

Pioneering for You

wilo

Wilo-EMU KPR



en Installation and operating instructions



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1 Introduction

Dear Customer,

Thank you for choosing one of our company's products. You have purchased a product which has been manufactured to the latest technical standards. Read this operating and maintenance manual carefully before you first use it. This is the only way to ensure that the product is safely and economically used.

The documentation contains all the necessary specifications for the product, allowing you to use it properly. In addition, you will also find information on how to recognize potential dangers, reduce repair costs and downtime, and increase the reliability and working life of the product.

All safety requirements and specific manufacturer's requirements must be fulfilled before the product is put into operation. This operating and maintenance manual supplements any existing national regulations on industrial safety and accident prevention. This manual must also be accessible to personnel at all times and also be made available where the product is used.

The manual is divided into several chapters. Each chapter has a clear heading which tells you what it describes.

The numbered chapters correspond to the standard chapters for a product. They contain all the detailed information on your product.

Chapters numbered alphabetically are added for specific customers. They contain information including the selected accessories, special coatings, connection diagrams and the declaration of conformity.

The table of contents also acts as a brief reference, because all the important sections are given headers. The header of each section is in the outside column, so that you can find everything, even when skimming through the manual.

All important operating and safety instructions are highlighted. You can find detailed information on the structure of these texts in chapter 2, "Safety".

All personnel who work on or with the product must be qualified for such work; electrical work, for example may only be carried out by a qualified electrician. The entire personnel must be of age.

Operating and maintenance staff must also work according to local accident prevention regulations.

It must be ensured that personnel have read and understood the instructions in this operating and maintenance handbook; if necessary this manual must be ordered from the manufacturer in the required language.

The illustrations used are of dummies and original drawings of the products. This is the only realistic solution for our wide range of products and the differing sizes enabled by the modular system. More exact drawings and specifications can be found on the dimension sheet, the planning information and/or the installation plan.

This operation and maintenance manual has been copyrighted by the manufacturer. The operation and maintenance handbook is intended for the use by assembly, operating and maintenance personnel. It contains technical specifications and diagrams which may not be reproduced or distributed, either completely or in part, or used for any other purpose without the expressed consent of the manufacturer.

Various abbreviations and technical terms are used in this operating and maintenance manual. Table 1 contains all the abbreviations, and Table 2 all the technical terms.

Preface

Structure of the manual

Personnel qualification

Illustrations

Copyright

Abbreviations and technical terms

Abbreviations	Explanation
p.t.o.	please turn over
re.	regarding
approx.	approximately
i.e.	that means
pos.	possible
if nec.	if necessary
incl.	including
min.	minimum
max.	maximum
etc.	and so on
s.a.	see also
e.g.	for example

Table 1-1: Abbreviations

Technical term	Explanation
Dry run	The product is running at full speed, however, there is no liquid to be pumped. A dry run is to be strictly avoided. If necessary, a safety device must be installed.
“wet” installation type	This installation type requires the product to be immersed in the pumped fluid. It is completely surrounded by the pumped fluid. Please observe the values for the maximum submersion depth and the minimum water coverage.
“dry” installation type	In this installation type, the product is installed dry, i.e. the pumped fluid is delivered to and discharged via a pipeline system. The product is not immersed in the pumped fluid. Please note that the surfaces of the product become very hot!
“transportable” installation type	With this installation type the product is equipped with a pedestal. It can be installed and operated at any location. Please observe the values for the maximum submersion depth and the minimum water coverage, and remember that the surfaces of the product become very hot.
“S1” operating mode (continuous operation)	At the rated load, a constant temperature is reached that does not increase even in prolonged operation. The operating equipment can operate uninterruptedly at the rated load without exceeding the maximum permissible temperature.

Table 1-2: Terms

Technical term	Explanation
“S2” operating mode (short-term operation)	The period of service at the rated load is short in comparison to the subsequent pause. The maximum operating period is indicated in minutes, for example, S2-15. The operating equipment can operate during this time uninterruptedly at the rated load without exceeding the maximum permissible temperature. The pauses must continue until the machine temperature no longer exceeds that of the coolant by more than 2K .
“Siphoning operation”	Siphoning operation is similar to dry running. The product operates at full speed, but only small amounts of liquid are pumped. Siphoning operation is only possible with certain types; see the “Product description” chapter.
Dry-run protection	The dry-run protection is designed to automatically shut down the product if the water level falls below the minimum water coverage value of the product. This is made possible by installing a float switch.
Level control	The level control is designed to switch the product on or off depending on the filling level. This is made possible by installing a float switch.

Table 1-2: Terms

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The manufacturer reserves the right to make technical alterations to systems or components. This operating and maintenance manual refers to the product indicated on the title page.

Rights of alteration

2 Safety

This chapter lists all the generally applicable safety instructions and technical information. Furthermore, every other chapter contains specific safety instructions and technical information. All instructions and information must be observed and followed during the various phases of the product's lifecycle (installation, operation, maintenance, transport etc.). The operator is responsible for ensuring that personnel follow these instructions and guidelines.

This manual uses instructions and safety information for preventing injury and damage to property. To make this clear for the personnel, the instructions and safety information are distinguished as follows:

Instructions and safety information

Instructions are indented by 10 mm and printed in 10pt bold script. Instructions contain text referring to previous text or particular sections of chapters, or highlight brief instructions. Example:

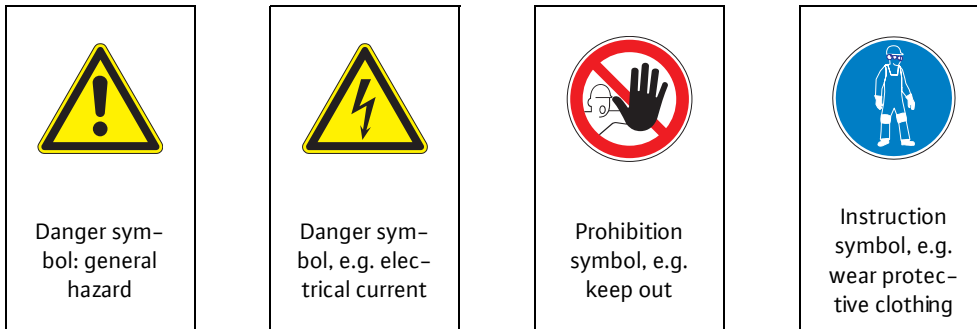
Instructions

For machines approved for work in explosion zones, please refer to the “Explosion protection in accordance with the regulation” chapter.

Safety information is indented by 5 mm and printed in 12pt bold script. Information only referring to damage to property is printed in gray.

Safety information

Information referring to personal injury is printed in black and always accompanied by a danger symbol. Danger, prohibition or instruction symbols are used as safety symbols. Example:



The safety symbols conform to the generally valid guidelines and regulations, for example DIN and ANSI.

Each safety instruction begins with one of the following signal words:

Signal word	Meaning
Danger	Serious or fatal injuries can occur.
Warning	Serious injuries can occur.
Caution	Injuries can occur.
Caution (Instruction without symbol)	Serious damage to property can occur, including irreparable damage.

Table 2-1: Signal words and what they mean

Safety instructions begin with a signal word and description of the hazard, followed by the hazard source and potential consequences, and end with information on preventing it.

Example:

Beware of rotating parts!
The moving rotor can crush and sever limbs. Switch off the machine and let the rotor come to a rest.

Safety

Guidelines used and CE certification

Our products are subject to

- various EC directives
- various harmonized standards
- various national standards.

Please consult the EU Declaration of Conformity for the precise information and the guidelines and norms in effect. The EU Declaration of Conformity is issued in accordance with EU Directive 98/37/EC, Appendix II A.

Also, various national standards are also used as a basis for using, assembling and dismantling the product. These include the German accident prevention regulations, VDE regulations, German Equipment Safety Law etc.

The CE symbol is found either on the type plate or next to the type plate. The type plate is attached to the motor casing or to the frame.

General safety

- Never work alone when installing or removing the product.
- The machine must always be switched off before any work is performed on it (assembly, dismantling, maintenance, installation). The product must be disconnected from the electrical system and secured against being switched on again. All rotating parts must be at a standstill.
- The operator should inform his/her superior immediately should any defects or irregularities occur.
- It is of vital importance that the system is shut down immediately by the operator if any problems arise which may endanger safety of personnel. Problems of this kind include:
 - Failure of the safety and/or control devices
 - Damage to critical parts
 - Damage to electric installations, cables and insulation
- Tools and other objects should be kept in a place reserved for them so that they can be found quickly.
- Sufficient ventilation must be provided in enclosed rooms.
- When welding or working with electronic devices, ensure that there is no danger of explosion.
- Only use fastening devices which are legally defined as such and officially approved.
- The fastening devices should be suitable for the conditions of use (weather, hooking system, load, etc). If these are separated from the machine after use, they should be expressly marked as fastening devices. Otherwise they should be carefully stored.
- Mobile working apparatus for lifting loads should be used in a manner that ensures the stability of the working apparatus during operation.
- When using mobile working apparatus for lifting non-guided loads, measures should be taken to avoid tipping and sliding etc.
- Measures should be taken that no person is ever directly beneath a suspended load. Furthermore, it is also prohibited to move suspended loads over workplaces where people are present.
- If mobile working equipment is used for lifting loads, a second person should be present to coordinate the procedure if needed (for example if the operator's field of vision is blocked).
- The load to be lifted must be transported in such a manner that nobody can be injured in the case of a power cut. Additionally, when working outdoors, such procedures must be interrupted immediately if weather conditions worsen.

These instructions must be strictly observed. Non-observance can result in injury or serious damage to property.

Electrical work

Our electrical products are operated with alternating or industrial high-voltage current. The local regulations (e.g. VDE 0100) must be adhered to. The "Electrical connection" data sheet must be observed when connecting the product. The technical specifications must be strictly adhered to.

If the machine has been switched off by a protective device, it must not be switched on again until the error has been corrected.

Beware of electrical current

**Incorrectly performed electrical work can result in fatal injury!
This work may only be carried out by a qualified electrician.**



Beware of damp

Moisture penetrating cables can damage them and render them useless. Never immerse cable ends in the pumped fluid or other liquids. Any unused wires must be disconnected.

The operator is required to know where the machine is supplied with current and how to cut off the supply.

When the machine is connected to the electrical control panel, especially when electronic devices such as soft startup control or frequency drives are used, the relay manufacturer's specifications must be followed in order to conform to EMC. Special separate shielding measures e.g. special cables may be necessary for the power supply and control cables.

The connections may only be made if the relays meet the harmonized EU standards. Mobile radio equipment may cause malfunctions.

Electrical connection

Beware of electromagnetic radiation

Electromagnetic radiation can pose a fatal risk for people with pacemakers. Put up appropriate signs and make sure anyone affected is aware of the danger.



Our products (machine including protective devices and operating position, auxiliary hoisting gear) must always be grounded. If there is a possibility that people can come into contact with the machine and the pumped liquid (e.g. at construction sites), the grounded connection must be additionally equipped with a fault current protection device.

The electrical products conform to motor protection class IP 68 in accordance with the valid norms.

Ground connection

When operating the product, always follow the locally applicable laws and regulations for work safety, accident prevention and handling electrical machinery. To help to ensure safe working practice, the responsibilities of employees should be clearly set out by the owner. All personnel are responsible for ensuring that regulations are observed.

Certain parts such as the rotor and propeller rotate during operation in order to pump the fluid. Certain materials can cause very sharp edges on these parts.

Beware of rotating parts

The moving parts can crush and sever limbs. Never reach into the pump unit or the moving parts during operation. Switch off the machine and let the moving parts come to a rest before maintenance or repair work.



Operating procedure

Our products are equipped with various safety and control devices. These include, for example suction strainers, thermo sensors, sealed room monitor etc. These devices must never be dismantled or disabled.

Equipment such as thermo sensors, float switches, etc. must be checked by an electrician for proper functioning before start-up (see the "Electrical Connection" data sheet). Please remember

Safety and control devices

that certain equipment requires a relay to function properly, e.g. posistor and PT100 sensor. This relay can be obtained from the manufacturer or a specialist electronics dealer.

Staff must be informed of the installations used and how they work.

Caution

Never operate the machine if the safety and monitoring devices have been removed or damaged, or if they do not work.

