OPERATING INSTRUCTIONS

EN

Translation of the Original

OKTA 4000 ATEX

Roots pump

PFEIFFER VACUUM

Dear Customer,

Thank you for choosing a Pfeiffer Vacuum product. Your new roots pump should support you in your individual application with full performance and without malfunctions. The name Pfeiffer Vacuum stands for high-quality vacuum technology, a comprehensive and complete range of top-quality products and first-class service. From this extensive, practical experience we have gained a large volume of information that can contribute to efficient deployment and to your personal safety.

In the knowledge that our product must avoid consuming work output, we trust that our product can offer you a solution that supports you in the effective and trouble-free implementation of your individual application.

Please read these operating instructions before putting your product into operation for the first time. If you have any questions or suggestions, please feel free to contact info@pfeiffer-vacuum.de.

Further operating instructions from Pfeiffer Vacuum can be found in the Download Center on our website.

Disclaimer of liability

These operating instructions describe all models and variants of your product. Note that your product may not be equipped with all features described in this document. Pfeiffer Vacuum constantly adapts its products to the latest state of the art without prior notice. Please take into account that online operating instructions can deviate from the printed operating instructions supplied with your product.

Furthermore, Pfeiffer Vacuum assumes no responsibility or liability for damage resulting from the use of the product that contradicts its proper use or is explicitly defined as foreseeable misuse.

Copyright

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1 About this manual

IMPORTANT
Read carefully before use.
Keep the manual for future consultation.

1.1 Validity

This operating instructions is a customer document of Pfeiffer Vacuum. The operating instructions describe the functions of the named product and provide the most important information for the safe use of the device. The description is written in accordance with the valid directives. The information in this operating instructions refers to the product's current development status. The document shall remain valid provided that the customer does not make any changes to the product.

1.1.1 Applicable documents

Document	Number
Declaration of conformity for “Equipment category 2G”	Part of this document
Declaration of conformity for “Equipment category 3G”	Part of this document
Technical information for the thermometer	Supplier document
Operating instructions for the motor	Supplier document
Operating instructions for the coupling	Supplier document

You can find these documents in the Pfeiffer Vacuum Download Center.

1.1.2 Variants

These instructions apply for different roots pump designs:

Permissible temperature range	Lubricant type
+5°C ≤ Ta ≤ +40°C	P3
-20°C ≤ Ta ≤ +40°C	H1

Tbl. 1: Variants

1.2 Target group

These operating instructions are aimed at all persons performing the following activities on the product:

- Transportation
- Setup (Installation)
- Usage and operation
- Decommissioning
- Maintenance and cleaning
- Storage or disposal

The work described in this document is only permitted to be performed by persons with the appropriate technical qualifications (expert personnel) or who have received the relevant training from Pfeiffer Vacuum.

1.3 Conventions

1.3.1 Instructions in the text

Usage instructions in the document follow a general structure that is complete in itself. The required action is indicated by an individual step or multi-part action steps.

Individual action step

A horizontal, solid triangle indicates the only step in an action.

► This is an individual action step.

Sequence of multi-part action steps

The numerical list indicates an action with multiple necessary steps.

1. Step 1
2. Step 2
3. ...

1.3.2 Pictographs

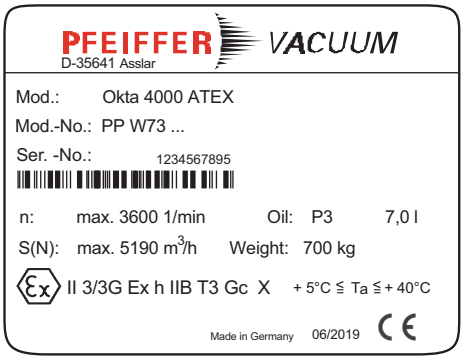
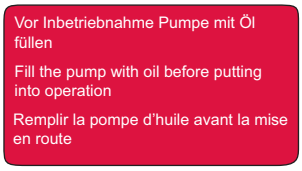
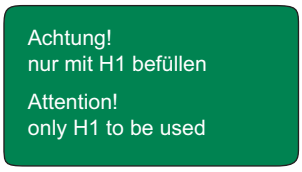
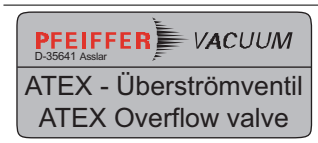
Pictographs used in the document indicate useful information.

Note

Tip

1.3.3 Stickers on the product

This section describes all the stickers on the product along with their meanings.

	**Rating plate** (example) The rating plate is located on the front side above the sight glass **Motor rating plate (not shown)**
	**Sticker (red)** Fill the roots pump with lubricant before commissioning
	**Sticker – only in case of H1 lubricant**: ● Caution: fill with **H1** only
	**Sticker - Overflow valve** Note: Pump design with overflow valve.

	**Warning hot surface** This sticker warns of injuries caused by high temperatures as a result of contact without protection during operation.
	**Magnetic field warning** This sticker warns of injuries to people with pacemakers.

Tbl. 2: Stickers on the product

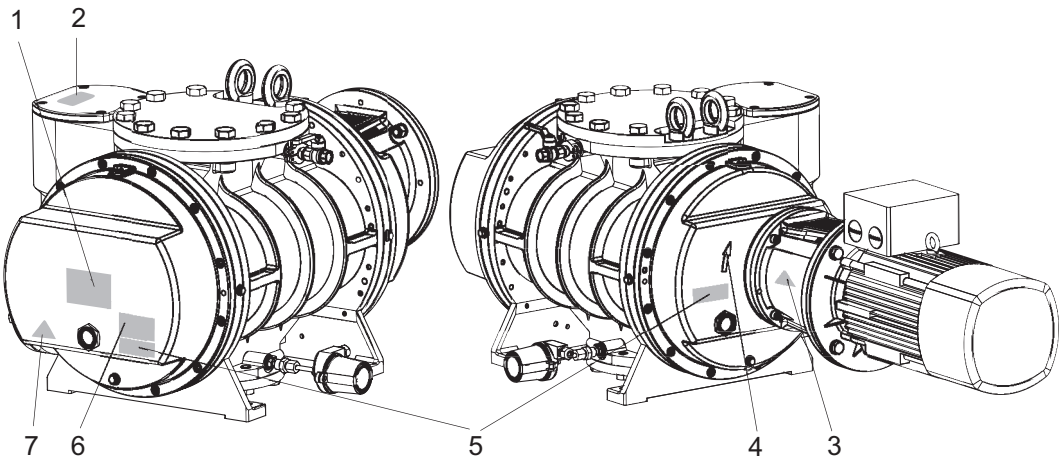


Fig. 1: Position of the stickers on the product

1 Rating plate
2 Note: ATEX overflow valve
3 Magnetic field warning sign
4 Direction of rotation arrow (cast in pump housing)
5 Note: Filling with lubricant
6 Notice: Only fill with H1 (optional)
7 Hot surface warning sign

1.3.4 Abbreviations

Abbreviation	Explanation
A_S	Sealing gas content at the operating gas flow
OI	Operating instructions
DIN	German Institute for Standardization (Deutsches Institut für Normung)
EPL	Equipment Protection Level
ISO	International Organization for Standardization
n	Rotation speed [Hz]
p	Intake pressure [hPa]
PE	Protective earth (earthed conductor)
p_0	Ambient pressure [hPa]
p_V	Fore-vacuum pressure [hPa]
PN	Nominal pressure stage (pressure nominal)
PWM	Pulse width modulation
Δp	Differential pressure max. [hPa]
Q_S	Sealing gas flow
SI	Service instructions
SIL	Safety Integrity Level in accordance with safety standard DIN EN 61508
SR	Voltage slew rate
S_{th}	Nominal pumping speed roots pump, theoretical
S_V	Pumping speed backing pump

Abbreviation	Explanation
WAF	Width Across Flats
Ta	Permissible ambient temperature

Tbl. 3: Abbreviations used

1.4 Trademark proof

- Loctite® is a trademark of HENKEL IP & HOLDING GMBH.

2 Safety

2.1 General safety information

The following 4 risk levels and 1 information level are taken into account in this document.

⚠ DANGER

Immediately pending danger

Indicates an immediately pending danger that will result in death or serious injury if not observed.

► Instructions to avoid the danger situation

⚠ WARNING

Potential pending danger

Indicates a pending danger that could result in death or serious injury if not observed.

► Instructions to avoid the danger situation

⚠ CAUTION

Potential pending danger

Indicates a pending danger that could result in minor injuries if not observed.

► Instructions to avoid the danger situation

NOTICE

Danger of damage to property

Is used to highlight actions that are not associated with personal injury.

► Instructions to avoid damage to property

Notes, tips or examples indicate important information about the product or about this document.

2.2 Safety instructions

All safety instructions in this document are based on the results of the risk assessment carried out in accordance with Machinery Directive 2006/42/EC Annex I and EN ISO 12100 Section 5. Where applicable, all life cycle phases of the product were taken into account.

Risks during transport

⚠ DANGER

Risk of explosion from electrostatic charging during transport

There is a risk of fatalities when transporting packaging material (foil) and plastic containers in potentially explosive areas. Ignition can cause very serious injuries, and even fatalities.

► Only unpack the vacuum pump outside of potentially explosive areas.

⚠ DANGER

Risk of explosion when carrying out installation and maintenance work in potentially explosive areas

There is a risk of explosion if unsuitable tools are used in potentially explosive areas. Ignition can cause very serious injuries.

► Transport, installation and maintenance work may not be performed in potentially explosive atmospheres.

► Always shut down the vacuum pump before commencing any work.

⚠ WARNING

Risk of serious injury from swinging, toppling or falling objects

During transport, there is a risk of crushing and impact on swinging, toppling or falling objects. There is a risk of injuries to limbs, up to and including bone fractures and head injuries.

- ► Secure the danger zone if necessary.
- ► Pay attention to the center of gravity of the load during transport.
- ► Ensure even movements and moderate speeds.
- ► Observe safe handling of the transport devices.
- ► Avoid sloping attachment aids.
- ► Never stack products.
- ► Wear protective equipment, e.g. safety shoes.

Risks during installation

⚠ DANGER

Danger to life from electric shock

Touching exposed and voltage-bearing elements causes an electric shock. Improper connection of the mains supply leads to the risk of touchable live housing parts. There is a risk to life.

- ► Before the installation, check that the connection leads are voltage-free.
- ► Make sure that electrical installations are only carried out by qualified electricians.
- ► Provide adequate grounding for the device.
- ► After connection work, carry out an earthed conductor check.

⚠ WARNING

Danger of injury due to bearing damage

If the valid temperature range of the permissible lubricants is exceeded, insufficient lubrication can lead to bearing damage. There is a risk of explosion due to causing an ignition hazard, and a risk of serious injuries.

- ► Exclusively utilize the permissible lubricants for the intended temperature range.
- ► When filling, refilling, or changing the lubricant, always utilize the lubricant type specified on the rating plate.

⚠ WARNING

Risk of fatal injury due to electric shock on account of incorrect installation

The device's power supply uses life-threatening voltages. Unsafe or improper installation can lead to life-threatening situations from electric shocks obtained from working with or on the unit.

- ► Ensure safe integration into an emergency off safety circuit.
- ► Do not carry out your own conversions or modifications on the unit.

⚠ WARNING

Risk of crushing from rotating parts

Fingers and hands may be caught by rotating pistons within the connection flange. This results in severe injuries.

- ► Keep limbs out of the reach of the roots pump.

⚠ WARNING

Risk of explosion when the ignition temperature of the pumped medium is reached

If the prescribed temperature monitoring is not in place, when the ignition temperature is reached in the suction chamber this results in ignition.

- ► Always monitor the gas temperature in the fore-vacuum flange in order to safely comply with temperature class T3.
- ► When a gas temperature of 180 °C is reached, switch the roots pump off (zero potential).

⚠ CAUTION

Danger of injury from bursting as a result of high pressure in the exhaust line

Faulty or inadequate exhaust pipes lead to dangerous situations, e.g. increased exhaust pressure. There is a danger of bursting. Injuries caused by flying fragments, the escaping of high pressure, and damage to the unit cannot be excluded.

- ► Route the exhaust line without shut-off units.
- ► Observe the permissible pressures and pressure differentials for the product.
- ► Check the function of the exhaust line on a regular basis.

⚠ CAUTION

Danger of injury from moving parts

After a power failure or a standstill as a result of overheating, the motor restarts automatically. There is a risk of injury to fingers and hands if they enter the operating range of rotating parts.

- ► Safely disconnect motor from the mains.
- ► Secure the motor against reactivation.
- ► Dismantle the vacuum pump for inspection, away from the system if necessary.

Risks during operation

⚠ DANGER

Risk of injury due to the bearing bursting after overheating

During longer operation with defective bearings, there is a risk of explosion due to hot surfaces if there is a potentially explosive atmosphere.

- ► Monitor the motor current of the roots pump so that in the event of a process-independent increase of the motor current > 10 %, the roots pump is switched off.
- ► As an alternative, perform a vibration measurement at the defined measuring points with the prescribed time intervals.

⚠ WARNING

Risk of crushing on rotating parts when reaching into the open flange

The pistons continue to run in the vacuum after switching off the motor, and can trap fingers and hands within their reach.

- ► Wait until the vacuum pump comes to a complete standstill.
- ► Secure the vacuum pump against re-start.

⚠ WARNING

Danger of poisoning due to toxic process media escaping from the exhaust pipe

During operation with no exhaust line, the vacuum pump allows exhaust gases and vapors to escape freely into the air. There is a risk of injury and fatality due to poisoning in processes with toxic process media.

- ► Observe the pertinent regulations for handling toxic process media.
- ► Safely purge toxic process media via an exhaust line.
- ► Use appropriate filter equipment to separate toxic process media.

