.2 Pump reversing
  - 1.3 No rotation of electric motor
  - 1.4 No rotation of pump
  - 1.5 Axial force on pump shaft
  - 1.6 Pump damage
- 2. Reduced flow/pressure
  - 2.1 Low inlet pressure
  - 2.2 Low fluid pressure
  - 2.3 RPM
  - 2.4 Low fluid temperature
  - 2.5 Inlet/outlet connections
  - 2.6 Main filtration
  - 2.7 Wear in pump (internal leakage)
  - 2.8 Type of fluid
  - 2.9 High fluid temperature
- 3. High torque on electric motor
  - 3.1 Too high inlet pressure from pump
  - 3.2 Pump starts against pressure
  - 3.3 Pump starts against pressure
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  - 3.6 Water pump damage
- 4. Noise from pump
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  - 4.3 Min/max nominal inlet pressure
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  - 4.5 High rotation speed (RPM)
- 5. Noise from installation
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  - 5.2 Main filtration
  - 5.3 Wear in pump (internal leakage)
  - 5.4 Type of fluid
  - 5.5 Vibration damper under the electric motor
## 1. No flow/no pressure

<table>
<thead>
<tr>
<th>Cause</th>
<th>Remedy</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.1 Dry running</strong> (no water supply to the pump)</td>
<td></td>
<td>Mount a low pressure switch in front of the pump and check its set point/function. The low pressure switch ensures that the pump does not start until the inlet pressure has reached minimum inlet pressure (see Data sheet).</td>
</tr>
<tr>
<td>If no water comes out of the pump:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1.1 Check that inlet valve is open.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1.2 Check that booster pump is running.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1.2 Pump reversing</strong> (electric motor is running the wrong direction, i.e. counter-clockwise)</td>
<td></td>
<td>Rotation direction for the APP pump is shown by an arrow on the sticker on the side of the pump.</td>
</tr>
<tr>
<td>1.2.1 Change the phase on the electric motor to make it run clockwise.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>WARNING:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- The pump must not run without water formore than a few seconds.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- If the pump takes in water from the high-pressure outlet line, it builds up pressure in pump housing and will eventually break down.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1.3 No rotation of electric motor</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3.1 Check that main switch is switched on.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3.2 Check the electricity at the facility.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3.3 Ensure that motor relay is switched on.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3.4 Ensure that fuse is not blown.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3.5 Ensure that booster pump is started.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3.6 Check that the monitor switches are working correctly.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3.7 Disconnect pump from electric motor and check that the motor is capable of running with no load.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1.4 No rotation of pump</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4.1 Ensure that coupling between electric motor and pump is connected.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4.2 Check if coupling is damaged.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4.3 Check that electric motor is sized correctly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4.4 Check that the electrical installation is correctly sized.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4.5 Contact Danfoss Sales office for guidelines in how to troubleshoot internal pump parts.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1.5 Axial load on pump shaft</strong> (may cause high internal leakage) Only applying to APP 0.6 to APP 3.5 and APP 21 to APP 26 only</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5.1 Ensure that the air gap between the two coupling parts is min 5 mm. It should always be possible to move the plastic part on the coupling at least 3 mm.</td>
<td></td>
<td>To ensure easymounting of the flexible coupling without using tools, the tolerances must be dimensioned accordingly.</td>
</tr>
<tr>
<td><strong>WARNING:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any axial and/or radial loads on the shaft must be avoided. Any axial or radial load will cause breakdown.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1.6 Pump damage</strong> (the internal parts may be damaged)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.6.1 Contact Danfoss sales office for guidelines in how to troubleshoot internal pump parts.</td>
<td></td>
<td>Instructions on internal elements are available on <a href="http://www.ro-solutions.com">www.ro-solutions.com</a>.</td>
</tr>
</tbody>
</table>

