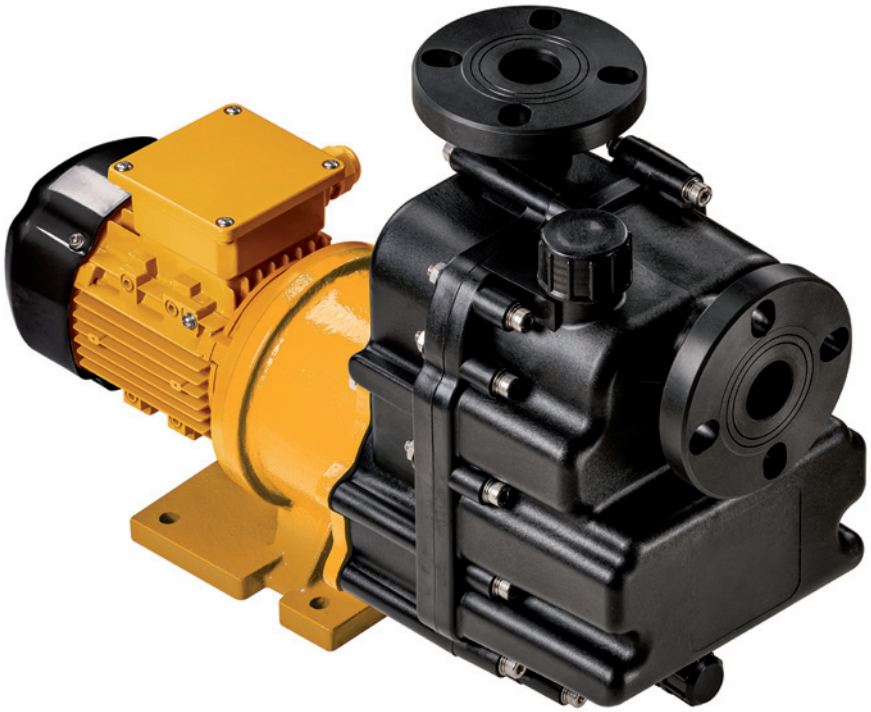
SCHMITT
chemical resistant pumps

# Pump series SMP self-priming magnetically coupled centrifugal pump

## Original operating manual



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Subject to technical modifications.

Read carefully before use.
Save for future use.

# Table of contents

# List of figures



# List of tables

# 1 About this document

This manual:

- is an integral part of the pump
- applies to all series referred to
- describes safe and proper operation during all operating phases

## 1.1 Target groups

**Operating company**

- Responsibilities:
  - Always keep this manual accessible where the device is used on the system.
  - Ensure that employees read and observe this document, particularly the safety instructions and warnings, and the documents which also apply.
  - Observe any additional country-specific rules and regulations that relate to the system.

**Qualified personnel, fitter**

- Mechanics qualification:
  - Qualified employees with additional training for fitting the respective pipework
- Electrical qualification:
  - Qualified electrician
- Transport qualification:
  - Qualified transport specialist
- Responsibility:
  - Read, observe and follow this manual and the other applicable documents, especially all safety instructions and warnings.

## 1.2 Other applicable documents

| Document/purpose | Where found |
|---|---|
| The following documents are available online:<br>• Resistance lists<br>– Resistance of materials used to chemicals<br>• Data sheet<br>– Technical specifications, operating conditions, dimensions<br>• www.schmitt-pumpen.de/de/support/downloads.html | |
| Spare parts list<br>• Ordering spare parts | Documentation included |
| Sectional drawing<br>• Sectional drawing, part numbers, component designations | |
| Documentation for the drive<br>• Technical documentation for drives | |
| Declaration of conformity<br>• Conformity with standards<br>• (→ 9.5 Declaration of conformity, Page 32). | |

Tab. 1 Other application documents, purpose and where found

## 1.3 Warnings and symbols

| Warning sign | Level of risk | Consequences if disregarded |
|---|---|---|
| ⚠ DANGER | immediate acute risk | Death, serious bodily harm |
| ⚠ WARNING | potentially acute risk | Death, serious bodily harm |
| ⚠ CAUTION | potentially hazardous situation | Minor injury |
| NOTE | potentially hazardous situation | Material damage |

Tab. 2 Warning signs and consequences if disregarded

| Symbol | Meaning |
|---|---|
| ⚠ | Safety warning sign<br>► Take note of all information highlighted by the safety warning sign and follow the instructions to avoid injury or death. |
| ► | Instruction |
| 1., 2., ... | Multiple-step instructions |
| ✓ | Precondition |
| → | Cross reference |
| ⓘ | Information, notes |

Tab. 3 Symbols and their meaning

# 2 General safety instructions

The manufacturer accepts no liability for damages caused by disregarding any of the documentation.

## 2.1 Intended use

- Only use the pump with suitable media. Pump parts in contact with media must be resistant to the media. (→ Order specification).
- Adhere to the operating limits and size-dependent minimum flow rates.
- Avoid dry running:
  Initial damage, such as destruction of plain bearings, seals and plastic parts, will occur within a few seconds.
  – Make sure the pump is only operated when filled with the conveyed fluid and never operated when not filled with the pumped liquid.
  – Ensure that there are no excessively high amounts of gas in the pumping medium.
  – Ensure that the pump is operated only within the permissible operating range.
  – Ensure that the use of shut-off valves or filters does not cause the pressure on the inlet side of the pump to be too low.
- Avoid cavitation:
  – Fully open the suction-side fitting, if installed.
  – Do not open the pressure-side fitting beyond the agreed operating point.
- Avoid overheating:
  – Do not operate the pump while the pressure-side fitting is closed.
  – Note minimum flow (→ Data sheet).
- Avoid damage to the motor:
  – Do not open the pressure-side fitting beyond the agreed operating point.
  – Note the maximum permissible number of times the motor can be switched on per hour (→ manufacturer's specifications).
- Consult with the manufacturer regarding any other use of the device.

**Prevention of obvious misuse (examples)**

- Observe pump limits of use regarding temperature, pressure, flow and speed (→ data sheet).
- The power consumption of the pump increases as the specific gravity of the pumped fluid increases. Adhere to the permissible specific gravity in order to eliminate the possibility that the pump, coupling and motor become overloaded (→ data sheet).
  A lower specific gravity is permissible. Adapt the auxiliary systems accordingly.
- Do not convey any media containing solids.
- The type of installation should be selected only in accordance with these operating instructions. For example, the following are not allowed:
  – Hanging pumps in the pipe
  – Overhead installation
  – Installation in the immediate vicinity of extreme heat or cold sources
  – Installation too close to a wall
  – Vertical installation

## 2.2 General safety instructions

Observe the following regulations before carrying out any work.

### 2.2.1 Product safety

The pump has been built according to state-of-the-art technology and the recognized technical safety regulations. Nevertheless, operation of the pump can still put the life and health of the user or third parties at risk or damage the pump or other property.

- Operate the pump only if it is in perfect technical condition and use it only as intended, staying aware of safety and risks, and in adherence to the instructions in this manual.
- Keep this manual and all other applicable documents complete, legible and accessible to personnel at all times.
- Refrain from any procedures and actions that would pose a risk to personnel or third parties.
- In the event of any safety-relevant faults, shut down the pump immediately and have the fault corrected by appropriate personnel.
- In addition to the entire documentation for the product, comply with statutory or other safety and accident-prevention regulations and the applicable standards and guidelines in the country where the pump is operated.

### 2.2.2 Obligations of the operating company

**Safety-conscious working**

- Operate the pump only if it is in perfect technical condition and use it only as intended, staying aware of safety and risks, and in adherence to the instructions in this manual.
- Ensure that the following safety aspects are observed and monitored:
  – Intended use
  – Statutory or other safety and accident-prevention regulations
  – Safety regulations governing the handling of hazardous substances
  – Applicable standards and guidelines in the country where the pump is operated
  – Applicable guidelines of the operator
- Make personal protective equipment available.

**Qualified personnel**

- Make sure all personnel tasked with work on the pump have read and understood this manual and all other applicable documents, especially the safety, maintenance and repair information, before they start any work.
- Organize responsibilities, areas of competence and the supervision of personnel.
- Ensure that all work is carried out by specialist technicians only:
  – Installation, repair and maintenance work
  – Transportation
  – Work on the electrical system
- Make sure that trainee personnel only work on the pump under supervision of specialist technicians.

**Safety equipment**

- Provide the following safety equipment and verify its functionality:
  – For hot, cold and moving parts: pump safety guarding provided by the customer
  – For pumps without capability to run dry: Dry run protection

**Warranty**

- Obtain the manufacturer's approval prior to carrying out any modifications, repairs or alterations during the warranty period.
- Only use genuine parts or parts that have been approved by the manufacturer.