⚠ WARNING

Risk of injury from reactive, potentially explosive or other hazardous gas/air mixtures

Uncontrolled gas inlet of air or gases containing oxygen provides ideal conditions for the formation of unexpected explosive gas/air mixtures in the vacuum system. This results in severe injuries.

- ► Use only inert gases for supplying the sealing gas supply in order to avoid a potential ignition.

⚠ CAUTION

Danger of burns on hot surfaces

Depending on the operating and ambient conditions, the surface temperature of the vacuum pump can increase to above 70 °C.

► Provide suitable touch protection.

Risks during maintenance, decommissioning and malfunctions

⚠ DANGER

Risk of explosion when carrying out installation and maintenance work in potentially explosive areas

There is a risk of explosion if unsuitable tools are used in potentially explosive areas. Ignition can cause very serious injuries.

► Transport, installation and maintenance work may not be performed in potentially explosive atmospheres.
► Always shut down the vacuum pump before commencing any work.

⚠ DANGER

Risk of explosion from electrostatic charging during transport

There is a risk of fatalities when transporting packaging material (foil) and plastic containers in potentially explosive areas. Ignition can cause very serious injuries, and even fatalities.

► Only unpack the vacuum pump outside of potentially explosive areas.

⚠ WARNING

Health hazard through poisoning from toxic contaminated components or devices

Toxic process media result in contamination of devices or parts of them. During maintenance work, there is a risk to health from contact with these poisonous substances. Illegal disposal of toxic substances causes environmental damage.

► Take suitable safety precautions and prevent health hazards or environmental pollution by toxic process media.
► Decontaminate affected parts before carrying out maintenance work.
► Wear protective equipment.

⚠ WARNING

Danger to life from electric shock in the event of a fault

In the event of a fault, devices connected to the mains may be live. There is a danger to life from electric shock when making contact with live components.

► Always keep the mains connection freely accessible so you can disconnect it at any time.

⚠ WARNING

Danger of injury due to bearing damage

If the valid temperature range of the permissible lubricants is exceeded, insufficient lubrication can lead to bearing damage. There is a risk of explosion due to causing an ignition hazard, and a risk of serious injuries.

► Exclusively utilize the permissible lubricants for the intended temperature range.
► When filling, refilling, or changing the lubricant, always utilize the lubricant type specified on the rating plate.

⚠ WARNING

Risk of crushing from rotating parts

Fingers and hands may be caught by rotating pistons within the connection flange. This results in severe injuries.

► Keep limbs out of the reach of the roots pump.

⚠ WARNING

Danger of injury from strong magnetic field

There is a risk of injury for people with pacemakers and medical implants.

- ► Make sure that such individuals do not enter the sphere of influence (≤ 2 m) of the magnetic field.
- ► Identify rooms in which magnetic couplings are openly accessible with the symbol: "**No access for people with pacemakers**".
- ► Always keep disassembled couplings away from computers, data carriers, and other electronic components.

⚠ WARNING

Health hazard and environmental damage from toxic contaminated lubricant

Toxic process media can cause lubricant contamination. When changing the lubricant, there is a health hazard due to contact with poisonous substances. Illegal disposal of toxic substances causes environmental damage.

- ► Wear suitable personal protective equipment when handling these media.
- ► Dispose of the lubricant according to locally applicable regulations.

⚠ CAUTION

Scalding from hot lubricant

Danger of scalding when draining lubricant if it comes into contact with the skin.

- ► Wear protective equipment.
- ► Use a suitable collection receptacle.

2.3 Safety precautions

Duty to provide information on potential dangers

The product holder or user is obliged to make all operating personnel aware of dangers posed by this product.

Every person who is involved in the installation, operation or maintenance of the product must read, understand and adhere to the safety-related parts of this document.

Infringement of conformity due to modifications to the product

The Declaration of Conformity from the manufacturer is no longer valid if the operator changes the original product or installs additional equipment.

- Following the installation into a system, the operator is required to check and re-evaluate the conformity of the overall system in the context of the relevant European Directives, before commissioning that system.

General safety precautions

- ► Do not expose body parts to the vacuum.
- ► Observe the safety and accident prevention regulations, if necessary wear personal protective equipment.
- ► Check all safety measures at regular intervals.
- ► Always ensure a secure connection to the earthed conductor (PE), protection class I.
- ► During operation, make sure that plug-and-socket connections are securely fitted.
- ► Never operate the vacuum pump with open vacuum flange.
- ► Never make your own conversions or modifications to the vacuum pump.
- ► Before returning the vacuum pump, observe the notes in the chapter Service.

2.4 ATEX classification and safety measures

Vacuum pumps of the ATEX series are specially designed and manufactured to comply with the requirements of Directive 2014/34/EU regarding the proper use of equipment and protective systems in

potentially explosive areas. The vacuum pumps are delivered with an ATEX-certified motor and are designated as follows:

Standard temperature range

- **Ɛx II 2/2G Ex h IIB T3 Gb X +5 °C ≤ Ta ≤ +40 °C**

Extended temperature range (with lubricant H1)

- **Ɛx II 2/2G Ex h IIB T3 Gb X -20 °C ≤ Ta ≤ +40 °C**

2.4.1 Labeling of the vacuum pump

Classification	Description
Device group	Devices which can be used for applications in potentially explosive atmospheres are divided into two groups: **Device group I**: Devices for mines susceptible to firedamp (will not be discussed in any more detail here) **Device group II**: Devices for all other potentially explosive areas with the exception of underground operations in mines and their surface installations which are susceptible to hazardous firedamp and / or combustible dust.
Device category	Device group II is divided into three categories which vary in their respective degree of safety. Devices of **Device category 1** are designed to guarantee an extremely high degree of safety. They must guarantee the necessary degree of safety even if malfunctions occur only rarely on the device. Devices of **Device category 2** are designed to guarantee a high degree of safety. They must guarantee the necessary degree of safety even with regular occurrences of malfunctions or fault conditions which are generally to be expected. Devices of **Device category 3** are designed to guarantee a normal degree of safety. They guarantee the necessary degree of safety for normal operation.
Combustible materials	**G**: Gases or vapors **D**: Dust (will not be discussed in any more detail here) **Note: The device may only be used in atmospheres susceptible to explosion due to gases or vapors. Operation in dust-charged, potentially explosive atmospheres is not permitted.**
Type of protection	Identification code “Ex h” designated in the standard DIN EN ISO 80079-36 for non-electrical equipment. A protection type established for electrical equipment is not used.
Explosion groups	Gases and vapors are divided into three Explosion groups based on their particular ignition capability (IIA, IIB and IIC). The ignition power in this regard decreases from Explosion group IIA to IIC. (The higher Explosion group, e.g. IIC incorporates the respectively lower IIB and IIA).
Temperature class	Classification of equipment depending on their maximum surface temperature, in accordance with assignment as follows: Temperature class --> Maximum surface temperature/gas temperature: • T1 --> +450 °C • T2 --> +300 °C • T3 --> +200 °C • T4 --> +135 °C • T5 --> +100 °C • T6 --> +85 °C The temperature class and the actual maximum surface temperature of the units includes a safety margin to the minimum ignition temperature of a potentially explosive atmosphere, as stipulated in DIN EN ISO 80079-36.
EPL according to DIN EN 60079	Equipment protection level **EPL Ga**: Equipment with “extremely high” protection level for use in potentially explosive gas atmospheres in which no risk of ignition exists during normal operation, with foreseeable or infrequent faults/malfunctions. **EPL Gb**: Equipment with “high” protection level for use in potentially explosive gas atmospheres in which no risk of ignition exists during normal operation, with foreseeable faults/malfunctions. **EPL Gc**: Equipment with “extended” protection level for use in potentially explosive gas atmospheres in which no risk of ignition exists during normal operation.

Classification	Description
X	Special operating conditions must be observed! Special conditions and notes in the operating instructions apply.
Ta	Permissible ambient temperature for operation of the vacuum pump prescribed on the rating plate.

Tbl. 4: ATEX designations

2.4.2 Potential hazards

The ignition hazard assessment for the roots pumps in the ATEX series was performed in accordance with the harmonized standard ISO 80079-36 (Non-electrical equipment for explosive atmospheres - Basic method and requirements). This assessment includes the identification of hazards described as follows which will not occur if the system is operated properly with the respective safety measures.

Potential hazard	Occurrence due to	Safety measures
Hot surfaces	Heating up of components due to compression work and friction	When used as intended, all surface temperatures are below the measuring gas temperature in the exhaust channel.
	Induction of eddy currents when the magnetic coupling slips through	• Note the information to avoid this in the operating instructions.
Hot gases	Compression of the required gases	• Measure the gas temperature in the exhaust channel using the supplied thermometer and evaluate the temperatures. • Note the information in the operating instructions of the thermometer.
Mechanical sparks	Contact of the pistons in the suction chamber	The air gaps for the maximum gas temperature are designed taking into account a safety factor.
Electrical sparks	Electric motor	The use of an explosion-proof electric motor is prescribed. • Observe the marking on the motor rating plate.
Static electricity	Vacuum pump not earthed	• Integrate the vacuum pump in the equipotential bonding at the installation location.
Chemical reaction	Between the process gas and lubricant or between the process gas and components that are part of the housing	• Evaluate the process and avoid hazardous process conditions.
Zone entrainment	due to leaky vacuum pump	The vacuum pump underwent a final inspection with helium leak test within the framework of a production control (leakage rate < 1×10^{-6} Pa m^3/s).

Tbl. 5: Potential hazards

2.4.3 Safety measures

► Observe and implement the following safety measures for safe operation of the roots pump in accordance with the respective device category:

Place	Measures/safety equipment	Category 2		Category 3	
		Specification	We recommend	Specification	We recommend
Magnetic coupling	First switch on the roots pump when the backing pump can accept the required amount of gas	x		x	
	You must observe the volume flow ratio of ≤ 10:1 between the roots pump and backing pump	x		x	
	Only use the motors specified by Pfeiffer Vacuum.	x		x	
	Limitation of the motor torque by: ● frequency converter that limits the permissible torque or ● soft starter and continuous monitoring of the power consumption		x		x
Piston bearing	Check the power input of the motor to protect against bearing damage on the roots pump (see chapter “Checking the power input”, page 37) Or: Regular vibration measurement at the defined measuring points and required time intervals	x			x
Coaxiality of the centering of the flange to the motor shaft	Check the coaxiality of the centering of the flange to the shaft in accordance with standard EN 50347: 2001, the table values reduced to 50 % are valid Or: Regular vibration measurement at the defined measuring points and required time intervals	x		x	
Gas outlet temperature	Monitor the gas outlet temperature with the supplied thermometer (see chapter “Setting and checking the temperature monitoring”, page 30).	x		x	

Tbl. 6: Measures and safety equipment

2.5 Limits of use of the product

Installation location	● Indoors, protected against: — dust deposits — falling objects — fire-fighting water ● Outdoors, protected against: — falling objects — direct influence of weather such as rain, splash water, strong drafts and sunlight — fire-fighting water — lightning strike
Installation altitude	according to the motor used. Observe the motor manufacturer's operating instructions
Ambient temperature, dependent on the pump design	+5°C to +40°C (for P3)
	-20°C to +40°C (for H1)
Relative humidity of air	max. 85 % (depending on the motor version)
Orientation	Horizontal
Pumped medium intake temperature, max.	process-specific
Permanent intake pressure in circulation mode	< 1300 hPa (abs.)

Max. speed in circulation mode	3600 rpm
Permanent intake pressure in vacuum mode	depending on max. pressure differential
Max. gas temperature, pressure side	180 °C

Tbl. 7: Permissible ambient conditions

2.6 Proper use

- ► Only use the vacuum pump to create a vacuum in connection with a suitable backing pump.
- ► To protect the lubricant, use sealing gas if high boiling or corrosive media (e.g. solvents) are pumped.
- ► Adhere to the installation, commissioning, operating, and maintenance instructions.
- ► Use only accessory parts recommended by Pfeiffer Vacuum.
- ► Use the vacuum pump to convey potentially explosive atmospheres in accordance with the labeling.
- ► Observe the corresponding safety measures (see chapter “Safety measures”, page 17).
- ► Operate the vacuum pump within the application limits of the product (see chapter “Limits of use of the product”, page 18) and in compliance with the technical data.
  - – When operating the vacuum pump with frequency converter, make sure that the vacuum pump never exceeds the max. permissible rotation speed, even in the event that the frequency converter malfunctions. Increased bearing wear is therefore avoided.
  - – When operating the vacuum pump with a rotation speed of less than 1500 min^{-1}, as can be the case in “windmilling” operation for example, you must ensure continuous vibration monitoring (see chapter “Vibration monitoring”, page 38). Therefore any bearing damage that is caused by deficient lubrication can be detected in advance.

    If this cannot be ensured, you must circumnavigate the vacuum pump by means of a bypass, until it can be operated with the minimum rotation speed.

2.7 Foreseeable improper use

Improper use of the product invalidates all warranty and liability claims. Any use that is counter to the purpose of the product, whether intentional or unintentional, is regarded as improper use; in particular:

- Pumping media that can corrode or not be withstood by the vacuum pump materials

  Components contained in the suction chamber are cast iron, steel, and stainless steel. Seals are FPM (alternative seals available on request)
- Pumping media that introduce an ignition source to the suction chamber
- Pumping media that form adhesive deposits inside the suction chamber and cause the pistons to touch or jam
- Pumping pressurized media (> atmospheric pressure)
- Pumping fluids – the use of fluids is permitted for cleaning purposes
- Pumping radioactive media
- Pumping media prone to spontaneous, specific exothermic reactions
- Use of the vacuum pump for cyclic evacuation procedures at and above atmospheric pressure (load lock)
- Use of the vacuum pump in systems in which sporadic loads and vibrations or periodic forces act on the unit
- Using the vacuum pump in strong electrical, magnetic, or electromagnetic fields
- Use of the vacuum pump without blocking the overflow valve for pumps with blocked version
- Use of the vacuum pump with open vacuum and/or fore-vacuum flange open to the atmosphere
- Use of pipes to lift the vacuum pump
- Use of accessories or spare parts not listed in these instructions
- Use of the vacuum pump as a climbing aid
- Overcoating the vacuum pump whereby the permissible layer thicknesses in accordance with DIN EN ISO 80079-36 are exceeded
- Use of operating lubricant other than that specified by Pfeiffer Vacuum

- Use of the vacuum pump outside the temperature range stated on the rating plate
- Use of mineral-based lubricant, such as P3 with an oxygen concentration > 21%

  Mineral-based lubricants are combustible and ignite at high temperatures, and when they come into contact with pure oxygen. These lubricants oxidize heavily and thus lose their lubricating capacity.

