Operating Instructions

Standard plastic pump with magnetic coupling
Type series NM and FM
Size bearing housing I
ISO 2858 / DIN EN 22858

Including pumps designed according to EC Council Directive 94/9 (ATEX)

WERNERT-PUMPEN

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2005-02h

1. General

1.1 Application of the pump

WERNERT chemical standard pumps of the NM and FM series, size of bearing housing I (Size I), are horizontally positioned machines to pump liquids. They are always and only intended to be installed in a suitable system. As the liquids being pumped are usually dangerous (poisonous, flammable, caustic), it is very important that the safety instructions contained within these operating instructions are adhered to.

1.2 Validity of the operating instructions

These operating instructions only apply to pumps of the NM and FM series, size of bearing housing I, in the standard designs. We reserve the right to make technical changes. In the case of special constructions and designs, the documentation specific to the order must be taken note of. If in doubt, please contact the manufacturer.

1.3 Declarations

1.3.1 Manufacturer's declaration

(as defined by EU directive Machines 98/37/EC, Appendix II B)

Manufacturer: WERNERT-PUMPEN GMBH
Oberhausener Str. 67-79
D-45476 Mülheim an der Ruhr - Germany

General manufacturer's declaration for standard chemical pumps of the NM and FM series

The manufacturer hereby declares that the pump(s) of the NM and FM series, size of bearing housing I, are meant to be installed in a machine (in this case plant).

The manufacturer would like to point out that starting up the above mentioned pump(s) is/are not permitted until it has been determined whether the machine (here plant), into which the above mentioned pump(s) is/are to be installed conform(s) with the EU directive Machines 98/37/EC.

Applied harmonised standards: DIN EN ISO 12100-1:2004-04
DIN EN ISO 12100-2:2004-04
DIN EN ISO 13857:2008-06
EN 809:1998-10
DIN EN ISO 14121-1:2007-12
DIN EN 12162:2001-12

Mülheim an der Ruhr, 30.06.2008

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1.3.2 Declaration of Conformity (Directive 94/9/EG) (refer 2.9.1)

In accordance with Directive 94/9/EC of the European Parliament and Council of 23 March 1994 concerning the harmonisation of legal regulations of the Member States governing equipment and protective systems destined for used in potentially explosive areas (Annex IX B).

Manufacturer: WERNERT-PUMPEN GMBH
Oberhausener Str. 67-79
D-45476 Mülheim an der Ruhr - Germany

Products: WERNERT chemical standard pumps of the **NM** and **FM** series, size of bearing housing I (Size I), are horizontally positioned machines to pump liquids.
qualify as "equipment" in accordance with Article 1, Para. 3a).

The conformity assessment procedure is based on Article 8, Para. 1 b) ii).
The pump is intended for use as equipment of Group II, category 2, gas atmosphere (G), in accordance with Directive 94/9/EC, for use in potentially explosive areas.

II 2 G c (T1-T4) Information on the temperature class and maximum working temperature of the pumped medium can be found in the operating manual. It is presumed that the product is installed and operated in conformity with its intended use. Information on the intended use can be found in the operating manual.

The manufacturer herewith declares that the pump **NM** and **FM** series is intended for installation in a machine (in this case plant).
The manufacturer draws attention to the fact that commissioning of the aforementioned pump is prohibited until it has been established that the machine (in this case plant) in which the pump is to be installed complies with the requirements of Directive 94/9/EC governing equipment and protective systems destined for use in potentially explosive areas, as well as of Directive 1999/92/EC concerning the minimum regulations for improving the health and safety of employees who may be endangered by potentially explosive atmospheres.

Applied Community Directive
and harmonised standards: Directive 94/9/EC governing equipment and protective systems destined for use in potentially explosive areas.
If the pump is delivered as a complete unit with motor and coupling, this unit complies with the requirements of Machine Directive 98/37/EC.
EN 13463-1 EN 13463-5
EN 1127-1

Mülheim an der Ruhr, 30.06.2003

ppa. Christian Wallrodt
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1.4 Technical design

The pumps of the NM and FM series are standard plastic pumps with magnetic coupling with axial entry PN 16 as defined by standard ISO 2858/ DIN EN 22858. The connections correspond with those of commercially standard metal pumps.

Type FM size I is the corresponding magnetic coupling pump of block design, i.e. with directly flange-mounted drive motor.

The dimensions "f" and "w" of pumps with torque flow design (hydraulic design identification F) do not comply with the standard ISO 2858/ DIN EN 22858. They are longer in the axial direction: other dimensions are identical.

The letter "D" is added to the type designation of pumps equipped with throttling bush (e.g NMPO 50-32-160 D). This throttling bush, which is not part of the pump, is centrally positioned on the delivery connector and secured between pump and the piping to be connected.

1.5 Type description

The type description is made up of a four letter code and the size as defined by standard ISO 2858/ DIN EN 22858 The letter "D" is added to the type designation of pumps equipped with throttling bush (please refer to 1.4 and 5.3.6).

1st and 2nd letter Series identification, here NM or FM

3rd letter Main material:

- A = PTFE, antistatic or PFA, antistatic
- B = Polypropylene (PP)
- K = Polyvinylidenfluoride (PVDF)
- L = UHMW-PE, antistatic
- P = ultra high molecular low pressure polyethylene (UHMW-PE)
- T = Polytetrafluorethylene (PTFE)
- W = reinforced mineral cast Wernit®

4th letter Hydraulic design:

- F = semi-open impeller in torque flow model
- O = semi-open impeller
- X = Special hydraulics

Example: A pump with magnetic coupling of size 50-32-200 as defined by DIN ISO 2858/ DIN EN 22858 with semi-open impeller, material UHMW-PE, is described as type NMPO 50-32-200.

1.6 Type plate

Every pump has a type plate attached to it. It lists the following details:

- Name and address of the WERNERT company as manufacturer
- Type description
- Serial number of the pump
- Impeller diameter, impeller blade height and number of blades
- Diameter of a possibly used throttling bush
- Designed volume flow [m³/h] and associated delivery head [m]
- Necessary coupling power and nominal power of driver [kW]
- Nominal speed
- Density of the liquid to be pumped
- Data regarding the mechanical seal used
- Marking for the potentially explosive atmosphere with equipment group, equipment category, type of protection and temperature class TX and as additional marking the symbol "X" for the limited ambient temperature of "-10°C Ta +40°C"
- Tech. Doc.: Manufacturer's reference number for the Technical Documentation
- Year of construction

Explanations regarding the name plate can be found in Annex A to this operation manual.

1.7 Liability

No warranty is furnished for any damages due to the following reasons: Unsuitable or improper use, incorrect mounting and/or commissioning by the customer or any third party, natural wear and tear, incorrect or negligent treatment, unsuitable operational equipment, exchange materials, defective construction work, unsuitable subsoil, chemical, electro-chemical or electric influences unless attributable to a fault of the supplier's.

2. Safety

This operation manual contains basic hints to be observed during installation, operation and maintenance. Therefore, prior to mounting and commissioning, this operation manual must by all means be read by the fitter as well as the responsible expert personnel/user and must always be available at the place of installation of the machine/plant.

Not only are the general safety hints listed under this Section "Safety" to be observed, but also the special safety hints added to the other sections.

2.1 Marking of hints in the operation manual

The safety hints contained in this operation manual which, in case of non-compliance, may cause danger to personnel, are particularly marked with the general danger symbol

Safety sign according to DIN 4844 - W9

in case of warning against electric voltage with

Safety sign according to DIN 4844 - W8.

When employed in potentially explosive atmospheres, the safety hints to be additionally observed are marked with

Pumps which, corresponding to EC Council Directive 94/9, are employed in potentially explosive atmospheres, must be marked with this symbol and the CE sign on the name plate (please refer to Annex A).

For safety hints, non-compliance with which may cause danger to the machine and its functions, the word

ATTENTION is added.

Hints directly attached to the machine such as
- rotation arrow
- sign for fluid connections

must by all means be observed and maintained in completely legible condition.

2.2 Personnel qualification and training

The personnel for operation, maintenance, inspection and mounting must have the corresponding qualification for these operations. Range of liability, competence and the supervision of the personnel must be exactly defined by the user. If the personnel do not have the required knowledge, same must be trained and instructed. If required, this may be effected by the manufacturer/supplier on behalf of the machine user. In addition, it must be ensured by the user that the contents of this operation manual and the operation manuals of the plant are fully understood by the personnel.

2.3 Dangers in case of non-compliance with the safety hints

Non-compliance with the safety hints may result not only in danger to personnel, but also to environment and machine. Non-compliance with the safety hints may lead to the loss of any claims for damages.

In detail, non-compliance may, for example, entail the following dangers:

- Failure of important functions of the machine/plant
- Failure of specified methods for maintenance and servicing
- Danger to personnel by electrical, mechanical, magnetic, thermal or chemical influences as well as by explosion
- Danger to the environment by leakage of dangerous substances

2.4 Responsible working

The safety hints mentioned in this operation manual, the current national rules for the prevention of accidents as well as any internal working, operating and safety regulations of the user must be observed.

2.5 Safety hints for the user/operator

If hot or cold machine parts lead to dangers, these parts must be protected by the user against accidental contact at the site according to EN 294. Protection against accidental contact with moving parts (e.g. coupling) must not be removed when the machine is in operation.

Leakages (e.g. of the shaft seal) of dangerous substances to be pumped (e.g. explosive, toxic, hot) must be discharged so as not to result in danger to personnel and the environment. Legal stipulations are to be observed.

Dangers by electrical energy are to be excluded (for details with regard hereto, please refer e.g. to the VDE regulations and the local energy supply associations).

If the pumps are used in potentially explosive atmospheres, any operating conditions must be avoided which may raise the surface temperature of the pump to an unacceptable degree or lead to sparking.

2.6 Safety hints for maintenance, inspection and mounting operations

The user shall see to it that all maintenance, inspection and mounting operations are performed by authorized and qualified expert personnel who have sufficiently informed themselves by thoroughly studying the operation manual. The pump must have taken ambient temperature and be depressurized and emptied. Pumps pumping media injurious to health must be decontaminated. Basically, operations at the machine may be performed during standstill only. The procedure for stopping the machines described in the operation manual must by all means be observed.
Immediately upon completion of the operations, all safety and protective devices must be mounted and/or made operational again. Prior to restarting, the items listed in Section "Initial operation" must be observed.

2.7 Unauthorized conversion and spare parts production

Conversion of or changes to the machine are only admissible on consultation with the manufacturer. Original spare parts and accessories authorized by the manufacturer serve safety purposes. The use of other parts may cancel the liability for the consequences resulting therefrom.

2.8 Inadmissible modes of operation

Safe working conditions of the machine supplied is ensured only in case of intended use in line with this operation manual. The service limits specified in order-related documents and under Item 4.2 below must by no means be exceeded or fallen below. Order-related documents shall prevail.

2.9 Explosion protection

If pumps are used in potentially explosive atmospheres, it is imperative to comply with the measures and hints attached to the pump and described in the following paragraphs and the safety hints provided with the  symbol to warrant the explosion protection. **Standard EN 1127-1 (explosion protection) must be complied with.**

2.9.1 Identifying marking

Pumps which are intended to be used in potentially explosive atmospheres must be marked according to EC Council Directive 94/9 (please refer to Annex A.1.1), and the conformity declaration according to EC Council Directive 94/9 must be available. The marking only refers to the pump. Coupling and motor must be marked separately according to EC Council Directive 94/9 and their conformity declarations according to EC Council Directive 94/9 must also be available.

2.9.2 Filling of pump

During pump operation, the interior pump space in contact with the liquid must be constantly filled with the medium pumped.

2.9.3 Modes of operation affecting the explosion protection

Dangers affecting the explosion protection are to be avoided. Unintended use may lead to that the admissible surface temperature is exceeded or sparks are produced which may result in a possible ignition. Friction on non-conducting surfaces is to be avoided.

Operation with closed shut-off devices in the suction and/or discharge line is not admissible. In this state, there is a danger that after a short period of time already, the medium pumped takes inadmissible temperatures and the maximum admissible surface temperature is exceeded. Due to the inadmissible stress, the rapid pressure rise in the pump inside may lead to the destruction and even bursting of the pump. The specified minimum volume flow must by all means be maintained (please refer to 4.2.4 below).

Dry running is not admissible. In case of dry running or lack of lubrication, sufficient lubrication and cooling of the mechanical seal is not possible. In such a case, the maximum admissible temperature limit may also be exceeded.

Dry running may be due to an insufficiently filled sealing chamber, excessive gas portions in the medium pumped (please refer to 4.2.5 below) and to operating the pump outside the admissible range of operation. When using shut-off devices or filters, excessive pressure drop on the suction side of the pump must be avoided. At high temperatures of the medium pumped or low supply pressures, the steam pressure in the sealing chamber may be fallen below. As a result hereof, a gas ring may be formed around the mechanical seal. In addition, there is a danger that owing to an insufficient supply pressure, air is drawn through the mechanical seal. With a single-acting mechanical seal, both will result in dry running and thus destruction of the pump. This may be remedied by inserting a double-acting mechanical seal. In principle, insertion of filters in the suction side of a pump must be strongly advised against.