![Diagram](A B C)
2. Reduced flow/reduced pressure

<table>
<thead>
<tr>
<th>Cause</th>
<th>Remedy</th>
<th>Comments</th>
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<tbody>
<tr>
<td>2.1 Wear on pump</td>
<td>2.1.1 Dismantle the pump.</td>
<td>See instruction on replacement criteria (52180925). Typical signs of wear: polished surface all over the swash plate. Normally, only half of the swash plate = the pressure side is polished. See index 6.3.</td>
</tr>
<tr>
<td></td>
<td>2.1.2 Check valve plate.</td>
<td>If the ring is missing, the piston is very worn.</td>
</tr>
<tr>
<td></td>
<td>Valves plate has marks/scratches on the surface facing the port plate.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Minor wear on valve plate can cause large internal leakage. See Index 6.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.1.3 Check port plate.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Port plate has marks/scratches on the surface facing the valve plate.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Minor wear on port plate can cause large internal leakage. See Index 6.2</td>
<td></td>
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<tr>
<td></td>
<td>2.1.4 Check cylinder barrel.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Liners in cylinder barrel may be scratched or worn. Insert a piston in</td>
<td></td>
</tr>
<tr>
<td></td>
<td>the liner and check the fit.</td>
<td></td>
</tr>
<tr>
<td>- Pre-treatment</td>
<td>2.1.5 Analyse fluid for content of particles.</td>
<td>The filters can be bypassed, even if they are not correctly mounted. Some filters can create channelling where particles can pass through the filter in tunnels. String wound filters are typically channelling filters. A string wound filter may have a filtration efficiency of only 50%, which will cause internal wear and must always be followed by a main filter.</td>
</tr>
<tr>
<td>- Main filtration</td>
<td>2.1.6 Check that filters are OK and working correctly.</td>
<td></td>
</tr>
<tr>
<td>- Fluid type</td>
<td>2.1.7 Install correct pre-filter (1 μm nom. string-wound filter).</td>
<td></td>
</tr>
<tr>
<td>- High fluid temperature</td>
<td>2.1.8 Check that the correct filter type is used (particles in fluid must not exceed 10 μm). Danfoss RO Solutions supply filters. Please contact Danfoss sales office.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.1.9 The APP pump is designed for seawater operation; for any other</td>
<td>Insufficient filtration means that too many or too large hard particles can pass the main filter because it is damaged, bypassed or simply too poor. Filtration efficiency must be 99.98% (Beta = 5000) at 10 μm to prevent abnormal wear of the pump.</td>
</tr>
<tr>
<td></td>
<td>fluid, please contact Danfoss sales office for further help.</td>
<td></td>
</tr>
<tr>
<td>2.2 Low inlet pressure</td>
<td>2.2.1 Check that booster pump supplies the right pressure/flow.</td>
<td>Temperature &gt; 50°C will cause wear on internal pump parts. Mount a temperature switch and check its set point / function. The temperature switch will ensure that the pump stops at fluid temperatures &gt; 50°C.</td>
</tr>
<tr>
<td></td>
<td>2.2.2 Check if filters require replacement.</td>
<td></td>
</tr>
<tr>
<td>2.3 Rotation speed (RPM)</td>
<td>2.3.1 If VFD-operated, check frequency.</td>
<td>If the pressure drop across the filters is too high, the booster pump does not deliver sufficient flow/pressure. No pressure or low pressure results in cavitation and insufficient internal lubrication causing wear on internal pump parts. Mount a low-pressure switch before the pump and check its set point / function. The low-pressure switch ensures that the pump does not start until the inlet pressure has reached 1 bar.</td>
</tr>
<tr>
<td></td>
<td>2.3.2 Check that rotation speed of the electric motor is as stated on</td>
<td></td>
</tr>
<tr>
<td></td>
<td>the name plate on electric motor. Check that the motor rotor winding</td>
<td></td>
</tr>
<tr>
<td></td>
<td>is not damaged.</td>
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</table>

*Note: Not all parts are always possible to move the plastic parts.*
### High torque on electric motor