3 Product description

3.1 Functional description

The operating principle of the roots pump is based on 2 synchronous pistons that rotate in a housing without touching. The pumping effect is produced as a result of the opposing rotation of 2 figure-of-eight shaped roots pistons. While suction chambers are formed between the rolling pistons and the housing, the rolling pistons continuously form a mutual seal without touching each other or the housing. A pair of gears positioned on the extended shaft ends, causes the opposing, synchronous running of the roots pistons. Lubrication is limited to the two bearing and gear chambers which are arranged separately from the suction chambers. Operation with a backing pump connected upstream enables compressing against atmospheric pressure.

Roots pumps from the ATEX series are equipped with a magnetic coupling and a thermometer.

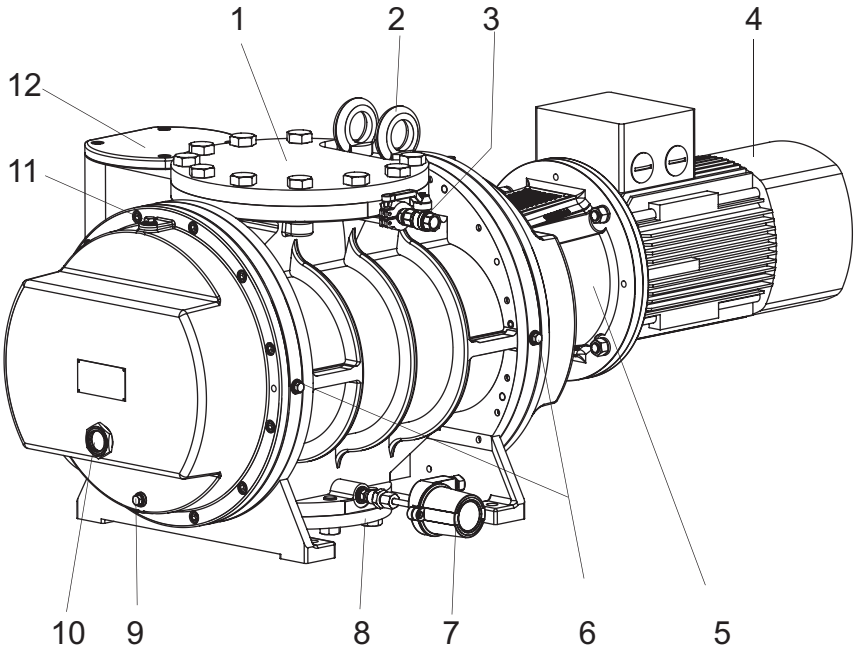


Fig. 2: Okta 4000 ATEX design

1 Blank flange (mounted on the vacuum flange)
2 Eye bolts
3 Valve for inert gas filling (mounted on the measurement connection)
4 Motor (ATEX design)
5 Magnetic coupling (hidden by the lantern)
6 Sealing gas connections (4×)
7 Thermometer
8 Fore-vacuum flange
9 Drain screw
10 Sight glass
11 Filler screw
12 Overflow valve

3.1.1 Design with overflow valve

In the design with overflow valve, the weight-loaded valve plate opens in the overflow valve when the maximum pressure differential is exceeded, and it allows, depending on the gas accumulation, a more or less large part of the in-coming gas to flow back from the pressure side to the intake side. This protects the roots pump against overloading and allows it to be switched on in the high pressure range at the start of evacuation. During the pump down process, if the pressure difference is undershot by the weight force of the valve plate, the overflow valve closes again.

You can switch on the roots pump directly after the fore-vacuum pump.

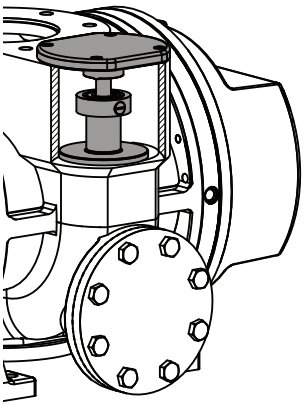


Fig. 3: Okta ATEX | Overflow valve active

3.1.2 Design with blocked overflow valve

Notes on overload protection for blocked overflow valve

- Utilize a frequency converter for operation.
- Alternatively: Do not switch on a roots pump with blocked overflow valve until a fore-vacuum pressure has been reached at which the backing pump can handle the conveyed volume of gas.
- Under no circumstances remove the blocked overflow valve.
- As an alternative, use the optionally available ATEX-compliant overflow valve.

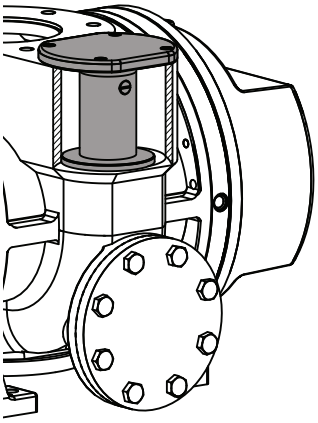


Fig. 4: Okta ATEX | overflow valve blocked

3.2 Identifying product

To ensure for a clear identification of the product when communicating with Pfeiffer Vacuum, always keep all of the information on the rating plate to hand.

The following information is shown on the rating plates:

- Pump model
- Model number
- Type and quantity of the lubricant
- Max. allowable pump rotation speed
- Date of manufacture
- Input voltage range (motor rating plate)

3.3 Scope of delivery

- Roots pump with motor / motor provided by the customer
- Connection flanges produced in accordance with PN 16
- Seal for the connection flange
- Protective cover for the connection flange
- Screw kit for the connection flange
- 2 eye bolts for lifting the roots pump
- Lubricant
- Thermometer
- Ball valve
- Locking screw
- Operating instructions of the roots pump
- Operating instructions of the motor
- Additional documents for the thermometer
- Additional documents for the coupling incl. declaration of conformity

4 Transportation and Storage

4.1 Transporting the vacuum pump

⚠ DANGER

Risk of explosion from electrostatic charging during transport

There is a risk of fatalities when transporting packaging material (foil) and plastic containers in potentially explosive areas. Ignition can cause very serious injuries, and even fatalities.

- ► Only unpack the vacuum pump outside of potentially explosive areas.

⚠ DANGER

Risk of explosion when carrying out installation and maintenance work in potentially explosive areas

There is a risk of explosion if unsuitable tools are used in potentially explosive areas. Ignition can cause very serious injuries.

- ► Transport, installation and maintenance work may not be performed in potentially explosive atmospheres.
- ► Always shut down the vacuum pump before commencing any work.

⚠ WARNING

Risk of serious injury from swinging, toppling or falling objects

During transport, there is a risk of crushing and impact on swinging, toppling or falling objects. There is a risk of injuries to limbs, up to and including bone fractures and head injuries.

- ► Secure the danger zone if necessary.
- ► Pay attention to the center of gravity of the load during transport.
- ► Ensure even movements and moderate speeds.
- ► Observe safe handling of the transport devices.
- ► Avoid sloping attachment aids.
- ► Never stack products.
- ► Wear protective equipment, e.g. safety shoes.

Instructions for safe transport

- Only remove the protective cover for the connection flange once the pipes have been mounted.
- Fill the gear and bearing chambers with lubricant only once the final installation position is reached.

Preparations for transport

Pfeiffer Vacuum recommends keeping the transport packaging and original protective cover.

General information regarding safe transport

1. Observe weight specified on the rating plate.
2. Where possible, always transport or ship the roots pump in its original packaging.
3. Remove the protective covers only immediately prior to installation.

Instructions for transport when packaged

1. Use a pallet truck to transport the vacuum pump in its packaging.
2. Note the center of gravity of the load.
3. Observe safe handling of manually operated transport devices.
4. Ensure harmonious movements and moderate speeds.
5. Ensure a flat substrate.
6. Wear protective equipment, e.g. safety shoes.

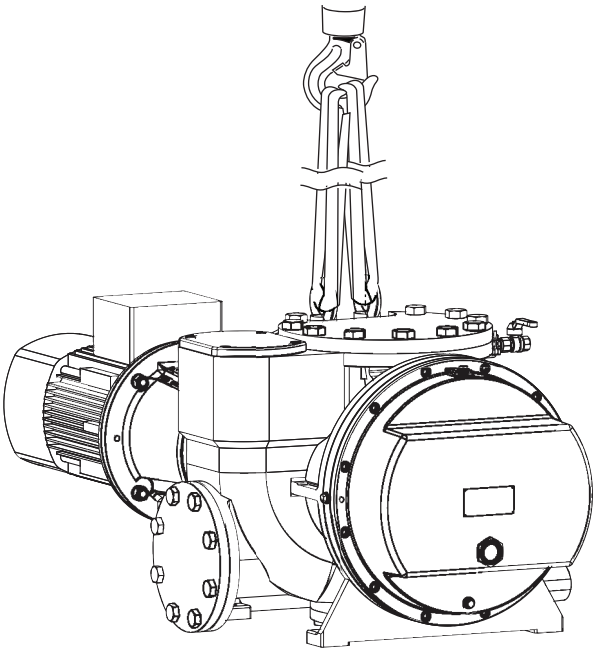


Fig. 5: Transporting the vacuum pump using a belt

Information for transport of the vacuum pump without packaging

2 eye bolts are included in the shipment, which are firmly bolted to the vacuum pump ex-factory.

1. Unpack the vacuum pump.
2. Attach suitable lifting tools to both eye bolts.
3. Pay attention to the correct use and fastening of the lifting equipment.
4. Lift the vacuum pump out of the transport packaging vertically.
5. If necessary, remove the eye bolts after transport and installation.
   – Keep the eye bolts for future use.

4.2 Storing vacuum pump

Neither the suction chamber nor the pistons in the roots pump in the roots pump interior are provided with **corrosion protection**.

Storage

Pfeiffer Vacuum recommends storing the products in their original transport packaging.

Procedure

1. Vacuum-seal both connection flanges.
2. Store the roots pump only in dry, dust-free rooms, within the specified ambient conditions.
3. Evacuate and then fill the suction chamber with nitrogen to achieve the best corrosion protection for the roots pump.
4. In rooms with humid or aggressive atmospheres, seal the roots pump airtight in a plastic bag, together with a drying agent.
5. Change the lubricant after a storage period of more than 2 years.
6. If you intend to store the roots pump for longer periods, we recommend that you use a special corrosion protection agreed with Pfeiffer Vacuum.

5 Installation

5.1 Preparatory work

⚠ WARNING

Risk of crushing from rotating parts

Fingers and hands may be caught by rotating pistons within the connection flange. This results in severe injuries.

► Keep limbs out of the reach of the roots pump.

Filling the nitrogen

The vacuum pump is filled with nitrogen to protect against corrosion, therefore the suction chamber has a slight over pressure (200 hPa) upon delivery

- Prior to installation, you must dismantle the fittings required for nitrogen filling.

Required tools

- Hexagon wrench **SW 19**
- Hexagon wrench **SW 22**
- Calibrated torque wrench (tightening factor ≤ 2.5)

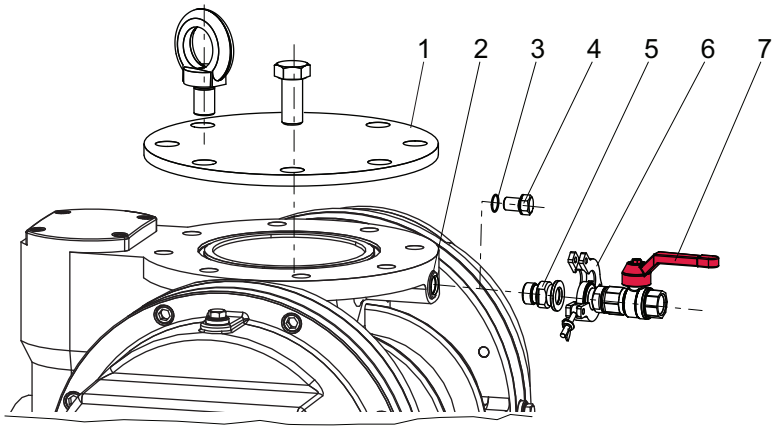


Fig. 6: Dismantle the fittings to vent the vacuum pump

1 Protective cover
2 Measurement connection
3 Seal
4 Locking screw
5 Small flange
6 Circlip
7 Ball valve

Draining the nitrogen

1. Open the ball valve and establish the pressure compensation.
2. Undo the circlip and at the same time remove the ball valve.
3. Unscrew the small flange on the measurement connection.
4. Lock the measurement connection using the locking screw.
   – Tightening torque: **32 Nm**
5. Dismantle the protective cap from the inlet flange and exhaust flange.

5.2 Setting up vacuum pump

⚠ CAUTION

Risk of injury from loss of stability

During setup, there is a risk of injury from tipping, if the vacuum pump is not anchored on the standing surface.

► Secure the vacuum pump using suitable lifting gear.
► Wear personal protective equipment.

General notes for the installation of vacuum components

- ► Choose an installation location that permits access to the product and to supply lines at all times.
- ► Observe the ambient conditions given for the limits of use.
- ► Provide the highest possible level of cleanliness during assembly.
- ► Ensure that flange components during installation are grease-free, dust-free and dry.