The specified pressure and volume flow of additional connections such as sealing, flushing liquid etc. must be assured by the operator (please refer to 5.4 and 7.2 below). This applies in particular to quenching and sealing liquid. Sufficient cooling and lubrication of the radial shaft sealing ring and the mechanical seal must be assured. Lack of lubrication or dry running result in the maximum admissible surface temperature being exceeded and in the destruction of the parts to be lubricated.

2.9.4 Explosion protection group

Pumps with marking (please refer to 2.9.1 above) correspond to **Group II**, i.e. they are provided for employment in explosive atmospheres. In this group, the employment in underground plants of mines and their above-ground plants is excluded.

2.9.5 Equipment category

Pumps with identifying marking (please refer to 2.9.1 above) correspond to **Category 2G**, thus, they are intended for use in areas where occasional potentially explosive atmosphere of gases, vapours and fogs must be expected.

2.9.6 Temperature class

As the maximum surface temperature mainly depends on the operating conditions (heated liquid in the pump, please refer to the temperature limits 2.9.7), the manufacturer may not provide any marking with a temperature or temperature class (EN 13463-1, 14.2 g).

Possible temperature classes of pumps with marking according to 2.9.1 as follows:

Bearing lubrication	**Medium temperature 1)**	**approved for temperature class**
Oil lubrication	≤ 160 °C	T3
Grease, lifetime-lubricated	≤ 160 °C	T3
Grease, with relubrication	≤ 160 °C	T3
Oil lubrication	≤ 100 °C	T3 / T4
Grease, lifetime-lubricated	≤ 100 °C	T3 / T4
Grease, with relubrication	≤ 100 °C	T3

1) The maximum admissible medium temperatures on the basis of the material of the pump housing and the bellows (please refer to 4.2.2 below) are to be observed.

The type of the bearing lubrication can be taken from the piece list or can be inquired at the manufacturer's by indicating the serial number.

2.9.7 Temperature limits

The operation of the pump outside the admissible ambient temperatures is not admissible (please refer to 4.2.3 below). The maximum admissible temperature of the liquid pumped depends on the respective specified temperature class and the material of the pump housing and/or mechanical seal (please refer to 4.2.2 below). Depending upon the material, the maximum admissible temperature of the liquid pumped may be below the following values.

Temperature class as per EN 50014 for electric equipment of Group II	Maximum surface temperature °C	**Maximum temperature of the liquid pumped °C**
T1	450	**165**
T2	300	**165**
T3	200	**160**
T4	135	**100**
T5	100	***)**
T6	85	***)**

Tab. 2.1 Temperature classes *) Please contact manufacturer

The admissible temperature class depends on the lubrication of the bearing (please refer to temperature class 2.9.6).

2.9.8 Pumping of inflammable media

Pumps by means of which inflammable media (Dangerous Goods Ordinance, Article 4 Dangerousness Characteristics) are to be pumped must not be equipped with a single-acting mechanical seal unless the operator, due to suitable control systems, is in a position to assure that no danger can be brought about by the medium pumped. The manufacturer must be contacted. Here, the use of a double-acting mechanical seal is to be preferred. The required sealing pressure system must be designed and operated with pressure, volume flow and temperature, if necessary, according to the requirements of the mechanical seal. The specification of the sealing medium and the operating instructions for the sealing pressure system must be complied with.

Note: Lubricants and/or coolants which are required to avoid explosive hot surfaces (here: medium pumped or sealing medium to cool and lubricate the mechanical seal) or mechanical sparks (please refer to prEN 13463-8) must have an ignition temperature (please refer to IEC 60079-4) of at least 50 K above the maximum surface temperature of the equipment in which the liquid is used (prEN 13463-5).

2.9.9 Maintenance

Only a pump or aggregate appropriately maintained and kept in a technically proper condition assures a safe and reliable operation. The relubrication and exchange intervals (please refer to 7.1 below) of the bearing must be observed by all means. **The lubrication being insufficient or the bearings defective, there is a danger of the maximum admissible surface temperature being exceeded and even of sparking through friction.**

According to the environmental conditions, the bearing bracket must be cleaned at suitable intervals. Proper functioning of the mechanical seal and the supply of the additional connections (please refer to 5.4 and 7.2 below) must be assured by the user through regular controls.

3. Transportation and Intermediate Storage

3.1 Transportation of the pumps and pump aggregates

The pumps and pump aggregates must on principle be transported so that no impact or shock loads act on the pump components. For an aggregate – i.e. pump with motor and coupling on a base plate – to be lifted, the lifting straps of the base plates must be used as sling points for the lifting appliance.

Fig. 3.1a illustrates transport of a type NM with free shaft end. **Fig. 3.1b–c** illustrate transport of a pre-assembled type FM pump unit with and without baseplate.

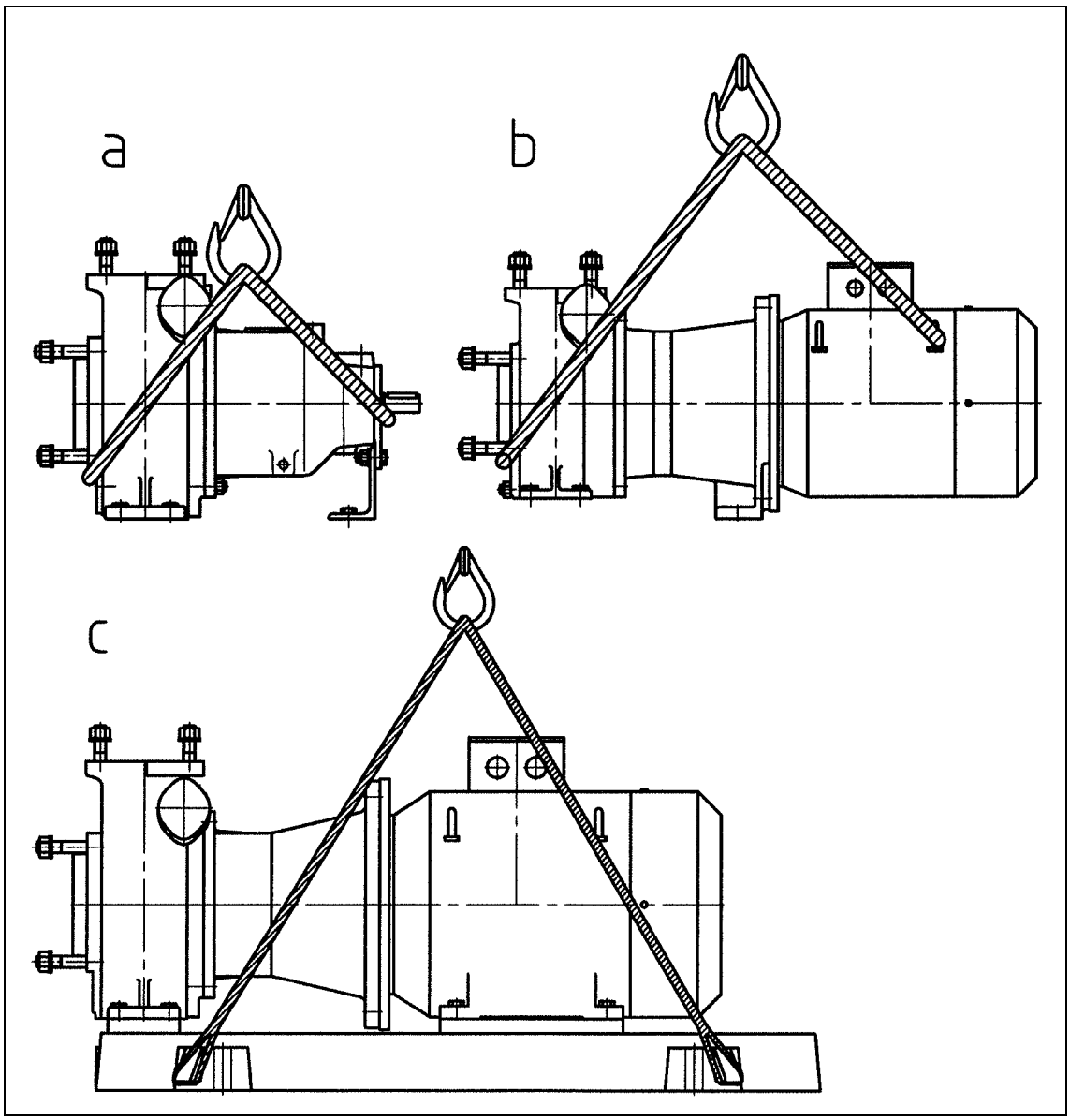


Fig. 3.1 Transport of a pump or pump unit

3.2 Intermediate storage under normal environmental conditions

Under normal environmental conditions, i.e. within a temperature range of -10 °C to +40 °C, special provisions need not be made for an intermediate storage. By closing the pump openings with sealing caps or dummy flanges, it must be assured that pollutions or foreign bodies in lumps are prevented from getting into the pump housing. The pumps must be placed in an intermediate storage so as not to be exposed to any shock or impact stresses. If this cannot be excluded, the pumps should be protected by means of solid wooden packings. The pumps should likewise not be exposed to any extraordinary weather and environmental influences.

Plastic pumps need not be filled with liquid preservatives. Acid or lye residues must not remain in the pumps as these crystallize out and lead to damages to the mechanical seal. Water must likewise not remain in the machines. Danger of freezing up.

3.3 Intermediate storage under special environmental conditions

Particular environmental conditions are as follows:

- Ambient temperatures below -10 °C or above +40 °C.
- Intermediate storage or installation in the open.
- Particularly high or very low air humidity (e.g. tropical or desert atmosphere).
- Intermediate storage in an environment with corrosive parts in the atmosphere (e.g. sea air or corrosive gases and aerosols)

The following are to be provided as protective measures:

- Special protection by solid wooden packing against impact and shock influences.
- Storage in areas not directly exposed to atmospheric influences. If necessary, provide protective roofs.
- Separate packing of the pumps with protective films and use of moisture binding agents.
- Anti-corrosive coatings of uncovered metallic parts exposed to the atmosphere.
- Sealing of the suction and delivery-side pump openings.

In each individual case, please contact the manufacturer for any measures to be taken regarding an intermediate storage under special environmental conditions.

3.4 Longer-term storage

In case of storage periods of more than one year make sure that the protection against mechanical and climatic stresses is sufficient. The suction and delivery-side pump openings must be kept closed The condition of the packing (wooden box, packing film and the like) must be checked regularly, at least once a year, and repaired as required. When using moisture-binding agents, these must be exchanged at least once a year. Uncovered pump components such as shaft and coupling must be provided with an anti-corrosive paint.
Prior to starting any pumps which have been stored for an extended period of time, the condition of the bearing grease or oil must be checked. After a storage period of two years, the lubricant of the bearing must be generally exchanged.
Under climatic conditions of a low humidity, the elastic properties of bellows and sealing elements of elastomer materials such as FPM or CSM may be reduced. The replacement of these parts after several years of storage is then required.

If the pump remains out of operation for a minimum period of six months, the pump shaft must be turned into a different position every three months by several manual rotations so as to avoid any pressure marks on the rolling bearings.

4. Description of product and accessories

4.1 General description

4.1.1 NM Size I

Pumps of the NM Size I series are horizontal magnetic coupling pumps following the standard ISO 2858/ DIN EN 22858 (trans-standard pump).
Due to the hermetically sealed construction, the pump is leak-proof and therefore a shaft seal is not necessary. Usually the pump is equipped with internal rinsing (product rinsing). External rinsing with external liquid however, can be installed as an alternative.
The wetted parts are made of plastic material or other suitable materials, their selection was dependent on the respective chemical, thermal and mechanical load. All structural plastic parts are enclosed or supported by metal to the largest possible extent.
The pump is always designed with semi-open impeller (without covering disc).Der Axialschub wird bei diesem halboffenen Laufrad durch Rückenschaufeln reduziert.

4.1.2 FM Size I

Pumps of the FM Size I series are constructed in the same way as the NM Size I series with the exception that the electrical motor driving them is flanged directly to the pump via a transmitting centering ring (block design).

4.2 Limits of application

4.2.1 Maximum admissible testing pressure

The statical testing pressure is determined as 1.3 to 1.5 times the maximum transport pressure according to ISO 2858/ DIN EN 22858, but a maximum of 24 bar and can be used to the temperature limit specified in section 4.2.2.

4.2.2 Maximum admissible temperature of the liquid being pumped

The maximum admissible temperature of the liquid to be pumped depends on the main material used. In exceptional cases it can be exceeded with the manufacturer's permission.