### 2.2.3 Obligations of personnel

- All directions given on the pump must be followed (and kept legible), e.g. the arrow indicating the sense of rotation and the markings for fluid connections.
- Pump and components:
  – Do not step on them or use as a climbing aid
  – Do not use them to support boards, ramps or beams
  – Do not use them as a fixing point for winches or supports
  – Do not use them for storing paper or similar materials
- Do not remove the safety guarding for hot, cold or moving parts during operation.
- Use personal protective equipment if necessary.
- Only carry out work on the pump while it is not running.
- Before all installation and maintenance work, disconnect the motor from the mains and secure it against being switched back on again.
- Never reach into the suction or pressure-side flange.
- Following all work on the pump, refit safety devices in accordance with the instructions and bring into service.
- Do not make any modifications to the device.

## 2.3 Specific hazards

### 2.3.1 Hazardous pumped liquids

- When handling hazardous fluids, observe the safety regulations for the handling of hazardous substances.
- Use personal protective equipment when carrying out any work on the pump.
- Collect leaking pumped liquid and residues in a safe manner and damage them in accordance with environmental regulations.

### 2.3.2 Magnetic field

Individuals with implanted pacemakers must:

- Be kept away from the pump with magnetic coupling and parts of the magnetic coupling
- Not be allowed to complete work with, or on, the magnetic parts

The magnetic field of the magnetic coupling can destroy products that are sensitive to magnets. These include

- Pacemakers
- ID cards with magnetic strips
- Credit cards and check cards
- Electrical, electronic precision devices (e.g. mechanical and digital clocks, calculators, hard disk drives)

# 3 Layout and Function

## 3.1 Marking

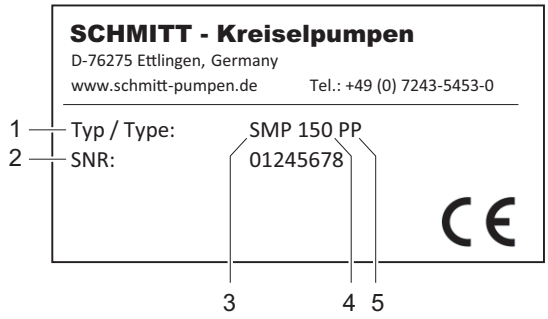


Fig. 1 Name plate (example)

1 Type
2 Serial number
3 Pump series
4 Size
5 Pump material

## 3.2 Description

Self-priming and magnetically coupled centrifugal pump in modular design:

- 2 housing chambers
- Media-lubricated plain bearings
- Direction of conveying
  - Flange, suction side, axial (suction pipe vertical)
  - Flange, pressure side, vertical
- Conveying from open or closed, but depressurized tanks, pits or vessels

## 3.3 Assembly

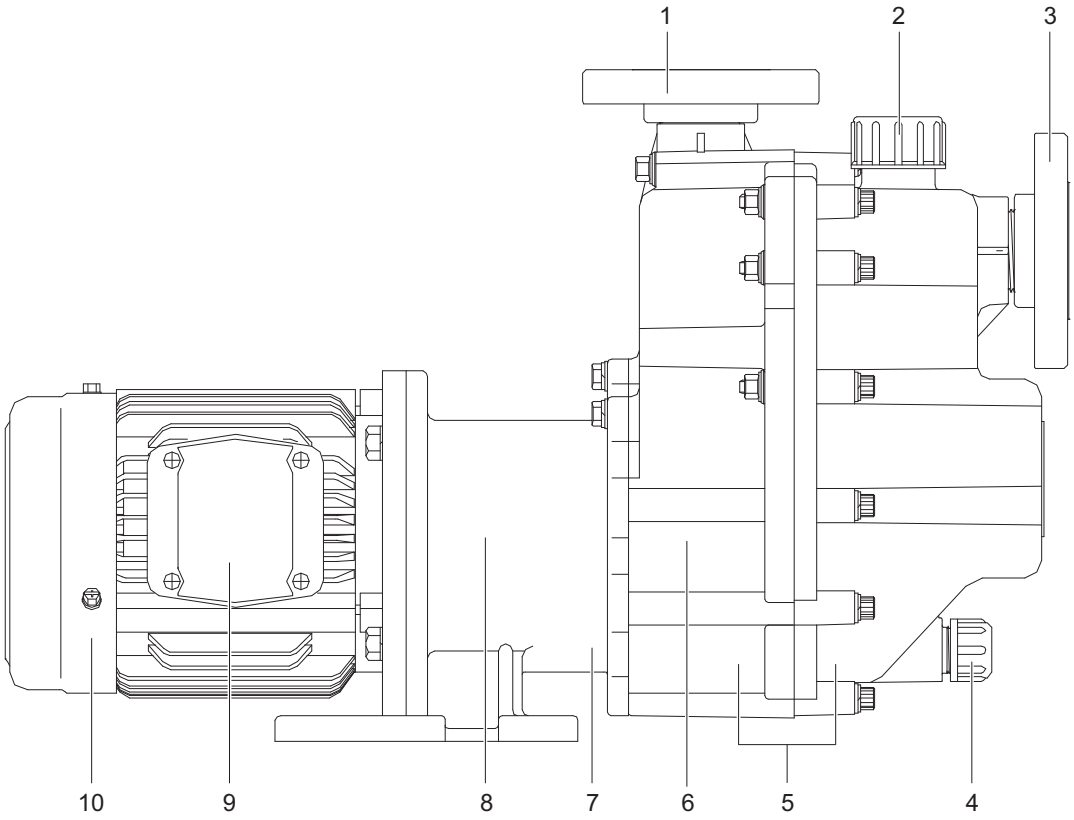


Fig. 2 SMP layout

1 Flange, pressure side
2 Filler opening
3 Flange, suction side
4 Exhaust opening
5 Housing (consisting of 2 chambers)
6 Impeller (concealed)
7 Pump support
8 Magnetic coupling (hidden)
9 Terminal box
10 Motor

## 3.4 Magnetic coupling

Pumps with magnetic couplings are hermetically sealed and leaktight. Power transmission from the motor is non-contact through an enclosed and hermetically sealed rear cover on the impeller.

# 4 Transport, Storage and Disposal

## 4.1 Transport

The user/owner is responsible for the transport of the pump.

Weight specification (→ Data sheet)

### 4.1.1 Unpacking and inspection on delivery

1. Unpack the pump/machine drive on delivery, and inspect it for transport damage.
2. Check completeness and accuracy of delivery.
3. Ensure that the information on the name plate agrees with the order/design data.
4. Report any transportation damage to the manufacturer immediately.
5. Dispose of packaging material according to local regulations.

### 4.1.2 Lifting

**⚠ DANGER**

**Death or limbs crushed as a result transported items falling over!**

- ► Use lifting gear appropriate for the total weight to be transported.
- ► Attach lifting gear in accordance with the following diagram.
- ► Do not stand under suspended loads.

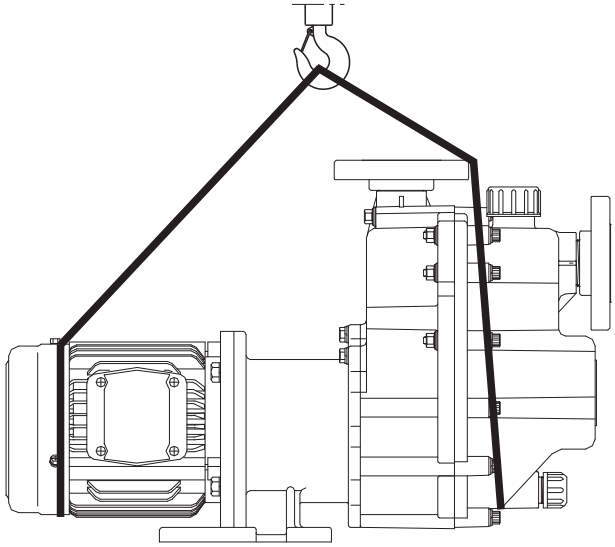

Fig. 3 Attach the lifting gear to the modular pump (illustration of general principle)

1. Attach lifting gear in accordance with the above diagram.
2. Lift the modular pump appropriately.

## 4.2 Storage

**NOTE**

**Material damage due to inappropriate storage!**

- ► Store the pump properly.

1. Rinse and empty the pump if necessary.
2. Seal all openings with blind plugs or plastic covers.
3. Make sure the storage room meets the following conditions:
   – Dry
   – Frost-free
   – Vibration-free
   – UV protected
4. Rotate the pump shaft once a month.
5. Make sure the shaft and bearing change their rotational position in the process.

## 4.3 Disposal

Plastic parts can be contaminated by poisonous or radioactive pumped liquids to such an extent that cleaning will be insufficient.