Procedure

1. Check the carrying capacity of the floor at the installation location.
2. Place the vacuum pump on a flat, horizontal and fixed surface, to safeguard the lubricant supply.
   – Reference surface is the vacuum flange.
3. Evenly screw the 4 feet of the vacuum pump onto the base without distorting the pump housing.
4. Use adjustment elements from the Pfeiffer Vacuum range of accessories for roots pumps to mount the feet horizontally.
5. When installing the pump in a closed housing, ensure adequate air circulation.
6. Keep both sight glasses freely accessible for checks and maintenance.
7. Keep the filling/drain holes freely accessible.
8. Ensure that the motor rating plate remains accessible at all times for a clear view of the voltage and frequency specifications.
9. Maintain the minimum distances to bordering surfaces to guarantee sufficient air circulation.
10. Fill with lubricant prior to first commissioning.

5.3 Filling with lubricant

The operating fluid type specified for the roots pump and the respective filling quantity are indicated on the rating plate. Only the lubricant used during initial installation is permissible. Subsequent change is possible only after consultation with Pfeiffer Vacuum.

⚠ WARNING

Danger of injury due to bearing damage

If the valid temperature range of the permissible lubricants is exceeded, insufficient lubrication can lead to bearing damage. There is a risk of explosion due to causing an ignition hazard, and a risk of serious injuries.

- ► Exclusively utilize the permissible lubricants for the intended temperature range.
- ► When filling, refilling, or changing the lubricant, always utilize the lubricant type specified on the rating plate.

Required tools

- Open-end wrench, **WAF 17**
- Calibrated torque wrench (tightening factor ≤ 2.5)

Permissible lubricants

- P3 (+5 °C ≤ Ta ≤ +40 °C)
- H1 (-20 °C ≤ Ta ≤ +40 °C)

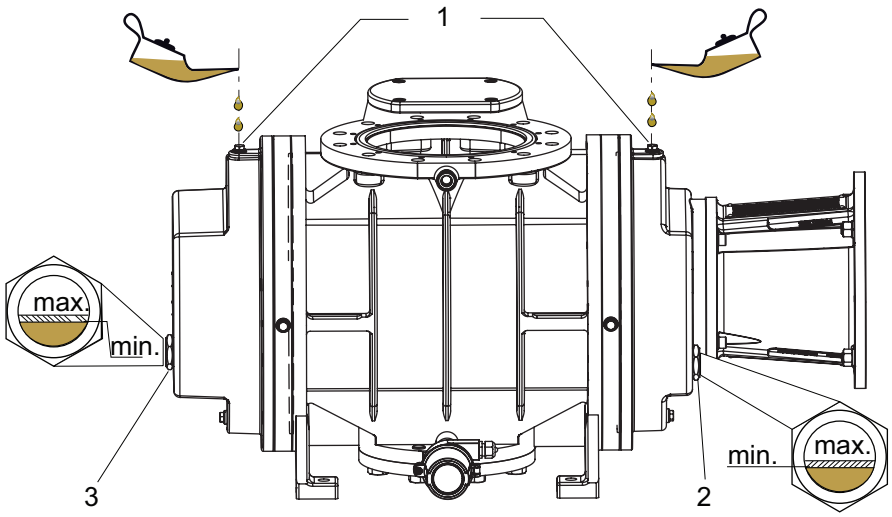


Fig. 7: Filling with lubricant

1 Filler screws
2 Sight glass, bearing chamber
3 Sight glass, gear chamber

Procedure

1. Unscrew the filler screws.
2. Fill the lubricant on both sides according to the sight glass.
   – Fill levels for the first fill: approx. 5 mm above the sight glass middle.
3. Seal the filler screws.
   – Tightening torque: **32 Nm**
4. Check the fill level during operation in the final vacuum.
5. If necessary, top up the lubricant only when the roots pump is switched off and vented.

5.4 Connecting vacuum side

⚠ WARNING

Risk of crushing from rotating parts

Fingers and hands may be caught by rotating pistons within the connection flange. This results in severe injuries.

► Keep limbs out of the reach of the roots pump.

NOTICE

Property damage from intake of solid particles

During commissioning, there is a risk of damage to the suction chamber from dirt from the system or the pipes.

► Use a suitable protective strainer ("start-up strainer") in the intake flange.
► Ensure that this strainer is only removed when the risk of solid particles entering the vacuum pump can be excluded.
   – Observe any pumping speed decrease.

Connecting vacuum side

1. Degrease the connection flange.
2. Clear welded lines of any tinder, loose parts or similar before installation.
3. Route the piping between the vacuum pump and vacuum chamber so that it remains as short as possible; at a minimum, the nominal diameter of the pump flange.
   – Use a greater nominal diameter on line lengths > 5 m.
4. Support or suspend the piping to the vacuum pump so that no piping system forces act on the vacuum pump.
5. Always use **all** prescribed screws to fasten the flange.

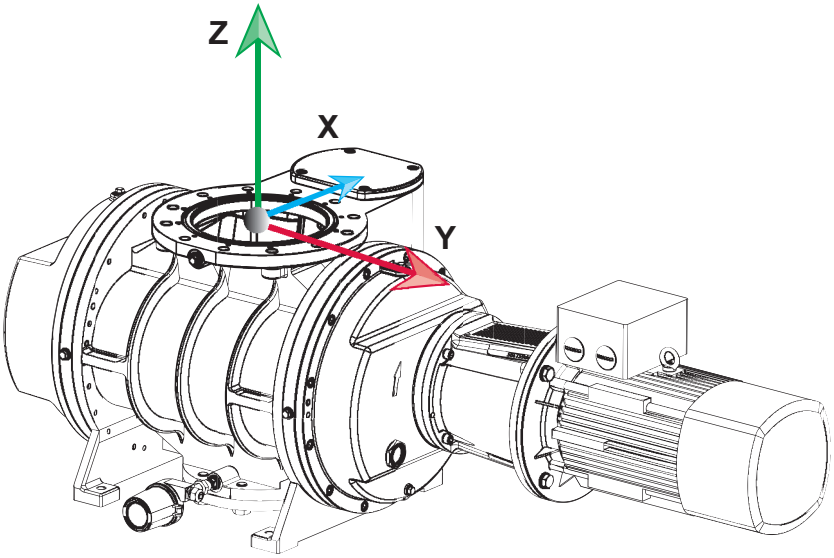


Fig. 8: Loading capacity of the connection flange

Installation of superstructural parts on the connection flange is the responsibility of the operating company. The loading capacity is specific for the roots pump used. The total weight of superstructural parts must not exceed the maximum values specified.

Maximum permissible forces	[N]	Maximum permissible torques	[Nm]
F_X	2740	M_X	1820
F_Y	1920	M_Y	2510
F_Z	-10140	M_Z	2490

Tbl. 8: Maximum permissible forces and torques on the intake flange

5.5 Connecting the fore-vacuum side

⚠ WARNING

Risk of crushing from rotating parts

Fingers and hands may be caught by rotating pistons within the connection flange. This results in severe injuries.

► Keep limbs out of the reach of the roots pump.

⚠ CAUTION

Danger of injury from bursting as a result of high pressure in the exhaust line

Faulty or inadequate exhaust pipes lead to dangerous situations, e.g. increased exhaust pressure. There is a danger of bursting. Injuries caused by flying fragments, the escaping of high pressure, and damage to the unit cannot be excluded.

► Route the exhaust line without shut-off units.
► Observe the permissible pressures and pressure differentials for the product.
► Check the function of the exhaust line on a regular basis.

Procedure

1. Choose a minimum pipe cross section equal to the nominal diameter of the pressure flange.
2. Clear welded lines of any tinder, loose parts or similar before installation.
3. Route the pipes so that no mechanical tension can act on the roots pump or the backing pump.
4. Install a bellows in the piping if necessary.
5. Ensure that mating flanges are in a parallel position.

6. Install the pipes downward from the roots pump, so that condensate does not flow back into the roots pump.
7. Install a condensate separator if necessary.
8. If an air trap is created in the system, then install a condensate drain facility at the lowest point.

5.6 Setting and checking the temperature monitoring

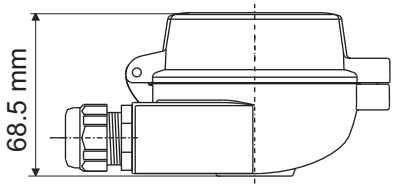
⚠ WARNING

Risk of explosion when the ignition temperature of the pumped medium is reached

If the prescribed temperature monitoring is not in place, when the ignition temperature is reached in the suction chamber this results in ignition.

- ► Always monitor the gas temperature in the fore-vacuum flange in order to safely comply with temperature class T3.
- ► When a gas temperature of 180 °C is reached, switch the roots pump off (zero potential).

Due to the compression work, the highest temperatures are generated in the exhaust channel of the roots pump. In order to avoid effective sources of ignition due to prevailing gas temperatures, the roots pump is equipped with a thermometer that measures the gas temperature in the exhaust channel.

Thermometer	Characteristics
Thermometer with flat **TA30A** connection head 	• 2 thermocouples in the protective pipe • 1 TMT82 type head transmitter in the connection head of the thermometer • The head transmitter has two input channels for both thermocouples • The device transmits the signals as an analog output signal. The prescribed SIL must be adhered to.

Tbl. 9: Thermometer type

5.6.1 Check thermometer installation dimension

Faulty temperature measurement

Faulty temperature measurement due to deviating installation dimension. The thermometer cannot detect any maximum values.

Required tools

- Open-end wrench, **WAF 17**

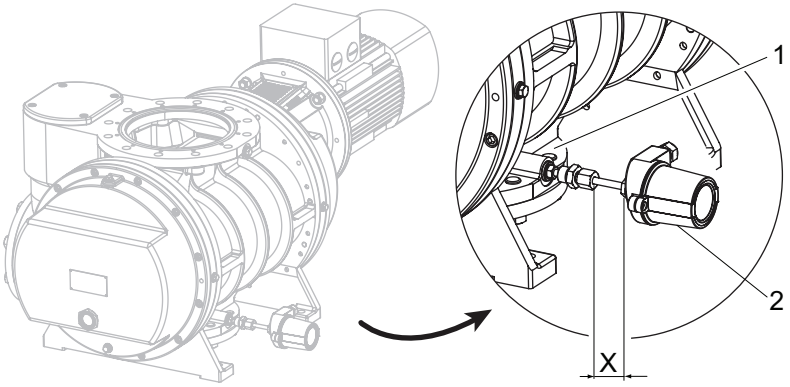


Fig. 9: Check temperature monitoring

1 Fore-vacuum flange
2 Thermometer
X Installation dimension

Checking the installation of the thermometer

- ► Check the installation dimension "X" and tighten the clamping screw if necessary.
  - – X = **85 mm**

5.6.2 Arrange a signal evaluation for the thermometer

A restart following "zero potential" without resetting the interlock of the ignition system is not permissible.

Device category	EPL	Result of the ignition hazard evaluation for the existing device	Ex “b” ignition protection system necessary	Ignition system
3	Gc	No effective ignition sources are to be expected during normal operation	The signal must be evaluated without the use of an ignition protection system	
2	Gb	No effective ignition sources are to be expected during normal operation	An individual system in order to avoid ignition sources where expected malfunctions are expected	b1
In accordance with DIN EN ISO 80079-37, the b1 ignition protection system complies with safety requirement level SIL1 and the IEC 61508 series of standards, and a "performance level" PL c in accordance with the ISO 13849 series of standards				

Tbl. 10: EPL (Equipment protection level)

Procedure

- ► Set up the ignition protection system on the operator side in accordance with the requirements for the device category or EPL.
- ► Observe the necessary ignition protection system type

Regular check

- ► Check the thermometer at regular intervals.
  - – Compare with other process temperatures.
- ► You can obtain information on calibration directly from Endress+Hauser.

5.7 Connect to mains power supply

⚠ DANGER

Danger to life from electric shock

Touching exposed and voltage-bearing elements causes an electric shock. Improper connection of the mains supply leads to the risk of touchable live housing parts. There is a risk to life.

- ► Before the installation, check that the connection leads are voltage-free.
- ► Make sure that electrical installations are only carried out by qualified electricians.
- ► Provide adequate grounding for the device.
- ► After connection work, carry out an earthed conductor check.

⚠ WARNING

Risk of fatal injury due to electric shock on account of incorrect installation

The device's power supply uses life-threatening voltages. Unsafe or improper installation can lead to life-threatening situations from electric shocks obtained from working with or on the unit.

- ► Ensure safe integration into an emergency off safety circuit.
- ► Do not carry out your own conversions or modifications on the unit.

⚠ CAUTION

Danger of injury from moving parts

After a power failure or a standstill as a result of overheating, the motor restarts automatically. There is a risk of injury to fingers and hands if they enter the operating range of rotating parts.

- ► Safely disconnect motor from the mains.
- ► Secure the motor against reactivation.
- ► Dismantle the vacuum pump for inspection, away from the system if necessary.

NOTICE

Risk of damage from excess voltage

Incorrect or excessive mains voltage will destroy the motor.

- ► Always observe the motor rating plate specifications.
- ► Route the mains connection in accordance with locally applicable provisions.
- ► Always provide a suitable mains fuse to protect the motor and supply cable in the event of a fault.
  - – Pfeiffer Vacuum recommends the circuit breaker type "K" with slow tripping characteristic.

NOTICE

Motor damage from overheating

Limited motor fan cooling capacity, caused by low speeds, causes the motor to overheat.

- ► During operation with frequency converter, observe the rotation speed range specified in the technical data.

The vacuum pumps are equipped with three-phase motors for different voltages and frequencies. The applicable motor type is shown on the motor rating plate.

Standard versions

- Three phase motor with PTC, without switch and mains cable

5.7.1 Connecting three phase motor with 6-pin terminal board

NOTICE

Property damage from high starting torque

The specific load behavior of the vacuum pump requires direct on-line starting at full motor power. Engine damage occurs if a different starting circuit is used.