Material of the pump casing	Maximum temperature
UHMW-PE	90 °C
PVDF	115 °C
PFA	165 °C

For operation in explosion hazard areas, the maximum permissible temperature of the pumped liquid also depends on the permitted temperature class (see 2.9.6 and 2.9.7), as well as on the motor. In the case of motors with explosion-proof type of protection or increased-safety type of protection, the permissible temperature rise on the shaft and flange specified by the motor manufacturer must not be exceeded. This ensures that the motor temperature will not exceed the permissible surface temperatures of the corresponding temperature class at any point. The following equation must be maintained for pumps with flanged motor (type FM):

$\Delta\vartheta_{\text{perm. M- flange}}$ = permissible temperature increase at motor flange / shaft

$\Delta\vartheta_{\text{P-flange}}$ = Temperature increase at the pump flange

$$\Delta\vartheta_{\text{perm. M-flange}} \geq \Delta\vartheta_{\text{P-flange}}$$

$$\Delta\vartheta_{P-flange} = 9\text{C}^\circ + 0.07 \times \vartheta_{\text{Temp. pumped liquid}}\ [^\circ\text{C}],$$

$$\text{Example: } \vartheta T_{\text{Ambient}} = 23\,^{\circ}\text{C}, \quad \vartheta T_{\text{Temp. pumped medium}} = 100\,^{\circ}\text{C}$$

$$\Delta\vartheta_{\text{P-Flange}} = 9^{\circ}\text{C} + 0.07 \times 100\,^{\circ}\text{C}$$

$$= 16^{\circ}\text{C}$$

$$\vartheta_{\text{P-Flange}} = \vartheta T_{\text{Ambient}} + \Delta\vartheta_{\text{P-Flange}}$$

$$= 39\,^{\circ}\text{C}$$

The following temperature limits must be maintained without fail in this context:

- **Maximum permissible ambient temperature: 40 °C**
- **Maximum permissible temperature of the pumped medium 160 °C and maintenance of the temperature limits specified above for the material.**

4.2.3 Admissible temperature range of the environment

The admissible range of the ambient temperature is –10 °C to +40 °C. The name plate for a pump according to EC Council Directive 94/9 receives the symbol "X" as additional marking for the limited ambient temperature.

4.2.4 Volume flow of the liquid pumped

Unless specified otherwise in the characteristic curves or the documentation, the following shall apply:
Q_{min} = 0.1 x Q_{opt} for short-time operation (approx. 5 min.)
Q_{min} = 0.15 x Q_{opt} for continuous operation, Q_{max} = according to characteristic diagram
Q_{opt} = Volume flow in the optimum efficiency of the characteristic pump curve
In case of a deviating working point, please contact the manufacturer.

4.2.5 Maximum admissible gas portion of the liquid pumped

Gas portions in the liquid pumped are only permissible after consulting the manufacturer. Gas portions in the liquid pumped reduce the capacity and the delivery head of the pump.

4.2.6 Maximum dimensions of sporadic solid matters in the liquid pumped

The following rule applies for pumps with internal flush:
A maximum concentration of 1% by weight and a maximum particle size of 50 µm are permitted with regard to the solids content.

The following rule applies for pumps with external flush:
The dimensions of sporadic solid matters in the liquid pumped must not exceed the dimension of half the blade height and/or half the nominal delivery branch diameter, whatever dimension is smaller. The flushing medium should be free of solids and clean.

4.2.7 Maximum transferable power

The maximum transferable power is as follows, depending on magnet size and speed:

Magnet size	Max. torque	max. Power transmitted / Speed	
		1450 rpm	2900 rpm
I	30 Nm	4,5 kW	9,0 kW
II	50 Nm	7,6 kW	15,2 kW
III	100 Nm	15,2 kW	30,4 kW

4.2.8 Maximum speeds

The maximum admissible speed must not be exceeded by mechanical transmission ratios or the employment of a frequency converter. For the maximum admissible speed for the respective pump size, please refer to Table B.2 of Annex B.

4.3 Construction

Fig. 4.1 shows a pump of the NM series and **Fig. 4.2** shows a pump of the FM series in section. The individual parts have been described and numbered according to DIN 24250.

4.3.1 Pump casing

The pump casing (part 101) is made of plastic material and is completely surrounded by a metal annular casing (part 103). Suction and discharge nozzles are fixed to the pump casing. The suction nozzle is fixed to the annular casing by means of the two-part retaining ring (part 506.2). The discharge nozzle is supported by the casing part (part 130) and so fixed to the annular casing.

The pump can be constructed with an outlet in the area under the suction nozzle. This is either closed with a cap or equipped with a valve.

4.3.2 Inner impeller gear

Semi-open plastic wheels with impressed metallic hubs are used as impellers (part 233). Semi-open impellers are also suitable to pump media containing solids. The impeller is attached to the rotor (part 818) via the metal pump shaft (part 211). The pump shaft is screwed both in the impeller as well as into the rotor. Together with the thrust bearing plate (part 384) which is made of a special silicon carbide quality, the bearing sleeve (part 529) takes on the function of protecting the shaft. The O-rings (parts 412.05 and 412.06) used in this area are made of the universal chemical resistant material FFKM.
The permanent magnets made of cobaltsamarium are positioned around the circumference of the metal core of the rotor (part 818). These are secured against the influence of centrifugal forces by an outer metal band. The entire rotor is equipped with a diffusion resistant PFA jacket in the areas where it comes into contact with the liquid. The counter thrust bearing plate (part 388) made of silicon carbide is inserted into the rotor so that they interlock.

4.3.3 Bearing for the inner impeller gear

The radial and axial bearings of the inner impeller gear is installed in two bearing bushes (parts 545) which are positioned into the bearing cartridge (part 381) so that they interlock. The bearing cartridge is covered with a diffusion resistant jacket in the areas where it comes into contact with liquid and closes the pump casing together with the O-ring (part 412.04).

The liquid being pumped cools and lubricates the bearing surfaces. This is directed into the bearing through appropriate channels in the bearing cartridge and in the bearing bushes. At the same time, the liquid flows through the inner area of the isolation shell and cools it. This type of flow-through of the bearing is described as "internal rinsing" and has been represented in Fig. 4.1. If liquids containing solid parts or if liquids which are unsuitable for lubricating the inner bearing in any other way, "external rinsing" is selected (see Fig. 4.3 for diagrammatic representation). In this case, the channels are directed along other paths to prevent the liquid being pumped from accessing the inner regions of the isolation shell and the bearing. Instead, suitable liquid from outside the pump is fed into the inner area of the isolation shell with excess pressure and on its way to the pump housing, it also lubricates the bearing. The metal holder (part 732), the flange transition made of plastic material (part 722) and the O-rings (parts 412.09 and 412.031) form the connections for the external rinsing system.

4.3.4 Isolation shell

The isolation shell (part 817) hermetically seals the pump. It is positioned with the adaptor (part 145) and connected with the bearing cartridge. The isolation shell is sealed using an O-ring (part 412.07). The isolation shell consists of a chemically universal resistant PTFE inliner and an outer shell made of carbon fibre reinforced synthetic resin (CFK) to take on the pressing power. It only has thin walls in the area of the magnetic force that is to be transmitted. The isolation shell is made of non-conducting materials and therefore free of eddy currents.

4.3.5 Outer impeller gear and magnetic coupling

The outer impeller gear which is not situated in the area of the liquid to be pumped is made up of the driver (part 830) and the permanent magnetic bush (part 540) which - in the case of the NM series - makes the connection to the drive shaft (part 213). In the case of the FM series, the driver (part 830) with the bush (part 540) is fixed by the coupling (part 860) directly on to the shaft of the driving electrical motor.
When the pump is operational, the driver locks in with the inner magnetic rotor through the isolation shell with synchronised speed. The maximum torque which can be transmitted is 100 Nm. If that is exceeded, the connections fails, i.e. even though the driver rotates with the operational number of revolutions, the rotor is only turning at a slow speed of approx. 10 rpm.

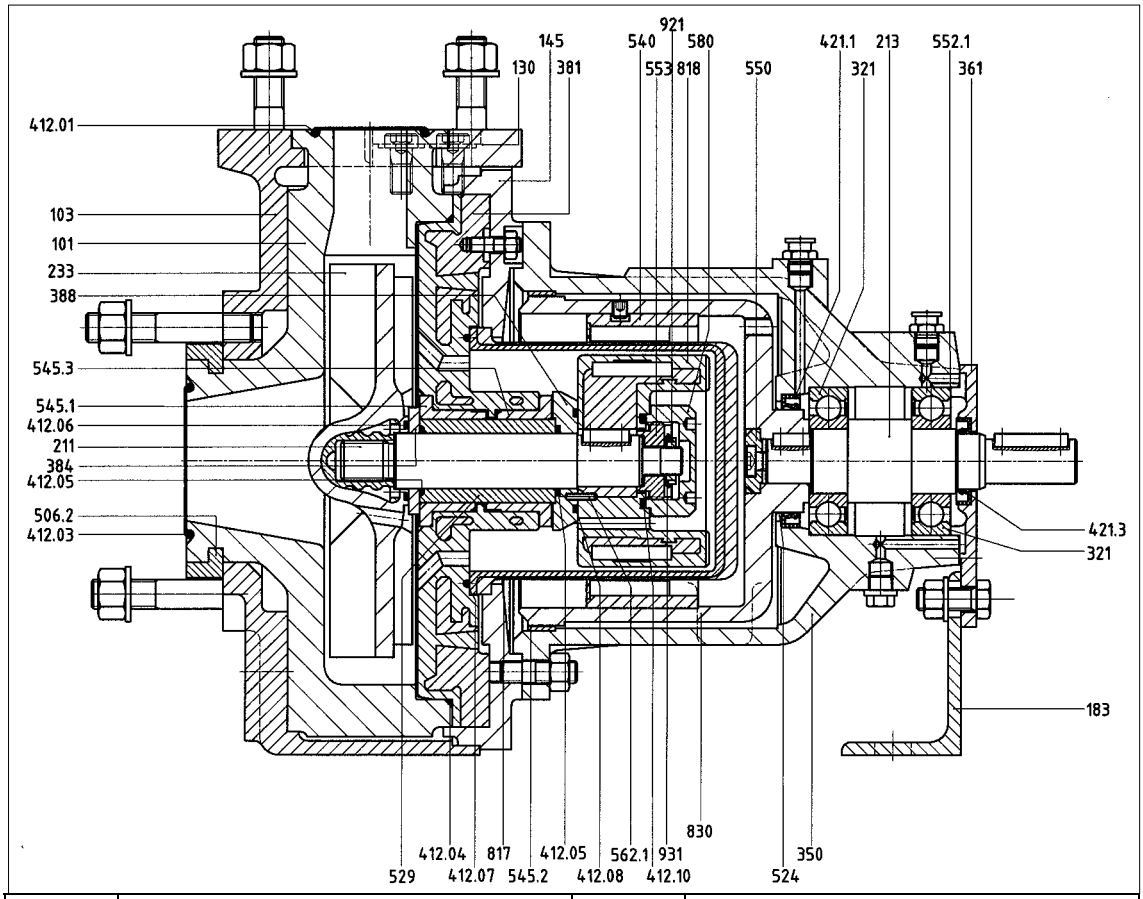
4.3.6 Bearing for the outer impeller gear and foot mounted lantern

In the case of the FM series, the bearing takes place using the driving electrical motor itself which is flanged to the foot mounted lantern (part 345) or motor stool (part 341).

In the case of the NM series, the bearing is made up of two grease lubricated radial ball bearings (part 321) which are protected with a bearing cover (part 360) with inserted radial shaft seal rings (parts 421). The bearing housing is flanged onto the adaptor (part 145). The bearing is lubricated with grease via the grease nipples (part 636). The shaft takes up the torque via a key connection.

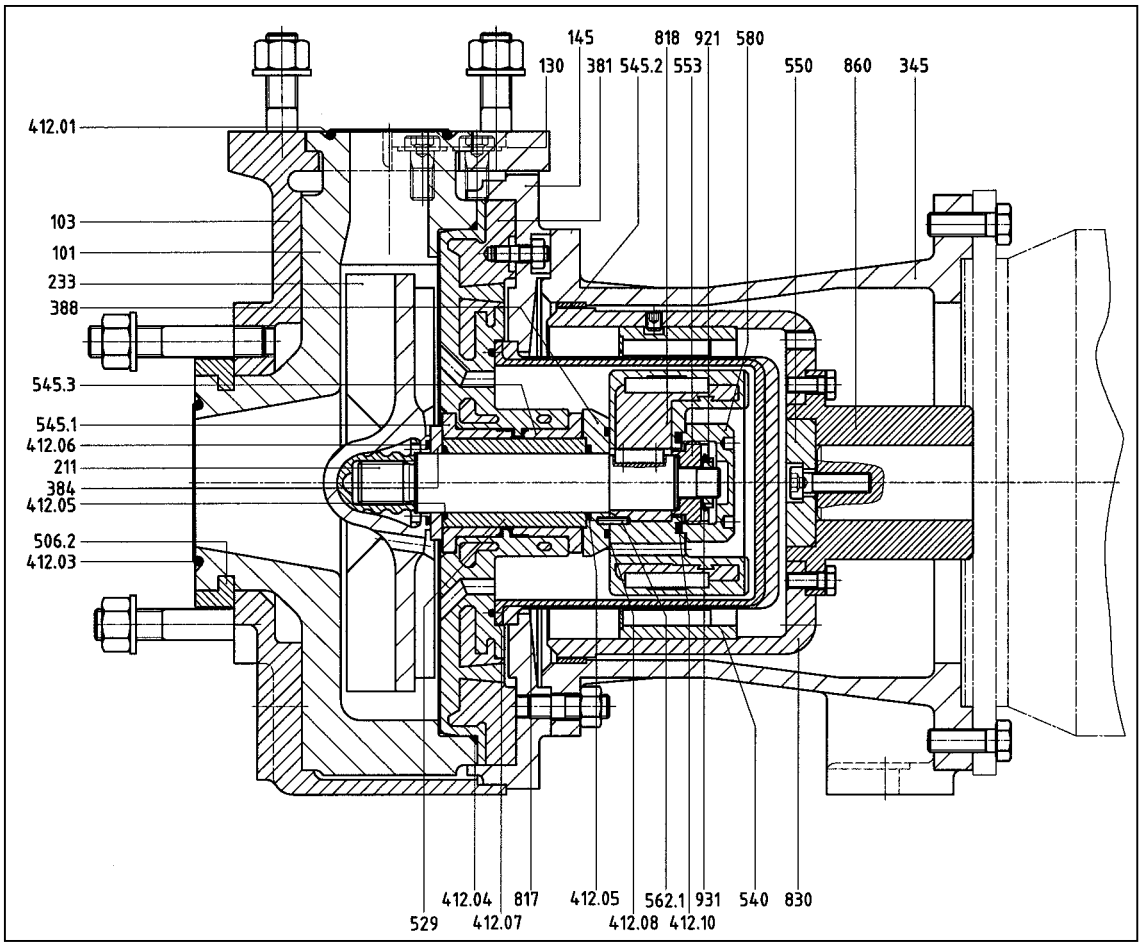
Two drainage holes (left and right) have been positioned in the bearing housing which are equipped with screw plugs (part 903.42). If the isolation shell is damaged, the liquid to be pumped collects here and isolation shell be emptied out of the system.