Operation in an explosive atmosphere

Products marked as explosion-proof are suitable for operation in an explosive atmosphere. The products must meet certain guidelines for this type of use. Certain rules of conduct and guidelines must be adhered to by the operator as well.

Products that have been approved for operation in an explosive atmosphere are labeled as explosion-protected "Ex" (e.g. T...Ex...). In addition, an "Ex" symbol must be included on the type plate! When used in an explosive atmosphere, the chapter entitled "Explosion protection according to the ...standard" must be observed!

Sound pressure

Depending on the size and capacity (kW), the products produce a sound pressure of approximately 70 dB (A) and 110 dB (A).

The actual sound pressure, however, depends on several factors. These include, for example, the installation type (wet, dry, transportable), fastening of accessories (e.g. suspension unit) and pipeline, operating site, immersion depth, etc.

Once the product has been installed, we recommend that the operator make additional measurements under all operating conditions.



Caution: Wear ear protectors

In accordance with the laws in effect, guidelines, standards and regulations, ear protection must be worn if the sound pressure is greater than 85 dB (A)! The operator is responsible for ensuring that this is observed!

Pumped fluids

Each pumped fluid differs in regard to composition, corrosiveness, abrasiveness, TS content and many other aspects. Generally, our products can be used for many applications. For more precise details, see chapter 3, the machine data sheet and the order confirmation. It should be remembered that if the density, viscosity or the general composition change, this can also alter many parameters of the product.

Different materials and impeller shapes are required for different pumped fluids. The more exact your specifications on your order, the more exactly we can modify our product to meet your requirements. If the area of application and/or the pumped fluid change, please inform us of this so that we can adapt the product to the new circumstances.

When switching the product into another pumped fluid, observe the following points:

- Products which have been operated in sewage or waste water must be thoroughly cleaned with pure water or drinking water before use.
- Products which have pumped fluids which are hazardous to health must always be decontaminated before changing to a new fluid. Also clarify whether the product may be used in a different pumped fluid.
- With products which have been operated with a lubricant or cooling fluid (such as oil), this can escape into the pumped fluid if the mechanical shaft seal is defective.



Danger - explosive fluids

It is absolutely prohibited to pump explosive liquids (e.g. gasoline, kerosene, etc.). The products are not designed for these liquids!

This chapter contains the general information on the warranty. Contractual agreements have the highest priority and are not superseded by the information in this chapter! *Warranty*

The manufacturer is obliged to correct any defects found in the products it sells, provided that the following requirements have been fulfilled:

- The defects are caused by the materials used or the way the product was manufactured or designed. *General information*
- The defects were reported in writing to the manufacturer within the agreed warranty period.
- The product was used only as prescribed.
- All safety and control devices were connected and inspected by authorized personnel.

If no other provisions have been made, the warranty period applies to the first 12 months after initial start-up or to a max. of 18 months after the delivery date. Other agreements must be made in writing in the order confirmation. They will remain valid at least until the agreed warranty period of the product has expired. *Warranty period*

Only original spare parts as supplied by the manufacturer may be used for repairs, replacements, add-ons and conversions. Only these parts guarantee a long working life and the highest level of safety. These parts have been specially designed for our products. Self-made add-ons and conversions or the use of non-original spare parts can seriously damage the product and/or injure personnel. *Spare parts, add-ons and conversions*

The prescribed maintenance and inspection work should be carried out regularly. This work may only be carried out by qualified, trained and authorized personnel. **The maintenance and inspection log supplied must be properly updated.** This enables you to monitor the status of inspections and maintenance work. Quick repairs not listed in this operation and maintenance manual and all types of repair work may only be performed by the manufacturer and its authorized service centers. *Maintenance*

The machine operator list **must** be filled out completely. By signing this list, all persons working on or with the product confirms that they have received, read and understood this operating and maintenance manual. *List of machine operators*

Damage as well as malfunctions that endanger safety must be eliminated immediately by authorized personnel. The product should only be operated if it is in proper working order. During the agreed warranty period, the product may only be repaired by the manufacturer or an authorized service workshop! The manufacturer reserves the right to recall the damaged product to the factory for inspection! *Damage to the product*

No liability will be assumed for product damage if one or more of the following points applies: *Exclusion from liability*

- Incorrect design on our part due to faulty and/or incorrect information provided by the operator or customer
- Non-compliance with the safety instructions, the regulations and the requirements set forth by German law and this operating and maintenance manual
- Incorrect storage and transport
- Improper assembly/dismantling
- Improper maintenance
- Unqualified repairs
- Faulty construction site and/or construction work
- Chemical, electrochemical and electrical influences
- Wear

This means the manufacturer's liability excludes all liability for personal, material or financial injury.

3 Product description

The machine is manufactured with great care and is subject to constant quality controls. Trouble-free operation is guaranteed if it is installed and maintained correctly.

Axial machines are suspended directly in the discharge pipe. They are used to pump large amounts of pure, river, raw and cooling water, pre-cleaned waste water or activated sludge up small elevations.

Proper use and fields of application

Axial machines with T motors are installed wet.

Use in siphoning mode is not permitted. The machine must be submerged in pumped liquid at least up to the top of the machine housing.

The machine can be used to pump water of all contamination levels. In the standard version, the pumped liquid has a permitted maximum density of 1050 kg/m³ and a maximum viscosity of approx. 1x10⁻⁶ m²/s. Additionally, special models are also available for use with abrasive and corrosive liquids. For information on these models, please consult the manufacturer. The exact details about your machine version can be found in the technical data.

Conditions of use

The machine is operated from the operating position intended for this purpose or by using the relay supplied.

The machine can only be operated in the “wet” installation type. Please also note the appropriate information on operating mode and minimum water coverage.

Please also note that this machine is not self-suctioning, meaning that the propeller must always be surrounded by liquid in order to pump.

The machine consists of the motor, guide housing and intake funnel as well as the corresponding propeller wheel.

Construction

The shaft and screw connections are made of stainless steel. The three-phase asynchronous motor consists of a stator in the “F” or “H” insulation class as well as the motor shaft with rotor package. The power supply cable is designed for the maximum mechanical load and is sealed against water pressure from the pumped liquid. The motor cable lead connections are sealed from the pumped liquid as well. The bearings used are permanently lubricated maintenance-free antifriction bearings.

Motor

The pumped liquid is supplied optimally to the propeller blades through the intake funnel. The two-part stationary wear ring is rotated spherically and allows a minimal gap between the blades and the ring. Both parts of the ring can be replaced when worn. The guide housing diverts the flow past the sealing chamber and motor. The outer and inner parts of the guide housing are connected to each other by the guide blades. The complete unit is found in a pipe / pit.

Axial pump

The motor is equipped with temperature sensors. These protect the motor from overheating. The sealing chamber can optionally be equipped with a sealing chamber electrode. This switches the machine off when the water reaches an impermissible level in the sealing chamber chamber. In addition, the machine is equipped with an electrode for motor chamber and terminal chamber monitoring. Depending on the connection, a warning signal can be displayed and/or the machine switched off if water enters the motor chamber, terminal chamber or the sealing housing.

Safety and monitoring devices

Details of the safety and monitoring devices used and how to connect these can be found in the “Electrical connection plan” data sheet.

The sealing chamber is integrated in the guide housing and is filled with medicinal white oil, which ensures a long-lasting lubrication of the sealing.

Sealing housing

Product description

Sealing

The sealing between the pump and motor is made by two mechanical shaft seals or a stainless steel block seal cartridge. The sliding and counter rings of the mechanical shaft seals are made from silicon carbide.

Propeller wheel

The propeller is fastened on the rotor shaft of the motor and is driven directly. The propeller blade angle can be adjusted using a setting washer.