**⚠ WARNING**

**Risk of poisoning and environmental damage by the pumped liquid!**

- ► Use personal protective equipment when carrying out any work on the pump.
- ► Prior to the disposal of the pump:
  – Collect and damage any escaping pumped liquid in accordance with local regulations.
  – Neutralize residues of pumped liquid in the pump.
- ► Remove plastic parts and damage them in accordance with local regulations.

- ► Dispose of the pump in accordance with local regulations.

# 5 Installation and connection

**NOTE**

**Material damage caused by dirt!**

- ▶ Do not remove the transport seals until immediately before installing the pump.
- ▶ Do not remove any covers or transport and sealing covers until immediately before connecting the pipes to the pump.

## 5.1 Preparing for installation

### 5.1.1 Check operating conditions

- ▶ Ensure the required operating conditions are met:
  - Resistance of body and seal material to the medium (→ resistance lists).
  - Required ambient conditions (→ 9.3.1 Ambient conditions, Page 30).

### 5.1.2 Preparing the installation site

- ▶ Ensure the installation site meets the following conditions:
  - Pump is freely accessible from all sides
  - Sufficient space for the installation/removal of the pipes and for maintenance and repair work, especially for the removal and installation of the pump
  - Pump not exposed to external vibration (damage to bearings)
  - Pump not exposed to external corrosive influences
  - Frost protection
  - Distance from the pump to the lowest tank fill level < max. permissible differential head

### 5.1.3 Prepare foundation and surface

- ✓ Aids, tools, materials:
  - Spirit level
- ▶ Ensure the foundation and surface meet the following conditions:
  - Level and horizontal
  - Clean (no oil, dust or other impurities)
  - Capable of bearing the weight of the machine drive and all operating forces
  - Ensures the stability of the machine drive

## 5.2 Setting up

1. Lift up the machine drive (→ 4.1 Transport, Page 10).
2. Put down the machine drive at the place of installation.
3. Screw the fastening screws into the flange and tighten them.

## 5.3 Planning pipelines

Note the installation example (→ 9.2 Installation example, Page 29).

Water hammer may damage the pump or the system. Plan the pipes and fittings as far as possible to prevent water hammer occurring.

### 5.3.1 Designing pipelines

- ▶ Plan pipes safely:
  - No pulling or thrusting forces
  - No bending moments
  - Adjust for changes in length due to temperature changes (compensators, expansion shanks)
  - Avoid bends close to the pressure-side flange

### 5.3.2 Arranging the supports and connections

**NOTE**

**Material damage due to excessive forces and torques on the pump!**

- ▶ Ensure pipe connection without stress.

1. Support pipes in front of the pump.
2. Ensure the pipe supports will always allow expansion and contraction of the pipes.

### 5.3.3 Specifying nominal widths

Keep the flow resistance in the pipes as low as possible.

1. Make sure the nominal suction line width is not smaller than the nominal suction flange width.
2. Make sure the nominal pressure line width is not smaller than the nominal discharge flange width.

### 5.3.4 Determine the pipe lengths and installation parameters

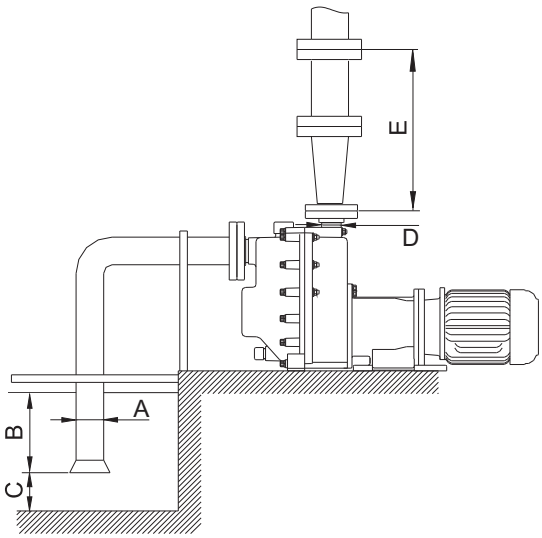


Fig. 4 Pipe lengths and installation parameters

A DNs
B ≥ 0.5 m
C ≥ 1.5 x DNs
D DNd
E > 5 x DNd

► Observe recommended minimum values when installing the pump.

Pressure side: Shorter lengths are possible, but may result in increased noise development.

### 5.3.5 Optimizing changes of cross section and direction

1. Avoid radii of curvature of less than 1.5 times the nominal pipe diameter.
2. Avoid abrupt changes of cross-section along the piping.

### 5.3.6 Providing safety and control devices (recommended)

**Avoid contamination**

► Install a dirt strainer with mesh size <3 mm at the inlet of the suction pipe.

**Avoid reverse running**

1. Install a foot valve or check valve between the pressure-side flange and shut-off valve to ensure that the medium does not flow back after the pump is switched off.
2. In order to enable venting, include vent connection between the pressure-side flange and foot valve or check valve.

**Make provisions for isolating and shutting off the pipes**

For maintenance and repair work.

► Provide shut-off valves in the suction pipe and pressure line.

**Dry run protection by measuring the operating conditions**

► Provide monitoring sensors for both pressure and flow rate, to protect the pump against dry running and consequential damage.

## 5.4 Connecting the pipes

**NOTE**

**Material damage due to excessive forces and torques on the pump!**

► Ensure pipe connection without stress.

### 5.4.1 Keeping the piping clean

**NOTE**

**Material damage due to impurities in the pump!**

► Make sure no impurities can enter the pump.

► Clean all piping parts and fittings prior to assembly.

### 5.4.2 Installing suction pipe

1. Remove the transport and sealing covers from the pump.
2. Fit suction pipe stress-free and sealed.
3. Avoid gas cavities:
   – Always lay the suction pipe rising.
   – Do not install bends with an angle ≤ 90°.
   – Do not install the suction pipe near whirlpools or supply lines.

### 5.4.3 Installing the pressure pipe

1. Remove the transport and sealing covers from the pump.
2. Position the pressure-side flange facing upwards, so as to allow the pump head to be vented.
3. Fit the pressure line stress-free and sealed.
4. Install the foot valve under the following operating conditions:
   – The outlet of the suction pipe is at least 10 m above the tank fill level height
   – Differential head > 15 m

### 5.4.4 Inspection for stress-free pipe connections

✓ Piping installed and cooled down
1. Disconnect the pipe connections from the pump.
2. Check whether the pipes can be moved freely in all directions within the expected range of expansion.
3. Make sure that the connections are parallel.
4. Reconnect the pipe connections to the pump.

## 5.5 Electrical connection

**⚠ DANGER**

**Risk of electrocution!**

- ▶ All electrical work must be carried out only by qualified electricians.
- ▶ Before all work on the electrical system, disconnect the motor from the mains and secure against being switched back on again.

### 5.5.1 Connecting the motor

ⓘ Follow the instructions of the motor manufacturer.

1. Connect the motor according to the connection diagram.
2. Make sure no danger arises due to electric power.
3. Install an EMERGENCY STOP switch.

# 6 Operation

## 6.1 Preparing for commissioning

### 6.1.1 Check downtimes

► Before starting up the pump, check the downtime and perform the following actions:
  – Check the fill level.
  – If the hydraulic parts are dirty, clean them.
  – Check that the impeller runs freely.
  – If the pump is shut down for over 1 year, replace elastomer seals (O-rings, shaft sealing rings).

### 6.1.2 Filling and bleeding

The pump housing is filled with conveyed fluid. During commissioning, the suction line is filled fully by the pump and vented. Additional measures for venting are not required.

**⚠ WARNING**

**Risk of injury and poisoning due to hazardous pumped liquids!**

► Use protective equipment for any work on the pump.
► Safely collect the fluid and dispose of it in accordance with environmental regulations.

1. Unscrew the filler cap.
2. Pour in the conveyed fluid. Note the fill volumes (→ 9.3.5 Pump housing fill volume, Page 30).
3. Screw the filler cap back on.

### 6.1.3 Check direction of rotation

**⚠ DANGER**

**Danger to life from rotating parts!**

► Use personal protective equipment when carrying out any work on the pump.
► Maintain an adequate distance from rotating parts.

**NOTE**

**Material damage as a result of dry running!**

► Make sure the pump is filled properly.

1. Switch on motor for max. 2 seconds and switch it off again immediately.
2. Visually check the direction of rotation of the motor fan impeller and make sure that the direction of rotation of the motor matches the direction arrow on the pump casing.
3. If the sense of rotation is different: Change over the two phases (→ 5.5 Electrical connection, Page 13).

## 6.2 Commissioning

### 6.2.1 Switching on

✓ Pump set up and connected properly
✓ Motor set up and connected properly
✓ All connections stress-free and sealed
✓ All safety equipment installed and tested for functionality
✓ Pump prepared, filled and vented correctly
✓ Tank fill sufficient

**⚠ DANGER**

**Risk of injury and poisoning due to pumped liquid spraying out!**

► Use personal protective equipment when carrying out any work on the pump.