4.4 Sectional drawing



Part no.	Description	Part no.	Description
101	Pump casing	506.2	Retaining ring
103	Annular casing	524	Shaft wearing sleeve
130	Casing part	529	Bearing sleeve
145	Adaptor	540	Bush
183	Support foot	545.x	Bearing bush
211	Pump shaft	550	Disc
213	Drive shaft	552.1	Spanner
233	Counter clockwise impeller	553	Thrust plug
321	Radial ball bearing	562.1	Parallel pin
350	Bearing housing	580	Cap
361	Bearing end cover	817	Isolation shell
381	Bearing cartridge	818	Rotor
384	Thrust bearing plate	830	Driver
388	Counter thrust bearing plate	921	Shaft nut
412.x	O-ring	931	Lockwasher
421.x	Radial shaft seal ring		

Fig. 4.1 Section of a pump of the NM series, represented here with internal rinsing system.



Part no.	Description	Part no.	Description
101	Pump casing	540	Bush
103	Annular casing	545.x	Bearing bush
130	Casing part	550	Disc
145	Adaptor	553	Thrust plug
211	Pump shaft	562.1	Parallel pin
233	Counter clockwise impeller	580	Cap
345	Foot mounted lantern	817	Isolation shell
381	Bearing cartridge	818	Rotor
384	Thrust bearing plate	830	Driver
388	Counter thrust bearing plate	860	Coupling part
412.x	O-ring	921	Shaft nut
506.2	Retaining ring	931	Lockwasher
529	Bearing sleeve		

Fig. 4.2 Section of a pump of the FM series, shown here with external rinsing system.

4.5 External flushing

Pumps for delivery of contaminated liquids can be equipped with a flushing port (external flush) to flush the axial face seal bearing with clean liquid – normally water – and keep impurities away from it. The flushing rate of 35 – 45 l/h required for external flush is achieved by setting the flushing pressure 0.5 – 0.8 bar above the inflow pressure. The manufacturer should be consulted if flushing rates other than those recommended are required for process engineering reasons.
A pressure gauge and valve must be installed in the flushing line to set and adjust the correct rate of flow for the flushing medium. The flushing rate can be checked with the aid of a fluid flow meter (rotameter).

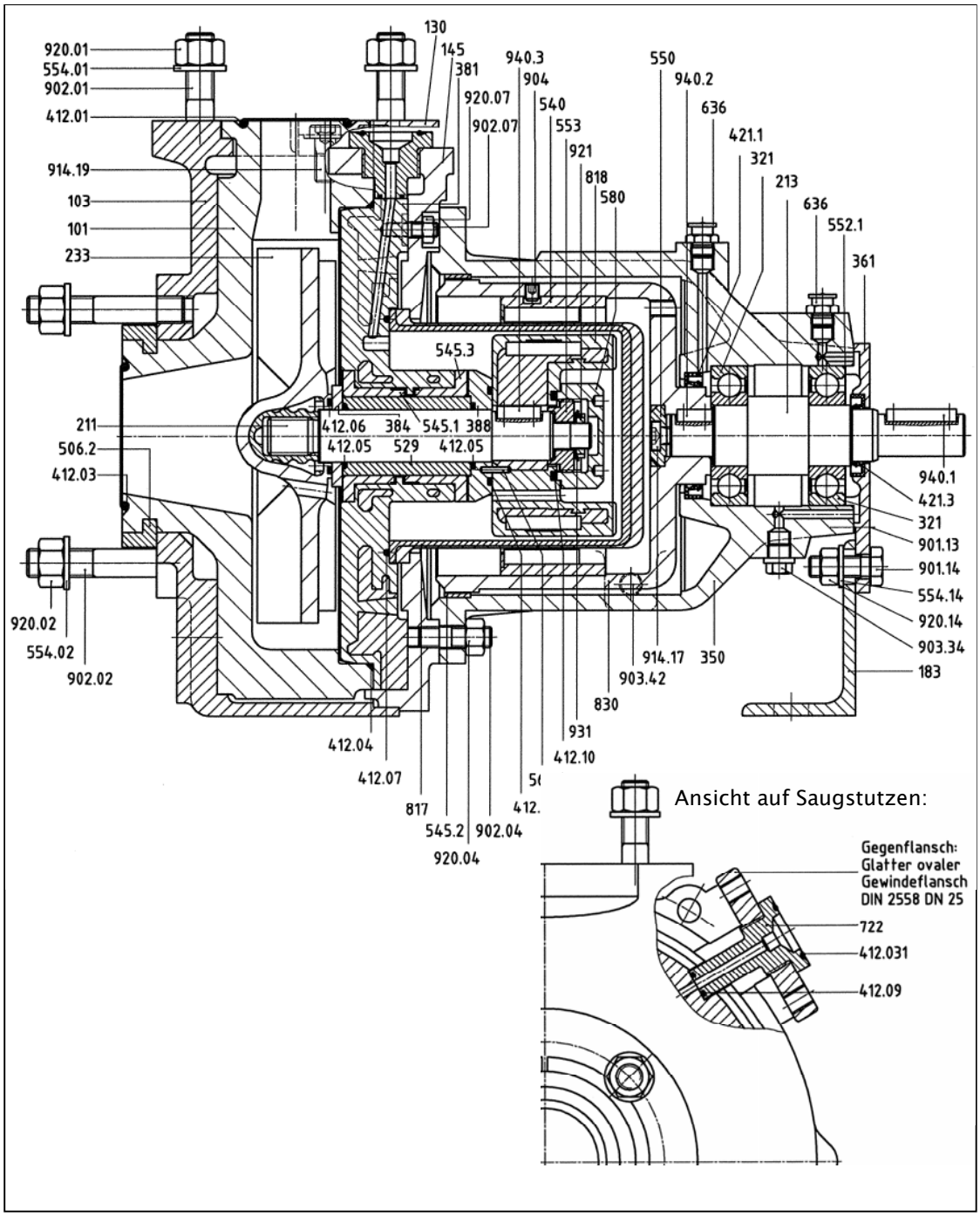


Fig. 4.3 Section of a pump of the NM series with external flushing

4.6 Special tools

The special tools described below are available from the manufacturer.

4.6.1 Impeller key (Part 051)

To disassemble and assemble semi-open impellers with screw attachment onto the drive shaft it is wise to use a so-called impeller key (Fig. 4.4). The inside of this key is shaped to be a negative of the impeller blades. The key is placed on the facing side of the impeller which is then removed from the shaft in the direction of rotation of the pump. The shaft must be fixed in order to prevent it turning too.

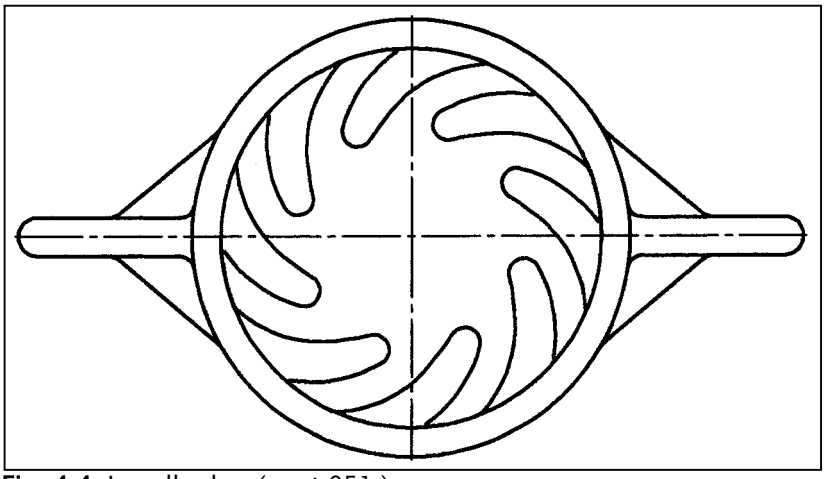


Fig. 4.4 Impeller key (part 051)

4.7 Noise emission values

The A-weighted equivalent permanent sound level at a one meter (1 m) distance from the reference cuboid according to EN ISO 3744 is below 85 dB(A).

4.8 Accessories

- Coupling: Flexible coupling with or without intermediate coupling sleeve (NM)
- Protection against accidental contact for coupling (NM)
- Base plate of torsion-resistant design of grey cast iron
- Foundation fastening and/or installation: Levelling elements, stone bolts, shear connectors
- Special accessories, according to order

4.9 Dimensions and weights

For the data on dimensions and weights, please refer to the dimensional drawing and/or installation plan of the pump.

5. Erection

5.1 General

To ensure faultless operation later on, it is very important that the pumps etc. are erected carefully and correctly. Incorrect erection can cause personal injuries and material damage as well as premature wearing of the pump. If the manufacturer does not erect the pump etc., any liability for erection faults and the consequences of ignoring safety instructions, is excluded.

The EC Council Directive 1999/92 on minimum regulations for the improvement of the health protection and safety of the employees who may be endangered by explosive atmospheres must be complied with. The EN 1127-1 Standard is to be observed (explosion protection).

5.2 Erection of pumps mounted on base plates

5.2.1 Aligning the base plate

Before delivery, the pump is aligned with the base plate and fixed. If, due to rough transport, the position of the pump to the base plate has changed, then the original position must be attained again by referring to the plans.
Otherwise, the pump is aligned to the plant merely by positioning the base plate!

When installing the plant, the base plate must be aligned so that
1.) the level of the discharge nozzle is horizontal in every direction. For example, this can be checked with a machine spirit level.
2.) Suction and discharge pipelines must be connected with the pump nozzle in such a way that the admissible nozzle loads are not exceeded. The admissible nozzle loads are listed in section 5.4.

The base plate is aligned according to the means of fixing selected for this aggregate. There are three ways of fixing possible:
1.) Simple fixing to the foundations
The base plate is fixed to the foundations by means of stone bolts or shear connectors which have been anchored into the foundation beforehand and which project through the corresponding holes in the base plate. Before these are tightened, the base plate must be aligned using spacers and thin pieces of metal.
The base plate is aligned in such a way that it is supported by three aligning spacers. Each spacer is positioned on the left and right longitudinal side in the area of the drive, the third spacer is positioned in the area of the pump on the short side.
2.) Fixing on foundations with subsequent casting
The base plate is fixed to the foundations by means of stone bolts or shear connectors which have been anchored into the foundations and which project through the corresponding holes in the base plate. Before casting, the base plate must be aligned using spacers and thin pieces of metal (as described in 1.). The foundation screws are tightened once the casting mass has hardened.
3.) Erection on levelling elements without a foundation
The position of the base plate is adjusted using levelling elements. The pump aggregate is supported above the floor on oscillation absorbers. No foundation screws are necessary.

The above three types of fixing are suitable for all pumps of the NM and FM series supplied on base plates. **If the pump aggregate is installed, isolated, as is the case, for example, with the foundation-free installation, a separate earthing is to be provided in order to avoid potential differences.**

5.2.2 Connecting the pipes

Before aligning the drive, the pump must be connected to the pipes making sure that the pipes do not twist the pump. The admissible nozzle loads listed in section 5.4 must not be exceeded! Section 5.3 lists suggestions on the design of the pipeline layout.

The necessary pipeline attachments and connections must be made if the magnetic coupling pump comes equipped with external rinsing.

5.2.3 Aligning the drive (only NM)

ATTENTION **The manufacturer's alignment of the drive to the pump must be checked under all circumstances and if necessary it must be corrected. Please refer to the operating instructions for the coupling.**

The position of the drive shaft to the pump shaft is measured via the coupling.

Usually, intermediate sleeve couplings are used for pumps of the NM series. Fig. 5.1 shows this type of coupling, the intermediate sleeve can be removed after loosening the connecting screws. Distance S2 between pin and packet part of the coupling must be 5 mm all around the circumference and can be determined using a feeler gauge.

After checking and if necessary creating this gap by aligning the drive in an axial direction, the angle and height of the drive must be checked. Three procedures are usual here, measurement with a straight-edge, measurement with a dial gauge and measurement with the help of a laser beam. All procedures give correct results. In every case the data regarding the alignment accuracy can be found in the operating instructions for the coupling.

The angle and height of the drive depends on the aggregate supplied and can be adjusted with the help of thin pieces of material or regulating screws. After aligning it, the drive must be fixed.