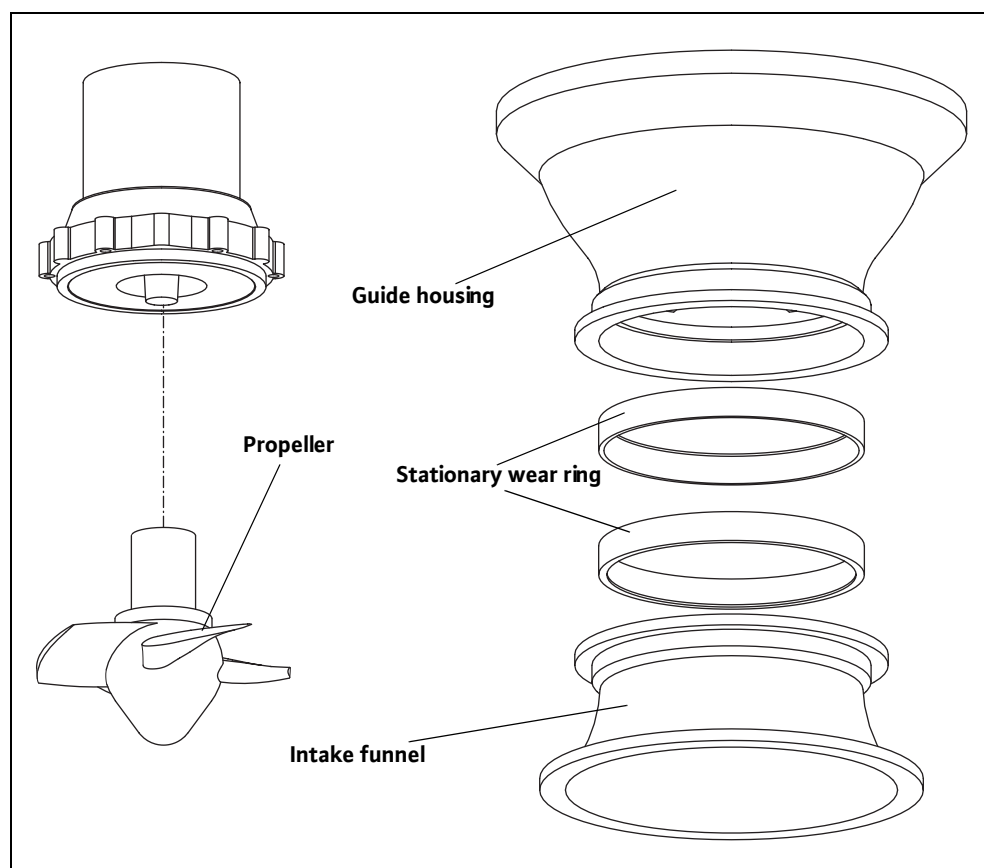


Fig. 3-1: Propeller wheel

Machine structure

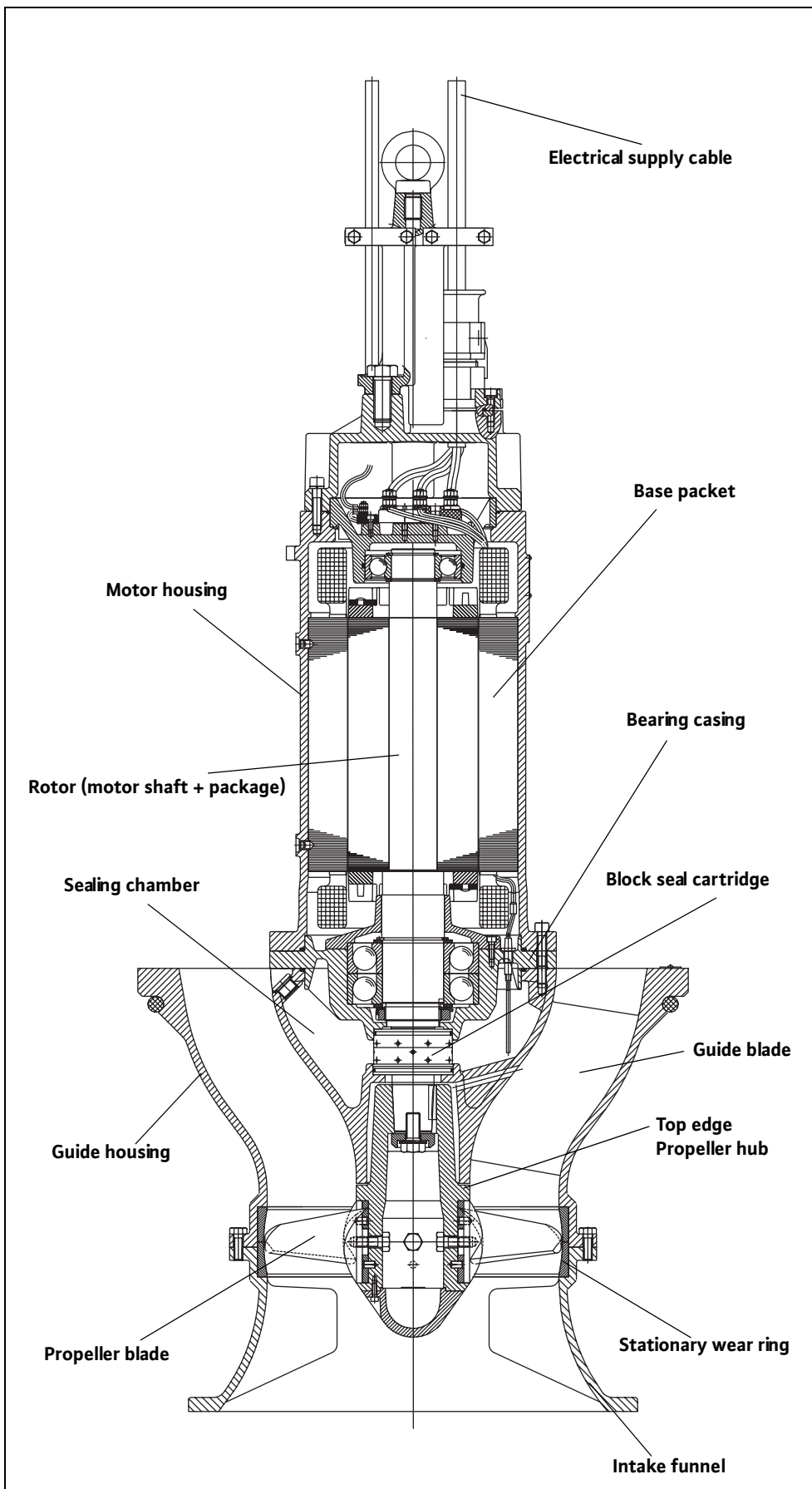


Fig. 3-2: Machine structure

Product description

Type designation

The type code provides information about the design of the machine.

Example pump: KPR340-6°	
KPR	Propeller submersible motor pump
340	Propeller diameter
6°	Propeller angle
Example motor: T 24-4/36P Ex	
T	Motor type
24	Package diameter
4	Number of poles
36	Package length in cm (rounded)
P	Motor for KPR
Ex	Ex-approval

Table 3-1: Type designation

Cooling

The T motor is a dry runner. This means that the motor chamber is filled with air. The heat escapes through the housing parts. These transfer the heat to the pumped liquid. Note the following information:

The machine must be immersed up to the top edge of the propeller hub.

Name plate

Symbol	Name	Symbol	Name
P-Type	Pump type	MFY	Year of manufacture
M-Type	Motor type	P	Rated power
S/N	Machine number	F	Frequency
Q	Pump flow	U	Rated voltage
H	Pump head	I	Rated current
N	Speed	I _{ST}	Starting current
TPF	Temperature of pumped fluid	SF	Service factor
IP	Protection class	I _{SF}	Current at service factor
OT	Operating mode (s = wet / e = dry)	MC	Motor wiring
Cos φ	Cosine phi	∇	Max. submersion
IMφ / S	Impeller diameter/number of levels		

Table 3-2: Name plate key

4 Transport and storage

On arrival, the delivered items must be inspected for damage. Also check that all parts are present. If any parts are damaged or missing, the transport company or the manufacturer must be informed on the day of delivery. Claims made after this date cannot be recognized. Any damage must be noted on the delivery or consignment note.

Delivery

Only the appropriate and approved fastening devices, transportation means and lifting gear may be used. These must have sufficient load bearing capacity to ensure that the product can be transported safely. If chains are used they must be secured against slipping.

Transport

The personnel must be qualified for the tasks and must follow all applicable national safety regulations during the work.

The product is delivered by the manufacturer or shipping agency in suitable packaging. This normally precludes the possibility of damage occurring during transport and storage. The packaging should be stored in a safe place for reuse if the product is frequently used at different locations.

Beware of frost!

If drinking water is used as a coolant/lubricant, the product must be protected against frost during transport (minimum temperature +3 °C). If this is not possible, the product must be drained and dried out.

Newly supplied products are prepared so that they can be stored for at least 1 year. The product should be cleaned thoroughly before it is put into temporary storage.

Storage

The following should be observed for storage:

- Place the product on a firm surface and secure it against falling over. Submersible mixers and pressure shroud pumps should be stored horizontally; waste water and sewage pumps, submersible sewage pumps, and submersible motor pumps should be stored vertically. Submersible motor pumps can also be stored horizontally. Ensure that they cannot bend if stored horizontally. Otherwise excessive bending tension may arise.

Danger from falling over!

Never set down the product unsecured. If the product falls over, injury can occur!



- Our products can be stored at temperatures down to -15°C. The store room must be dry. We recommend a frost-protected room with a temperature of between 5°C and 25°C for storage.

Products that are filled with drinking water must be stored in rooms with an ambient temperature of between +3 °C and +40 °C. If this is not possible, they must be drained and dried out!

- The product may not be stored in rooms where welding work is conducted as the resulting gases and radiated heat can damage the elastomer parts and coatings.
- Any suction or pressure connections on products should be closed tightly before storage to prevent impurities.
- The power supply cables must be protected against kinking, damage and moisture.



Electrical hazard!

Damaged power supply cables can cause fatal injuries! Defective cables must be replaced by a qualified electrician immediately.

Beware of moisture!

Moisture penetrating cables can damage the cables and render them useless. Therefore, never immerse cable ends in the pumped liquid or other liquids.

- The machine must be protected from direct sunlight, heat, dust, and frost. Heat and frost can cause considerable damage to propellers, rotors and coatings!
- The rotors or propellers must be rotated at regular intervals. This prevents the bearing from locking, and the film of lubricant on the mechanical shaft seal is renewed. This also prevents the gear pinions (if present on the product) from locking and also renews the lubricating film on the gear pinions (preventing rust film deposits).



Beware of sharp edges!

Sharp edges can form on rotors and propellers. There is a risk of injury! Wear protective gloves.

- If the product has been stored for a long period of time it should be cleaned of impurities such as dust and oil deposits before start-up. Rotors and propellers should be checked for smooth operation. The housing coatings should be checked for damage.

Before start-up, the filling levels (oil, motor filling etc) of the individual products should be checked and topped up if required. Products that are to be filled with drinking water must be completely filled before start-up if necessary. Please refer to the machine data sheet for specifications on filling.

Damaged coatings should be repaired immediately. Only a coating that is completely intact fulfills the criteria for the intended use.

If these rules are observed, your product can be stored for a lengthy period. Please remember that elastomer parts and coatings become brittle over time. If the product is to be stored for longer than 6 months, we recommend checking these parts and replacing them as necessary. Consult the manufacturer for details.

Return delivery

Products which are returned to the plant must be clean and correctly packaged. In this context, clean means that impurities have been removed and decontaminated if the products have been used with materials which are hazardous to health. The packaging must protect the product against damage. If you have any questions please contact the manufacturer.

5 Installation

In order to prevent damage to the machine or serious injury during installation the following points must be observed:

- Installation work – assembly and installation of the machine – may only be carried out by qualified persons. The safety instructions must be followed at all times.
- The machine must be inspected for transport damage before any installation work is carried out.

After pumping water containing lime, clay or cement, flush out the machine with clean water in order to prevent encrustation and subsequent breakdowns.

If you are using level control, make sure that the minimum water coverage is present. Air pockets in the pipeline system must be avoided at all costs and must be removed using a suitable ventilation system. Protect the machine from frost.

General information

Possible types of vertical machine installation:

- Installation in pipes with underground discharge
- Installation in pipes in covered intake chambers
- Installation in pipe overflow models

Installation types

The operating area must be laid out for each machine. You must ensure that lifting gear can be fitted without any trouble, since this is required for assembly and removal of the machine. It must be possible to safely reach the machine in its operating and storage locations using the hoisting gear. The machine must be located on a firm foundation.

The operating area

Electric power cables must be laid out in such a way that safe operation and non-problematic assembly/dismantling are possible at all times.

The structural components and foundations must be of sufficient stability to ensure safe and functional operation. The operator or the supplier is responsible for the provision of the foundations and their accuracy in terms of dimensions, stability and strength.

Never let the machine run dry. Therefore, we recommend installing a level control unit or a dry-run protection system where there are great variations in the level.

Use guide and deflector plates for the pumped fluid intake. If the water jet reaches the surface of the water or the machine, air will be introduced into the pumped liquid. This will lead to unfavorable current and pumping conditions. As a result, the machine does not run smoothly and is subjected to higher wear and tear.

Assembly accessories

The maximum bearing capacity must be greater than the weight of the machine, add-on units and cable. It is essential that the machine can be lifted and lowered without hindrance or endangering personnel. There should be no objects or obstacles in the swiveling range of the hoisting gear.

Swiveling hoisting gear

The electric power cables should be fastened properly to the pipeline with cable holders or other suitable equipment. This should prevent loose hanging and damage to the electric power cables. Depending on the cable length and weight, a cable holder should be fitted every two to three meters.

Cable holders

Make sure you have the required tools (such as wrenches) and other material (such as plugs and anchor bolts). The fastening materials should be sufficiently stable to ensure safe assembly.

Fixing materials and tools

The following information should be taken into consideration when installing the machine:

Installation

- This work may only be carried out by qualified personnel. Electrical work may only be carried out by qualified electricians.
- Lift the machine by the handle or lifting eyelets, never by the the power supply cable. When assembling with chains, they must be connected with a shackle to the lifting eyelets or the carrying handle. Fastening devices must have official approval.
- Please observe all guidelines, rules and legal requirements for working with and underneath heavy suspended loads.
- Wear the appropriate protective clothing/equipment.
- If there is danger that poisonous or asphyxiating gases may collect, then the necessary counter-measures should be taken.
- Please also observe all accident prevention guidelines, trade association safety guidelines and the advice contained in this operating and maintenance manual.
- The coating of the machine is to be examined before installation. If defects are found, these must be eliminated.

An intact coating is necessary for the best possible protection from corrosion.



Danger of falling!

Installation work for the machine and its accessories is performed directly on the edge of the basin. Carelessness or wearing inappropriate clothing could result in a fall. There is a risk of fatal injury! Take all necessary safety precautions to prevent this.

- 1 Lower the pump into the steel pipe or concrete pit.
- 2 Ensure that the pump lies correctly on the support ring and is centered on the tapered ring.
- 3 The round cord ring on the guide housing seals the intake and discharge sides apart from each other after the centering process.
- 4 The cables within a pipe shaft should be guided through the bolted connection and clamped so that they do not strike against the pipe walls during operation.
- 5 The chain should be tightened without raising the machine.