**NOTE**

**Risk of cavitation if suction flow is restricted!**

► Open the suction-side fitting and do not use it to regulate the flow, if installed.
► Do not open the pressure-side fitting beyond the operating point.

**NOTE**

**Material damage due to overheating!**

► Do not operate the pump for long periods with the pressure-side fitting closed.
► Observe the minimum flow rate (→ 9.3.6 Suction head after 180 s, Page 30).

**NOTE**

**Material damage as a result of dry running!**

► Make sure the pump is filled properly.

1. Open the suction-side fitting, if installed.
2. Close the pressure-side fitting.
3. Open the exhaust line fitting.
4. Switch on the motor and check it for smooth running.
5. Make sure that the suction pipe and pump are vented fully. Check the vacuum gauge.

   Gas escapes through the exhaust line.
6. Once the motor has reached its nominal speed, open the pressure-side fitting slowly until the operating point is reached.
7. Close the exhaust line fitting.
8. Make sure temperature change is smaller than 5 K/min for pumps with hot fluids.
9. After the initial stress due to the pressure and operating temperature, check that the pump is not leaking.

10. If leaks are present at the housing seals or flanges, proceed as follows:
    – Switch off motor.
    – Close the control valves.
    – Remedy the leaks.

### 6.2.2 Switching off

✓ Pressure-side fitting closed (recommended)

**⚠ WARNING**

**Risk of injury due to hot pump parts!**

► Use personal protective equipment when carrying out any work on the pump.

1. Switch off motor.
2. Check all connecting bolts and tighten them if necessary (only after initial commissioning).

## 6.3 Shutting down the pump

**⚠ DANGER**

**Risk of injury due to running pump!**

► Do not touch the pump when it is running.
► Do not carry out any work on the pump when it is running.
► Before all installation and maintenance work, disconnect the motor from the mains and secure it against being switched back on again.

**⚠ DANGER**

**Risk of electrocution!**

► All electrical work must be carried out only by qualified electricians.
► Before all work on the electrical system, disconnect the motor from the mains and secure against being switched back on again.

**⚠ WARNING**

**Risk of injury and poisoning due to hazardous pumped liquids!**

► Use protective equipment for any work on the pump.
► Collect leaking liquid safely and damage fitting in accordance with local regulations.

► Take the following measures whenever the pump is shut down:

| Pump is | Action |
|---|---|
| shut down | ► Take measures appropriate for the fluid (→ Tab. 5 Measures depending on the behavior of the pumped liquid, Page 15). |
| …emptied | ► Close suction and pressure-side fitting. |
| …dismounted | ► Isolate the motor from its power supply and secure it against unauthorized switch-on. |
| …put into storage | ► Note measures for storage (→ 4.2 Storage, Page 10). |

Tab. 4 Measures to be taken if the pump is shut down

| Behavior of the pumped liquid | Duration of shutdown (depending on process) | |
|---|---|---|
| | Short | Long |
| Crystallized or polymerized, solids sedimenting | ► Flush the pump. | ► Flush the pump. |
| Solidifying/ freezing, non-corrosive | ► Heat up or empty the pump and containers. | ► Empty the pump and containers. |
| Solidifying/ freezing, corrosive | ► Heat up or empty the pump and containers. | ► Empty the pump and containers. |
| Remains liquid, non-corrosive | – | – |
| Remains liquid, corrosive | – | ► Empty the pump and containers. |

Tab. 5 Measures depending on the behavior of the pumped liquid

## 6.4 Restoring the pump to service

1. If the pump is shut down for over 1 year, replace elastomer seals.
2. Complete all steps as for commissioning (→ 6.2 Commissioning, Page 14).

## 6.5 Operating the stand-by pump

✓ Stand-by pump filled and bled
✓ Suction pipe not vented

Operate the stand-by pump at least once a week.

1. Fully open the suction-side fitting, if installed.
2. Open pressure-side fitting far enough so that the stand-by pump operating temperature is achieved and heating is even (→ 6.2.1 Switching on, Page 14).

# 7 Maintenance

Opening the pump casing invalidates the warranty.

When used for the intended purpose the bearings and seals are virtually free of wear and will not require replacement during the warranty period.

Maintenance and repair work should be undertaken in consultation with Schmitt Kreiselpumpen. The chapter describes maintenance not within the warranty period.

Maintenance during the warranty period will be performed by Schmitt Kreiselpumpen. Submit evidence of conveyed medium on request (DIN safety data sheet or confirmation of decontamination).

## 7.1 Inspections

The inspection intervals depend on the operational strain on the pump.

**DANGER**

**Risk of injury due to running pump!**

- ► Do not touch the pump when it is running.
- ► Do not carry out any work on the pump when it is running.

**WARNING**

**Risk of injury and poisoning due to hazardous pumped liquids!**

- ► Use personal protective equipment when carrying out any work on the pump.

1. Check at appropriate intervals:
   - Adherence to the minimum flow rate
   - Normal operating conditions unchanged
   - Tank fill level
2. For trouble-free operation, always ensure the following:
   - No dry running
   - No leaks
   - No cavitation
   - Shut-off valve open on the suction side, if installed
   - Free and clean filters
   - Sufficient pump inlet pressure
   - No unusual running noises or vibrations
   - No parting of magnetic coupling

## 7.2 Servicing

Plain bearings are subject to natural wear and tear which is heavily dependent on the respective operating conditions. It is therefore not possible to make general statements about the operating life.

**DANGER**

**Danger to life and material damage due to magnetic field!**

- ► Make sure that personnel with pacemakers do not complete work on the pump.
- ► Secure the work place and if necessary cordon off:
  - Make sure that personnel with pacemakers keep a safe distance of > 1 m.
  - Make sure that no magnetizable metal parts can be attracted by the pump's magnetic coupling.
  - Make sure that parts of the magnetic coupling cannot be attracted by the magnetizable metal parts.
- ► Maintain a safe distance of at least 150 mm from the magnetic coupling for magnetically sensitive objects.

**DANGER**

**Risk of injury due to running pump!**

- ► Do not touch the pump when it is running.
- ► Do not carry out any work on the pump when it is running.
- ► Before all installation and maintenance work, disconnect the motor from the mains and secure it against being switched back on again.

**DANGER**

**Risk of electrocution!**

- ► All electrical work must be carried out only by qualified electricians.
- ► Before all work on the electrical system, disconnect the motor from the mains and secure against being switched back on again.

**WARNING**

**Risk of injury and poisoning due to hazardous or hot fluid!**

- ► Use personal protective equipment when carrying out any work on the pump.
- ► Allow the pump to cool completely before commencing any work.
- ► Make sure the pump is depressurized.
- ► Empty the pump, safely collect the pumped liquid and damage it in accordance with environmental rules and requirements.

### 7.2.1 Maintenance in accordance with maintenance schedule

- ► Perform maintenance work in accordance with the maintenance schedule (→ 9.4 Maintenance schedule, Page 31).

### 7.2.2 Check the plain bearings and replace them

When changing the plain bearings, refer to the drawings (→ 9.1.2 Drawings , Page 27).

Request spare parts from the manufacturer (→ 7.4 Replacement parts and return, Page 20).

When checking the plain bearings, inspect the following parts for damage and exchange them as needed:

- Impeller
- Housing
- Seals and O-rings

#### Dismount the pump

To allow the plain bearings to be checked and replaced, disassemble the pump.

✓ Prepared for disassembly (→ 7.3.1 Preparations for dismounting, Page 20).

1. Remove the hexagon nuts and washers (12) from the hexagon socket screws (2).
2. Remove the hexagon socket screws (2).
3. Remove the front pump housing from the rear pump housing (10).
4. Remove the housing seal (6) and check it for damage. If necessary dispose of the housing seal and fit a new part.
5. Remove the partition (7).
6. Remove the filter (9), check it for dirt and clean it if necessary.
7. Remove the O-ring (8) and check it for damage. If necessary dispose of the O-ring and fit a new part.
8. Remove the hexagon screws (18).
9. Remove the rear pump housing (10).
10. Remove the O-ring (15) and check it for damage. If necessary dispose of the O-ring and fit a new part.
11. Pull the rear cover (16) with impeller (13) off the external magnet (19).
12. Remove the seal from the pump support (17) and check it for damage. If necessary dispose of the seal and fit a new part.