- ► Always start the motor directly.
- ► **Never** use a star-delta start-up circuit.

Ports U1 – L2, V1 – L1 and W1 – L3 rotate the motor shaft clockwise when looking at the motor fan.

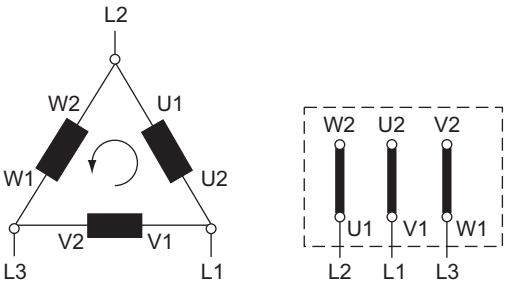


Fig. 10: Delta connection for low voltage

The 3 phases are connected in series, and their connection points connected to the mains. The voltage per phase is equal to the mains voltage, while the mains current is √3 times the phase current. The delta connection is marked with the Δ symbol. The voltage between the incoming mains supply lines is called mains voltage. The mains current is the current flowing in the incoming supply lines.

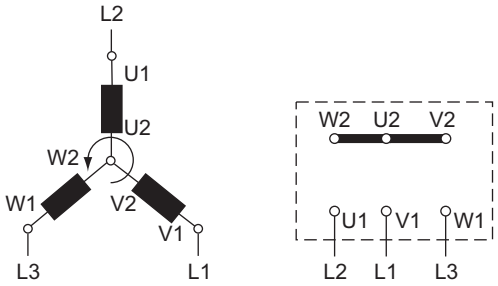


Fig. 11: Star circuit for high voltage

The ends of the 3 phases are connected in the star point. The terminal voltage is √3 times the phase voltage, the mains current is equal to the phase current. The star circuit is marked with the Y symbol.

5.7.2 Checking the direction of rotation

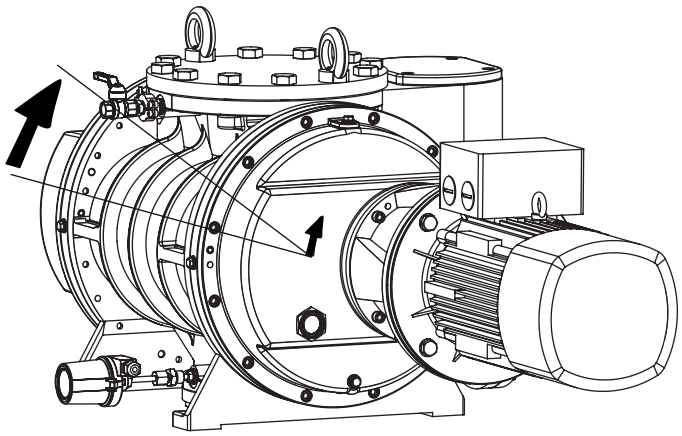


Fig. 12: Checking the direction of rotation

Procedure

When switching on for the first time, check the roots pump's direction of rotation.

1. Switch the vacuum pump on briefly (2 to 3 seconds)
   – The motor and coupling must rotate clockwise (see directional arrow on housing cover).
2. If the direction of rotation is incorrect, exchange the two phases on the connection cable in the terminal box.

5.7.3 Connecting the PTC thermistor tripping unit

Tripping units store the shut-down

Pfeiffer Vacuum recommends connecting motors with PTC in the stator winding to a PTC resistor tripping device for protection against overload.

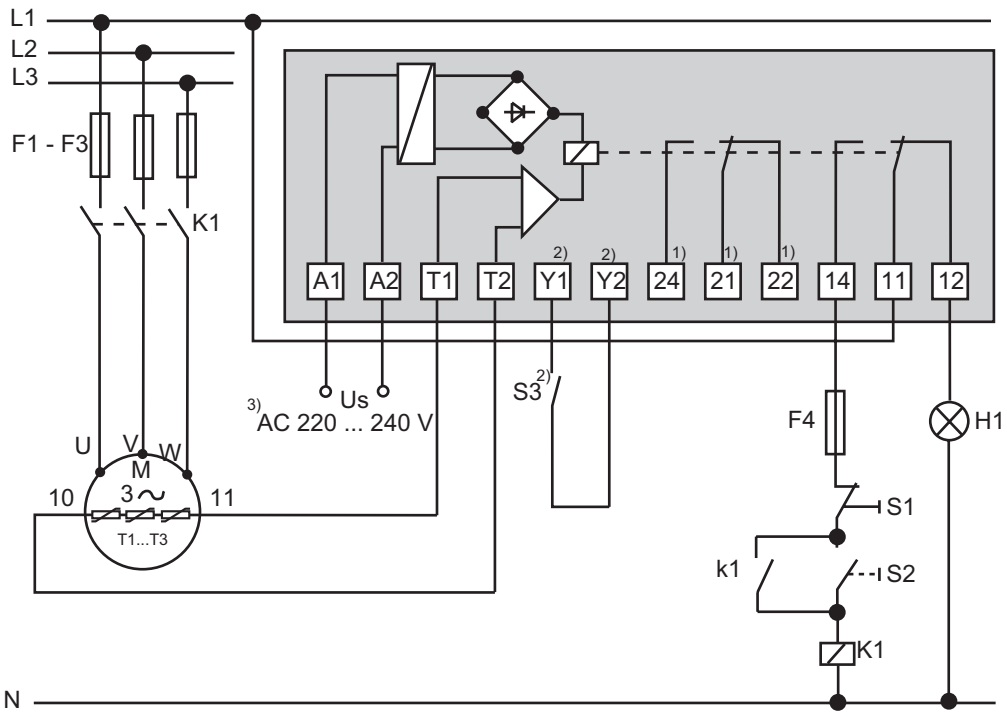


Fig. 13: Connection example with PTC thermistor tripping unit

U_S	Control voltage	T1 – T3	PTC resistor sensor
S_1	OFF button	H1	Tripping indicator
S_2	ON button	M	Motor, 3-phase
S_3	RESET button	1)	For devices with two relay outputs only
K1	Contactor	2)	For MSR type (model) only
F1 – F4	Fuses	3)	Only for order no.: P 4768 052 FQ and P 4768 052 FE

Procedure

► After shut-down, switch the tripping unit back on manually via the installed RESET button or via the external RESET S3.

– Switching on mains detected as automatic RESET.

5.8 Observing the motor torque

When the magnetic coupling is overloaded, there is a loss of synchronization between the inner and outer coupling. The eddy currents that are caused as a result lead to the overheating of the magnetic coupling. When the vacuum pump is used as intended, the magnetic coupling is unlikely to become overloaded.

Causes of overloading if not used as intended

- The backing pump cannot handle the volume of gas required by the Okta ATEX (increased pressure build-up between the roots pump and the backing pump). You must observe the volume flow ratio of ≤ 10:1 between the roots pump and the backing pump.
- Failure of the backing pump. In this case, you must switch the roots pump off immediately.
- Increased starting torque, e.g. caused by a motor not specified by Pfeiffer Vacuum.
- The piston is blocked due to deposits.
- The roots pump was switched on before the backing pump.

Torque limitation Okta 4000 ATEX

A soft starter (e.g. Siemens 3RW30, Eaton DS7) or a frequency converter enables you to limit the torque.

- Maximum permissible motor torque **140 Nm**

6 Operation

6.1 Putting the vacuum pump into operation

Before switching on

1. Check the lubricant levels on both sight glasses.
2. Compare the specifications on the motor rating plate with the available mains voltage and frequency.
3. Make sure that the suction chamber is free from all foreign matters.
4. Check the vacuum pump for visible damage and put the vacuum pump into operation only in a correct state.
5. Protect the vacuum pump from sucking in contamination using suitable measures (e.g. dust filter).
6. Make sure that the shut-off units on the pressure side open before starting the pump.

6.2 Operation with frequency converter

6.2.1 Observe the voltage slew rate

NOTICE

Damage to motor components when operating with frequency converter

Operation of the motors with standard insulation resistance on a frequency converter may lead to potential damage of the motor insulation from an output voltage of > 480 V.

- ► Use a suitable filter to smooth voltage peaks as output switching of the frequency converter, e.g. sinus filter.
- ► Observe the permissible voltage slew rate.
  - – SR max (Δu/Δt) = **1.5 kV/µs**
- ► Observe the permissible impulse voltage at the motor terminals.
  - – V max. = **1.35 kV**

Frequency converters generate a pulse width modulated (PWM) motor voltage that comprises voltage blocks with a relatively steep rise and fall speed. The steepness of the flanks of the voltage blocks define the voltage slew rate (SR = Δu/Δt). Factors which influence the voltage slew rate are the line length, line cross-section and shielding. Information is provided by the motor manufacturer in accordance with IEC60034 and IEC61800-2.

Configuring the frequency converter

- ► Observe the instructions of the manufacturer regarding installation and operation.
- ► Observe the maximum permissible torque of the motor.
- ► Set the current limit according to the rated motor current.
- ► Observe the permissible speed range of the vacuum pump.

6.2.2 Observe the mechanical resonance

NOTICE

Damage from mechanical resonance when operating with frequency converter

The use of a frequency converter allows operation of the vacuum pump with variable speed ranges. Potentially critical speed ranges lead to increased frequencies and vibrations. Permanent operation in critical speed ranges impairs running behavior of the vacuum pump. Damage is caused to the housing, gear, bearings, seals and motor.

- ► Decouple the vacuum pump mechanically by means of an anti-vibration buffer on the pump feet.
- ► Install the compensators at the inlet and outlet flange.
- ► When installing the vacuum pump, always ensure a new vibration-capable arrangement with specific structure resonance frequencies.

6.3 Switching on vacuum pump

⚠ WARNING

Danger of poisoning due to toxic process media escaping from the exhaust pipe

During operation with no exhaust line, the vacuum pump allows exhaust gases and vapors to escape freely into the air. There is a risk of injury and fatality due to poisoning in processes with toxic process media.

- ► Observe the pertinent regulations for handling toxic process media.
- ► Safely purge toxic process media via an exhaust line.
- ► Use appropriate filter equipment to separate toxic process media.

⚠ CAUTION

Danger of burns on hot surfaces

Depending on the operating and ambient conditions, the surface temperature of the vacuum pump can increase to above 70 °C.

- ► Provide suitable touch protection.

Procedure for roots pumps with an overflow valve

- ► Switch on the roots pump at the same time as the backing pump.
  - – The overflow valve is open at the beginning of evacuation in high pressures ranges. This protects the Roots pump from overload.
  - – The overflow valve closes as soon as the differential pressure between the suction side and pressure side falls below 20 hPa.

Procedure for roots pumps with blocked overflow valve

- ► Do not switch on the roots pump with blocked overflow valve until a fore-vacuum pressure has been reached at which the backing pump can handle the conveyed volume of gas.
  - – Depending on the pumping speed of the backing pump (S_V), the fore-vacuum pressure for the roots pump is calculated as (p_V) = 70 hPa/(1 – S_V/S_{th}).

Example:

- Okta ATEX with nominal pumping speed S_{th} = 2155 m^3/h at 50 Hz
- Backing pump with pumping speed S_V = 250 m^3/h at 50 Hz
- Cut-in pressure p_V = 70 hPa/(1 – 250 [m^3/h]/2155 [m^3/h]) = **79.2 hPa**

Impermissible continuous operation

Continuous operation of the roots pump with this pressure differential is not permissible as the maximum gas temperature will be exceeded in the exhaust channel.

Switching on

1. Switch the vacuum pump on.
2. Allow the vacuum pump to warm up for approx. 30 minutes prior to process start with the vacuum flange closed.
3. Check the lubricant level with the vacuum pump running and at operating temperature.
   - – The fill level must be within the marks on the sight glass during operation.
4. Check the fill level daily during continuous operation, and every time the vacuum pump is switched on.

6.4 Adjusting the sealing gas amount

⚠ WARNING

Risk of injury from reactive, potentially explosive or other hazardous gas/air mixtures

Uncontrolled gas inlet of air or gases containing oxygen provides ideal conditions for the formation of unexpected explosive gas/air mixtures in the vacuum system. This results in severe injuries.

- ► Use only inert gases for supplying the sealing gas supply in order to avoid a potential ignition.

NOTICE

Property damage from impermissibly high sealing gas pressure

Excessive sealing gas pressure leads to damage to the seals after switching on the vacuum pump.

- ► Make sure that the sealing gas pressure inside the pump does not exceed 1200 hPa.
- ► Stop the sealing gas supply immediately after switching off the vacuum pump.

Procedure

The set quantity of sealing gas influences effective pumping speed and achievable ultimate pressure. Depending on the operating pressure, the empirical value for the supplied sealing gas amount is between 1 % (for a high operating pressure) and 8 % (for a lower operating pressure) of the effective suction capacity.

Inert gases, mostly nitrogen (N_2), are used as sealing gas.

1. Open the sealing gas supply on the gas cylinder.
2. Set a max. pressure of 2500 hPa on the pressure reducer.
3. Set the desired quantity of sealing gas on the dosing valve of the flow meter.

Equation for calculating the sealing gas flow:

$Q_S = (S_{th} \times p \times A_S)/p_0$

- Q_S = Sealing gas flow under standard conditions [Nm^3/h]
- p = Intake pressure [hPa]
- p_0 = Ambient pressure under standard conditions [hPa]
- Δp = Differential pressure max. [hPa]
- p_V = Fore-vacuum pressure [hPa]
- A_S = Sealing gas content at the operating gas flow ($0.01 \leq A_S \leq 0.08$)
- S_{th} = Rated volume flow rate of the roots pump [m^3/h]

Example for Okta 4000 ATEX with e.g. 50 hPa intake pressure and 8 % sealing gas content

$Q_S = (4860 \times 50 \times 0.08)/1013$

$Q_S = 19.2\ Nm^3/h$

At discharge pressures > 100 mbar:

$Q_S = (S_{th} \times (p_V - \Delta p) \times A_S)/p_0$

6.5 Checking the power input

DANGER

Risk of injury due to the bearing bursting after overheating

During longer operation with defective bearings, there is a risk of explosion due to hot surfaces if there is a potentially explosive atmosphere.