<table>
<thead>
<tr>
<th>Cause</th>
<th>Remedy</th>
<th>Comments</th>
</tr>
</thead>
</table>
| **3.1 Too high outlet pressure from pump** | 3.1.1 Check fluid salinity.  
3.1.2 Check temperature.  
3.1.3 Check pressure drop across RO membrane. | Pump conditions may change (more salt, lower water temperature or scaling of RO membrane) causing higher pressure, resulting in higher motor torque. |
| **3.2 Pump starts against pressure** | 3.2.1 Check that electric motor is correctly sized.  
3.2.2 Check internal parts (see item 2.1).  
3.2.3 Systems with more than one electric motor installed: Start motors simultaneously. | Pumps run in parallel with cascade start, may switch off the motor relay due to too high torque caused by high outlet pressure. |
| **3.3 Constant torque**         | 3.3.1 Please contact Danfoss sales office.                             | If the electric motor is too small for the APP pump it cannot provide sufficient torque.   |
| **3.4 Water pump damage**       | 3.4.1 Dismantle pump and check for wear.                               | Too heavy damage in the pump will increase friction causing a high torque (see item 6, Typical signs of wear). |
### 4. Noise from pump

<table>
<thead>
<tr>
<th>Cause</th>
<th>Remedy</th>
<th>Comments</th>
</tr>
</thead>
</table>
| 4.1 Air in fluid             | 4.1.1 Ensure that the entire inlet line is bled before starting up the system.  
4.1.2 Ensure that air cannot enter into the inlet line. | Small air bubbles will accumulate and create large bubbles causing internal cavitation and thus making the pump very noisy.  
**WARNING:** The pump can only run few minutes with air in the fluid without being damaged. |
| 4.2 Bleeding conditions of pump | 4.2.1 Follow the instructions “Initial start-up” supplied with the new pump.  
4.2.2 Ensure that the pump is completely bled before start-up. | The pump and the inlet line must be completely bled before start-up, otherwise the pump will cavitate and make high noise.  
**WARNING:** The pump can only run few minutes with air in the fluid without being damaged. |
| 4.3 Min/max nominal inlet pressure | 4.3.1 Ensure that inlet pressure is between 1 and 5 bar.  
4.3.2 Check the pump for internal damage. | Too high inlet pressure causes too high pressure inside the pump damaging the pistons and eventually the pump.  
Inlet pressure below 1 bar causes cavitation and insufficient internal lubrication resulting in wear on internal pump parts.  
Mount a low-pressure switch before the pump and check its set point/function. The low-pressure switch will ensure that the pump does not start until the inlet pressure has reached 1 bar. |
| 4.4 Pump reversing            | 4.4.1 Dismantle pump and check if anything is broken or worn (See “1. No flow”, item 1.2 Pump reversing”).  
**WARNING:** The pump must not run without water for more than a few seconds. If the pump takes in water from the high-pressure outlet line, it builds up pressure and will eventually be damaged. | If pump rotates in wrong direction, it will take in water from the high-pressure outlet line. Pressure will be built up inside the pump and it will eventually be damaged. |
| 4.5 High rotation speed (RPM) | 4.5.1 If electric motor RPM is too high, dismantle pump and check for damage.  
4.5.2 If the RPM is within the specified range of the pump data sheet and abnormal noise remains, dismantle pump and check for damage. | Higher RPM than specified in the pump data sheet results in wear of the pistons, i.e. pistons may be damaged.  
High RPM will also increase pressure pulsations from the pump, and the noise level will increase.  
If RPM is changed, noise frequency will also change. |
| 4.6 Outlet pressure           | 4.6.1 If outlet pressure is too low, check set point of outlet pressure valve.  
4.6.2 If outlet pressure is lower than mentioned in the pump data sheet, please contact Danfoss A/S RO Solutions Technical Support.  
4.6.3 If outlet pressure has exceeded its maximum, check set point of outlet pressure valve.  
4.6.4 Check internal parts for wear/damage. | At too low outlet pressure, the pump will create higher pressure pulsations and thus make noise. Too low pressure also causes insufficient internal lubrication and wear on internal parts. Pump may eventually be damaged.  
Too high outlet pressure may damage the pump. |
| 4.7 Soft start/stop           | 4.7.1 Check if noise is normal when the pump is running at operation speed.  
4.7.2 If noise is abnormal at operation speed, check internal parts (see above). | Noise frequency changes during soft start-up/stop. |
### 5. Noise from installation