#### Check the plain bearings and replace them

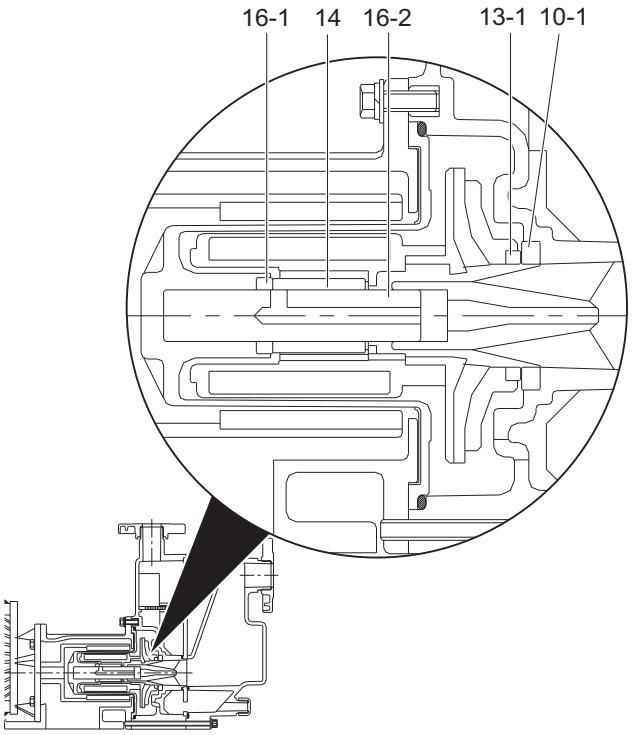


Fig. 5 Components of the plain bearing

10-1 Bearing ring, rear housing
13-1 Bearing ring, impeller
14 Bearing bush
16-1 Bearing ring, rear cover
16-2 Fixed axle in the rear cover

**NOTE**

**Material damage due to incorrect use!**

► Inspect the ceramic parts of the plain bearings carefully; do not strike them or knock them.

13. Check the bearing ring (10-1) on the rear pump housing (10) for damage. In case of damage, dispose of the entire rear housing and fit a new part.
14. Remove the impeller (13) from the rear cover (16).
15. Check the bearing ring (13-1) on the impeller (13) for damage. In case of damage, dispose of the entire impeller and fit a new part.
16. Check the impeller (13) for dirt and damage. If necessary clean the impeller or dispose of it, and fit a new part.
17. Pull the bearing bush (14) off the fixed axle in the rear cover (16-2) and check it for damage. In case of damage, dispose of the bearing bush and fit a new part.
18. Check the bearing ring (16-1) and the fixed axle (16-2) on the rear cover (16) for damage. In case of damage, dispose of the entire rear cover and fit a new part.
19. If necessary, clear the through holes and relief holes.

**Installing the pump**

20. Slide the impeller (13) onto the bearing bush (14).
21. Slide the bearing bush (14) with impeller (13) onto the fixed axle in the rear cover (16).
22. Install the O-ring (15) in the rear cover (16).
23. Install the seal in the pump support (17).
24. Insert the rear cover (16) together with the impeller (13) into the external magnets (19).
25. Install the rear housing (10) on the pump support (17) and tighten the hexagon screws (18) hand-tight.
26. Install the filter (9).
27. Install the O-ring (8).
28. Install the partition (7).
29. Install the housing seal (6).
30. Install the front pump housing on the rear pump housing (10).
31. Install the hexagon socket screws (2).
32. Tighten the hexagon nuts with washers (12) and hexagon screws (18) crosswise (→ 9.3.4 Tightening torques of casing screws, Page 30).
33. Spin the motor fan impeller and make sure that the impeller (13) runs freely in the plain bearings.

### 7.2.3 Cleaning the pump

**NOTE**

**High water pressure or spray water can cause material damage!**

► Do not direct water jets or steam jets into the opening of the pump support.

► Regularly clean the pump to remove heavy dirt.

## 7.3 Dismounting

**⚠ DANGER**

**Danger to life and material damage due to magnetic field!**

► Make sure that personnel with pacemakers do not complete work on the pump.
► Secure the work place and if necessary cordon off:
  – Make sure that personnel with pacemakers keep a safe distance of > 1 m.
  – Make sure that no magnetizable metal parts can be attracted by the pump's magnetic coupling.
  – Make sure that parts of the magnetic coupling cannot be attracted by the magnetizable metal parts.
► Maintain a safe distance of at least 150 mm from the magnetic coupling for magnetically sensitive objects.

**⚠ DANGER**

**Risk of injury due to running pump!**

► Do not touch the pump when it is running.
► Do not carry out any work on the pump when it is running.
► Before all installation and maintenance work, disconnect the motor from the mains and secure it against being switched back on again.

**⚠ DANGER**

**Risk of electrocution!**

► All electrical work must be carried out only by qualified electricians.
► Before all work on the electrical system, disconnect the motor from the mains and secure against being switched back on again.

**⚠ WARNING**

**Risk of injury and poisoning due to hazardous or hot fluid!**

► Use personal protective equipment when carrying out any work on the pump.
► Allow the pump to cool completely before commencing any work.
► Make sure the pump is depressurized.
► Empty the pump, safely collect the pumped liquid and damage it in accordance with environmental rules and requirements.

**⚠ WARNING**

**Risk of injury due to heavy components!**

► Pay attention to the component weight. Lift and transport heavy components using suitable lifting gear.
► Set down components safely and secure them against overturning or rolling away.

**⚠ WARNING**

**Risk of injury during disassembly!**

- ▶ Secure the pressure-side shut-off valve against accidental opening.
- ▶ Wear protective gloves, components can become very sharp-edged due to wear or damage.
- ▶ Observe the manufacturer's specifications (e.g. for the motor).

**NOTE**

**Material damage due to incorrect dismounting/installation of the pump!**

- ▶ Only specialist mechanics should complete dismounting/ installation work.

### 7.3.1 Preparations for dismounting

- ✓ Pump is depressurized
- ✓ Pump completely empty, flushed and decontaminated
- ✓ Electrical connections disconnected and motor secured against switch-on
- ✓ Pump cooled down
- ✓ Pressure gauge lines, pressure gauge and fixtures dismounted

1. Dismantle the pipes on the suction and pressure side.
2. Remove pump from the system.
3. When dismounting, observe the following:
   – Mark the precise orientation and position of all components before dismounting them.
   – Dismount components concentrically without canting.

### 7.3.2 Dismount the pump

ⓘ Following the drawings for disassembly (→ 9.1.2 Drawings , Page 27).

**NOTE**

**Material damage, fragile components!**

- ▶ Perform disassembly carefully, and do not strike or knock the fragile ceramic parts of the plain bearing.

1. Remove the hexagon nuts and washers (12) from the hexagon socket screws (2).
2. Remove the hexagon socket screws (2).
3. Remove the front pump housing from the rear pump housing (10).
4. Unscrew the flange (3).
5. Remove the O-ring (4).
6. Unscrew the filler cap with O-ring (5).
7. Unscrew the exhaust cap (1).
8. Remove the housing seal (6).
9. Remove the partition (7).
10. Remove the filter (9).
11. Remove the O-ring (8).
12. Remove the hexagon screws (18).
13. Remove the rear pump housing (10).
14. Unscrew the flange (11).
15. Remove the O-ring (12).
16. Remove the O-ring (15).
17. Pull the rear cover (16) with impeller (13) off the external magnet (19).
18. Remove the impeller (13) from the rear cover (16).
19. Pull the bearing bush (14) off the fixed axle in the rear cover (16).
20. Remove the seal from the pump support (17).
21. Remove the hexagon screws on the motor flange.
22. Remove the pump support (17).
23. Remove the fastening screw from the external magnet (19).
24. Pull the external magnet (19) off the motor shaft.

## 7.4 Replacement parts and return

1. Have the following information as shown on the name plate ready to hand when ordering spare parts (→ 3.1 Marking, Page 8 ).
   – Serial number
   – Type
2. Please complete and enclose the confirmation of decontamination for returns
   (→ www.schmitt-pumpen.de/de/support/downloads.html).
3. Use only spare parts from SCHMITT.
   (E-Mail: sales@schmitt-pumpen.de).

## 7.5 Installing

Install components concentrically and without tilting in accordance with the markings applied.

**⚠ DANGER**

**Danger to life and material damage due to magnetic field!**

- ▶ Make sure that personnel with pacemakers do not complete work on the pump.
- ▶ Secure the work place and if necessary cordon off:
  - – Make sure that personnel with pacemakers keep a safe distance of > 1 m.
  - – Make sure that no magnetizable metal parts can be attracted by the pump's magnetic coupling.
  - – Make sure that parts of the magnetic coupling cannot be attracted by the magnetizable metal parts.
- ▶ Maintain a safe distance of at least 150 mm from the magnetic coupling for magnetically sensitive objects.

**⚠ WARNING**

**Risk of injury due to heavy components!**

- ▶ Pay attention to the component weight. Lift and transport heavy components using suitable lifting gear.
- ▶ Set down components safely and secure them against overturning or rolling away.

**⚠ WARNING**

**Risk of injury during assembly!**

- ▶ Observe the manufacturer's specifications (e.g. for the motor).

**NOTE**

**Material damage due to incorrect dismounting/installation of the pump!**

- ▶ Only specialist mechanics should complete dismounting/installation work.