- ► Monitor the motor current of the roots pump so that in the event of a process-independent increase of the motor current > 10 %, the roots pump is switched off.
- ► As an alternative, perform a vibration measurement at the defined measuring points with the prescribed time intervals.

There are two possible procedures for monitoring the pumping operation:

- Checking the power input
- Vibration monitoring:

  With vibration monitoring (see chapter “Vibration monitoring”, page 38), the condition of the roots pump and the bearing are monitored.

Procedure

It is not possible to specify a precise switch-off threshold as the power input depends on the process and motor as well as other parameters, such as rotation speed and pressure differential.

- ► Pfeiffer Vacuum recommends that you determine the comparison value for the max. permissible power input in the first operating year.
- ► Measure the power input of the motor at least **1x daily** during operation.

6.6 Vibration monitoring

⚠ WARNING

Risk of injury due to the bearing bursting after overheating

During longer operation with defective bearings, there is a risk of explosion due to hot surfaces if there is a potentially explosive atmosphere.

- ► Perform a vibration measurement at the defined measuring points at the prescribed time intervals.
- ► Switch the roots pump off if process-independent trend changes of characteristic variables occur.

Boundary conditions of the vibration measurement

The boundary conditions of the vibration measurement (including the operating conditions, measurement parameters, etc.) and the equipment for vibration measurement (including the vibration sensors) must comply with the requirements of the following directives and standards.

- **VDI 3836**: Measurement and evaluation of mechanical vibrations of screw compressors and roots blowers
- **VDI 3832**: Measurement of structure-borne sound of rolling element bearings in machines and plant for evaluation of condition
- **DIN ISO 10816-1**: Mechanical vibrations – Evaluation of machine vibration by measurements on non-rotating parts – Part 1
- **DIN ISO 10816-3**: Mechanical vibrations – Evaluation of machine vibration by measurements on non-rotating parts – Part 3

Assess the condition of pump, motor and bearing over the service life of the roots pump using changes in the trend of characteristic variables, compared with a defined reference value from the start-up phase. Due to the different set-up and process conditions, Pfeiffer Vacuum will not specify any binding, generally-applicable limit values. The alarm, warning and shutdown limits for the oscillation variables specified in the guidelines and standards are not adequate assessment criteria.

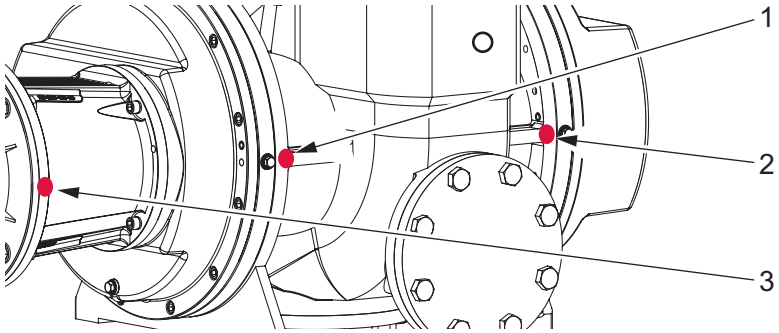


Fig. 14: Position of the vibration sensors

1 Position 1 (pump housing on fixed bearing side)
2 Position 2 (pump housing on floating bearing side)
3 Position 3 (motor connection flange)

Installing the vibration sensors

The vibration sensors are installed using the designated M8 threads at the designated positions.

- Position 1 and 2: Condition monitoring of the vacuum pump and the pump bearing
- Position 3: Condition monitoring of the motor

1. Screw the sensors in at the designated positions.
2. Use suitable adapters for sensors with a different thread.
3. As an alternative, fix the sensors to the intended positions using magnets (recessed areas).

Evaluation of the vibration measurement

Regular vibration measurements ensure reliable evaluation of the condition of the pump, motor, and bearing.

1. After commissioning, conduct vibration measurements every 2 weeks and evaluate the results.
   – Keep to this interval for a period of at least 3 months until the vacuum pump has been "run in."
2. Shorten the interval to weekly and daily measurements if there are anomalies in the trend.
3. Extend the vibration measurement interval to the periods stated in the applicable standards, or define suitable intervals that reflect the operating conditions.

Carrying out a bearing replacement

1. Carry out a bearing replacement in accordance with Maintenance Level 3 if significant changes occur in the trend (significant rise or drop) in accordance with the guidelines VDI 3836 or VDI 3832 during condition monitoring of the vacuum pump or the pump bearing.
2. Using your own experience of condition monitoring, define limit values that will initiate Maintenance Level 3 for the vacuum pump in the event of changes in trend.

Carrying out an motor replacement

1. Carry out a motor replacement if significant changes occur in the trend for vibrations (significant rise or drop) in accordance with standards DIN ISO 10816-1 or DIN ISO 10816-3 during condition monitoring of the motor.
2. In accordance with your own experience of condition monitoring, define limit values that result in a motor replacement in the event of a change in trend.

6.6.1 Monitor the operating condition

You must evaluate the vibrations in two relevant frequency ranges in accordance with the broadband method:

- Frequency range A incorporates the significant mechanical and aerodynamic vibration stimulations of the roots pump.
- Frequency range B takes into account the vibration stimulations through imbalance of the rotating components.

Procedure

► Generate and evaluate a broadband root-mean-square-value for the sound velocity (v_{eff}) when evaluating the respective frequency ranges.

Frequency	Frequency limits (rotation speed)	Description
Frequency range A	10 Hz – 1000 Hz	Due to the permissible rotation speeds, only the range between 10 and 1000 Hz is relevant
Frequency range B	10 Hz – (2 × n) Hz	Deviating from VDI 3836, the upper limit is derived from twice the rotation frequency.

Tbl. 11: Evaluated frequency ranges

6.6.2 Monitoring the bearing condition

Evaluation of the pump bearing oscillations is based on the frequency-selective method (narrow band method).

- A performance spectrum or envelope curve spectrum extracts the anti-friction bearing-specific or characteristic frequencies (rollover frequencies, bearing damage frequencies).
- Evaluation of the amplitudes as characteristic values.
- Concentrating multiple lines of a characteristic frequency to a narrow band.
- Assessment of the root-mean-square-value of the vibration acceleration and / or the maximum value amount of the vibration acceleration in a band.

Evaluating the vibration spectrum

Due to the early and clearer diagnosis for bearing damage, Pfeiffer Vacuum recommends using the envelope curve spectrum.

Bearing	Bearing damage frequency	Okta 4000 ATEX
Fixed bearing	Cage rotation frequency	(0.42 × n) Hz[1)]
	Rollover frequency of an irregularity on the outer ring	(5.81 × n) Hz
	Rollover frequency of an irregularity on the inner ring	(8.19 × n) Hz
	Rolling element rotation frequency	(2.43 × n) Hz
	Rollover frequency of an irregularity on both rolling tracks	(4.86 × n) Hz
Loose bearing	Cage rotation frequency	(0.40 × n) Hz
	Rollover frequency of an irregularity on the outer ring	(4.44 × n) Hz
	Rollover frequency of an irregularity on the inner ring	(6.58 × n) Hz
	Rolling element rotation frequency	(2.49 × n) Hz
	Rollover frequency of an irregularity on both rolling tracks	(4.99 × n) Hz
Harmonic (integral numbers of multiples) of these frequencies can also be of relevance for the diagnosis.		

Tbl. 12: Characteristic bearing damage frequencies of the roots pump

Frequency	Okta 4000 ATEX
Rotation frequency	(n) Hz
Output frequency	(4 × n) Hz
Tooth engagement frequency	(58 × n) Hz
Harmonic (integral numbers of multiples) of these frequencies can also be of relevance for the diagnosis	

Tbl. 13: Characteristic frequencies of the roots pump

Optional method for the overall roots pump

► The characteristic frequencies of the roots pump can also be evaluated using the frequency-selective method (narrow band method).
  – The evaluation is not relevant for the ignition protection concept.

6.6.3 Monitoring the motor condition

The frequency range to be evaluated incorporates the significant mechanical vibration stimulations of the motor.

Frequency range of the motor	10 Hz – 1000 Hz

Tbl. 14: Relevant frequency range of the motor

1. Evaluate the vibrations in a relevant frequency range using the broadband method.
2. Determine and evaluate the broadband root-mean-square-value for the vibration speed (v_{eff}) within the relevant frequency range.

6.7 Switching off and venting the vacuum pump

⚠ WARNING

Risk of crushing on rotating parts when reaching into the open flange

The pistons continue to run in the vacuum after switching off the motor, and can trap fingers and hands within their reach.

► Wait until the vacuum pump comes to a complete standstill.
► Secure the vacuum pump against re-start.

1) n: Rotation speed in Hz

NOTICE

Property damage from impermissibly high sealing gas pressure

Excessive sealing gas pressure leads to damage to the seals after switching on the vacuum pump.

- ► Make sure that the sealing gas pressure inside the pump does not exceed 1200 hPa.
- ► Stop the sealing gas supply immediately after switching off the vacuum pump.

Procedure with clean processes

You can switch off the vacuum pump in every pressure range, between atmospheric pressure and ultimate pressure directly after the process end.

1. Close the shut-off valve in the vacuum line and disconnect the vacuum pump from the process.
2. Switch off the vacuum pump.
3. Vent the vacuum pump via the intake side.
4. Make sure that you do not vent the vacuum chambers through the vacuum pump.
5. Switch off the process- and pump-specific media supply (e.g. the sealing gas supply).

Procedure with contaminated medium

With media that heavily contaminate the suction chamber, flush the suction chamber with air, nitrogen or any other suitable flushing medium at the end of the process.

1. Close the shut-off valve in the vacuum line and disconnect the vacuum pump from the process.
2. At the end of the process, continue to operate the vacuum pump with flushing gas supply at the vacuum flange for another approx. 20 to 40 minutes.
3. Then stop the flushing gas supply.
4. Switch off the vacuum pump.
5. Vent the vacuum pump via the intake side.
6. Make sure that you do not vent the vacuum chambers through the vacuum pump.
7. Switch off the process- and pump-specific media supply (e.g. the sealing gas supply).

7 Maintenance

7.1 Maintenance information

⚠ DANGER

Risk of explosion when carrying out installation and maintenance work in potentially explosive areas

There is a risk of explosion if unsuitable tools are used in potentially explosive areas. Ignition can cause very serious injuries.

- ► Transport, installation and maintenance work may not be performed in potentially explosive atmospheres.
- ► Always shut down the vacuum pump before commencing any work.

⚠ WARNING

Health hazard through poisoning from toxic contaminated components or devices

Toxic process media result in contamination of devices or parts of them. During maintenance work, there is a risk to health from contact with these poisonous substances. Illegal disposal of toxic substances causes environmental damage.

- ► Take suitable safety precautions and prevent health hazards or environmental pollution by toxic process media.
- ► Decontaminate affected parts before carrying out maintenance work.
- ► Wear protective equipment.

⚠ WARNING

Risk of crushing from rotating parts

Fingers and hands may be caught by rotating pistons within the connection flange. This results in severe injuries.

- ► Keep limbs out of the reach of the roots pump.

⚠ WARNING

Danger of injury from strong magnetic field

There is a risk of injury for people with pacemakers and medical implants.

- ► Make sure that such individuals do not enter the sphere of influence (≤ 2 m) of the magnetic field.
- ► Identify rooms in which magnetic couplings are openly accessible with the symbol: "**No access for people with pacemakers**".
- ► Always keep disassembled couplings away from computers, data carriers, and other electronic components.

NOTICE

Damage from incorrect maintenance work

Unprofessional work on the vacuum pump will lead to damage for which Pfeiffer Vacuum accepts no liability.

- ► Ensure that only the following categories of persons are authorized to perform servicing tasks:
  - – Pfeiffer Vacuum employees with corresponding qualifications.
  - – Persons who have undergone training from Pfeiffer Vacuum and have subsequently taken part in refresher courses at intervals of no more than every two years.
  - – Persons who have been awarded official certification in accordance with Article 14 (6) BetrSichV (Ordinance on Industrial Safety and Health).
- ► We recommend taking advantage of our service training offering.

Maintenance instructions

1. Shut down the vacuum pump and allow it to cool if necessary.
2. Vent the vacuum pump to atmospheric pressure via the intake side.

3. Safely disconnect the drive motor from the mains.
4. Secure the motor against switching back on.
5. Remove the vacuum pump from the system if necessary.
6. Dispose of used lubricant according to applicable regulations in each case.
7. For maintenance work, only dismantle the vacuum pump to the extend needed.
8. Only use alcohol or similar media to clean the pump parts.
9. Avoid residues of cleaning agents inside the vacuum pump.

7.2 Checklist for inspection and maintenance

You can carry out maintenance work at **Maintenance Level 1** yourself.

We recommend that Pfeiffer Vacuum Service (PV) carry out maintenance work at **Maintenance Level 3** (inspection).

The interval for **Maintenance Level 3** (overhaul) can be extended if you use vibration monitoring. Comply with the specifications in the "Vibration monitoring" section. Pfeiffer Vacuum recommends an interval of four years in this case.

If the required intervals listed below are exceeded, or if maintenance work is carried out improperly, no warranty or liability claims are accepted on the part of Pfeiffer Vacuum. This also applies if original spare parts are not used.