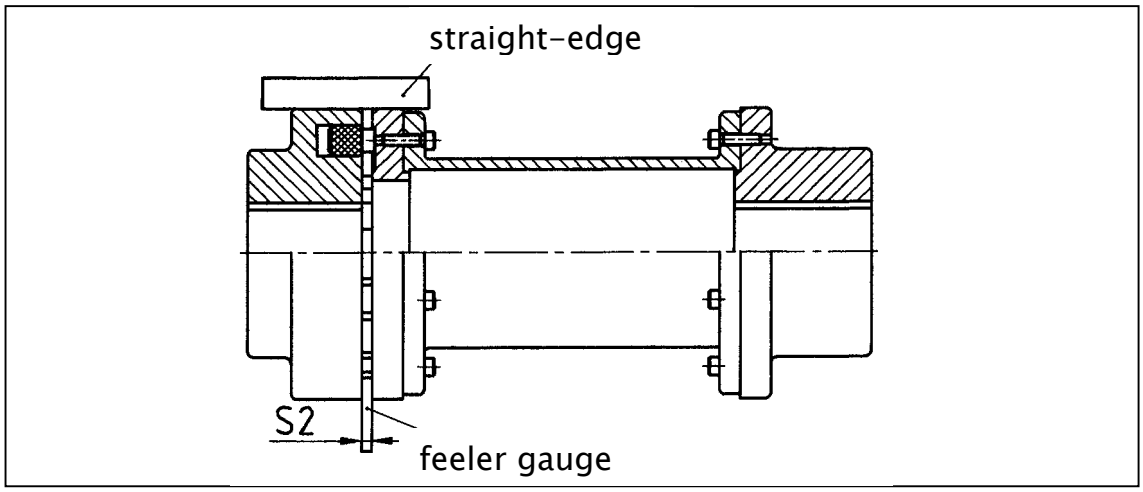


Fig. 5.1 Intermediate sleeve coupling, measurement using feeler gauge and straight-edge.

5.3 Pipes

5.3.1 General

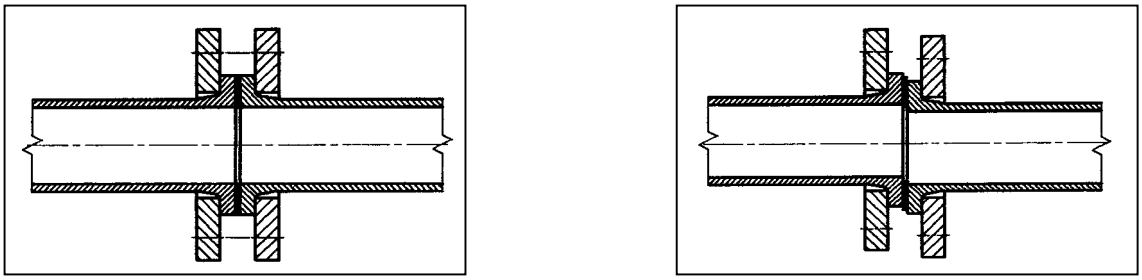
The pipe diameter and the layout of the pipes has usually been determined during the planning stage. The recommendations for pipeline layout can only be basic considering that the final laying of the pipes will have to take the specific local situation, which the pump manufacturer is usually not aware of, into consideration.

5.3.2 Notes on laying pipes

Please ensure that the forces and moments from the pipes acting on the pump nozzles do not exceed the permissible nozzle loads as listed in section 5.4. This applies to when the plant is both operational and non-operational. Under no circumstances may the pump serve as a fixed point within the pipeline system. If necessary, the pipelines must be held by brackets so that the pump is not twisted and so that they can not set up oscillations in the pump whilst it is operational.
In addition, it is recommended that compensators are installed before the suction and discharge nozzles of the pump. To avoid increased flow resistance, compensators should have the nominal width of the pipe concerned.

Tightening connection screws on the pump flanges must not cause any twisting. Torque should be approx. 35 Nm for each screw.

When laying and connecting the pipes care must be taken that seals do not project into the clear diameter. **Fig. 5.2** shows the correct arrangement on the left hand side and the incorrect arrangement on the right hand side.



correct incorrect

Fig. 5.2 Connection of pipelines

Only NM

ATTENTION **The alignment of the drive to the pump must be checked, and if necessary corrected, after the pipes have been connected and before starting up.**

5.3.3 Suction pipe

The suction pipe should be as short as possible and its diameter should never be smaller than that of the suction nozzle. If the suction pipe is larger, an eccentric transition with synchronous upper edge which prevents the formation of air sacs, must be used. **Fig. 5.3**.

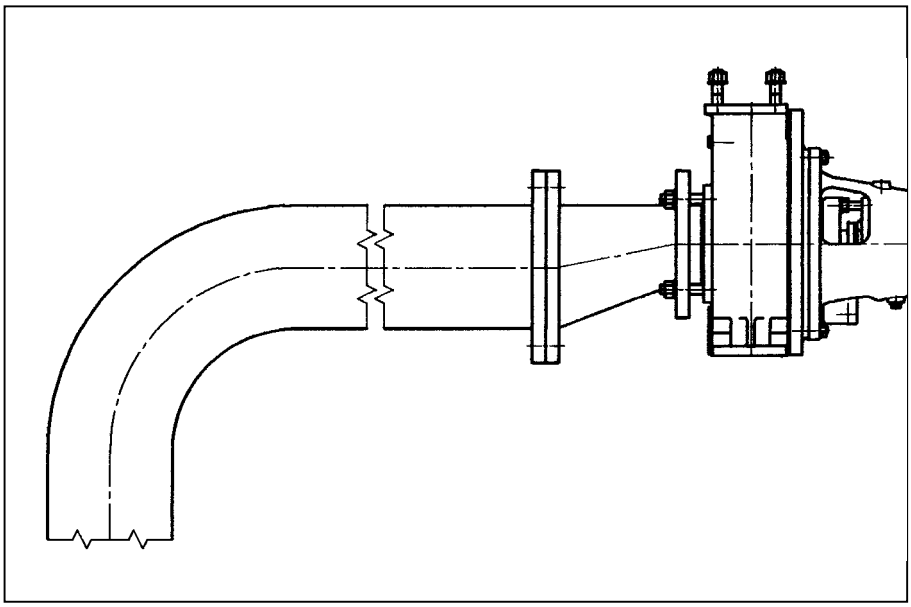


Fig. 5.3 Transition between suction pipe and pump suction nozzle

The diameter of the suction pipe must be selected so that a flow velocity of 2m/s of water or of liquids of the same viscosity, is not exceeded. Greater losses in pressure due to long pipe lengths or baffles must be avoided. The pipe must be completely leak-proof (pressure test) and must not contain any air sacs. Horizontal pieces of pipes should have an ascending gradient of at least 1% in the direction of the pump. Sharp corners and bends must be avoided in the pipes, as is "suctioning over the mountain".

In the case of automatic suction pumps, the suction pipe is easier to evacuate if the pump is switched on when the highest possible level of liquid is in the pump sump. Gassing liquids should not be pumped in suction operation. If in doubt, ask the manufacturer.

5.3.4 Automatic suction by means of liquid provision (attached storage container).

By attaching a liquid provision system (storage container) to the pump suction nozzle, a normal suctioning rotary pump can evacuate the suction pipe.

When using an attachment tank with inflammable media to be pumped (Dangerous Goods Ordinance, Article 4 Dangerousness Characteristics), the user must ensure that an explosive mixture can be developed neither in the pump nor in the attachment tank.

The useful volume of the storage container (between bottom edge - supply nozzle and top edge outlet nozzle) must be at least 50% larger than the volume of the suction pipe. Standard storage containers are allocated to the pump models for the following suction ratios:

- Overall length (stretched length) of suction pipe 5 m
- Nominal width of suction pipe according to nominal width of the suction nozzle
- Maximum geodesic suction height 3 m

If the volume of the suction pipe and / or the geodesic suction height is larger than the above figures, the storage containers must be adapted to suit the suction conditions.

Before starting the system up for the first time, or after the system has been emptied, the storage container must be filled with liquid through a filling plug. Please also ensure that the suction pipe is sufficiently resistant to vacuum.

Pipes which are to be connected to the attached storage container must be secured without tension. They must be supported by brackets or retainers. The pipes must not apply any forces or moments to the container and connectors. The attached storage container must be connected as close to the pump as possible. If possible, pump and attached storage container should be mounted on a common base plate. If the attached storage container is not placed on the base plate, care must be taken to ensure that the bottom of the attached storage container rests fully on a level surface and is properly secured.

5.3.5 Supply pipe

The supply pipe must be positioned so that it continuously descends towards the pump suction nozzle and should never be smaller than the suction nozzle of the pump. The diameter of the supply pipe must be selected so that a rate of flow of water or of liquids of the same viscosity, of 2.5 m/s is not exceeded.

For repair purposes, a shut-off valve should be positioned at a sufficient distance away from the suction nozzle (approx. 2 - 3 times the diameter of the pipeline) which must be completely open whilst the pump is operational. The arrangement of shut-off valves in the supply or suction pipelines must be such that depending on the design of the fittings, no air sacs can be formed. The supply flow is only to be regulated using fittings in the discharge pipes.

To avoid increased flow resistance, further fittings which are to be installed should have the same nominal width as the supply line. Sharp corners and bends are to be avoided.

5.3.6 Discharge line, throttling bush

The discharge line should not be smaller than the delivery branch of the pump. In addition, the diameter depends on economic aspects, however, the flow velocity should not be selected above 5 m/s. A shut-off and/or control instrument is to be installed as close as possible to the pump.

Pumps whose type designation bears the supplementary letter "D" (e.g. NMPO 80-50-315 D), are designed with a smaller cross section in the delivery branch. The working point of this pump has been designed with a throttling bush, therefore, the pump must be operated with the same. **In case of changes to the cross-sectional area of the throttling bush, considerable damages to the pump must be expected.**

ATTENTION

5.3.7 Non-return valve

A non-return valve must be located far enough above the pump delivery connector to ensure that when the pump is started, it is safely filled with medium even when a cushion of air forms before the non-return valve.

5.4 Admissible nozzle loads

The admissible nozzle loads listed below use API 610 as a guide. The x-axis runs co-axial to the pump shaft, the y-axis represents the vertical line and the z-axis represents the horizontal line. The forces and moments listed can be taken up independently of their direction.

Series NM and FM	Vertical forces		Horizontal forces		Moments		
	Suction nozzle	Discharge nozzle	Suction nozzle	Discharge nozzle	Suct/Dis. nozzle	Suct/Dis. nozzle	Suct/Dis. nozzle
Component size	Fy [N]	Fy [N]	Fx/Fz [N]	Fx/Fz [N]	Mx [Nm]	My [Nm]	Mz [Nm]
50-32-160 50-32-200	±579	±690	±890/ ±712	±512/ ±401	±461/ ±271	±353/ ±210	±230/ ±129
65-40-200	±712	±779	±1113/ ±890	±579 ±467	±705 ±366	±664/ ±271	±353/ ±176
80-50-200	±890	±890	±1335/ ±1068	±712/ ±579	±949/ ±461	±719/ ±353	±475/ ±230

5.5 Additional connections

For the dimensions and position of the additional connections required for the pump (sealing liquid, flushing liquid etc.), please refer to the installation plan.

ATTENTION **These connections are decisive for the function and must therefore be properly attached. The required volume flows and pressures are to be set (please refer to 7.2 below).**

5.6 Coupling protection (NM)

The pump may only be operated with a suitable coupling protection. Due to its strength, distance to the coupling and material, a coupling protection contained in the scope of supply of an aggregate corresponds to the employment in a potentially explosive atmosphere.

5.7 Final inspection and testing

The alignment according to Item 5.2 above as well as the proper distance of coupling and coupling protection are to be checked. At the coupling, the shaft must be capable of being turned by hand.

5.8 Electric connection

The electric connection may only be made by an electrical expert. The suitability of the motor for the available mains voltage is to be checked against the data on the name plate. A suitable circuit is to be selected. The employment of a protective motor device is recommended. In potentially explosive atmospheres, DIN EN 60079-14 must be observed.

6. Starting up / Shutting down

6.1 Measures to be taken before starting up

6.1.1 Cleaning and hydraulic pressure test of pipes

Before starting the pump up for the first time, all foreign bodies which might be left in the pipes from the installation of the pump, must be removed (screws, forging scales, welding drops etc.). Then the pipes are checked for leaks. Suction and discharge pipes must be hydraulically tested in accordance with the respective safety instructions.

Before starting up the pump again after repairs have been made to a damaged pump, all broken parts of any kind – especially duroplastic or ceramic parts – must be removed from the pipelines. These broken parts can be caused when the inside bearings have been damaged or the action of foreign bodies.

ATTENTION **Broken parts or foreign bodies remaining in the pipeline system can cause disastrous damage to the pump or other parts of the plant.**

6.1.2 Ensuring bearing lubrication (only NM)

Bearings are lubricated with suitable grease before delivery.

ATTENTION **It is not necessary to re-lubricate before starting up, in fact this could cause damage as too much lubrication can cause the bearings to overheat.**

6.1.3 Checking the direction of rotation

a) **NM**

Pump aggregates with intermediate sleeves are supplied in an uncoupled state. To do this, the cam plate of the coupling is unscrewed, but still projects into the packet part of the coupling. The screws are on the inside of the intermediate sleeve which must be removed before the direction of rotation is checked.
Pump aggregates without intermediate sleeves are – if possible – also supplied in an uncoupled state.