**NOTE**

**Material damage due to unsuitable components!**

- ▶ Always replace lost or damaged screws with screws of the same strength where required.
- ▶ Only replace seals with seals of the same material.

**NOTE**

**Material damage, fragile components!**

- ▶ Install ceramic parts of the plain bearing and magnets of the magnetic coupling with care, do not strike them or knock them.

### 7.5.1 Preparations for installation

- ▶ When installing please observe:
  - – Replace worn parts with genuine spare parts.
  - – Replace seals, inserting them in such a way that they are unable to rotate.
  - – Do not apply synthetic or mineral oil, grease or cleaning agents to elastomer components.

### 7.5.2 Assembly of the pump

Following the drawings for assembly (→ 9.1.2 Drawings , Page 27).

Note the correct tightening torque for assembly (→ 9.3.4 Tightening torques of casing screws, Page 30).

**Preparing the impeller for installation**

The impeller, bearing bush, O-ring and rear cover are completely assembled as a unit, so as to avoid material damage during the following installation operations.

1. Make sure that the plain bearing rings on the impeller (13), rear cover (16) and rear housing (10) are undamaged.
2. Slide the impeller (13) onto the bearing bush (14).
3. Slide the bearing bush (14) with impeller (13) onto the fixed axle in the rear cover (16).
4. Install the O-ring (15) on the rear cover (16).
5. Put the unit safely aside.

**Installing the pump**

6. Slide the external magnet (19) on the motor shaft.
7. Set the correct installation dimension **A** at the end of the motor shaft and external magnet (19) (→ 9.3.3 Installation dimensions, Page 30).
8. Tighten the fastening screw on the external magnet (19).
9. Insert the external magnet (19) into the pump support (17).
10. Install the pump support (17) on the motor flange. Orient the motor so that the terminal box can be operated at the installation location.
11. Tighten the hexagon screws on the motor flange crosswise.
12. Install the seal in the pump support (17).
13. Insert the unit of the rear cover (16) together with the impeller (13) into the external magnets (19).
14. Install the O-ring (15).
15. Install the O-ring (12).
16. Screw on the flange (11).
17. Install the rear pump housing (10) on the pump support (17) and tighten the hexagon screws (18) hand-tight.
18. Install the filter (9).
19. Install the O-ring (8).
20. Install the partition (7).
21. Install the housing seal (6).
22. Screw on the exhaust cap (1).
23. Screw on the filler cap with O-ring (5).
24. Install the O-ring (4).
25. Screw on the flange (3).
26. Install the front pump housing on the rear pump housing (10).

27. Install the hexagon socket screws (2).
28. Tighten the hexagon nuts with washers (12) and hexagon screws (18) crosswise.
29. Spin the motor fan impeller and make sure that the impeller (13) runs freely in the plain bearings.

### 7.5.3 Install the pump into the system

► Install the pump in the system (→ 5 Disposal, Page 11).

# 8 Troubleshooting

**⚠ DANGER**

**Danger to life and material damage due to magnetic field!**

- ▶ Make sure that personnel with pacemakers do not complete work on the pump.
- ▶ Secure the work place and if necessary cordon off:
  - – Make sure that personnel with pacemakers keep a safe distance of > 1 m.
  - – Make sure that no magnetizable metal parts can be attracted by the pump's magnetic coupling.
  - – Make sure that parts of the magnetic coupling cannot be attracted by the magnetizable metal parts.
- ▶ Maintain a safe distance of at least 150 mm from the magnetic coupling for magnetically sensitive objects.

If faults occur which are not specified in the following table or cannot be traced back to the specified causes, please consult the manufacturer.

Possible faults are identified by a fault number in the table below. This number identifies the respective cause and remedy in the troubleshooting list.

| Fault | Number |
|---|---|
| Pump not pumping | 1 |
| Pumping rate insufficient | 2 |
| Pumping rate excessive | 3 |
| Pumping pressure insufficient | 4 |
| Pumping pressure excessive | 5 |
| Pump running roughly / loud noises / vibration | 6 |
| Pump leaks | 7 |
| Excessive motor power uptake | 8 |
| Housing temperature too high | 9 |

Tab. 6 Fault/number assignment

| Fault number | | | | | | | | | Cause | Remedy |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | |
| X | – | – | – | – | – | – | – | – | Suction pipe and/or pressure line closed by fitting | ▶ Open the fitting. |
| X | – | – | – | – | – | – | – | – | Transport and sealing cover still in place | ▶ Remove the transport and sealing cover.<br>▶ Dismount the pump and inspect it for dry-running damage. |
| X | X | – | – | – | – | – | – | – | Suction pipe too long | ▶ Shorten suction pipe. |
| X | X | – | – | – | – | – | – | – | Pump flange deformed or damaged | ▶ Change the pump flange. |
| X | X | – | X | – | – | – | – | – | Motor speed too low | ▶ Compare the required motor speed with the specifications on the pump type plate. Replace the motor if necessary.<br>▶ Increase the motor speed if speed control is available. |
| X | X | – | X | – | – | – | – | – | Magnetic coupling has parted | ▶ Switch off pump and switch on again. |
| X | X | – | X | – | X | – | – | – | Intake / suction pipe, pump or suction strainer blocked or encrusted | ▶ Clean intake/suction pipe, pump or suction strainer. |
| X | X | – | X | – | X | – | – | – | Air is sucked in | ▶ Seal source of problem. |
| X | X | – | X | – | X | – | – | – | Proportion of gas too high: pump is cavitating | ▶ Consult the manufacturer. |
| X | X | – | X | – | X | – | – | – | Pump running in the wrong direction | ▶ Change over any two phases in the motor. |
| X | X | – | X | – | X | – | – | – | Impeller out of balance or blocked | ▶ Dismount the pump and inspect it for dry-running damage.<br>▶ Clean the impeller. |
| X | X | – | – | X | X | – | – | – | Pressure pipe blocked | ▶ Clean the pressure pipe. |
| X | – | – | – | – | X | – | – | – | Suction pipe and pump not correctly vented or not completely filled | ▶ Completely fill and vent pump and/or pipe. |
| X | – | – | – | – | – | – | – | X | Standstill, plain bearing stuck | ▶ Disassemble the pump and carefully free the plain bearing rings. |
| – | X | – | X | – | X | – | – | – | Cross section of suction pipe too narrow | ▶ Increase cross section.<br>▶ Clean encrustation from suction pipe.<br>▶ Fully open the fitting, if installed. |
| – | X | – | X | – | X | – | – | – | Hydraulic parts of the pump dirty, clotted or encrusted | ▶ Dismount the pump.<br>▶ Clean the parts. |
| – | X | – | X | – | X | – | – | – | Suction head too large: $NPSH_{pump}$ is larger than $NPSH_{system}$ | ▶ Increase pump inlet pressure.<br>▶ Consult the manufacturer. |
| – | X | – | X | – | X | – | – | – | Back pressure of the system is too high, pump selected is too small. | ▶ Consult the manufacturer. |
| – | X | – | X | – | X | – | – | – | Pump parts worn | ▶ Replace the worn pump parts. |
| – | X | – | X | – | X | – | – | – | Pump jammed | ▶ Consult the manufacturer. |
| – | X | – | X | – | X | – | X | – | Motor running on 2 phases | ▶ Check the fuse and replace it if necessary.<br>▶ Check the cable connections and insulation. |

| Fault number | | | | | | | | | Cause | Remedy |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | |
| – | X | – | X | – | X | – | – | X | Temperature of fluid is too high: pump is cavitating | ▶ Increase pump inlet pressure.<br>▶ Lower temperature.<br>▶ Contact the manufacturer. |
| – | X | – | X | – | – | – | X | X | Viscosity or specific gravity of the pumped liquid outside the range specified for the pump | ▶ Consult the manufacturer. |
| – | X | – | X | – | – | – | – | X | Geodetic differential head and/or pipe flow resistances too high | ▶ Remove sediments from the pump and/or pressure pipe.<br>▶ Install a larger impeller and consult the manufacturer.<br>▶ Reduce the system pressure. |
| – | X | – | – | X | X | – | – | – | Pressure-side fitting not opened wide enough | ▶ Open the pressure-side fitting. |
| – | – | X | X | – | X | – | X | – | Pressure-side fitting opened too wide | ▶ Throttle down at the pressure-side fitting.<br>▶ Machine the impeller down. Consult the manufacturer and adjust the impeller diameter. |
| – | – | X | – | X | – | – | – | – | Viscosity lower than expected | ▶ Machine the impeller down. Consult the manufacturer and adjust the impeller diameter. |
| – | – | X | – | X | X | – | X | – | Motor speed too high | ▶ Compare the required motor speed with the specifications on the pump type plate. Replace the motor if necessary.<br>▶ Reduce the motor speed if speed control is available. |
| – | – | X | – | X | X | – | X | – | Impeller diameter too large | ▶ Throttle down the flow rate at the pressure-side fitting. Observe the minimum flow rate.<br>▶ Machine the impeller down. Consult the manufacturer and adjust the impeller diameter. |
| – | – | X | – | – | X | – | X | – | Geodetic differential head, pipe flow resistances and/or other resistances lower than specified | ▶ Throttle down the flow rate at the pressure-side fitting. Observe the minimum flow rate.<br>▶ Machine the impeller down. Consult the manufacturer and adjust the impeller diameter. |
| – | – | – | – | – | X | X | X | – | Pump distorted | ▶ Check the pipe connections and pump attachment. |
| – | – | – | – | – | X | – | – | – | Pipes and fittings blocked | ▶ Disassemble and clean the pipes and fittings. |
| – | – | – | – | – | X | – | X | – | Plain bearing faulty | ▶ Change the plain bearing (→ 7.2.2 Check the plain bearings and replace them , Page 18). |
| – | – | – | – | – | – | X | – | – | Connecting bolts not correctly tightened | ▶ Tighten the connecting bolts. |
| – | – | – | – | – | – | X | – | – | Faulty housing seal | ▶ Replace the housing seal. |