Installation

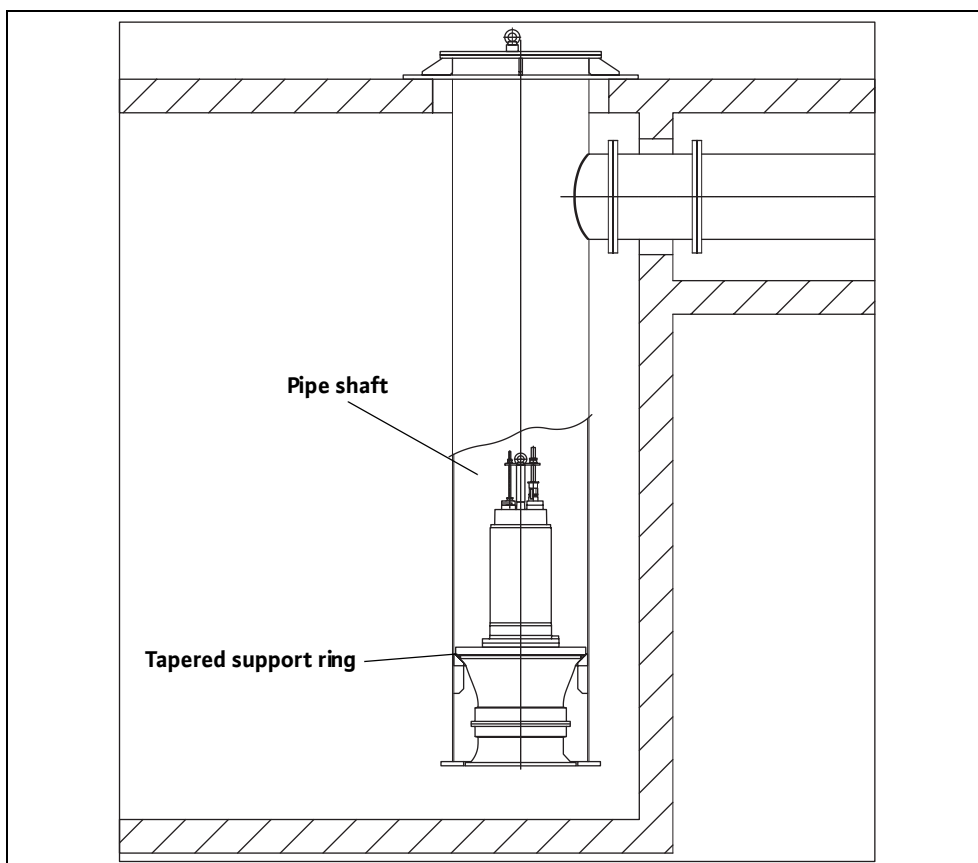


Fig. 5-1: Installation in pipes with underground discharge

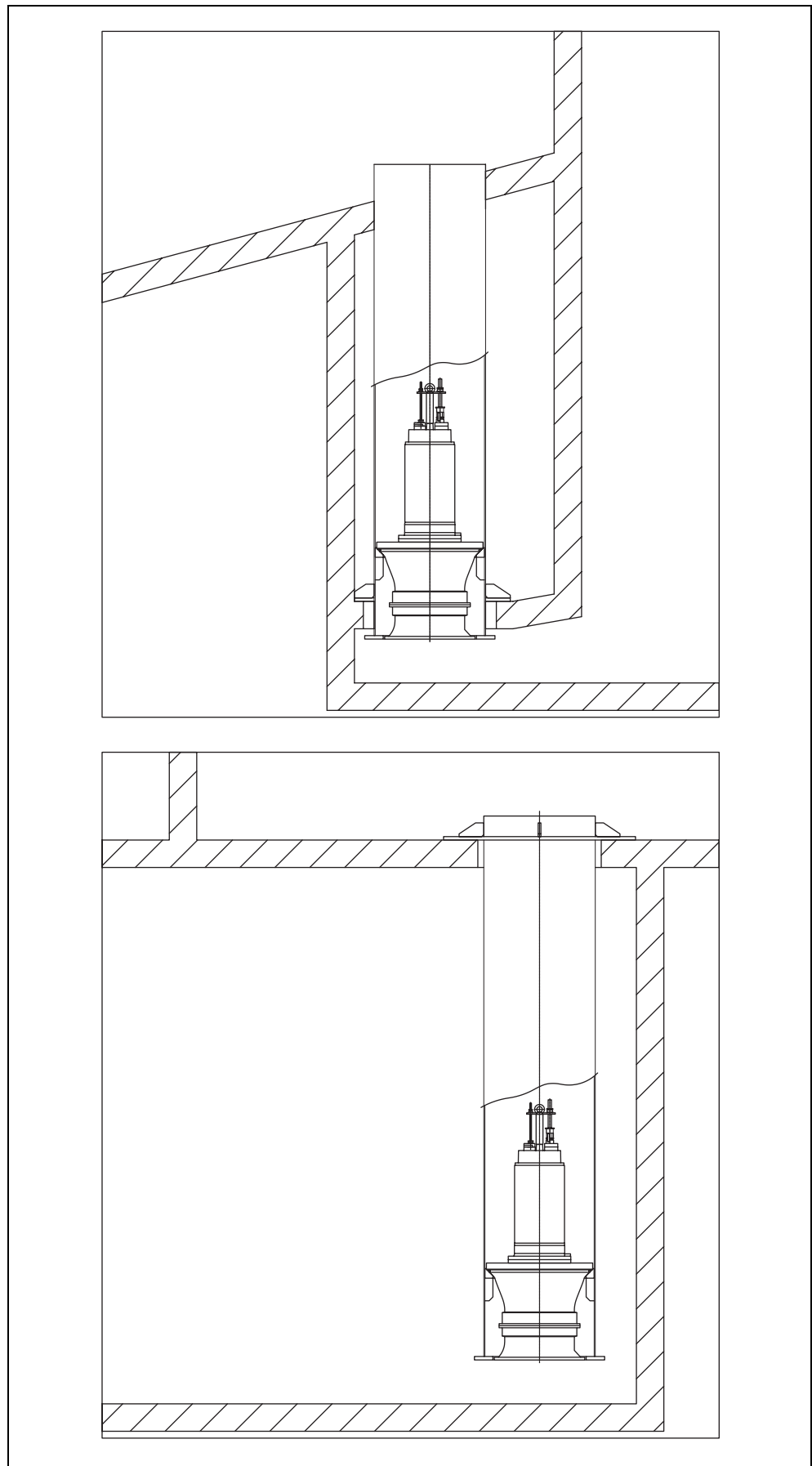


Fig. 5-2: Installation in pipes in covered intake chambers and pipe overflow models

The machine must always be immersed up to the top edge of the propeller hub.

For optimum reliability, we recommend installing a dry-run protection system. Correct running is ensured by float switches or electrodes. The float switch / electrode is fastened in the pit and switches off the machine when the water level falls below the minimum coverage level.

Please observe the information about the minimum water coverage.

If dry-run protection is only put into effect with one float or electrode when filling levels deviate strongly, then the machine may turn on and off constantly!

This can result in the maximum number of motor start-ups being exceeded.

Dry-run protection

Corrective measures

The motor is switched off when the water level falls below the minimum coverage level and switched back on when a sufficient water level is reached.

Manual reset

Using a second switching point (additional float or electrode), a sufficient difference is obtained between the activation and deactivation points. This prevents constant switching. This function can be put into effect with a level control relay.

Separate reactivation point

When removing the machine, make sure that it is first disconnected from the mains.

Removal

The machine is raised out of the pit by the chain or lifting cable with the help of a hoisting gear. This does not have to be emptied especially for this purpose. Make sure the power supply cable does not become damaged.

Beware of poisonous substances!

Machines which pump fluids hazardous to health present a fatal risk. These machines must be decontaminated before any other work is carried out. Wear the necessary protective clothing/equipment when doing so.



6 Startup

The "Startup" chapter contains all the important instructions for the operating personnel for starting up and operating the machine safely.

The following specifications must be adhered to and checked:

- Type of installation
- Operating mode
- Minimum water coverage / max. submersion

If the machine has not been operated for some time, check these specifications again and rectify any faults you find.

The operation and maintenance handbook must always be kept either by the machine or in a place specially reserved for it where it is accessible for operating personnel at all times.

In order to prevent damage or serious injury during startup of the machine, the following points must be observed:

The machine may only be started up by qualified personnel. The safety advice must be followed at all times.

- Every person working on the machine must have received, read and understood this operating and maintenance manual. This must also be confirmed with a signature in the machine operator list.
- Activate all safety devices and emergency stop elements before startup.
- Electrical and mechanical settings may only be made by specialists.
- This machine may only be used under the working conditions specified in this handbook.

The machine has been designed and constructed using the very latest technology. Under normal working conditions it will operate reliably and for long periods. The one condition for this is that all instructions and advice are observed.

Minor oil leakage in the mechanical shaft seal on delivery is no cause for concern. However, it must be removed prior to submersion in the pumped liquid.

Please check the following:

- Cable guidance – no loops, slightly taut
- Check the temperature of the pumped liquid and the submersion depth – see machine data sheet
- Clean the pump sump
- Clean the pipeline system on the discharge and intake side, and open all sliders
- The guide housing must be flooded, i.e. it should be completely filled with liquid
- Check that all accessories, the pipeline system and the clamping system are properly fitted
- Check all level control and dry-run protection systems

An insulation test and filling level check must be carried out prior to start-up, as described in chapter 7.

Preparatory measures

Observe the relevant local and national regulations when laying out and selecting the electric lines as well as when connecting the motor. The motor must be protected by a motor protection switch. Have the motor connected in accordance with the "Electrical connection" data sheet. Pay attention to the direction of rotation. Using an incorrect direction of rotation will damage the machine. In accordance with the machine data sheet, check the operating voltage and make certain that the current consumption remains uniform during all phases.

Electrical system

Make sure that all temperature sensors and monitoring devices, such as the moisture sensors, are connected and that their functionality is tested. For more details, see the “Electrical connection plan” data sheet.



Beware of electrical current!

**Electrical current can cause fatal injuries if not handled correctly!
All machines with free cable ends (i.e. without plugs) must be connected by a qualified electrician.**

Direction of rotation

The machine must be connected in accordance with the “Electrical connection plan” data sheet. The direction of rotation is controlled by a rotating field tester. This tester is switched on when the pump is connected and displays the rotation direction of the rotating field. There must be a clockwise rotating field for the machine to run correctly.

If a counter-clockwise rotating field is displayed, two phases must be replaced.

Ensure the direction of rotation is correct!

A clockwise rotating field is necessary. Using an incorrect direction of rotation will damage the machine!

Motor protection and activation types

Motor protection

The minimum requirement is a thermal relay / motor protection switch with temperature compensation, differential triggering and an anti-reactivation device in accordance with VDE 0660 or the appropriate national regulations. If the machines are connected to electrical systems in which faults frequently occur, we recommend installing additional protective devices (overvoltage, undervoltage or phase failure relays, lightning protection). Local and national regulations must be adhered to when connecting the machine.

Activation types for cables with free ends (without plugs)

Direct activation

Motor protection should be set to the rated current when fully loaded. At partial load, we recommend that motor protection is set 5% above the measured current at the operating point.

Star-delta activation

If the motor protection is installed in the line:

Set the motor protection to 0.58 x the rated current. The maximum start-up time in star-delta mode is 3 seconds.

If the motor protection is not installed in the line:

Set the motor protection to the rated current when fully loaded.

Starting transformer/soft start

Motor protection should be set to the rated current when fully loaded. At partial load, we recommend that motor protection is set 5% above the measured current at the operating point. The maximum start-up time at reduced voltage (approx. 70%) is 3 seconds.

Operation with frequency transformers

The machine can be operated on frequency transformers.

Observe the data sheet in the appendix of this manual.

Activation types with plugs / relays

Units with plugs

Connect the plug to the socket provided and press the On/Off switch on the relay.

Please observe the relay manual.*Units with relays*

The rated current is briefly exceeded during the start-up procedure. Once this process has ended, the operating current should no longer exceed the rated current.

After starting

If the motor does not start immediately after the machine is switched on, it must be switched off immediately. The start pauses specified in the technical data must be adhered to before starting up again. If the fault recurs, the machine must be switched off again immediately. The machine may only be started again once the fault has been rectified.

The following items should be monitored:

- Operating voltage (permissible deviation +/- 5% of the rated voltage)
- Frequency (permissible deviation +/-2% of the rated frequency)
- Current consumption (permissible deviation between phases is a maximum of 5%)
- Voltage difference between the individual phases (max. 1%)
- Starts and stops per hour (see technical data)
- Air entry in the infeed, a deflector plate should be fitted if necessary
- Minimum water immersion level, level control unit, dry-run protection
- Smooth running
- Check for leaks, if need be, follow the necessary steps as set out in "Maintenance"

As mechanical shaft seals have a certain running-in phase, it is possible that minor leaks may occur. This running-in phase lasts approx. 1 - 3 months. Change the oil several times during this phase. Please consult the manufacturer if leakage continues after this running-in phase has ended.

The maximum limit range deviation for operational data is +/- 10% of the rated voltage and +3% to -5% of the rated frequency. Significant deviation from the operational data is to be expected (also see DIN VDE 0530, Section 1). The permissible voltage difference between the individual phases is a maximum of 1%. Continuous operation in the limit range is not recommended.

Operation in the limit range

7 Maintenance

The machine and the entire system must be inspected and maintained at regular intervals. The time limit for maintenance is set by the manufacturer and applies to the general conditions of use. The manufacturer should be consulted if the system is to be used with corrosive and/or abrasive pumped liquids, as the time limit between inspections may need to be reduced.