ATTENTION **Only check that the direction of rotation of the motor is identical to the direction of rotation of the pump in an uncoupled state.**

Please ensure that the motor has been cut off from the power supply when the intermediate sleeve is being removed and re-installed.

Each pump has been given an arrow to indicate the direction of rotation on the bearing housing (part 350) by the factory.

ATTENTION **Even if the motor runs in the wrong direction for only a short time, the pump can be damaged!**

b) **FM**

Each pump has been marked with an arrow to indicate the direction of rotation on the foot mounted lantern (part 345) by the factory.
There are two ways of checking whether this block designed pump is running in the right direction of rotation:

1. The entire outer impeller gear including the motor, is pulled off the pump. This is equivalent to magnetic decoupling. The following applies:

Please ensure that when the motor is removed and re-installed, the outer impeller gear is disconnected from the power supply. Do not touch rotating parts whilst checking the direction of rotation!

After the motor has been connected to the power supply correctly, the outer impeller gear in installed back in to the pump by flanging the centering ring onto the foot mounted lantern

2. A viewing glass is positioned in the foot mounted lantern through which the direction of rotation of the driver at low revolution numbers can be checked with the help of the arrows. Now you can also check the direction of rotation whilst the pump is magnetically coupled if the test takes place with only

a very short power impulse. This is sufficient to be able to recognise the direction of rotation through the viewing glass. Screwing of the impeller from the shaft is not possible if the impeller has been attached to the shaft with a torque of at least 50 Nm. Even allowing the pump to run dry for less than 5 seconds can be tolerated in this case.

ATTENTION **Allowing the pump to run dry for longer than 5 seconds can lead to damage to the pump!**

6.1.4 Safety devices for the protection of people

ATTENTION **Please ensure that before starting up, rotating parts of the pump are not freely accessible.**

Only NM: The protective device above the coupling to prevent it being touched, must be in position.

Electrical motors and other devices must be installed in accordance with the currently valid safety regulations.

6.2 Starting up the pump

When starting up the pump, please follow the following procedures:
1.) If an external rinsing system has been installed, please ensure that this is started up first. Volume flow: 35 - 45 litres per hour
2.)The supply and suction pipelines as well as the pump body must be filled with liquid.

ATTENTION **The pump must not be run dry.**

3.) Fittings on the suction side must be opened completely. Shut-down fittings on the discharge side should be open slightly in order that the pump is not operated against closed fittings, i.e. operating at zero liquid flow. **If, due to the design of the system, the pump does have to be operated with closed fittings, the pump may overheat.**

The pump may only be operated with closed shut-down fittings during start up and for no longer than one minute.

ATTENTION The manufacturer's consent is required if it is to be operated with closed shut-down fittings for longer periods of time.

4.) The drive is started up.
5.) Regulators on the discharge side must be opened so far that nominal flow is achieved.

If during operation, it is expected that the shut-down fittings on the discharge side will be closed down, then a bypass must be installed in front of these and returned to the pump container (not to the suction nozzle!). This is the only way in which overheating of the pump can be avoided.

If the pump is being switched continuously (i.e. more than 3 switching on processes per hour) an auxiliary start-up device should be installed (star- triangle-switch, electronic smooth start up device, hydraulic clutch or similar) in order to reduce mechanical strain. The use of this type of device depends on the utilisation factor of the machine (coupling performance, speed, switching frequency) and should be discussed with the manufacturer.

6.3 Switching the pump off for a short period of time

The following procedure is to be performed if the pump is to be switched off for a short period of time:

1.) The shut-down fitting on the discharge side must be closed or reduced to minimum flow (close completely after the motor has been stopped).
2.) The drive machine is switched off.

ATTENTION **External rinsing system, if applicable, must continue even after the drive machine has been switched off.**

3.) If there is the danger of freezing, the liquid to be pumped must be removed from the pump.

6.4 Shutting the pump down permanently

The following steps must be carried out if the pump is to be shut down permanently:
1.) The shut-down fitting on the discharge side is to be closed or turned to minimum volume (after the motor has been switched off, it must be closed completely).
2.) The drive is shut down
3.) The entire plant systems, including the pump, must be relaxed and emptied.
4.) An external rinsing system, if applicable, must be turned off.
5.) If the liquid to be pumped tends to crystallise, the pump must be rinsed with clean water.

7. Maintenance / Repairs

7.1 Only NM Size I: Bearing of the outer impeller gear

The pumps are equipped with rolling bearings. In case of continuous operation, the bearing temperature may be approx. 60°C above the ambient temperature. **If a pump is employed in a potentially explosive atmosphere (refer to 2.9.1 above), the bearings must be exchanged after a maximum of 16.000 operating hours. Bearings must be regularly checked and/or controlled to avoid the risk of an ignition. If the pump is not employed in a potentially explosive atmosphere, the bearings must be checked and exchanged, if necessary, after approx. 16.000 operating hours, at the latest, however, after three years. Insufficient lubrication may lead to an inadmissible temperature increase. Due to an excessive wear, it leads to a reduction of the service life through to the destruction of the bearings. The limitation of the temperature class due to the kind of lubrication must be observed (please refer to 2.9.6 above).**

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7.1.1 Grease lubrication

Unless otherwise specified, lifetime-lubricated bearings are provided. Regreasable bearings may optionally be selected. Greased bearings may be selected if preferred. Oil lubrication is provided for fluid temperatures in excess of 100 °C.

7.1.1.1 Lifetime-lubricated grooved ball bearings

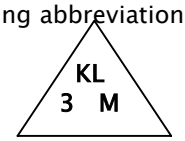
The lifetime-lubricated grooved ball bearings are serially designed with guard disks on both sides. The bearings sealed on both sides are lifetime-lubricated and maintenance-free. Therefore, prior to installation, they should by no means be heated to above 80°C or rinsed. The grooved ball bearings are filled with standard lubricating greases. The lubricating grease has good anti-corrosive properties and contains lithium soap as thickener.

7.1.1.2 Grease lubrication with relubrication

At the factory, grease-lubricated bearings are filled with a suitable bearing grease. Prior to commissioning, relubrication is not necessary, often even harmful and may result in excessive heating.

Fresh grease is filled into the gaps of the bearing cage. The grease chambers may only be filled with grease to one third as too much grease results in an excessive bearing heating. Suitable bearing greases are supplied by all known grease manufacturers.

At normal ambient temperatures, greases for a temperature range of -20°C to +120°C are to be used. According to DIN 51502, the lubricating greases have the following abbreviation: **KL 3 M**. The corresponding symbol:



7.1.2 Oil lubrication

Ex factory, the pumps are delivered without oil filling. In case of oil-lubricated bearings, the bearing housing, prior to commissioning, must be filled through the top filling opening until the oil has reached the middle of the oil-level gauge.

ACHTUNG

The bearing housing must not be filled with oil beyond this level.

If preferred, the bearing bracket can be equipped with an oil regulator (constant level oiler) instead of the oil level sight glass. Oil must be filled in via the filling port S1 until the oil appears in the screw-in element of the tilted oil regulator (see **Fig. 7.1**).

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The oil level of the bearing housing must not exceed this level as otherwise oil leaks at the ventilation channel of the constant level oiler.

Please take great care to ensure that the cork seal under the glass container of the constant level oiler is exactly central under the edge of the glass and that the glass container is screwed on tight. Do not screw it too tight, as this will cause the cork seal to slip and this in turn will cause oil to leak. The glass container should also never be removed from its holder.

If an oil level sight glass is installed, the oil must be visible in the middle of the sight glass. Oil dipsticks must be wetted up to the mark. **A visual inspection must be performed at regular intervals. The oil level being too low, oil must be refilled.**

An oil change should be performed annually, at least, however, after 10,000 operating hours. The lubricating oils are to be selected according to the ambient temperature. In case of ambient temperatures between 0°C and 40°C, C-LP oils of viscosity class ISO VG 68-100, DIN 51517 part III, are used (SAE 20-30). For ambient temperatures deviating herefrom, the required lubricating oil qualities must in each individual case be agreed with the manufacturer.

The required filling quantity is app. 0,8 liter.

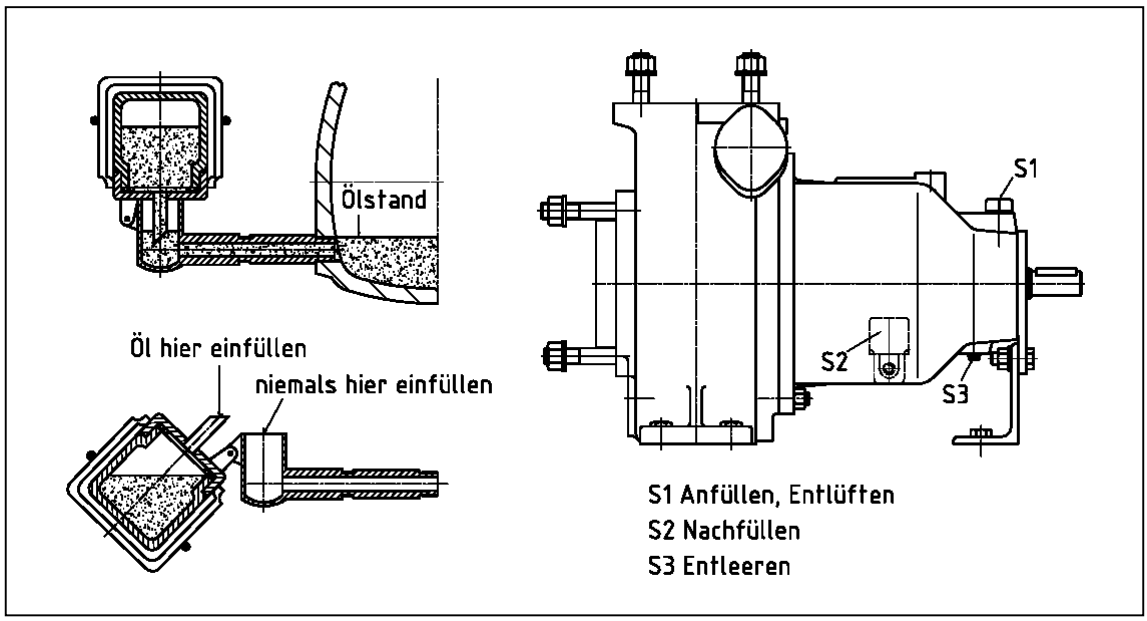


Fig. 7.1 Oil lubrication and constant level oiler

7.2 Bearing of the internal running gear

Plain bearings of special silicon carbide grades are used for the radial and axial bearings of the internal running gear. In versions with internal flush, this bearing is lubricated directly by the pumped medium. In versions with external flush, the type of flushing medium and the flushing rate are specified in the order confirmation and/or data sheets. The values listed below are guideline values. Care must be taken to ensure that the selected flushing medium is compatible with the pumped fluid.

a) Internal flush:
No external supply required.

b) External flush:
Medium: usually, clean, filtered water
Volume: 30 l/h to 45 l/h

7.3 Disassembly and assembly of the pump

Disassembly and assembly are described on the basis of assembly steps. The tightening torques in Annex B must be maintained.

Danger of accidents due to magnetic forces! Endangers the functioning of heart pacemakers!

If possible, anti-magnetic tools are to be used for disassembly and assembly work!

7.3.1 Disassembly of the pump

Any work on the machine may on principle be done only with the electric junctions disconnected. The pump aggregate must be protected from unintended starting.

Prior to being dismounted, the pump must be decontaminated and neutralized. Always wear suitable protective clothing! Contact with the liquid being pumped must be avoided under all circumstances! When draining the medium pumped make sure to avoid any danger to personnel and environment. Statutory provisions must be complied with.

Disassembly steps 1) to 10) for type NM size I

1) Disconnect electric motor from power supply.
2) If fitted, disconnect external flushing line.
3) Remove protection against accidental contact.
4) Remove the cylindrical screw and take off the intermediate coupling sleeve.
5) Unscrew and remove the nut (part 920.03) on annular casing/ adaptor (part 103+145) and (part 920.14) on the support foot (part 183). Remove the support foot.
6) Draw the complete running gear (bearing housing, adaptor, bearing cartridge, left-hand impeller) out of the pump casing. The pump casing / annular casing can remain in the piping system.
7) Unscrew the nut (part 920.04) to disconnect the adaptor (part 145) from the bearing housing (part 350). The pump is magnetically decoupled by removing the bearing housing (part 350).
8) Unscrew the driver (part 830) from the top shaft (part 213) by removing the cylindrical screw (part 914.17) and disc (part 550) with the aid of an Allen key (width across flats 5). **(Important: beware of the magnetic force.)**
9) Remove the bearing end cover (part 361) with radial shaft seal ring (part 421.3), and the spanners (part 552.1) .
10) Drive or force the top shaft with the radial ball bearings (part 213 + 321) out of the bearing housing (part 350) with the aid of a round bar.