Tab. 7 Troubleshooting list

# 9 Appendix

## 9.1 Replacement parts

### 9.1.1 Part numbers and designations

| Part no. | Designation |
|---|---|
| 1 | Exhaust cap |
| 2 | Hexagon socket screw |
| 3 | Flange (suction side) |
| 4 | O-ring |
| 5 | Filler cap with O-ring |
| 6 | Housing seal |
| 7 | Partition |
| 8 | O-ring |
| 9 | Filter |
| 10 | Rear pump housing |
| 11 | Flange (pressure side) |
| 12 | O-ring |
| 13 | Impeller |
| 14 | Bearing bush |
| 15 | O-ring |
| 16 | Rear cover |
| 17 | Pump support |
| 18 | Hexagon head bolt |
| 19 | External magnet |

Tab. 8 Designation of components according to part numbers

### 9.1.2 Drawings

**Sectional drawing**

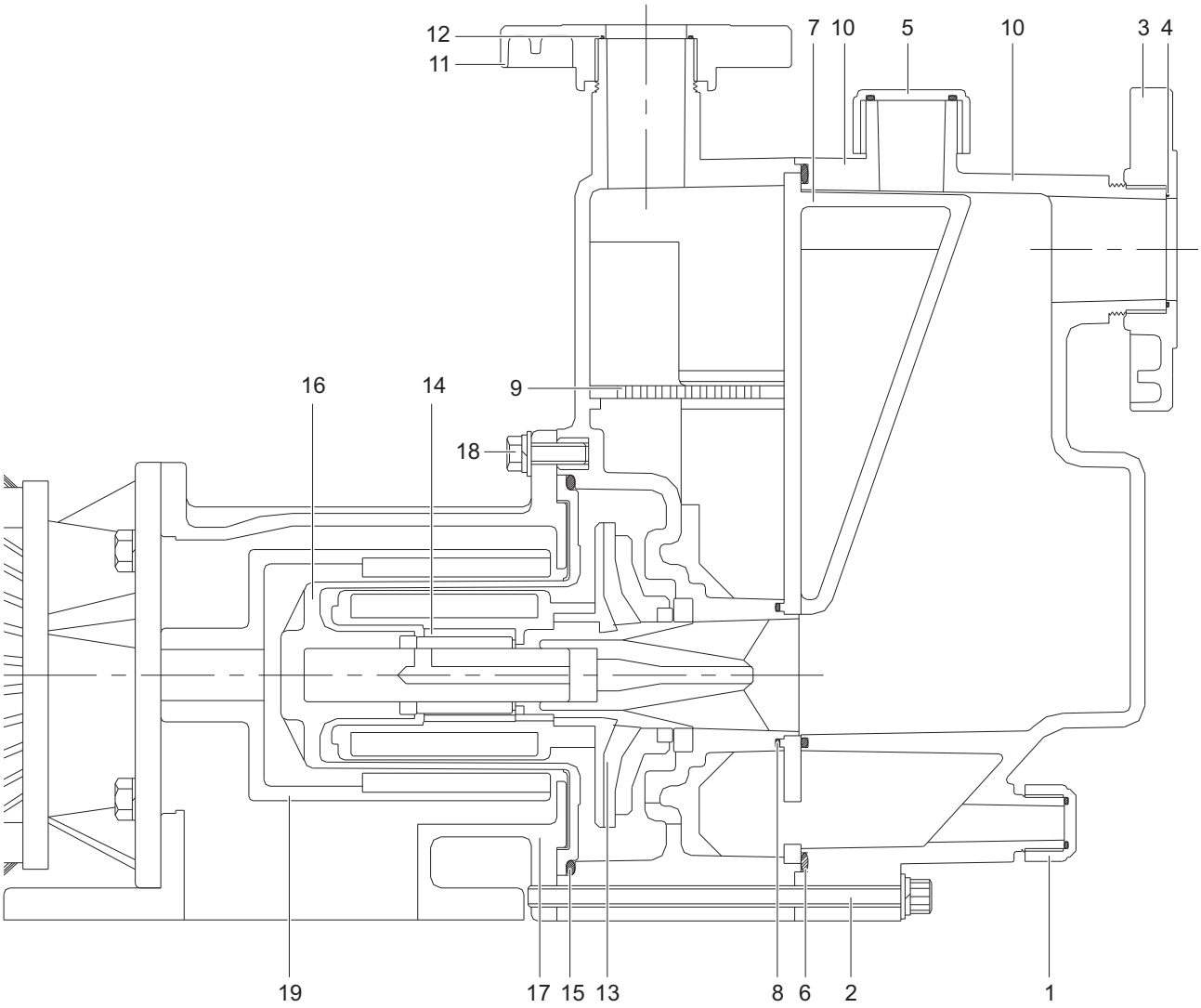


Fig. 6 Parts (sectional drawing)

## Exploded drawing

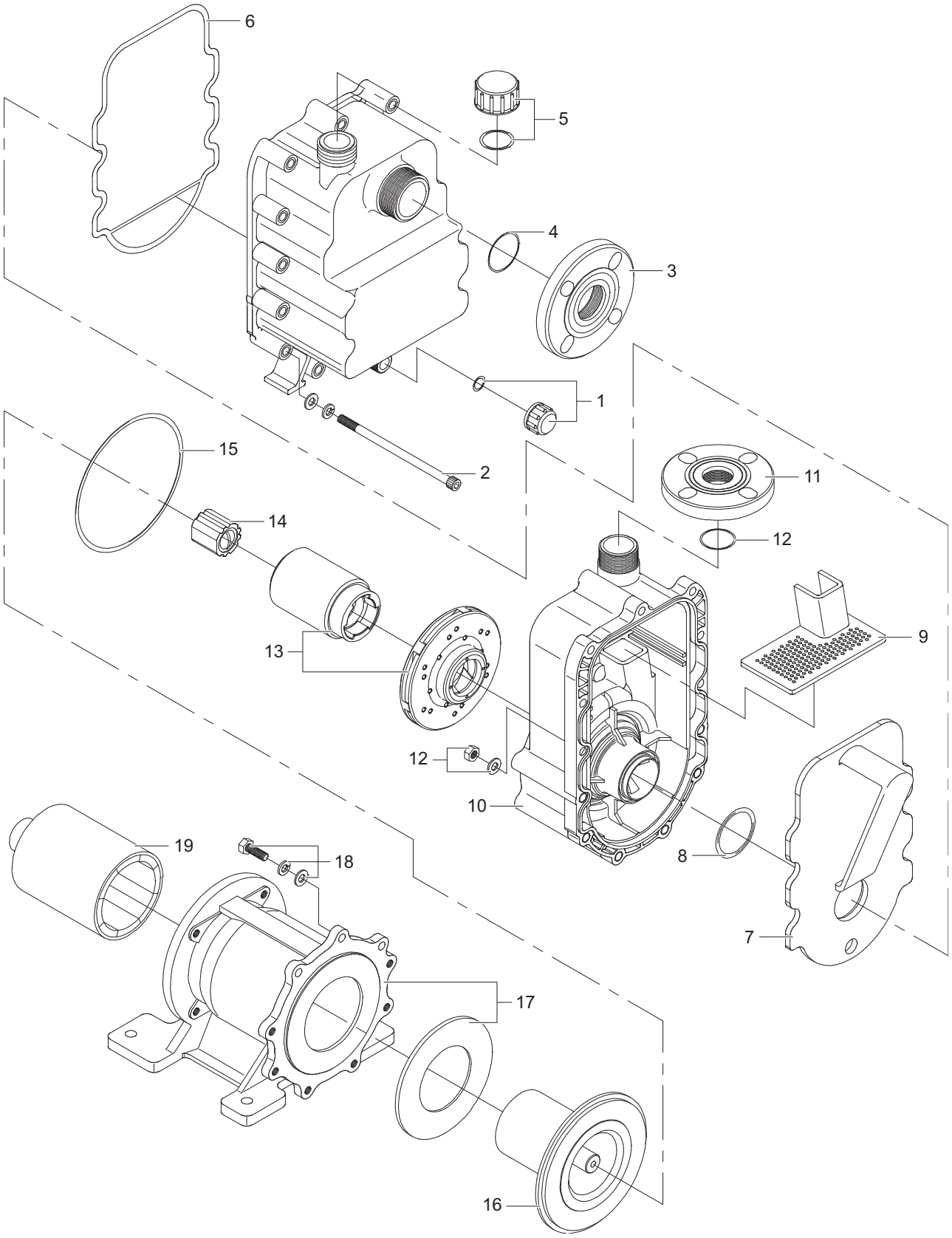


Fig. 7 Parts (exploded drawing)

## 9.2 Installation example

The following example pipe schematic shows the main components of a pump installation.