Note the following information:

- The operating and maintenance manual must be available to the maintenance personnel and its instructions followed. Only the repair and maintenance measures listed here may be performed.
- All maintenance, inspection and cleaning work on the machine and the system may only be carried out by trained specialists exercising extreme care in a safe workplace. Proper protective clothing is to be worn. The machine must be disconnected from the electricity supply before any work is carried out. There must be no way that it can be inadvertently switched on. Additionally, the appropriate protective measures as defined by the BGV/GNV should be enforced when working in basins and/or containers.
- Above a weight of 50kg, only hoisting gear which has been officially approved and which is in a technically perfect condition should be used for lowering and raising the machine.

Make sure that all fastening devices, ropes and safety devices of the hand winch are in a technically perfect condition. Work may only commence if the auxiliary hoisting gear has been checked and found to be in perfect working order. If it is not inspected, danger to personnel may result.

- Electrical work on the machine and system must be carried out by an electrician. For machines approved for work in areas subject to explosion danger, please refer to the "Explosion protection in accordance with the regulation" chapter. Defective fuses must be replaced. Under no circumstances are they to be repaired. Only fuses at the specified current and of the prescribed type may be used.
- When working with inflammable solvents and cleaning agents, fires, unshielded lighting and smoking are prohibited.
- Machines which circulate fluids hazardous to health, or which come into contact with them, must be decontaminated. It must be ensured that no dangerous gases can form or are present.

If injuries involving hazardous pumping liquids or gases occur, first-aid measures must be performed in accordance with the notices in the workplace and a doctor should be called immediately.

- Ensure that all necessary tools and materials are available. Tidiness and cleanliness guarantee safe and problem-free operation of the machine. After working on the machine all cleaning materials and tools should be removed from it. All materials and tools should be stored in an appropriate place.
- Operating supplies such as oil and lubricants must be collected in appropriate vessels and properly disposed of (in accordance with the 75/439/EEC directive and with §§5a, 5b AbfG). Appropriate protective clothing is to be worn for cleaning and maintenance jobs. This is to be disposed of in accordance with waste code TA 524 02 and EC Directive 91/689/EEC. Only lubricants expressly recommended by the manufacturer may be used. Oils and lubricants should not be mixed. Only use genuine parts made by the manufacturer.

A trial run or functional test of the machine must be performed as instructed in the general operating conditions.

Lubricants

You will find an overview of the lubricants used below:

Manufacturer	Gear oil (DIN 51 519 /ISO VG 220 Type CLP)	Transformer oil (DIN 57370 /VDE 0370)	White oil
Aral	Degol BG 220	Isolan T	Autin PL*
Shell	Omala 220	Diala D	ONDINA G13*, 15*, G17*
Esso	Spartan EP 220	UNIVOLT 56	MARCOL 52*, 82*
BP	Energol GR-XP 220	Energol JS-R	Energol WM2*
DEA	Falcon CLP 220	Eltec GK 2	
Texaco	Meropa 220	KG 2	Pharmaceutical 30*, 40*
ELF mineral oil		TRANSFO 50	ALFBELF C15
Tripol	Food Proof 1810/220*		

Table 7-1: Lubricant overview

The following can be used as grease in accordance with DIN 51818/NLGI class 3:

- Esso Unirex N3
- Tripol Molub-Alloy-Food Proof 823 FM*

When using white oil, note the following:

- The machine lubricants may only be topped up or replaced with lubricants from the same manufacturer.
- Machines which have previously been operated using other lubricants must first be thoroughly cleaned before they can be operated using white oil.

Lubricants which are approved for use with foodstuffs in accordance with USDA-H1 are marked with an asterisk.

The specified lubricants are used in the motor chamber and/or sealing chamber.

Maintenance intervals

Overview of the maintenance intervals needed:

Before initial start-up or after a longer period of storage

- Checking the insulation resistance
- Fill level check in sealing room/chamber – lubricant must reach up to the lower edge of the filling opening

Monthly

- Monitoring the current consumption and voltage
- Checking the used relays for posistors, sealing room monitor, etc.

Every six months

- Visual inspection of the power supply cable
- Visual inspection of the cable holder and the cable bracing
- Visual inspection of accessories, e.g. the suspension device and hoisting gears

8,000 operating hours or after two years, whichever is earlier

- Checking the insulation resistance
- Changing the lubricant in the sealing room/chamber
- Emptying the leakage chamber (not present in all models)
- Functional inspection of all safety and control devices

- Coating check and touch-up as required
- General overhaul

If it is used in highly abrasive or corrosive material, the maintenance intervals should be reduced by 50%!

15,000 operating hours or after five years, whichever is earlier

Overview of the individual maintenance intervals:

Maintenance tasks

The current consumption and voltage is to be monitored periodically during all 3 phases. This remains constant during normal operation. Slight fluctuations are a result of the composition of the pumped fluid. The current consumption can assist in early detection and correction of damage and/or faulty operation in the impeller/propeller, bearings and/or the motor. More extensive resulting damage can thus be largely prevented and the risk of a total failure can be reduced.

Monitoring the current consumption and voltage

Check the relays used are functioning fault-free. Defective devices must be immediately replaced, because these cannot ensure safe operation of the machine. The test procedure details should be followed closely (in the operating instructions for each relay).

Checking the used relays for pistons, sealing room monitor, etc.

To check the insulation resistance, the power supply cable must be disconnected. The resistance can then be measured with an insulation tester (measuring voltage = 1000V DC). The following values may not be exceeded:

Checking the insulation resistance

The insulation resistance may not be below 20mega-ohms during initial operation. For all further measurements the value must be greater than 2mega-ohms.

Insulation resistance too low: Moisture may have penetrated the cable and/or the motor.

Do not connect the machine, consult manufacturer.

The power supply line must be examined for bubbles, cracks, scratches, chafed areas and/or crushed sections. If damage is found, the power cable must be exchanged immediately.

Visual inspection of the power supply cable

The cables may only be changed by the manufacturer or an authorized/certified service workshop. The machine may not be used again until the damage has been adequately rectified.

When the machine is used in basins or pits, the lifting cables/cable holders (carabiners) and the cable bracing are subject to constant wear. Regular inspections are necessary in order to prevent the lifting cables/cable holders (carabiners) and/or cable bracing from wearing out and to prevent the electricity cable from being damaged.

Visual examination of the cable holders (carabiners) and the cable bracing

The lifting cables/cable holders (carabiners) and the cable bracing are to be immediately replaced if any signs of wear appear.

Inspect accessories such as suspension units and hoisting gear to check whether they are secured in a stable manner. Loose and/or defective accessories should be repaired immediately or replaced.

Visual inspection of accessories

Monitoring devices are temperature sensors in the motor, sealing room monitors, motor protection relays, overvoltage relays, etc.

Functional inspection of safety and control devices

Motor protection and overvoltage relays and other trip elements can generally be triggered manually for test purposes.

To inspect the sealing room monitor or the temperature sensor, the machine must be cooled to ambient temperature and the electrical supply cable of the monitoring device in the switch cabinet must be disconnected. The monitoring device is then tested with an ohmmeter. The following values should be measured:

Bi-metal sensor: Value = "0" - throughput

PTC sensor: A PTC sensor has a cold resistance of between 20 and 100ohms. For 3 sensors in series this would result in a value of between 60 and 300ohms.

PT 100 sensor: PT 100 sensors have a value of 100ohms at 0°C. Between 0°C and 100°C this value increases by 0.385ohms per 1°C. PT 20 sensors have a value of 107.7ohms at 20°C.

Moisture sensor: This value must approach infinity. If there is a low value, there may be water in the oil. Also observe the instructions of the optionally available evaluation relay.

In the case of larger deviations, please consult the manufacturer.

Please consult the appropriate operating manual for details on inspecting the safety and monitoring devices on the auxiliary lifting gear.

General overhaul

During this the bearings, shaft seals, O rings and power supply cables are inspected and replaced as required in addition to normal maintenance work. This work may only be conducted by the manufacturer or an authorized service workshop.

Changing the lubricant

The drained lubricant must be checked for dirt and water content. If the lubricant is very dirty and contains more than 1/3 water, it must be changed again after four weeks. If there is again water in the lubricant then, it seems likely that a seal is defective. In this case, please consult the manufacturer.

If a sealing room or leakage monitoring system is being used, the display will light up again within four weeks of changing the lubricant if a seal is defective.

The general procedure for changing lubricants is as follows:

Switch off the machine, let it cool down, disconnect it from the mains (have this done by an electrician), clean it and place it vertically on a solid base.

Warm or hot lubricants may be pressurized. The leaking lubricant may cause burns. For that reason, let the machine cool down to ambient temperature before you touch it.

Secure it from falling over and/or slipping. For certain housing coatings (e.g. Ceram C0) the plugs are protected with plastic covers. These must be removed and put back on after a successful lubricant change. They must be lined with an acid-resistant sealant (such as SIKAFLEX 11FC).

Sealing chamber

As there are several versions and designs of these motors, the exact location of the screw plugs varies depending on the pump unit used.

- 1 Slowly and carefully remove the filling plug (D+) from the sealing room.

Caution: The lubricant may be pressurized.

- 2 Remove the drain plug (D-). Drain the lubricant and collect it in a suitable reservoir. Clean the drain plug, fit with a new sealing ring and screw it in again. For complete drainage, the machine must be slightly tipped on to its side.

Make sure that the machine cannot fall and/or slip away.

- 3 Fill lubricant by means of the opening in the filling plug (D+). Comply with the specified lubricants and filling quantities.
- 4 Clean the filling plug (D+), fit with a new sealing ring and screw it in again.

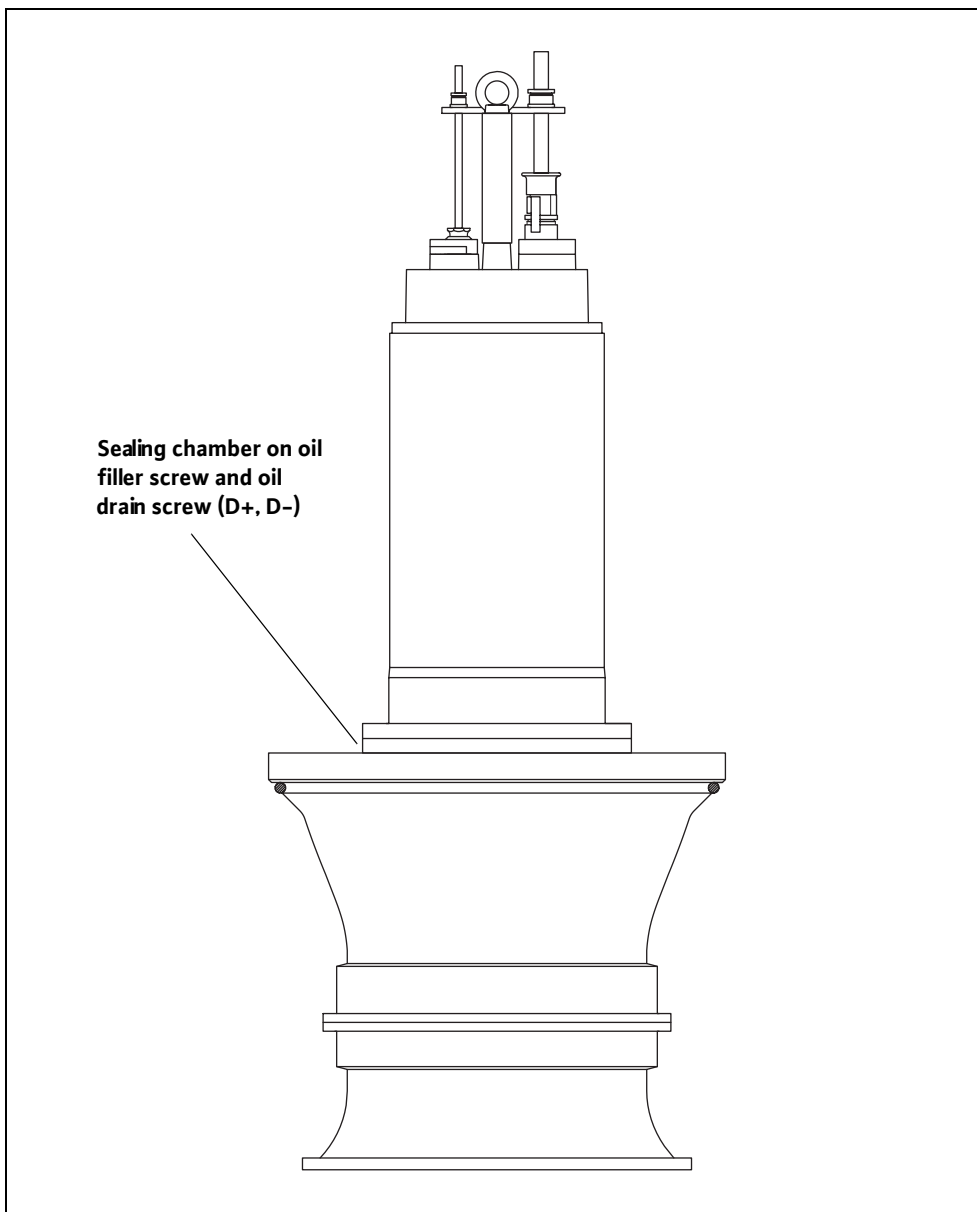


Fig. 7-1: Position of the screw plugs

The following repairs can be carried out on this machine:

- Changing the propeller
- Changing the stationary wear rings

Repairs

When carrying out repair work, the following information should always be observed:

- Round sealing rings as well as existing seals should always be replaced.
- Thread lockers such as spring washers or the self-locking Nord-Lock thread lockers should always be replaced.
- If no self-locking Nord-Lock thread lockers are used or it is not possible to use them, then screws made from A2 or A4 materials must be used. The correct torques must be observed.
- If self-locking Nord-Lock thread lockers are used, then only dacromet-coated screws (strength category 10.9) may be used.
- Never use brute force during this work.