Disassembly steps 11) to 21) for types NM and FM size I

11) Unscrew the bearing cartridge (part 381) from the adaptor (part 145) (part 920.07 6 nut M8). Remove the can (part 817).
12) Unscrew the cap (part 580) from the thrust plug (part 553) **(important: left-hand thread)** and then draw the thrust plug off the pump shaft (part 211) by unscrewing the shaft nut (part 921) and lock washer (part 931).
13) Pull the rotor (part 818) and counter thrust bearing plate (part 388) off the shaft. The rotor is highly magnetic and must be laid on a non-magnetic surface (e.g. wood) after removal.
14) Draw the left-hand impeller (part 233) with pump shaft (part 211) and bearing sleeve (part 529) out of the bearing cartridge (part 381).
15) Remove the bearing bush (parts 545.1 + 545.3) from the bearing cartridge (part 381).
16) Draw the thrust bearing plate (part 384) and bearing sleeve (part 529) off the shaft .
17) Unscrew the left-hand impeller (part 233) from the pump shaft (part 211) with the spanner (part 051) (right-hand thread). The shaft extension must be clamped via the two keys for this purpose.

18) Undo the grub screw (part 904) and push the bush (part 540) out of the driver (part 830) with the aid of three screws which must be screwed into the threaded holes in the driver.
19) Disconnect the pipes from the intake and delivery connectors and pull the annular casing (part 103) with pump casing (part 101) out of the piping system.
20) Then unscrew the casing part (part 130) from the outlet flange of the annular casing by means of the cylindrical screw (part 914.19) .
21) Remove the retaining ring (part 506.2) on the intake side before removing the pump casing (part 101) from the annular casing (part 103). The studs (part 902.02) must be removed for this purpose.

Disassembly steps 1) to 8) for type **FM** size I

1) Disconnect the electric motor from the power supply.
2) Disconnect the external flushing line if fitted.
3) Unscrew the hexagon head bolts (parts 901.28) and draw the electric motor (part 800) out of the pump with the complete driver and coupling parts (part 830 + 860). The pump is magnetically decoupled at the same time.
4) Release the cylindrical screw (part 914.17) in the motor shaft with an Allen key and remove it.
5) The coupling part (part 860) with driver (part 830) can then be pulled off the motor shaft.
6) Unscrew the hexagon head bolts (parts 901.37) and disconnect the driver (part 830) from the coupling parts (part 860).
7) Unscrew and remove the nut (parts 920.03) on the annular casing/ adaptor (part 103+145). From motor size 160 onwards, two hexagon head bolts on the support foot of the foot mounted lantern (part 345) must also be removed. Pull the complete running gear (foot mounted lantern, adaptor, bearing cartridge, left-hand impeller) out of the pump casing. The pump casing/ annular casing can remain in the piping system.
8) Unscrew the nut (part 920.04) from the adaptor (part 145) and remove the foot mounted lantern (part 345).

Continue with disassembly steps 11) to 21) for types **NM** and **FM** size I (see above).

7.3.2 Assembly of the pump

Montageschritte 1) bis 19) für **NM** und **FM** Gr. I
Assembly steps 1) to 19) for types **NM** and **FM** size I

1) Place the pump casing (part 101) in the annular casing (part 103). Insert the two-part retaining ring (part 506.2).
2) Screw the intake-side studs (parts 902.02) into the annular casing (part 103) to secure the two-part retaining ring (part 506.2). Make up the stud with washer (parts 554.02) and nut (parts 920.02).
3) Slide the casing part (part 130) on the delivery connector of the annular casing (part 103) under the plastic collar of the pump casing (part 101) and secure it with the cylindrical screw (parts 914.19).
4) Screw the delivery-side stud (part 902.01) into the annular casing (part 103).
5) Make up the stud with washer (parts 554.01) and nut (parts 920.01).
6) Screw the stud (parts 902.03) into the annular casing (part 103).
7) Insert the bearing bush (parts 545.1 + 545.3) in the bearing cartridge (part 381).
8) The lugs on the bearing bush must engage in the corresponding grooves in the bearing cartridge (part 381).
9) Coat the thread of the pump shaft with Loctite and clamp the shaft via the two keys (part 940.3). Screw on the left-hand impeller (part 233) with the aid of the spanner (part 051) (note the tightening torque in accordance with Annex B).
10) Place O-ring (part 412.06) in the groove and slide the thrust bearing plate (part 384) onto the pump shaft (part 211).
11) Slide the first O-ring (part 412.05) onto the pump shaft (part 211) and then the bearing sleeve (part 529).
12) Carefully slide the bearing cartridge (part 381) with the two bearing bushes (part 545.1 + 545.3) over the bearing sleeve.

13) Now fit the second O-ring (part 412.05) and the counter thrust bearing plate (part 388). Insert the O-ring (part 412.08).
14) Slip the rotor (part 818) onto the shaft seat with two parallel pins (part 562.1).
15) Guide the parallel pins (part 562.1) into the two opposing holes (dia. 3.5 mm) on the counter thrust bearing plate (part 388).
16) Insert O-ring (part 412.10) in rotor.
17) Tighten the thrust plug (part 553) and lock washer (part 931) with the shaft nut (part 921). An axial clearance of 0.5 mm must now be present in the rotor bearing. The rotor must turn easily.
18) Screw on the cap (part 580) (left-handed thread).
19) Place O-ring (part 412.07) in bearing cartridge (part 381). Slip the can (part 817) over the rotor; centre it over the adaptor (part 145) and screw down tightly (part 920.07, 6 nuts M8).

Assembly steps 20) to 31) for type NM size I

20) Uniformly heat the radial ball bearing (parts 321) and slip them onto the top shaft (part 213) so that the sealing discs face inwards. Grease the bearing.
21) Fit the radial shaft seal rings (parts 421) in the bearing end cover and bearing housing (part 361 und 350) in the correct direction.
22) Drive the top shaft (part 213) with radial ball bearing (part 321) as far as possible into the bearing housing (part 350). Check: the rear radial ball bearing must be positioned at a depth of 5 mm in relation to the rear plane of the bearing housing.
23) Place the spanners (part 552.1) in the remaining space on the rear radial ball bearing and introduce the bearing end cover (part 361) with radial shaft seal ring into the bearing housing (part 350) via the top shaft and secure it with four hexagon head bolts (part 901.13).
24) Screw the grease nipple (parts 636) into the bearing housing (part 350).
25) Fit the keys (parts 940.1) in the top shaft (part 213).
26) Slide the driver (part 830) onto the journal of the top shaft (part 213).
27) Carefully pull the bearing housing (part 350) with bearing, driver and top shaft (part 213) over the can, magnetically coupling the parts at the same time. Then centre them in the adaptor (part 145). Screw the studs (part 902.03) tight.
28) External flush only: Connect the flushing line.
29) The pump is now hermetically tight. Perform pressure test.
30) Secure the intermediate coupling sleeve with the cylindrical screw and align it. Refit the protection against accidental contact.
31) Reconnect the electric motor.

Assembly steps 20) to 26) for type FM size I:

20) Centre the foot mounted lantern (part 345) over the studs (part 902.03) in the adaptor (part 145) and then screw it tight with nut (part 920.03).
21) External flush only: Connect the flushing line.
22) The pump is now hermetically tight. Perform pressure test.
23) Join the driver (part 830) with the coupling parts (part 860) via the hexagon head bolts (part 901.37).
24) Then slide the driver (part 830) with the coupling parts (part 860) onto the motor shaft and secure it with the cylindrical screw (part 914.17) and disc (part 550).
25) Carefully pull the driver (part 830) with electric motor into the foot mounted lantern (part 345) over the can. The pump is magnetically coupled at the same time. Secure the motor flange to the foot mounted lantern (part 345) via the hexagon head bolts (part 901.28).
26) Reconnect the electric motor.

7.4 Spare parts

On principle, replacement parts should only be ordered according to a parts list belonging to the pump stating the identification number of the part and / or the serial number of the pump. On principle, every individual part can be supplied. Standard parts are always in stock at the manufacturer's or his representatives and this guarantees short delivery periods. However, we recommend that the client should also keep the parts listed below in his stores.

The following parts are spare parts:

- part 101	pump casing
- part 233	left-hand impeller
- part 321	radial ball bearing (only type NM)
- part 384	thrust bearing plate
- part 388	counter thrust bearing plate
- part 412.01	O-ring (outlet flange)
- part 412.03	O-ring (inlet flange)
- part 412.04	O-ring (pump casing)
- parts 412.05	O-ring (bearing sleeve)
- part 412.06	O-ring (left-hand impeller, hinten)
- part 412.07	O-ring (can)
- part 412.08	O-ring (counter thrust bearing plate)
- part 412.10	O-ring (Rotor, rear)
- part 421.1	radial shaft seal ring (im bearing housing, only type NM)
- part 421.3	radial shaft seal ring (im bearing end cover, only type NM)
- part 529	bearing sleeve
- parts 545	Bearing bush
- part 552	spanner (at bearing end cover, only type NM)
- part 817	can

The manufacturer can at any time - if the serial number of pump is stated - provide an offer for the replacement parts required for the pump in question.

	Fault		Possible cause	Rectification
8.1	**Pump not pumping even though engine is working.**	8.1.1	Pump not filled sufficiently before starting up.	Refill again and de-air.
		8.1.2	Storage container empty or liquid level below inlet nozzle of suction line, therefore no liquid is flowing.	Install automatic monitoring device. Train personnel.
		8.1.3	Suction height too great, therefore liquid does not flow.	Position pump lower, and / or position liquid level higher.
		8.1.4	Pump sucking in additional air, there fore liquid does not flow.	Check suction pipe and shaft seal for leaks.
		8.1.5	Air sac formation in the pipes, therefore no liquid flow.	Lay pipes correctly. Check position of fittings. If necessary fit de-airing fittings.
		8.1.6	The overall delivery head is greater than that stated.	Adapt plant to suit pump or vice versa, otherwise use different pump.
		8.1.7	Impeller melted open in the hub region or has been destroyed due to faults as described in 8.5, 8.6 or 8.7.	Repair pump, check operational conditions. Train personnel.
		8.1.8	Magnetic coupling torn away due to fault as defined in 8.4.	Check and change operational conditions. Start up pump again.
8.2	**Flow and / or delivery head too small.**	8.2.1	Direction of rotation of pump is incorrect.	Change direction of motor to ensure pumps rotates in the right direction. Check pump for damage before starting up again.
		8.2.2	Plant conditions do not agree with pump design.	Adapt plant to suit pump or vice versa, if necessary use a different pump.
		8.2.3	High pressure losses in unfavourably laid pipes.	Increase diameter of pipes and fittings, avoid bends, create favourable transitions.
		8.2.4	Pipes or pump blocked.	Clean sieve, filter, pipes, fittings and pump.
		8.2.5	High pressure loss in suction pipe, therefore cavitation.	Clean suction basket or suction pipe, possibly increase diameter of suction pipe. Check foot valve to see if it opens fully.
		8.2.6	Suction height too great, therefore cavitation.	Position pump lower and / or position level of liquid higher.
		8.2.7	Temperature of liquid to be pumped too high, therefore cavitation.	Reduce temperature of liquid to be pumped and / or increase initial pressure.
		8.2.8	High proportion of gas in liquid to be pumped.	Calm liquid to be pumped. Prevent water spouts using guide crosses. Lengthen circulation times. Make gassing out possible.
		8.2.9	Viscosity of liquid to be pumped higher than originally assumed.	Adapt pump, if necessary use a different pump. Alternative: Dilute or heat liquid to be pumped.
		8.2.10	Impeller worn due to abrasion.	Replace impeller.

	Fault		Possible cause	Rectification
8.3	**Motor is overloaded**	8.3.1	Pump cannot generate intended pressure due to system design. Actual operational level is reached at a higher volume than was intended with original design. This leads to increased power requirement.	Close fittings on discharge side until intended pressure achieved. If no regulators have been fitted, pump must be adapted to suit actual system (Impeller correction, adjusting speed, install throttle flaps).
		8.3.2	Only in the case of speed regulation: number of revolutions too high.	Reduce no. of revs. Remove causes which led to no. of revs. being too high (e.g. clean filter, remove deposits in pipes).
		8.3.3	Density of liquid to be pumped greater than originally assumed.	Fit motor with greater power.
		8.3.4	Viscosity of liquid to be pumped greater than originally assumed.	Fit motor with more power. Alternatively dilute liquid or preheat liquid to be pumped.
		8.3.5	Damage to pump. Therefore increased friction.	Repair pump.
8.4	**Magnetic coupling tears off.**	8.4.1	Pump cannot build up intended pressure due to design of system. Actual operation point is reached at a greater flow than was intended at planning stage. This leads to increased transition moment.	Close fittings on discharge side until intended pressure achieved. If no regulators have been fitted, pump must be adapted to suit actual system (Impeller correction, adjusting speed, install throttle flaps).
		8.4.2	Only in the case of speed regulation: number of revolutions too high.	Reduce no. of revs. Remove causes which led to increase in no. of revs. (e.g. clean filter, remove deposits in pipes).
		8.4.3	Density of liquid to be pumped greater than originally assumed.	Reduce volume to be pumped. Alternatively use pump with stronger magnetic coupling.
		8.4.4	Viscosity of liquid to be pumped greater than originally assumed.	Reduce volume to be pumped. Alternatively use pump with stronger magnetic coupling.