<table>
<thead>
<tr>
<th>Cause</th>
<th>Remedy</th>
<th>Comments</th>
</tr>
</thead>
</table>
| **5.1 Inlet/outlet connections (hoses/pipes)** | **5.1.1** Use flexible hoses at inlet/outlet connections. Danfoss A/S can provide flexible hoses. Please contact Danfoss sales office for further information.  
**5.1.2** Mount the connections to the frame by a vibration damper mounting plate. | Non-flexible connections mounted directly on the frame will cause even small pressure pulsations from pump and create vibrations in the system/plant. |
| **5.2 Length/dimension of inlet/outlet line** | **5.2.1** Increase pipe diameter and/or reduce the number of bends. | Too small pipes or too many bends may create too fast flow/turbulence through the pipes and thus increase the noise level. |
| **5.3 Hose stiffness**                     | **5.3.1** Use a more flexible hose. Danfoss A/S can provide flexible hoses. Please contact Danfoss sales office for further information. | Too stiff hoses cannot damp the small pressure pulsations from the pump, and subsequently vibrations occur in the system/plant. |
| **5.4 Hoses/pipes mounted directly on frame** | **5.4.1** Mount the connections to the frame by a vibration damper mounting plate. | If the hoses are mounted directly on the frame, the small pressure pulsations from the pump can be transferred to the frame and the rest of the system/plant. |
| **5.5 Vibration damper under the electric motor** | **5.5.1** Mount a vibration damper below the motor/pump. | When no damper is installed below the electric motor, vibrations from the motor and pump may be transferred to the frame/rest of the system/plant. |
## 6. Typical signs of wear
### 6.1 Valve plate

<table>
<thead>
<tr>
<th>Picture 1</th>
<th>A normally worn valve plate has no marks/scratches but only a slightly polished surface. No scratches or marks should be felt. The surface must be flat and level.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Picture 2</td>
<td>A worn valve plate has scratches, and/or a polished surface. Even small scratches will give a loss of flow.</td>
</tr>
<tr>
<td>Scratch</td>
<td>A good way to identify a worn valve plate is to hold a straight knife edge over the valve plate. When holding it up to the light, it will be possible to see any space between the knife edge and the valve plate. See picture 3. If any light can be seen between the two arrows on the picture, the valve plate is worn. If any scratches or marks can be felt by running a fingernail over the surface, the valve plate is worn. The valve plate on picture 3 is highly damaged.</td>
</tr>
</tbody>
</table>

![Picture 1](image1.png)

![Picture 2](image2.png)

![Picture 3](image3.png)
6.2 Port plate

If the port plate has scratches, level differences or both between the arrows, the port plate must be replaced.

Even small scratches or wear will cause loss of flow.

To check: See item 6.1, picture 3

6.3 Swash plate

If the swash plate is polished 360°, it is an indication of insufficient filtration.

The surface of the swash plate must be plane and even at same level all over. To check this, please see item 6.1, picture 3.

If the surface has any marks/scratches it is worn/damaged and a new one is required.

Please contact Danfoss sales office for further information
Right and wrong
Trouble shooting guide for water hydraulic systems
Design

1. Choice of material
   - Rubber
   - Plastic
   - Stainless steel
   - Iron
   - Copper
   - Brass
   - Aluminium

   Always use system components made of corrosion proof materials.
   Non-corrosion proof materials may cause damage.

2. Choice of filter
   - Install a 10 micron absolute filter with pressure switch.
   - Return filter with bypass valve and poorer filterability than 10 μm will damage the system.
   - System to be dimensioned to provide a suction pressure of the pump inlet of max. 0.1 bar vacuum.
   - Poor suction conditions will cause malfunction and damage the pump.

3. Filter location
   - Locate the return filter in the return line immediately before the tank.
   - Placing the return filter upstream of the final load may damage the pump.

4. Pump location
   - Pump always to be placed below water surface level.
   - Pump location above water surface level will cause damage.

5. Suction conditions
   - System to be dimensioned to provide a suction pressure of the pump inlet of max. 0.1 bar vacuum.

6. Pressure Relief valve
   - Pressure relief valve to be mounted vertically or with vertical outlet and connected to return hose or tank.
   - Coupling the pressure relief valve outlet directly to the pump inlet may damage the pump.