In general, the following applies to repairs:

Switch off the machine, disconnect it from the mains (have this done by

an electrician), clean it and place it on a solid base in a horizontal position. Secure it from falling over and/or slipping. For certain housing coatings (e.g. Ceram C0) the screw plugs are protected with plastic covers. These must be removed and then replaced after a successful lubricant change. They must be lined with an acid-resistant sealant (e.g. SIKAFLEX 11FC).

Changing the propeller

- Loosen the screws on the guide housing and set it down with the spring washer.
- Carefully lift up the axial machine slightly using a suitable hoisting gear.
- Lightly tap the intake funnel using a rubber mallet until it comes free from the guide housing.
- Unscrew the three M5 hexagon socket screws and remove the propeller cap.
- Unscrew the M16 hexagon socket screw and set it down with the washer.
- Pull the propeller from the shaft. A tight propeller can be removed using a wheel puller or two pry bars.
- Assembly is carried out in the reverse order.

If required, new stationary wear rings should be used during propeller installation.

Changing the stationary wear ring

If this gap between the propeller blade and stationary wear ring is too large, then the performance of the machine decreases and/or it can lead to entanglements. The stationary wear ring is designed so that it can be replaced. This minimizes wear on the intake funnel and guide housing, which consequently reduces replacement part costs.

The correct manual for changing the stationary wear rings is supplied with the replacement part.

Changing the sealing parts

Changing the sealing parts on the liquid side (e.g. the block seal cartridge and the mechanical seal shaft) requires a certain amount of specialist knowledge about these sensitive components. Additionally, much of the machine must be dismantled in order to carry out the work.

Only original parts may be used for replacement.

Inspection and replacement of these parts is performed by the manufacturer during the general overhaul or by specially trained personnel.

For machines approved for work in explosive areas, please refer to the “Explosion protection in accordance with the regulation” chapter.

Torque values

Overview of the correct torques for dacromet-coated screws with Nord-Lock screw fixing

Thread	Tensile strength 10.9	
	Nm	kp m
M5	9.2	0.94
M6	15.0	1.53
M8	36.8	3.75
M10	73.6	7.50
M12	126.5	12.90
M16	316.3	32.24
M20	621.0	63.30
M24	1069.5	109.02
M27	1610.0	164.12

Table 7-2: Dacromet-coated screws with Nord-Lock screw fixing

Thread	Tensile strength 10.9	
	Nm	kp m
M30	2127.5	216.87

Table 7-2: Dacromet-coated screws with Nord-Lock screw fixing

Overview of the correct torques for rustproof screws without screw fixing:

Thread	Nm	kp m	Thread	Nm	kp m
M5	5.5	0.56	M16	135.0	13.76
M6	7.5	0.76	M20	230.0	23.45
M8	18.5	1.89	M24	285.0	29.05
M10	37.0	3.77	M27	415.0	42.30
M12	57.0	5.81	M30	565.0	57.59

Table 7-3: Rustproof screws without Nord-Lock screw fixing

8 Shutdown

This chapter provides an overview of the various ways to shut down the machine.

For this type of shutdown, the machine remains installed and is not cut off from the electricity supply. For temporary shutdown, the machine must remain completely submerged so that it is protected from frost and ice. Make sure the operating room and the pumped fluid cannot be covered by ice.

Temporary shutdown

This ensures that the machine is always ready for operation. During longer shutdown periods, carry out a regular (monthly to quarterly) function run for a period of 5 minutes.

Caution

Only carry out a function run under the proper conditions of operation and use (see “Product Description”). Never run the machine dry. This can result in irreparable damage!

Switch off the system, disconnect the machine from the electricity supply and dismantle and store it. Note the following information concerning storage:

Final shutdown / storage

Beware of hot parts!

When removing the machine, be careful of the temperature of the housing components. These can heat up to well above 40 °C. Let the machine cool down to ambient temperature before you touch it.



Caution!

You must ensure that products filled with drinking water are stored in a room with an ambient temperature of between 3 °C and 40 °C. If this is not possible, the motor filling fluid must be drained and the machine dried out.

- Clean the machine.
- Store it in a clean, dry place, protect the machine against frost.
- Place it down vertically onto a firm foundation and secure it against falling.
- Seal the intake and discharge ports of pumps with suitable material (such as foil).
- Support the electric connecting lead on the cable lead-in to help avoid a permanent deformation.
- Protect the ends of the electric power cable from moisture.
- Protect the machine from direct sunshine as a preventive measure against brittleness in elastomer parts and the propeller and casing coating.
- When storing the machine in a garage please remember: Radiation and gases which occur during electric welding destroy the elastomers of the seals.
- During lengthy periods of storage, regularly (for example every six months) turn the impeller or propeller by hand. This prevents indentations in the bearings and stops the rotor from jamming.
- See also the “Transport and storage” section.

Shutdown

Restarting after an extended period of storage

Before restarting the machine, clean it of dust and oil deposits. Then carry out the necessary maintenance actions (see “Maintenance”). Check that the mechanical shaft seal is in good order and working properly.

Once this work has been completed, the machine can be installed (see “Installation”) and connected to the electricity supply by a specialist. See “Startup” a for instructions on restarting.

Only restart the machine if it is in perfect condition and ready for operation.

9 Troubleshooting and possible solutions

In order to prevent damage or serious injury while rectifying machine faults, the following points must be observed:

- Only attempt to rectify a fault if you have qualified staff. This means each job must be carried out by trained specialist staff. For example, electrical work must be performed by a trained electrician.
- Always secure the machine against an accidental restart by disconnecting it from the mains. Take appropriate safety precautions.
- Always have a second person on hand to ensure the machine is switched off in an emergency.
- Secure moving parts to prevent injury.
- Unsanctioned changes to the machine are made at the operator's own risk and release the manufacturer from any warranty obligations.

Fault: The machine will not start

Cause	Solution
Electricity supply interrupted, short circuit or earth fault in the cable or motor windings	Have the motor and wires checked by a specialist and replaced if necessary
Fuses, the motor protection switch and/or monitoring devices are triggered	<p>Have a specialist inspect the connections and correct them as necessary</p> <p>Have the motor protection switches and fuses installed or adjusted according to the technical specifications, and reset monitoring equipment</p> <p>Check that the impeller/propeller runs smoothly. Clean or free it as necessary</p>
The moisture sensors (optional) have interrupted the power circuit (operator-related)	See fault: Mechanical shaft seal leaks, moisture sensors report a fault or switch the machine off

Table 9-1: The machine will not start

Fault: The motor starts, but the motor protection switch triggers shortly after start-up

Cause	Solution
The thermal trigger on the motor protection switch is incorrectly set	Have a specialist compare the setting of the trigger with the technical specifications and correct if necessary
Increased power consumption due to major voltage drop	Have an electrician check the voltage on each phase and rewire if necessary
Two-phase operation	Have a specialist inspect the connection and correct it as necessary
Excessive voltage differences on the three phases	Have a specialist inspect the connection and the switching system and correct it as necessary

Table 9-2: The motor starts, but the motor protection switch triggers shortly after start-up

Troubleshooting and possible solutions

Cause	Solution
Impeller/propeller impeded by adhesive material, blockages and/or solid matter, increased current consumption	Switch off the machine, secure it against being switched on again and free the impeller/propeller or clean the intake port
The pumped fluid is too dense	Contact the manufacturer

Table 9-2: The motor starts, but the motor protection switch triggers shortly after start-up

Fault: Machine runs but does not pump

Cause	Solution
No pumped fluid	Open the container intake or sliders
Intake blocked	Clean the intake, slider, intake port or intake strainer
Impeller/propeller blocked or obstructed	Switch off the machine, secure it against being switched on again and free the impeller/propeller
Defective hose or pipeline	Replace defective parts
Intermittent operation	Check the control panel
Incorrect direction of rotation	Check the machine for damage. Replace two phases on the mains supply

Table 9-3: Machine runs but does not pump

Fault: The machine runs, but not at the stated operating levels

Cause	Solution
Intake blocked	Clean the intake, slider, intake port or intake strainer
Slider in the discharge pipe closed	Fully open the slider
Impeller/propeller blocked or obstructed	Switch off the machine, secure it against being switched on again and free the impeller/propeller
Air in the system	Check the pipelines, pressure shroud and/or pump unit, and bleed if necessary
Machine pumping against excessive pressure	Check the slider in the discharge pipe and open it completely if necessary, use a different impeller or contact the factory
Signs of wear	Replace worn parts
Defective hose or pipeline	Replace defective parts
Inadmissible levels of gas in the pumped liquid	Contact the factory

Table 9-4: The machine runs, but not at the stated operating levels

Cause	Solution
Two-phase operation	Have a specialist inspect the connection and correct it as necessary
Excessive decrease in the water table during operation	Check the supply and capacity of the system, and inspect the level control settings and functionality

Table 9-4: The machine runs, but not at the stated operating levels

Fault: The machine does not run smoothly and is noisy

Cause	Solution
Machine is running in an inadmissible operation range	Check the operational data of the machine and correct if necessary and/or adjust the operating conditions
The intake port, strainer and/or impeller/propeller is blocked	Clean the intake port, strainer and/or impeller/propeller
The impeller is impeded	Switch off the machine, secure it against being switched on again and free the impeller
Inadmissible levels of gas in the pumped liquid	Contact the factory
Two-phase operation	Have a specialist inspect the connection and correct it as necessary
Incorrect direction of rotation	Check the machine for damage. Replace two phases on the mains supply
Signs of wear	Replace worn parts
Defective motor bearing	Contact the factory
The machine is installed under mechanical strain	Check the installation, use rubber spacers if necessary

Table 9-5: The machine does not run smoothly and is noisy

Moisture sensor monitoring is optional, and is not available for all types. For more details, see the order confirmation or the electrical connection plan

Fault: Mechanical shaft seal leaks, moisture sensors report a fault or switch the machine off

Cause	Solution
Condensation build-up due to lengthy storage and/or temperature fluctuations	Operate the machine briefly (max. 5 min.) without moisture sensors
Expansion tank (optional for polder pumps) is too high	Install the expansion tank no more than 10m above the bottom edge of the intake port
Increased leakage when running in new mechanical shaft seals	Change the oil
Defective moisture sensor cables	Replace the moisture sensors

Table 9-6: Mechanical shaft seal leaks, moisture sensors report a fault or switch the machine off

Troubleshooting and possible solutions

Cause	Solution
Mechanical shaft seal is defective	Replace the mechanical shaft seal and contact the factory!

Table 9-6: Mechanical shaft seal leaks, moisture sensors report a fault or switch the machine off

Further steps for troubleshooting

If the points listed here do not rectify the fault, contact our customer service. They can help you as follows:

- Telephone or written support from customer service
- On-site support from customer service
- Inspection or repair of the machine at the factory

Please note that you may be charged for some services provided by our customer support. For more details, please contact customer service.