	Fault		Possible causes	Rectification
8.5	**The bearing being rinsed by liquid is spontaneously destroyed. Therefore other parts are destroyed and possibly the pump begins to leak**	8.5.1	Pump has run dry, i.e. there is no liquid in the entire pump. Hence the bearing surfaces run hot and they are thermally / mechanically destroyed as well as frequent destruction of adjacent plastic parts. (so-called running hot).	Running dry is a typical operating error. The pump must be filled completely and de-aired before it is started up. Fittings on the suction side must be completely open. Train personnel accordingly. Repair pump.
		8.5.2	Semi- running -dry if the flow of liquid stops, i.e. even though a liquid ring is rotating with the impeller, it does not reach the interior sliding faces. Therefore the pump runs hot.	Take measures to prevent flow being interrupted. Install automatic monitoring device. Train personnel. Repair pump. If necessary refit pump with external rinsing system.
		8.5.3	The liquid is virtually being pumped at boiling temperature. Due to the increased temperature caused by friction and simultaneous decrease in pressure, the liquid being pumped evaporates in the bearing. Possible crystals in the liquid might crystallise out. Therefore the pump runs hot.	Repair pump. Refit pump with external rinsing system.
8.6	**Pump is destroyed by "running in its own juice"**	8.6.1	Pump running "in its own juice", i.e. drive performance is completely transformed into increased pump temperatures if liquid cannot be exchanged properly. This occurs if fittings on pressure side remains closed after pump has been started up...	After starting up open fittings on pressure side at least so far that the minimum volume flow is achieved. Train personnel accordingly. If necessary install automatic device. Repair pump.
		8.6.2	or the pipe lines are blocked...	Clean pipelines, repair pump.
		8.6.3	or the static head of the system is not achieved by the pump.	Adapt system to suit pump or vice versa, possibly use different pump.

	Fault		Possible causes	Rectification
8.7	**Pump is destroyed because it was rotating the wrong way. (Impeller started up, hub thread torn out of impeller, bearing cover destroyed, liquid no longer being pumped**	8.7.1	Pump rotating in the wrong direction.	Change poles on motor in order to achieve correct direction of rotation for the pump. Repair pump.
8.8	**Increased bearing temperature (only type NM)**	8.8.1	Motor aligned badly (Coupling halves are displaced in an axial, radial, angled direction).	Realign motor. Ensure axial coupling distance of 5 mm.
		8.8.2	Pump body is twisted by pipes.	Change position of pipes or position of pump to remove tension. Then align motor. Possibly position aggregate freely.
		8.8.3	Not sufficient, too much, used or unsuitable grease.	Correct this situation.
8.9	**Uneven running (noises, vibrations)**	8.9.1	Motor aligned badly (coupling halves are displaced in an axial, radial, angled direction, only NM series).	Realign motor, make sure axial coupling distance is 5 mm.
		8.9.2	Coupling packets worn. Only NM series.	Replace coupling packets.
		8.9.3	Bearing is damaged. Only NM series.	Replace roller bearings and shaft seal rings.
		8.9.4	Not fixed tightly to foundation. Only NM series.	Tighten fixing screws and anchors.
		8.9.5	Magnetic coupling torn due to fault as defined in 8.4.	Check operating conditions and change them. Re-start pump.
		8.9.6	Cavitation.	Take measure to avoid cavitation: - reduce volume flow being pumped - increase preliminary pressure - reduce losses on suction side.

9. Associated documentation

Each pump of the NM or FM 40-25-160 series is supplied with these operating instructions.

Other documentation which describes the pump is not included in delivery as standard. The scope of the documentation to be delivered is agreed for each order separately.

A.1 Design of the name plate

The design of the name plate is explained by means of code letters a – o.

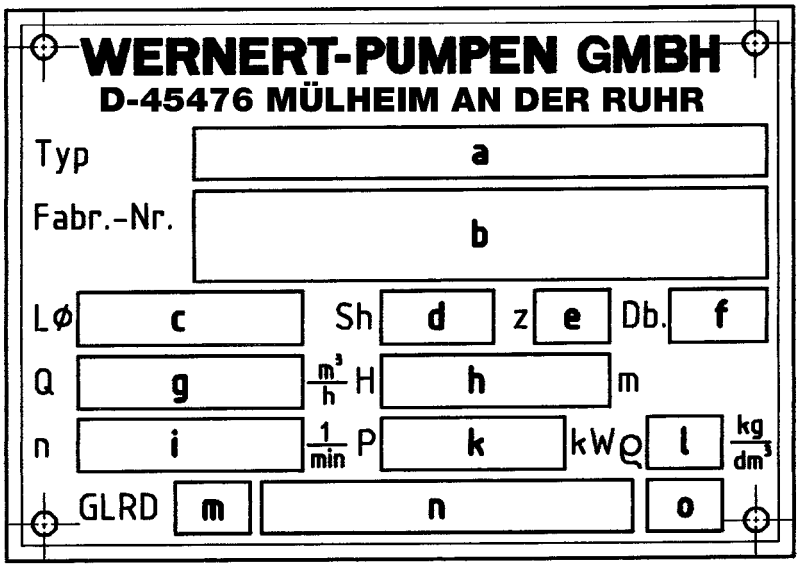
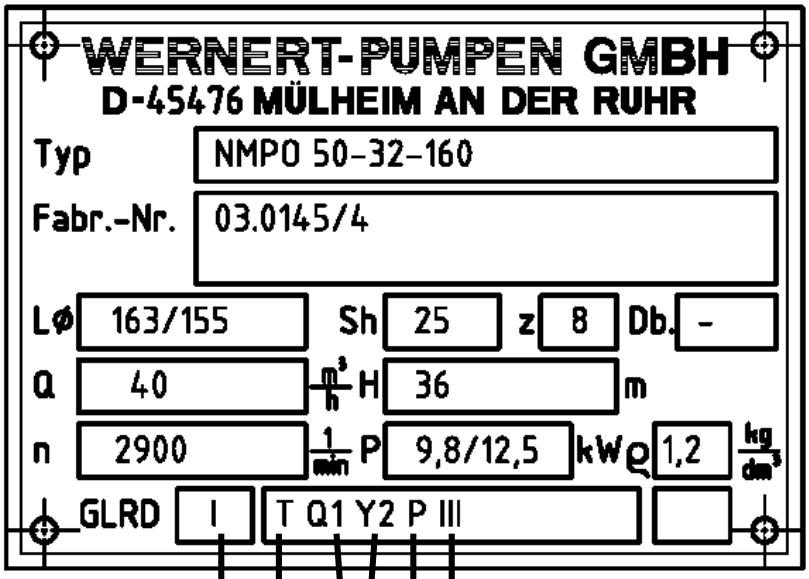


Figure A.1 Name plate with code letters

Field a = Type designation
Field b = Serial number
Field c = Impeller: Diameter in mm
Field d = Impeller: Blade height in mm
Field e = Impeller: Blade number
Field f = Possible throttling bush: Diameter in mm
Field g = Nominal flow rate Q in m³/h
Field h = Nominal delivery head H in m
Field i = Nominal speed in 1/min
Field k = Coupling power with density as per Field l / nominal drive power, each in kW
Field l = Liquid density in kg/dm³
Field m = Kind of flushing
Field n = Material and size of magnetic transmission
Field o = without use

Figure A.2 Exemplary name plate



Size of magnetic transmission: I, II or III

Material of bearing cartridge: P = PFA
R = UHMW-PE

Material of bearing bush: B = Carbon (synthetic-resin impregnated)
Q1 = SSiC (Silicon carbide, sintered at zero pressure)
Y2 = PTFE/Carbon

Material of CanSpalttopfes: T = PTFE/CFK
Q1 = SSiC (Silicon carbide, sintered at zero pressure)

Kind of flushing: I = Internal flushing
D = External flushing

A.1.1 Additional name plate for pumps according to EC Council Directive 94/9

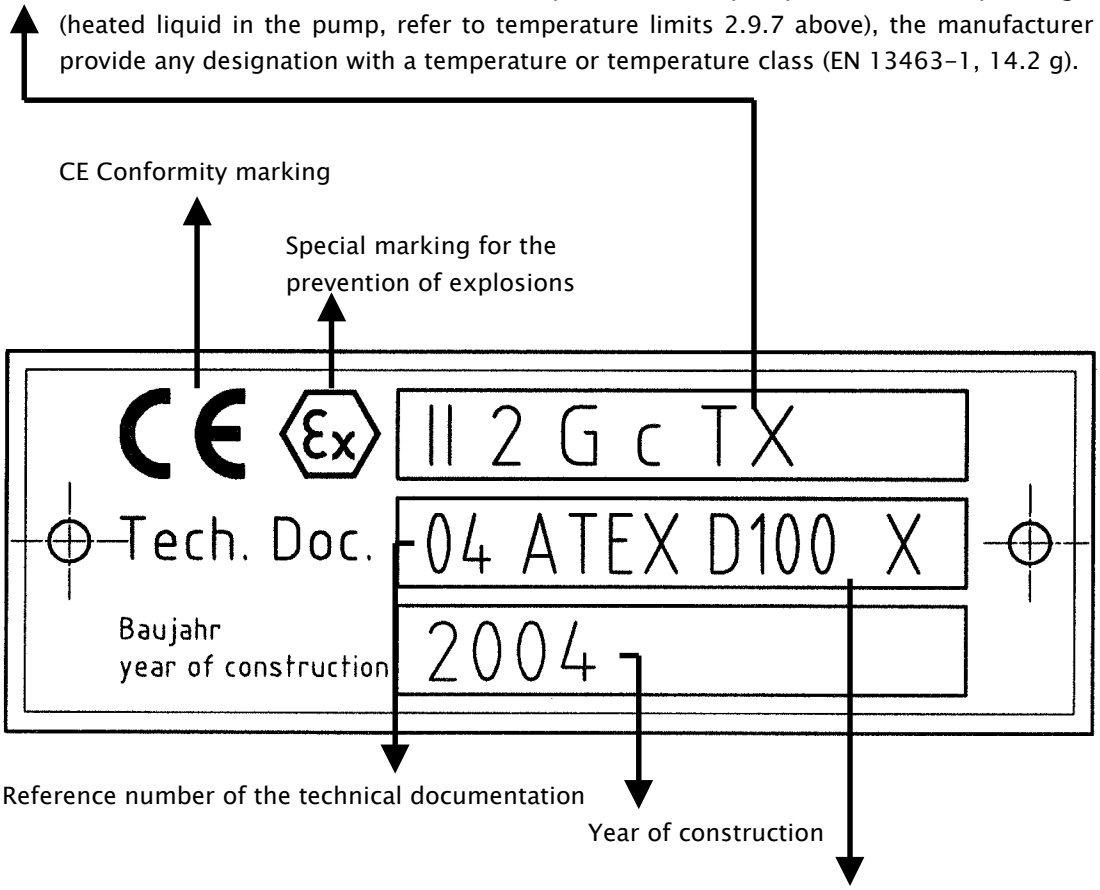
Degree of explosion protection

II **Equipment group II** applies to equipment for application in areas which may be endangered by an explosive atmosphere. Except for underground workings of mines and their surface installations which may be endangered by fire damp and/or combustible dust.

2G **Category 2** comprises machines of such a structural design that they can be operated in agreement with the characteristic quantities specified by the manufacturer assuring a high degree of safety. Machines of this category are intended for use in areas where an explosive atmosphere of gases, vapours, fogs may be occasionally expected. Even in case of frequent equipment troubles or fault conditions which are normally to be expected, the explosion protection measures of this category of equipment assure the required degree of safety.

c **Constructional-safety type of protection "c"** is a type of explosion protection where structural measures are taken to assure protection against potential ignition due to hot surfaces, sparks and adiabatic compressions (EN 13463-5).

TX **Temperature classes** T1 – T6 of which only temperature classes T1 to T4 are currently admitted. As the maximum surface temperature mainly depends on the operating conditions (heated liquid in the pump, refer to temperature limits 2.9.7 above), the manufacturer must not provide any designation with a temperature or temperature class (EN 13463-1, 14.2 g).



X The admissible area of the ambient temperature is -10 °C up to +40 °C. Behind the number of the technical documentation, the name plate is provided with the symbol "X" as an additional marking for the limited ambient temperature.

Thread size	Strength class	Tightening torque [Nm]	
		min.	max.
M4	8.8	1,7	2,8
M5	8.8	3,5	5,5
M6	8.8	6	9,5
M8	8.8	15	23
M10	8.8	30	46
M12	8.8	50	79
M14	8.8	90	125
M16	8.8	150	195
M18	8.8	225	280
M20	8.8	320	390
M22	8.8	440	530
M24	8.8	550	670
M27	8.8	810	1000
M30	8.8	1090	1350

Thread size	Strength class	Tightening torque [Nm]	
		min.	max.
M4	A2/A4 70	1,5	2
M5	A2/A4 70	2,5	3,5
M6	A2/A4 70	5	7
M8	A2/A4 70	9	14
M10	A2/A4 70	20	30
M12	A2/A4 70	33	50
M14	A2/A4 70	57	87
M16	A2/A4 70	84	120
M18	A2/A4 70	115	196
M20	A2/A4 70	190	275
M22	A2/A4 70	260	370
M24	A2/A4 70	330	476
M27	A2/A4 70	460	680
M30	A2/A4 70	650	930

Table B.1 Tightening torques for screw connections

Size of Bearing housing	Tightening torque [Nm]
Size. 1	80 Nm

Table B.2 Tightening torques of the impellers

The following applies to the "outlet" variant:
The screws for fastening the flange, Part 723 and the cap, Part 580 must be tightened with a tightening torque of 15 Nm.