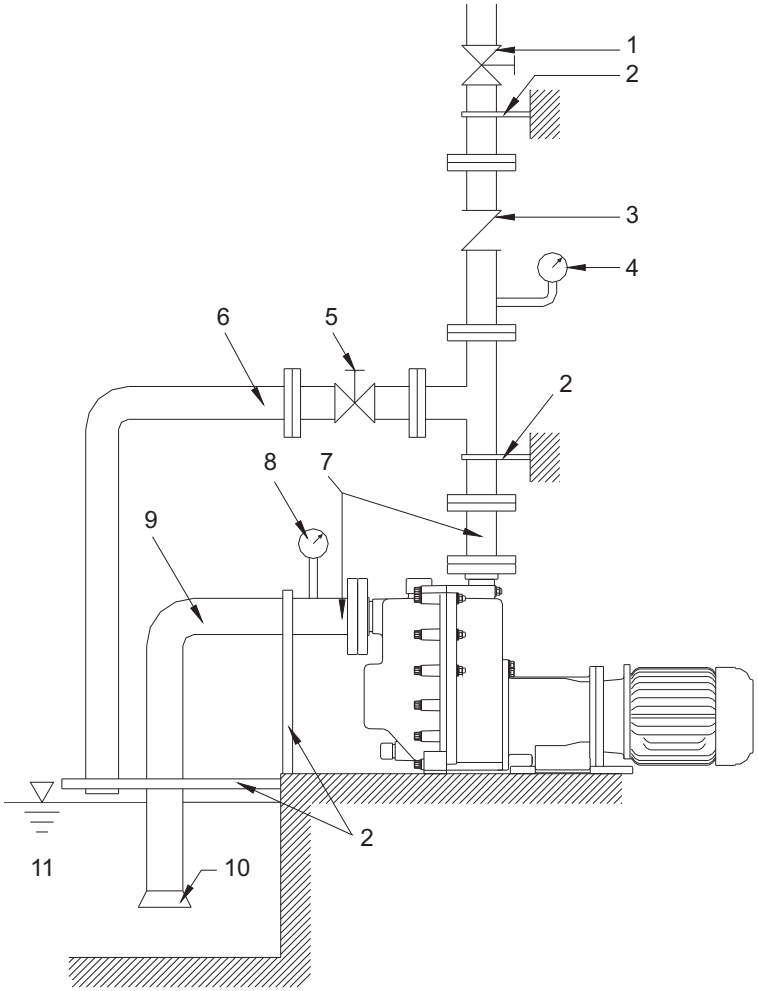


Fig. 8 Installation example

1 Shut-off valve (pressure side)
2 Pipe fixture
3 Foot valve or check valve
4 Pressure gauge
5 Shut-off valve (ventilation)
6 Exhaust line
7 Compensator
8 Vacuum gauge
9 Suction pipe
10 Strainer
11 Tank

## 9.3 Technical specifications

Further technical data (→ data sheet).

### 9.3.1 Ambient conditions

Operation under any other ambient conditions should be agreed with the manufacturer.

| Temperature [°C] | Relative humidity [%] | | Installation height above sea level [m] |
|---|---|---|---|
| | Long-term | Short-term | |
| –20 to +40 [1)] | ≤ 85 | ≤ 100 | ≤ 1000 |

Tab. 9 Ambient conditions

1) material-dependent

### 9.3.2 Total pressure

Total pressure = system pressure + pressure build-up in the pump

Max. permissible total pressure ($p_t$) = 6 bar

### 9.3.3 Installation dimensions

The end of the motor shaft and the inner surface of the external magnet (19) must be flush:

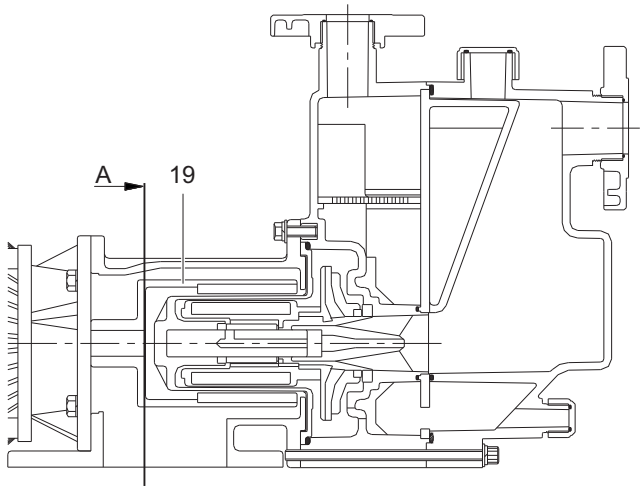


Fig. 9 Installation dimension

A End of motor shaft and external magnet (19)

### 9.3.4 Tightening torques of casing screws

Comply with the following tightening torques and use a torque wrench:

| SMP size ... | Tightening torque [Nm] |
|---|---|
| 130 | 3 |
| 150 | 3 |
| 170 | 5 |

Tab. 10 Tightening torques of casing screws

### 9.3.5 Pump housing fill volume

| SMP size ... | Fill volume [l] |
|---|---|
| 130 | 5.7 |
| 150 | 5.7 |
| 170 | 8.0 |

Tab. 11 Pump housing fill volume

### 9.3.6 Suction head after 180 s

| SMP size ... | Motor power rating [kw] | Max. permissible suction head [m] |
|---|---|---|
| 130 | 0.37 | 4.5 |
| 150 | 0.75 | 5.5 |
| 170 | 1.5 | 6.5 |

Tab. 12 Suction head

### 9.3.7 Cleaning agents

- Strongly alkaline soap solution
- Steam jet (only for individual parts)

## 9.4 Maintenance schedule

The manufacture recommends shorter maintenance intervals if the medium being conveyed contains solid matter. The operating company should choose the maintenance intervals appropriate to the medium being conveyed.

| Interval | Designation | Action |
|---|---|---|
| Daily | Conveyed fluid | ▶ Check temperature.<br>▶ Check discharge pressure. |
| | Tank | ▶ Check the fill level. |
| Weekly | Operating temperatures | ▶ Check motor temperature. |
| | Pump | ▶ Check the pump for leaks and vibration. |
| Quarterly | Undoable screwed connections | ▶ Check the screw fastenings for correct and secure fitting. |
| | Impeller | ▶ Check the impeller for dirt and damage:<br>– If the impeller is dirty, clean it.<br>– If the impeller is damaged, replace it. |
| Annually | Plain bearing | ▶ Check the plain bearing for damage and change it if necessary (→ 7.2.2 Check the plain bearings and replace them , Page 18). |
| | Housing | ▶ Check the housing and housing seals for damage and change them if necessary (→ 7.3 Dismounting, Page 19). |
| | External magnet | ▶ Check the external magnet for correct and secure fitting (→ 9.3.3 Installation dimensions, Page 30). |
| As required | Motor | ▶ Check the motor against the supplier's documentation and perform maintenance if necessary (→ 1.2 Other applicable documents, Page 4 ). |

Tab. 13 Maintenance schedule

## 9.5 Declaration of conformity

**EU Declaration of Conformity**

SCHMITT
chemical resistant pumps

Manufacturer **SCHMITT-Kreiselpumpen GmbH & Co. KG**
Einsteinstrasse 33
D-76275 Ettlingen

Type of pump **Centrifugal pump**

Pump type **SMP 130, SMP 150, SMP 170**

We declare that the design of the listed pumps satisfies the provisions of the EU Directives.
The relevant points satisfy the requirements of the

| | |
|---|---|
| EC Machinery Directive | **2006 / 42 / EC** |
| Low Voltage Directive | **2014 / 35 / EU** |
| Electromagnetic Compatibility | **2014 / 30 / EU** |
| Harmonized standards applied | **EN ISO 12100:2010** |

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