A List of machine operators and maintenance

All persons working on or with the product confirm with their signatures that they have received, read and understood this operating and maintenance manual. In addition, they obligate themselves to conscientiously follow the instructions provided. Non-observation releases the manufacturer from any warranty obligations.

List of machine operators

Name	Starting date	Signature

Table A-1: List of machine operators

List of machine operators and maintenance

Maintenance and inspection log

Every person is required to enter all maintenance and alteration work which then is to be confirmed with the person's own signature and that of their supervisor.

This list is to be shown on request to representatives of controlling organizations, government inspection teams and the manufacturer!

Maintenance / Revision on	Date	Signature	Signature of the person in charge

Table A-2: Maintenance and inspection log

B Explosion protection in accordance with the CSA standard for zone 1

This chapter contains special information for owners and operators of machines which have been built and certified for use in environments where explosions may occur.

General information

It expands on and therefore supplements the standard instructions for these machines. It also expands on and supplements the “General safety information” (Chapter 2) and must be read and fully understood by all owners and operators of the machines.

This chapter applies only to explosion-proof machines and contains additional instructions for these machines. You can find these specifications on the type plate and data sheet of your machine.

The explosion-proof motors have been –certified by an officially authorized unit, in accordance with the following standards:

Certification and classification

CAN/CSA–C22.2 No. 60079–0 / CAN/CSA–C22.2 No. 60079–1. The motor has been certified for use in environments where explosions may occur and electrical devices in Device group II, category 2 are required. The motors can be used in both zone 1 and zone 2.

These motors may not be used in zone 0.

During operation (S1, S2) the machine may only be switched on and operated if it is fully installed and submerged (with the pump housing completely filled with the pumped fluid).

T motors must be immersed up to the top edge of the machine housing, unless indicated otherwise, or if the motors are designed to be operated when not submerged!

The explosion symbol and coding can be found on the type plate. The explosion coding indicates the following:

Explosion symbol and coding

- Ex = Explosion-proof device complying with IEC standard
- d = Ignition protection for motor casing: Flameproof enclosure
- de = Ignition protection for motor casing: Flameproof enclosure
Ignition protection for terminals: Increased safety
- II = Intended for places where explosions may occur, with the exception of mines
- B = Intended for use with gases in sub-group B (all gases excluding H₂, C₂H₂, CS₂)
- T4 = Max. surface temperature of the machine 135 °C

Motors with this protection type in our machines are equipped with a temperature control system as follows:

“Flameproof enclosures” protection type

- Motor sizes T 24, T 30 and T 34:
Winding: temperature limiter 140 °C, temperature regulator 130 °C

The temperature control system should be connected in such a manner that if the temperature regulator is triggered an automatic switch on can be performed. If the temperature limiter is triggered then switching on again should only be possible if the release button has been manually activated.

For certification numbers (see explosion number in the data sheet) with an X, special conditions must be fulfilled for operation in environments where explosions may occur!

Special conditions

Explosion protection in accordance with the CSA standard for zone 1

In general, please note the following

- The cable of the motors must be connected outside the hazardous location or within a housing which is designed with an ignition protection method compliant with CAN/CSA-C22.2 No. 60079-0.
- The motors may be operated with a voltage tolerance of +/- 10%.

When using a converter, please note:

For operation with a converter, the motors must be protected by a device which directly monitors the temperature. This device consists of:

- A temperature sensor built into the winding (triple PTC, DIN 44082 – the temperature depends on the motor type)
- A suitable trigger unit

External sealing room monitoring

For machines equipped with an **external** moisture sensor, the electrodes may only be connected to an intrinsically safe circuit with the protection type Ex i!

We recommend that you use our ER 143 relay.

Operation and installation types

When operating the machine, the specified operation and installation type must be observed. These are shown on the machine data sheet.

For S1 (continuous operation) and S2 (temporary operation), the pump section must always be completely immersed in the pumped fluid and filled with it

Non-submerged operation

The following T motors can be operated for a short time when not submerged: T 24, T 30 and T 34

In this case, the motor must be fitted with a temperature regulator (low temperature) and temperature limiter (high temperature). When removed from the fluid, the motor may be activated using the temperature regulator. In this operating mode it is essential that the maximum permitted start-ups/h are not exceeded. This operating mode is intended to allow the fluid level to fall to the bottom edge of the motor.

Maintenance and repair work, alterations to the construction

The maintenance and repair work described in this operating and maintenance handbook must be carried out properly. Furthermore, national and international regulations must be observed!

Repairs and alterations to the construction which are not listed in this operating and maintenance handbook or which may impair explosion protection may only be performed by the manufacturer or by service dealers certified by the manufacturer.

Repair

The spark-proof gaps may only be repaired according to the manufacturer's design specifications. It is not permitted to carry out repairs according to the values in tables 1 and 2 of CAN/CSA-C22.2 No. 60079-1.

Only the screw plugs stipulated by the manufacturer, fulfilling at least strength category A2-50, may be used.

Sealing change for explosion-proof motors

The following table lists the seals which can be replaced without impairing the explosion-protection:

Motor type	Liquid side mechanical shaft seal	Cartridge
T 24	--	OK
T 30	--	OK
T 34	--	OK

Table B-1: Sealing change for explosion-proof motors

The symbols in the table have the following meanings:

-- = not present or replacement not possible without endangering explosion protection

OK = replacement possible without endangering the explosion protection

C Explosion protection in accordance with the FM standard

This chapter contains special information for owners and operators of machines which have been built and certified for use in environments where explosions may occur.

General information

It expands on and therefore supplements the standard instructions for these machines. It also expands on and supplements the “General safety information” (Chapter 2) and must be read and fully understood by all owners and operators of the machines.

This chapter applies only to explosion-proof machines and contains additional instructions for these machines. You can find these specifications on the type plate and data sheet of your machine.

The FM motors are certified by the recognized testing and certification agency FM Approvals in accordance with the FMRC 3600, 3615, 3615.80 and ANSI/UL-1004 norms. The motor has been certified for use in environments where explosions may occur and where electrical devices in the “Explosion-proof, Class 1, Division 1” protection class are required. This means that the motor can also be used in areas where the protection classes “Explosion-proof, Class 1, Division 2” in accordance with the FM standard are required.

Certification and classification

During operation (S1, S2) the machine may only be switched on and operated if it is fully installed and submerged (with the pump housing completed filled with the pumped fluid).

T motors must be immersed up to the top edge of the machine housing unless indicated otherwise.

The FM symbol and the explosion coding can be found on the type plate. The explosion coding indicates the following: (Cl. = Class)

Explosion symbol and coding

- Cl. 1=gas, vapor, mist
Division 1 = explosive atmosphere constantly present or occasionally present under normal conditions
Groups C, D = gas groups: ethylene (C), propane (D)
- Cl. 2=dust
Division 1 = explosive atmosphere constantly present or occasionally present under normal conditions
Groups E, F, G = dust groups: metal (E), coal (F), cereal (G)
- Cl. 3=fibers and lint
- T3C=max. surface temperature of the machine 160°C

The type plate also shows the information on the maximum submersion depth and the maximum temperature of the pumped fluid.

Motors with this protection type in our machines are equipped with a temperature control system as follows:

“Explosion-proof” protection class

Winding: temperature regulator 130°C, temperature limiter 140°C

Motor sizes T17 and larger

Winding: temperature limiter 120°C, cooling liquid: 100°C

Motor sizes FK 17.1

Winding: temperature limiter 160°C, sheet package: temperature limiter 110°C

Motor sizes T20.1, HC20.1, FKT27.1 and FKT27.2

Explosion protection in accordance with the FM standard

The temperature control system should be connected in such a manner that if the temperature regulator is triggered an automatic switch on can be performed. If the temperature limiter is triggered then switching on again should only be possible if the release button has been manually activated.

The specialist who performs the work is responsible for the correct electrical connection.

Additional information for motor FK17.1

The external pencil electrode has to be connected to a separately intrinsically safe circuit.

Maintenance and repair work, alterations to the construction

The maintenance and repair work described in this operating and maintenance handbook must be carried out properly.

Repairs and alterations to the construction which are not listed in this operating and maintenance handbook or which may impair explosion protection may only be performed by the manufacturer or by service dealers certified by the manufacturer.

Sealing change for explosion-proof motors

The following table lists the seals which can be replaced without impairing the explosion-protection:

Motor type	Liquid side mechanical shaft seal	Cartridge
T 12	OK	--
T 13	OK	--
T 17	OK	--
T 20	OK	OK
T 20.1	OK	OK ₃
T 24	--	OK
T 30	--	OK
T 34	--	OK
T 49	OK	--
T 56	OK	--
FK 17.1	--	--
FKT27.1	--	OK
FKT27.2	--	OK
FKT 49	OK	--
FKT 56	OK	--
HC 20.1	OK	OK ₃

Table C-1: Sealing change for explosion-proof motors

The symbols in the table have the following meanings:

-- = not present or replacement not possible without endangering explosion protection

OK = replacement possible without endangering the explosion protection

OK₃ = cartridge replacement possible, mechanical shaft seal cannot be removed

Explosion protection in accordance with the FM standard

The following signs are attached to the machine.

Signs used

The type plate is attached to the motor casing. This sign contains the technical data.

Type plate

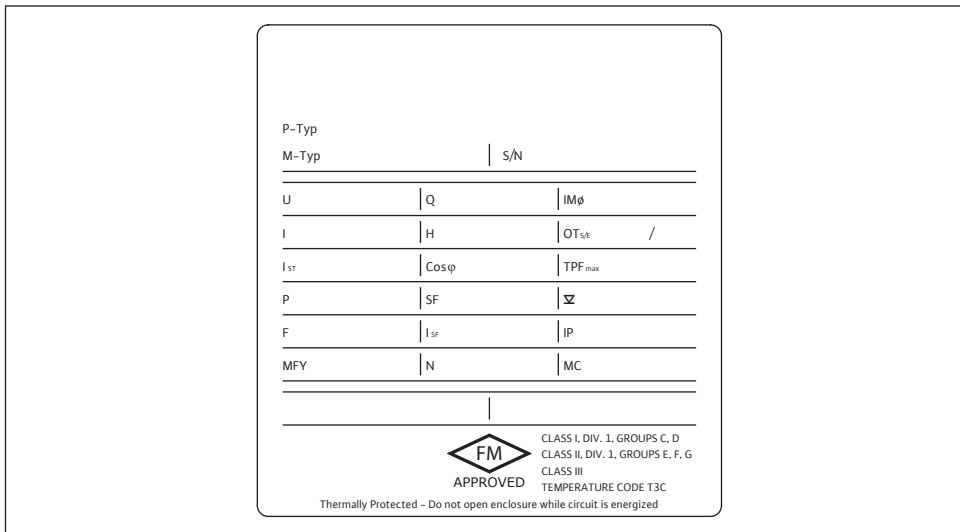


Fig. C-1: Type plate

Only on HC 20.1, T 20.1, FKT27.1 and FKT27.2 motors.

Indicator plate

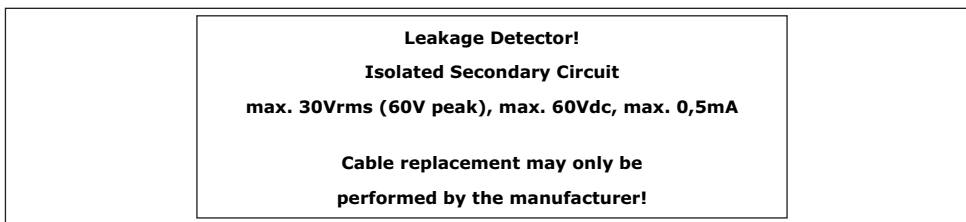


Fig. C-2: Leak sensor

Only on FK 17.1 motors.