Action	**Inspection**	**Maintenance level 1**	**Maintenance level 2**	**Maintenance level 3**	**Required material**
described in document	**OI**	**OI**	**Not relevant**	**SI**	
Interval	**daily**	**≤ 1 year**		**≤ 2 years**	
Inspection					
Visual and acoustic pump check ● Checking lubricant level and color of the lubricant	■				
● Checking vacuum pump for leaks ● Checking vacuum pump for running noises	■				
Maintenance level 1					
Clean the vacuum pump ● Pump housing from outside ● Flushing suction chamber with a suitable cleaning agent adapted to the process		■ as required			Lubricant
● Change lubricant and check o-rings for damage; replace if needed		■			
Maintenance level 3					

OI: Operating instructions, **SI:** Service instructions

Depending on the process, the required maintenance intervals can be shorter than the reference values specified in the table. Please consult Pfeiffer Vacuum if necessary.

Action	Inspection	Maintenance level 1	Maintenance level 2	Maintenance level 3	Required material
described in document	**OI**	**OI**	**Not relevant**	**SI**	
Interval	**daily**	**≤ 1 year**		**≤ 2 years**	
Dismantling and cleaning vacuum pump • Replace the seals and all wearing parts • Replace 4 piston bearings (ball bearings/roller bearings)				■	Overhaul kit Lubricant **Option** • Magnetic coupling set • Set of gear wheels
Checking critical components and replacing if necessary: • Magnetic coupling (check magnets for damage) • Thermometer (calibrate the sensor with the reference temperature) • Gear wheels (check the teeth for breaks) • Check the runout of the motor shaft (in accordance with DIN EN 50347:2001)				■	
• Changing lubricant				■	

OI: Operating instructions, **SI:** Service instructions

Depending on the process, the required maintenance intervals can be shorter than the reference values specified in the table. Please consult Pfeiffer Vacuum if necessary.

Tbl. 15: Maintenance intervals

Action	Inspection	Maintenance level 1	Maintenance level 2	Maintenance level 3	Required material
described in document	**OI**	**OI**	**OI**	**OI**	
Interval	**daily**	**≤ 1 year**	**After 5000 cycles, or ≤ 2 years**	**After 10000 cycles, or ≤ 4 years**	
Overflow valve inspection					
• Check the overflow valve for pulsating noises	■				
• Cleaning the overflow valve			■		
• Replace the overflow valve wear parts			■		Overflow valve revision set
• Completely replace the overflow valve				■	Valve body set

OI: Operating instructions

Depending on the process, the required maintenance intervals can be shorter than the reference values specified in the table. Please consult Pfeiffer Vacuum if necessary.

Tbl. 16: Overflow valve maintenance intervals

7.3 Changing lubricant

⚠ WARNING

Danger of injury due to bearing damage

If the valid temperature range of the permissible lubricants is exceeded, insufficient lubrication can lead to bearing damage. There is a risk of explosion due to causing an ignition hazard, and a risk of serious injuries.

- ► Exclusively utilize the permissible lubricants for the intended temperature range.
- ► When filling, refilling, or changing the lubricant, always utilize the lubricant type specified on the rating plate.

⚠ WARNING

Health hazard and environmental damage from toxic contaminated lubricant

Toxic process media can cause lubricant contamination. When changing the lubricant, there is a health hazard due to contact with poisonous substances. Illegal disposal of toxic substances causes environmental damage.

- ► Wear suitable personal protective equipment when handling these media.
- ► Dispose of the lubricant according to locally applicable regulations.

⚠ CAUTION

Scalding from hot lubricant

Danger of scalding when draining lubricant if it comes into contact with the skin.

- ► Wear protective equipment.
- ► Use a suitable collection receptacle.

Pfeiffer Vacuum recommends determining the precise service life of the lubricant in the first operating year.

The usable life may deviate from the reference value specified depending on thermic and chemical loads, or due to penetrating process media in gear and bearing chambers.

Safety data sheets

You can obtain the safety data sheets for lubricants from Pfeiffer Vacuum on request, or from the Pfeiffer Vacuum Download Center.

Prerequisite

- Vacuum pump switched off and cooled
- Vacuum pump vented

Required consumables

- Lubricant

Required tools

- Ring spanner, **WAF 17**
- Calibrated torque wrench (tightening factor ≤ 2.5)

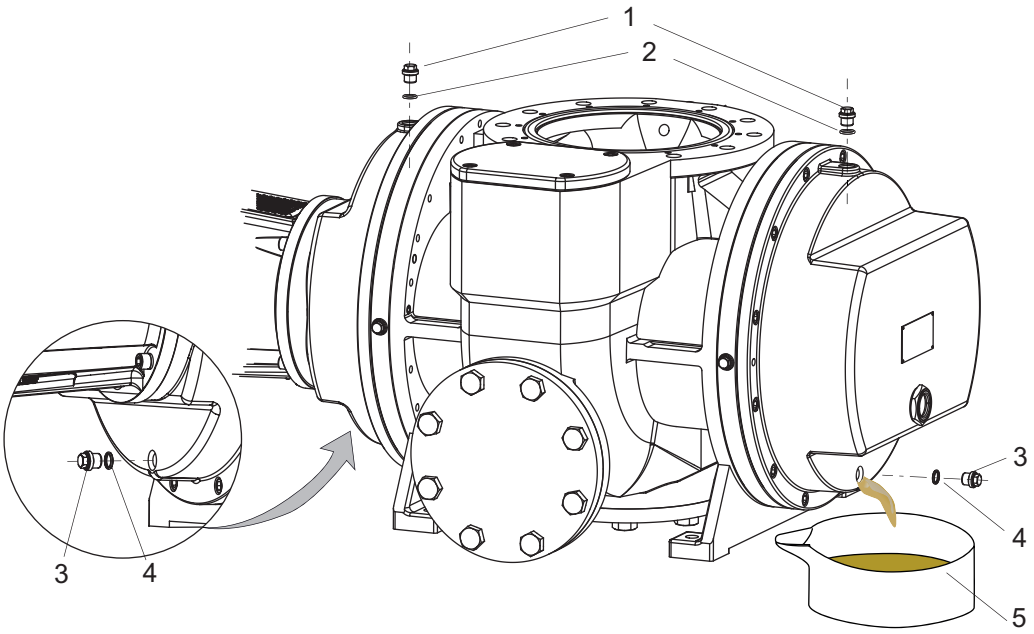


Fig. 15: Draining lubricant

1 Filler screws
2 O-rings
3 Drain screws
4 O-rings
5 Collection receptacle

Draining lubricant

The change interval of the lubricant depends on the vacuum pump application and is highly dependent on the operating conditions.

1. Place the collection receptacle underneath.
2. Unscrew the filler screws.
3. Unscrew both drain screws.
4. Fully drain the lubricant.
5. Screw the drain screws back in.
   – Tightening torque: **max. 32 Nm**

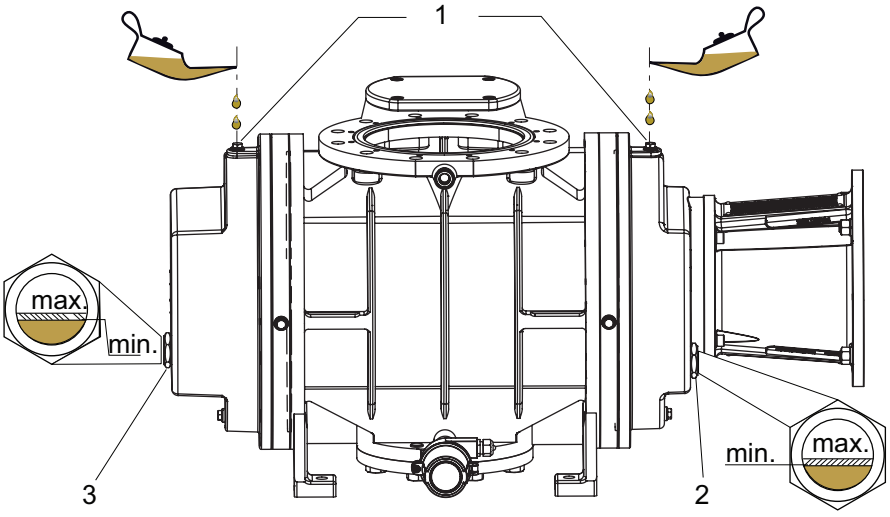


Fig. 16: Filling with lubricant

1 Filler screws
2 Sight glass, bearing chamber
3 Sight glass, gear chamber

Procedure

1. Unscrew the filler screws.
2. Fill the lubricant on both sides according to the sight glass.
   – Fill levels for the first fill: approx. 5 mm above the sight glass middle.
3. Seal the filler screws.
   – Tightening torque: **32 Nm**
4. Check the fill level during operation in the final vacuum.

You must only refill the lubricant when the roots pump is switched off and vented.

7.4 Cleaning the suction chamber

⚠ WARNING

Risk of crushing from rotating parts

Fingers and hands may be caught by rotating pistons within the connection flange. This results in severe injuries.

► Keep limbs out of the reach of the roots pump.

NOTICE

Property damage from incorrect cleaning procedure

Flushing fluid and process media that enters the bearing and oil chambers will stick.

► During the cleaning processes, always protect all bearings with sealing gas in order to prevent a contamination of the lubricant and bearing chambers.

The clearance between pistons and housing are within a tenth of a centimeter range. Sustained, accumulating contamination has the following effect:

- the friction heat inside the roots pump increases
- the power consumption of the roots pump increases
- the pistons jam

Required aids

- Brushes and cleaning agents
- Suitable vessel for collecting the cleaning fluid
- Absorbent materials for absorbing the cleaning fluid

Procedure

1. Dismantle the pipes from the vacuum and fore-vacuum connections.
2. Clean the suction chamber and the overflow channel with suitable brushes and cleaning agents.
3. After cleaning, completely remove remaining fluids using absorbent materials, and dry the suction chamber.
4. After cleaning, mount all pipes.
5. Screw in the drain screws.

7.5 Cleaning the overflow valve

Cleaning is only possible on the variant with overflow valve

No cleaning is intended for the variant with "blocked overflow valve".

Required tools

- Allen key, **WAF 10**
- Calibrated torque wrench (tightening factor ≤ 2.5)

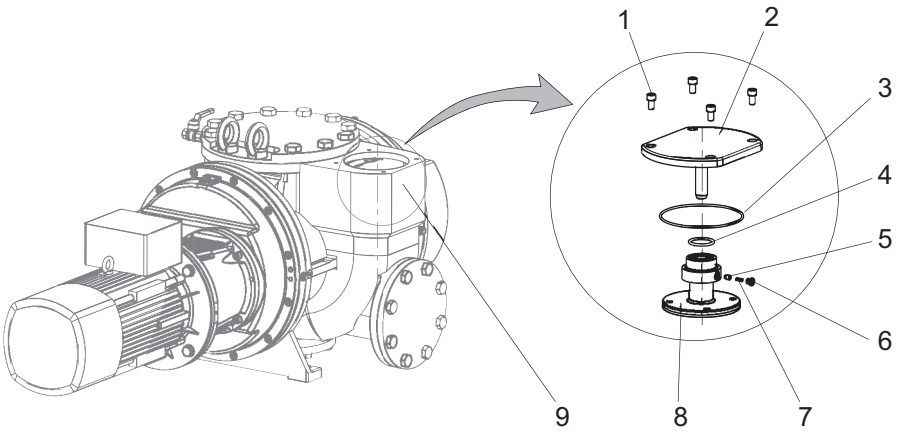


Fig. 17: Overflow valve

1	Allen head screws	6	Pressure screw
2	Valve cover	7	Compression spring
3	O-ring	8	Valve plate
4	O-ring	9	Housing
5	Friction pin		

Remove the overflow valve

1. Unscrew the screws and remove the valve cover.
2. Be careful with the O-ring.
3. Remove the valve plate from the overflow channel, watching out for the O-ring in the process.
4. Unscrew and remove the pressure screw and at the same time remove the compression spring and friction pin.
5. Clean and dry the guide pin from the valve cover.
6. Lightly rub the surface with emery cloth (grain size 180).
   - Never oil the guide pin, this has an adverse effect on damping.
   - If necessary, replace completely if there are pronounced traces of wear.
7. Clean the other parts.
8. Inspect all parts for wear and replace if necessary.

Install the overflow valve

1. Lock the thread on the pressure screw with Loctite 243.
2. Mount the friction pin, compression spring and pressure screw.
3. Locate the valve plate in the overflow channel.
4. Mount both O-rings in the respective grooves.
5. Place the valve cover on the housing.
6. Tighten the screws crosswise.
   - Tightening torque: **25 Nm**

8 Decommissioning

8.1 Shutting down for longer periods

Before shutting down the vacuum pump, observe the following instructions to adequately protect the interior of the vacuum pump (suction chamber) from corrosion:

Procedure for a longer downtime of the vacuum pump (> 1 year)

1. Allow the vacuum pump to cool down.
2. Clean suction chamber.
3. Change the lubricant.
4. Seal the vacuum flange and fore-vacuum flange and any other openings with screw caps.
5. Evacuate the pump interior via the measurement connection on the vacuum side, to p < 1 hPa.
6. Vent the suction chamber of the vacuum pump through the measurement connection using dry air or nitrogen.
7. Store the vacuum pump in dry, dust-free rooms, within the specified ambient conditions.
8. In rooms with humid or aggressive atmospheres: Hermetically seal the vacuum pump together with a drying agent in a plastic bag.
9. For storage durations of more than 2 years, we recommend you carry out maintenance and a lubricant change prior to recommissioning.
10. Please note, the vacuum pump may not be stored in the vicinity of machines, traffic routes, etc., as strong vibrations may damage the bearing.

8.2 Recommissioning

⚠ DANGER

Risk of explosion from electrostatic charging during transport

There is a risk of fatalities when transporting packaging material (foil) and plastic containers in potentially explosive areas. Ignition can cause very serious injuries, and even fatalities.

► Only unpack the vacuum pump outside of potentially explosive areas.