7. Water supply
   - System to be filled via filter.
   - Filling system with unfiltered water causes damage.
Installation

8. Impurities
Prior to installation, burrs and chips and other impurities must be removed from pipes and hoses, eg with a felt plug.

Chips or other impurities in the system may cause damage.

9. Sealing
Fittings in screwed components to be sealed with O-rings or bonded seals.

Using teflon tape or packing yarn in joints may cause damage.

10. Grease
Correctly limited quantities of grease prevent seizing.

Too much grease may develop biofilm causing operational failures.

11. Assembly of coupling
The coupling must be easy and simple to assemble (see product instruction).

Never use force when assembling the coupling parts, as this will damage the motor/pump.

12. Coupling
Ensure always to have 3 mm distance between coupling flanges.

Insufficient distance and/or misalignment between the coupling flanges will damage the pump.

13. Water supply
Fill system with water before starting to ensure lubrication and cooling.

Starting without water will cause damage.
Wiring

Starting procedure

Cleaning procedure

1. Fill cold water into the system via the return filter and bleed the pump (Power Packs PPH 4 - 6.3 - 10 and 12.5 are self-bleeding)

2. Start and bleed the system -without pressure by opening the bypass valve

3. Add the cleaning agent to give 3% agent/water solution

4. Run the system for 60 min. and activate all components as often as possible to ensure effective flushing with the cleaning agent

5. Empty the system of the cleaning agent solution

Flushing procedure

6. Fill cold water through the return filter and bleed the pump (Power Packs PPH 4 - 6.3 - 10 and 12.5 are self-bleeding)

7. Run the system for 30 min. and activate all components as often as possible

8. Empty the system of the water

9. Alternatively the system may be flushed by running the unit without the return hose while continuously filling up water. The flushing should continue until there is no trace of cleaning agent in the return water

10. Change the return filter element, fill cold water through the return filter and bleed the pump during start up

11. The system is now ready for operation

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Trouble shooting

Open ended water systems

No water supply

• Is the water supply ok?
  • Is water supplied to the pump?

No
  • Is water coming out of the tap?
    • Are all taps open?

Yes

No
  • Is the electric motor of the pump unit rotating?

Yes
  • Is the water in the tank very hot? i.e above 50°

No
  • Lower inlet temperature or provide better cooling

Yes

 zero water pressure

• Is the control light for "low pump suction pressure" on?
  • The filter is clogging

No

Yes

• Is water coming through the filter?

No

Yes

• Replace filter element

• Turn on the tap for water supply

• Is the control light for "low pump suction pressure" on?

Yes

no water pressure

• Is the filter clogged?

No

Yes

• Replace filter element

• A blown fuse / or short circuit?
  • Check power supply and fuses and contact electrician

Contact serviceman

• Is the power supply ok?
  • Are control lights on?

No

Yes

• Is the control light on?

Yes

no water pressure

• Is the water in the tank very hot? i.e above 50°

Yes

no water pressure

• Is the water supply ok?
  • Is water supplied to the pump?
Trouble shooting

Closed water systems

The system does not work

- Is there sufficient water in the tank? Yes No

- Is the electric motor of the pump unit rotating? Yes No

- Is the water in the tank very hot? Ie above 50° Yes No

- Is the filter clogged? Yes No

- Is the filter control light on? Yes No

- Is there a blown fuse/or short circuit? Yes No

- Check power supply and fuses and contact electrician

- Is the power supply ok? Yes No

- Are control lights on? Yes No

- At temperatures higher than 50° the pump drive cuts out. Consequently the cooler must be checked/cleaned

- Fill water into the system

- Trace leakage, if any

- Replace filter element

Contact serviceman

Stamp
Trouble shooting

Closed water systems

The system does not work. Is there sufficient water in the tank? No. Is the water in the tank very hot? Ie above 50°C. Is the power supply ok? No. Are control lights on? No. Is the filter clogged? No. Is the filter control light on? No. Replace filter element Contact serviceman. Fill water into the system. Trace leakage, if any. A blown fuse/or short circuit? Check power supply and fuses and contact electrician. At temperatures higher than 50°C the pump drive cuts out. Consequently the cooler must be checked/cleaned. Is the electric motor of the pump unit rotating?