Indicator plate

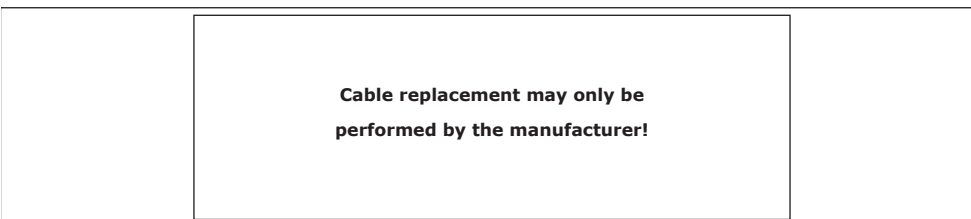


Fig. C-3: Cable replacement

D Explosion protection in accordance with the Atex standard for zone 1

This chapter contains special information for owners and operators of machines which have been built and certified for use in environments where explosions may occur.

General information

It expands on and therefore supplements the standard instructions for these machines. It also expands on and supplements the "General safety information" (Chapter 2) and must be read and fully understood by all owners and operators of the machines.

This chapter applies only to explosion-proof machines and contains additional instructions for these machines. You can find these specifications on the type plate and data sheet of your machine.

The explosion-proof motors have been certified by an officially authorized unit, in accordance with EC directive 94/09/EC (ATEX 95) and the following European norms: DIN EN 60079-0, EN 60079-1 and EN 60079-7 (valid for motors from size T42 upwards). The motor has been certified for use in environments where explosions may occur and electrical devices in Device group II, category 2 are required. The motors can be used in both zone 1 and zone 2.

Certification and classification

These motors may not be used in zone 0.

Non-electrical devices such as pump parts, mixers and shredding equipment also comply with EC directive 94/09/EC.

During operation (S1, S2) the machine may only be switched on and operated if it is fully installed and submerged (with the pump housing completed filled with the pumped fluid).

T motors must be immersed up to the top edge of the machine housing, unless indicated otherwise, or if the motors are designed to be operated when not submerged!

The explosion symbol and coding can be found on the type plate. The explosion coding indicates the following:

Explosion symbol and coding

- Ex=Explosion-proof device complying to Euro norm
- d=Ignition protection for motor casing: Pressure-resistant encapsulation
- de=Ignition protection for motor casing: Pressure-resistant encapsulation
Ignition protection for terminals: Increased safety
- II=Intended for places where explosions may occur, with the exception of mines
- B=Intended for use with gases in sub-group B (all gases excluding H₂, C₂H₂, CS₂)
- T4=Max. surface temperature of the machine 135 °C

Motors with this protection type in our machines are equipped with a temperature control system as follows:

"Pressure-resistant encapsulation" protection type

Winding: temperature limiter 140°C, temperature regulator optional 130°C

Motor sizes T12 and T13

Winding: temperature regulator 130°C, temperature limiter 140°C

Motor sizes T17 and larger

Winding: temperature limiter 120°C, Oil: temperature limiter 100 °C

Motor sizes FK17.1 and larger

Explosion protection in accordance with the Atex standard for zone 1

Motor size T20.1

Winding: temperature limiter 160°C, temperature regulator optional 140°C

Motor sizes HC20.1, FKT27.1 and FKT27.2

Winding: temperature limiter 160°C, sheet package: temperature limiter 110°C

The temperature control system should be connected in such a manner that if the temperature regulator is triggered an automatic switch on can be performed. If the temperature limiter is triggered then switching on again should only be possible if the release button has been manually activated.

Special conditions

For EC type testing certificates (see explosion number in the data sheet) with an X, special conditions must be fulfilled for operation in environments where explosions may occur!

In general, note the following

- The non-connected line of the motors must be connected in an area within the housing where there is no risk of explosion, which is designed with an ignition protection method compliant with DIN EN 60079-0.
- The motors may be operated with a voltage tolerance of +/- 10%.

Only the T 56 und FKT 56 motors may be operated with a voltage tolerance of just +/- 5%.

When using a converter, note

For operation with a converter, the motors must be protected by a device which directly monitors the temperature. This device consists of:

- A temperature sensor built into the coil (triple PTC, DIN 44082 – the temperature depends on the motor type)
- A temperature sensor built into the sheet package (single posistor, DIN 44082 – the temperature depends on the motor type T20.1 and HC20.1)
- A suitable trigger unit

External sealing room monitoring

For machines equipped with an **external** moisture sensors, the electrodes may only be connected to an intrinsically safe circuit with the protection type Ex i!

We recommend that you use our ER 143 relay.

Operation and installation types

When operating the machine, observed the specified operation and installation type. These are shown on the machine data sheet.

For S1 (continuous operation) and S2 (temporary operation), the pump section must always be completely immersed in the pumped fluid and filled with it

Non-submerged operation

The following T motors can be operated for a short time when not submerged: T 12, T 13, T 17, T 20.1, T 24, T 30 and T 34

In this case, the motor must be fitted with a temperature regulator (low temperature) and temperature limiter (high temperature). When removed from the fluid, the motor may be activated using the temperature regulator. In this operating mode it is essential that the maximum permitted start-ups/h are not exceeded. This operating mode is intended to allow the fluid level to fall to the bottom edge of the motor.

If the T 12 motor is not submerged, it must not be operated if the fluid/ambient temperature exceeds 30°C.

Maintenance and repair work, alterations to the construction

The maintenance and repair work described in this operating and maintenance handbook must be carried out properly.

Repairs and alterations to the construction which are not listed in this operating and maintenance handbook or which may impair explosion protection may only be performed by the manufacturer or by service dealers certified by the manufacturer.

Explosion protection in accordance with the Atex standard for zone 1

The spark-proof gaps may only be repaired according to the manufacturer's design specifications. It is not permitted to carry out repairs according to the values in tables 1 and 2 and DIN EN 60079-1.

Repair

Only the screw plugs stipulated by the manufacturer, fulfilling at least strength category A2-50, may be used.

The following table lists the seals which can be replaced without impairing the explosion-protection:

Sealing change for explosion-proof motors

Motor type	Liquid side mechanical shaft seal	Cartridge
T 12	OK	--
T 13	OK	--
T 17	OK	--
T 20	OK	OK
T 20.1	OK	OK ₃
T 24	--	OK
T 30	--	OK
T 34	--	OK
T 56	OK	--
FK 17.1	--	--
FKT 27.1, FKT 27.2	--	OK
FKT 56	OK	--
HC 20.1	OK	OK ₃

Table D-1: Sealing change for explosion-proof motors

The symbols in the table have the following meanings:

-- = not present or replacement not possible without endangering explosion protection

OK = replacement possible without endangering the explosion protection

OK₃ = cartridge replacement possible, mechanical shaft seal cannot be removed

Explosion protection in accordance with the Atex standard for zone 1

Signs used

The following signs are attached to the machine.

Type plate

The type plate is attached to the motor casing. This sign contains the technical data.

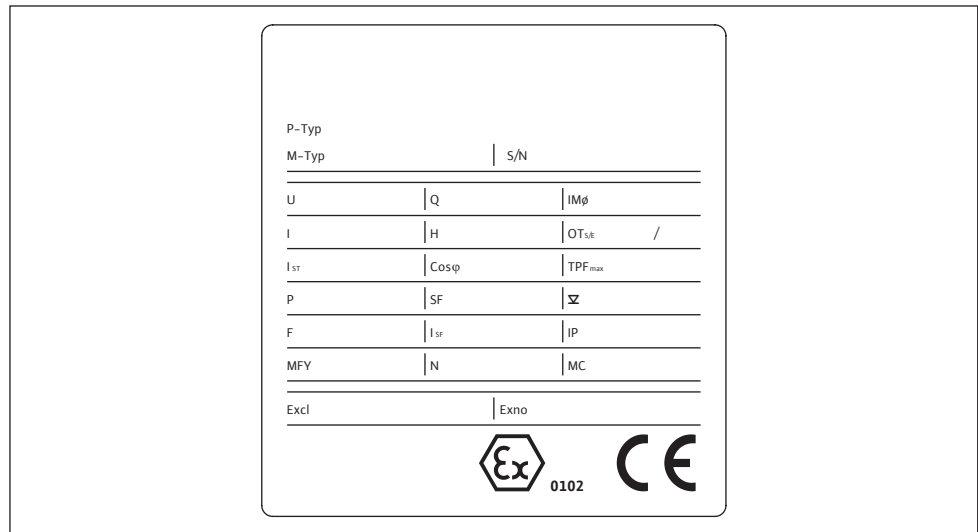


Fig. D-1: Type plate

E Operation with a static frequency converter

WILO products can be operated with standard frequency converters. These are normally pulse-width-modulated converters. However, the following points must be observed when operating the converter:

Any standard WILO motor can be used. **If the rated voltage is above 415 V, you must consult the manufacturer.** Because of the additional heating caused by harmonics, the rated power of the motor should be around 10% more than the power requirement of the pump. For converters with a **low-harmonic output**, it may be possible to reduce the 10% power reserve. This is normally done by using output filters. Ask the converter manufacturer.

Selecting the motor and converter

The size of the converter depends on the rated motor current. Selecting the motor power in kW can cause problems, since submersible motors have **different specifications** to standard motors. **Waste water motors are marked with the appropriate rated power** (type sheet power in catalog).

Submersible pumps have water-lubricated bearings. A minimum speed is required in order for a lubricating film to form.

Minimum speed for submersible pumps (well pumps)

Continuous operation at frequencies below 25 Hz (30 Hz 4-pole) must be avoided, since the lack of lubrication and possible occurrence of mechanical vibrations may cause damage to the bearings.

The lowest speed range (up to 12.5 Hz) should be passed through within 2 seconds.

In practice, the speed should only be lowered to the extent that a pump flow of at least 10% of the maximum flow remains. The precise value depends on the type – ask the manufacturer for details.

There is no prescribed minimum speed for waste water and sewage pumps.

Minimum speed for waste water and sewage pumps

However, make sure that the motor operates without jerking or vibrating, especially in the lower speed range. Otherwise, the mechanical shaft seals could be damaged and start leaking.

It is important that the pump motor operates across the entire control range without vibrations, resonance, oscillation or excessive noise (ask the manufacturer if necessary).

Operation

Increased motor noise caused by the harmonics of the power supply is normal.

When configuring the converter, always make sure the quadratic curve (U/F characteristic) for pumps and fans is correctly set. This ensures that the output voltage at < 50 Hz frequencies is adjusted to the power requirement of the pump. Newer converters feature an automatic power optimization function which achieves the same effect. See the converter operating manual for this setting and other parameters.

Submersible motors with water-cooled windings are more susceptible to voltage peaks than dry motors.

Max. voltage peaks and rise speed

The following thresholds may not be exceeded:

Max. voltage rise speed: 500 V/μs

Max. voltage peak to earth: 1250 V

These values apply for well pumps < 1 kV and can usually be attained by replacing a sinusoidal filter or dV/dt filter. For motors > 1 kV, the permissible values can be obtained from the plant. It remains the case that the lowest possible pulse frequency should be set.

Operation with a static frequency converter

EMC

In order to comply with EMC (electromagnetic compatibility) regulations, it may be necessary to use shielded wires, lay cables in metal tubes and install filters. The exact actions required to comply with the EMC directives depend on the converter type, converter manufacturer, length of cable laid and other factors. In individual cases it is therefore necessary to look up the actions to be taken in the converter operating manual or contact the manufacturer directly.

Motor protection

As well as the built-in electrical current monitor system in the converter, or the thermal relay in the switching system, we recommend installing temperature sensors in the motor. Cold conductor temperature sensors (PTC) and resistor temperature sensors (PT 100) are both suitable.

Explosion-proof motors (whose type code has the addition “Ex”) must always be fitted with cold-type thermistors in frequency conversion mode. Also, an approved motor protection relay for cold-type thermistors (such as MSS) must be used.

Operation up to 60 Hz

A WILO submersible motor can be adjusted up to 60 Hz provided the motor has been rated for the pump’s higher power requirement. However, the rated power should be taken from the 50 Hz data sheets.

Efficiency

As well as the efficiency of the motor and the pump, the efficiency of the converter (approx. 95 %) must also be taken into account. The efficiency of all components is lower when the speed is reduced.

Formulas

Pump flow	Pump head	Power
$Q_2 = Q_1 * \left(\frac{n_2}{n_1} \right)$	$H_2 = H_1 * \left(\frac{n_2}{n_1} \right)^2$	$P_2 = P_1 * \left(\frac{n_2}{n_1} \right)^3$

Table E-1: Formulas

Summary

As long as all these points are taken into account and the instructions for the converter are followed, speed-regulated operation with WILO products is possible without any problems.







wilo



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