NOTICE

Damage to the roots pump due to aging of the lubricant

The useful life of the lubricant is limited (max. 2 years). Prior to recommissioning, carry out the following operations following inactivity of **2 years or more**:

► Observe the maintenance instructions – consult Pfeiffer Vacuum where necessary.
► Change the lubricant.
► Check the bearings and replace any aged elastomer parts.

Control work before re-commissioning

1. Check the roots pump for visible damage and operate the roots pump only in an appropriate operating status.
2. Check the interior of the pump for contaminants.
3. Remove any drying pearls from the suction chamber.
4. Do not operate the vacuum pump and notify Pfeiffer Vacuum Service in the event of housing parts exhibiting signs of rust.
5. Perform a leak test prior to recommissioning the vacuum pump as required.

9 Recycling and disposal

⚠ WARNING

Health hazard through poisoning from toxic contaminated components or devices

Toxic process media result in contamination of devices or parts of them. During maintenance work, there is a risk to health from contact with these poisonous substances. Illegal disposal of toxic substances causes environmental damage.

- ► Take suitable safety precautions and prevent health hazards or environmental pollution by toxic process media.
- ► Decontaminate affected parts before carrying out maintenance work.
- ► Wear protective equipment.

Environmental protection

You **must** dispose of the product and its components in accordance with all applicable regulations for protecting people, the environment and nature.

- Help to reduce the wastage of natural resources.
- Prevent contamination.

Environmental protection

The product and its components **must be disposed of in accordance with the applicable regulations relating to environmental protection and human health**, with a view to reducing natural resource wastage and preventing pollution.

9.1 General disposal information

Pfeiffer Vacuum products contain materials that you must recycle.

- ► Dispose of our products according to the following:
  - – Iron
  - – Aluminium
  - – Copper
  - – Synthetic
  - – Electronic components
  - – Oil and fat, solvent-free
- ► Observe the special precautionary measures when disposing of:
  - – Fluoroelastomers (FKM)
  - – Potentially contaminated components that come into contact with media

9.2 Dispose of Okta roots pumps

Pfeiffer Vacuum roots pumps from the Okta series contain materials that you must recycle.

1. Fully drain the lubricant.
2. Dismantle the motor.
3. Decontaminate the components that come into contact with process gases.
4. Separate the components into recyclable materials.
5. Recycle the non-contaminated components.
6. Dispose of the product or components in a safe manner according to locally applicable regulations.

10 Malfunctions

⚠ WARNING

Danger to life from electric shock in the event of a fault

In the event of a fault, devices connected to the mains may be live. There is a danger to life from electric shock when making contact with live components.

► Always keep the mains connection freely accessible so you can disconnect it at any time.

⚠ CAUTION

Danger of burns on hot surfaces

In the event of a fault, the surface temperature of the vacuum pump can increase to above 105 °C.

► Allow the vacuum pump to cool down before carrying out any work.
► Wear personal protective equipment if necessary.

NOTICE

Damage from incorrect maintenance work

Unprofessional work on the vacuum pump will lead to damage for which Pfeiffer Vacuum accepts no liability.

► Ensure that only the following categories of persons are authorized to perform servicing tasks:
  – Pfeiffer Vacuum employees with corresponding qualifications.
  – Persons who have undergone training from Pfeiffer Vacuum and have subsequently taken part in refresher courses at intervals of no more than every two years.
  – Persons who have been awarded official certification in accordance with Article 14 (6) BetrSichV (Ordinance on Industrial Safety and Health).
► We recommend taking advantage of our service training offering.

Problem	Possible causes	Remedy
Roots pump will not start up	• Mains voltage is missing or the incorrect operating voltage is present	• Check mains voltage • Check mains fuse protection • Check motor switch
	• Thermal protection switch has triggered	• Detect and fix the cause; allow roots pump to cool down if necessary
	• Suction chamber contaminated	• Clean the suction chamber; contact Pfeiffer Vacuum Service if necessary
	• Gear (gear wheels) damaged	• Switch the roots pump off immediately; contact Pfeiffer Vacuum Service
	• Bearing damage present	• Change the bearing; contact Pfeiffer Vacuum Service if necessary
	• Motor faulty	• Replace the motor
Roots pump switches off after a while after being started	• Thermal protection switch of the motor has triggered	• Detect and fix the cause of overheating; allow the motor to cool down if necessary
Roots pump/pumping station does not reach ultimate pressure	• Suction chamber dirty	• Cleaning the suction chamber
	• Lubricant soiled	• Changing the lubricant
	• Backing pump operates incorrectly	• Check the backing pump
	• Leak in system	• Check the system for leaks; carry out a leak test if necessary • Fix leak
	For pumps with overflow valve: • Overflow valve does not close completely	• Check the overflow valve; replace if necessary

Problem	Possible causes	Remedy
Unusual noises during operation	• Suction chamber dirty	• Switch the roots pump off immediately and clean the suction chamber
	• Damage to the bearing or gear wheels	• Switch the roots pump off immediately; contact Pfeiffer Vacuum Service
	• Damage to motor bearing	• Switch the roots pump off immediately • Replace the motor; contact Pfeiffer Vacuum Service

Tbl. 17: Troubleshooting

11 Service solutions by Pfeiffer Vacuum

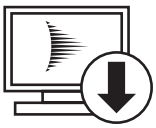
We offer first-class service
High vacuum component service life, in combination with low downtime, are clear expectations that you place on us. We meet your needs with efficient products and outstanding service.

We are always focused on perfecting our core competence – servicing of vacuum components. Once you have purchased a product from Pfeiffer Vacuum, our service is far from over. This is often exactly where service begins. Obviously, in proven Pfeiffer Vacuum quality.

Our professional sales and service employees are available to provide you with reliable assistance, worldwide. Pfeiffer Vacuum offers an entire range of services, from original replacement parts to service contracts.

Make use of Pfeiffer Vacuum service
Whether preventive, on-site service carried out by our field service, fast replacement with mint condition replacement products, or repair carried out in a Service Center near you – you have various options for maintaining your equipment availability. You can find more detailed information and addresses on our homepage, in the Pfeiffer Vacuum Service section.

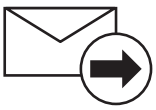
You can obtain advice on the optimal solution for you, from your Pfeiffer Vacuum representative.
For fast and smooth service process handling, we recommend the following:



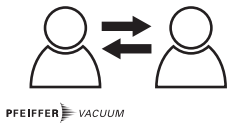
1. Download the up-to-date form templates.
   - Explanations of service requests
   - Service requests
   - Contamination declaration

a) Remove and store all accessories (all external parts, such as valves, protective screens, etc.).
b) If necessary, drain operating fluid/lubricant.
c) If necessary, drain coolant.

2. Complete the service request and contamination declaration.

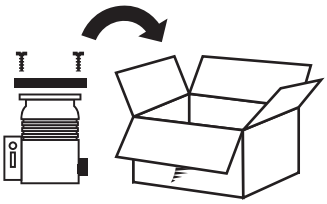


3. Send the forms by email, fax, or post to your local Service Center.

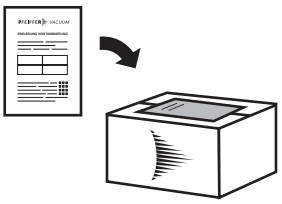


4. You will receive an acknowledgment from Pfeiffer Vacuum.

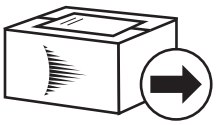
Submission of contaminated products
No microbiological, explosive, or radiologically contaminated products will be accepted. Where products are contaminated, or the contamination declaration is missing, Pfeiffer Vacuum will contact you before starting service work. Depending on the product and degree of pollution, **additional decontamination costs** may be incurred.



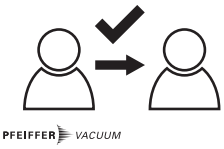
5. Prepare the product for transport in accordance with the provisions in the contamination declaration.
a) Neutralize the product with nitrogen or dry air.
b) Seal all openings with blind flanges, so that they are airtight.
c) Shrink-wrap the product in suitable protective foil.
d) Package the product in suitable, stable transport containers only.
e) Maintain applicable transport conditions.



6. Attach the contamination declaration to the **outside** of the packaging.



7. Now send your product to your local Service Center.



8. You will receive an acknowledgment/quotation, from Pfeiffer Vacuum.

Our sales and delivery conditions and repair and maintenance conditions for vacuum devices and components apply to all service orders.

12 Spare parts

12.1 Ordering spare parts packs

Observe the following instructions when ordering spare parts:

- ► Have the vacuum pump part number, and any other necessary details from the rating plate, to hand when ordering spare parts.
- ► Install original spare parts only.

13 Accessories

View the line of accessories for Pfeiffer Vacuum roots pumps online at pfeiffer-vacuum.de.

13.1 Accessory information

Sealing gas device
The use of sealing gas at the bearing points protects the lubricant from contamination by the ingress of process media and flushing fluid into the bearing and oil chambers.

13.2 Ordering accessories

Description	Order number
Sealing gas kit	PP 045 920 -T
Screw set for Okta 4000/M/ATEX | Okta 6000/M, DN PN16, zinc-plated steel	PP 045 884 -T
Blank flange set for Okta 4000/M/ATEX | Okta 6000/M, DN PN16 (stainless steel)	PP 045 889 -T
Seal kit (FKM) for Okta 4000/M/ATEX | Okta 6000/M, DN PN16	PP 045 890 -T

Tbl. 18: Accessories

Description	Order number
P3, mineral oil, 1 l	PK 001 106 -T
P3, mineral oil, 5 l	PK 001 107 -T
P3, mineral oil, 20 l	PK 001 108 -T
H1, 1 l	PK 001 210 -T
H1, 5 l	PK 001 211 -T
H1, 20 l	PK 001 212 -T
H1, 208 l	PK 001 213 -T

Tbl. 19: Consumables

14 Technical data and dimensions

14.1 General

Basis for the technical data of Pfeiffer Vacuum roots pumps

- Specifications according to PNEUROP committee PN5
- ISO 21360-1: 2016 “Vacuum technology - Standard methods for measuring vacuum-pump performance - General description”
- Leak test to ascertain the integral leakage rate according to EN 1779: 1999 technique A1; with 100 % helium concentration, 10 s measurement duration
- Sound pressure level: distance to vacuum pump 1 m

	mbar	bar	Pa	hPa	kPa	Torr | mm Hg
mbar	1	$1 \cdot 10^{-3}$	100	1	0.1	0.75
bar	1000	1	$1 \cdot 10^{5}$	1000	100	750
Pa	0.01	$1 \cdot 10^{-5}$	1	0.01	$1 \cdot 10^{-3}$	$7.5 \cdot 10^{-3}$
hPa	1	$1 \cdot 10^{-3}$	100	1	0.1	0.75
kPa	10	0.01	1000	10	1	7.5
Torr | mm Hg	1.33	$1.33 \cdot 10^{-3}$	133.32	1.33	0.133	1
1 Pa = 1 N/m^2						

Tbl. 20: Conversion table: Pressure units

	mbar l/s	Pa m^3/s	sccm	Torr l/s	atm cm^3/s
mbar l/s	1	0.1	59.2	0.75	0.987
Pa m^3/s	10	1	592	7.5	9.87
sccm	$1.69 \cdot 10^{-2}$	$1.69 \cdot 10^{-3}$	1	$1.27 \cdot 10^{-2}$	$1.67 \cdot 10^{-2}$
Torr l/s	1.33	0.133	78.9	1	1.32
atm cm^3/s	1.01	0.101	59.8	0.76	1

Tbl. 21: Conversion table: Units for gas throughput

Special versions

The technical data and dimensions for the vacuum pump refer to the specified standard version.

- For deviations in special versions, please refer to the rating plates or the enclosed information.

14.2 Technical data

Type designation	Okta 4000 ATEX	Okta 4000 ATEX
Connection flange (in)	DN 250 PN 16	DN 250 PN 16
Connection flange (out)	DN 150 PN 16	DN 150 PN 16
Nominal pumping speed	2 160 – 5 190 m³/h	2 160 – 5 190 m³/h
Nominal pumping speed at 50 Hz	4325 m³/h	4325 m³/h
Nominal pumping speed at 60 Hz	5190 m³/h	5190 m³/h
Nominal pumping speed min.	2160 m³/h	2160 m³/h
Nominal pumping speed max.	5190 m³/h	5190 m³/h
Input voltage 50 Hz	230 / 400 V	230 / 400 V
Input voltage 60 Hz	265 / 460 V	265 / 460 V
Input voltage: tolerance	±5 %	±5 %
Rated power 50 Hz	11 kW	11 kW

Type designation	Okta 4000 ATEX	Okta 4000 ATEX
Rated power 60 Hz	13 kW	13 kW
Nominal rotation speed at 50 Hz	3000 rpm	3000 rpm
Nominal rotation speed at 60 Hz	3600 rpm	3600 rpm
Rotation speed	1 500 – 3 600 rpm	1 500 – 3 600 rpm
Leakage rate	$1 \cdot 10^{-6}$ Pa m³/s	$1 \cdot 10^{-6}$ Pa m³/s
Emission sound pressure level (EN ISO 2151) at intake pressure 1 hPa	74 dB(A)	74 dB(A)
Emission sound pressure level (EN ISO 2151) at intake pressure 10 hPa	79 dB(A)	79 dB(A)
Protection degree	IP55	IP55
Cooling method	Air	Air
Motor protection	3TF	3TF
Ambient temperature	5 – 40 °C	-20 – 40 °C
Shipping and storage temperature	-10 – 40 °C	-10 – 40 °C
Operating fluid	P3	H1
Operating fluid amount	6.8 l	6.8 l
Weight: with motor	700 kg	700 kg

Tbl. 22: Technical data Okta 4000 ATEX with lubricant P3 and H1

14.3 Dimensions

Dimensions in mm

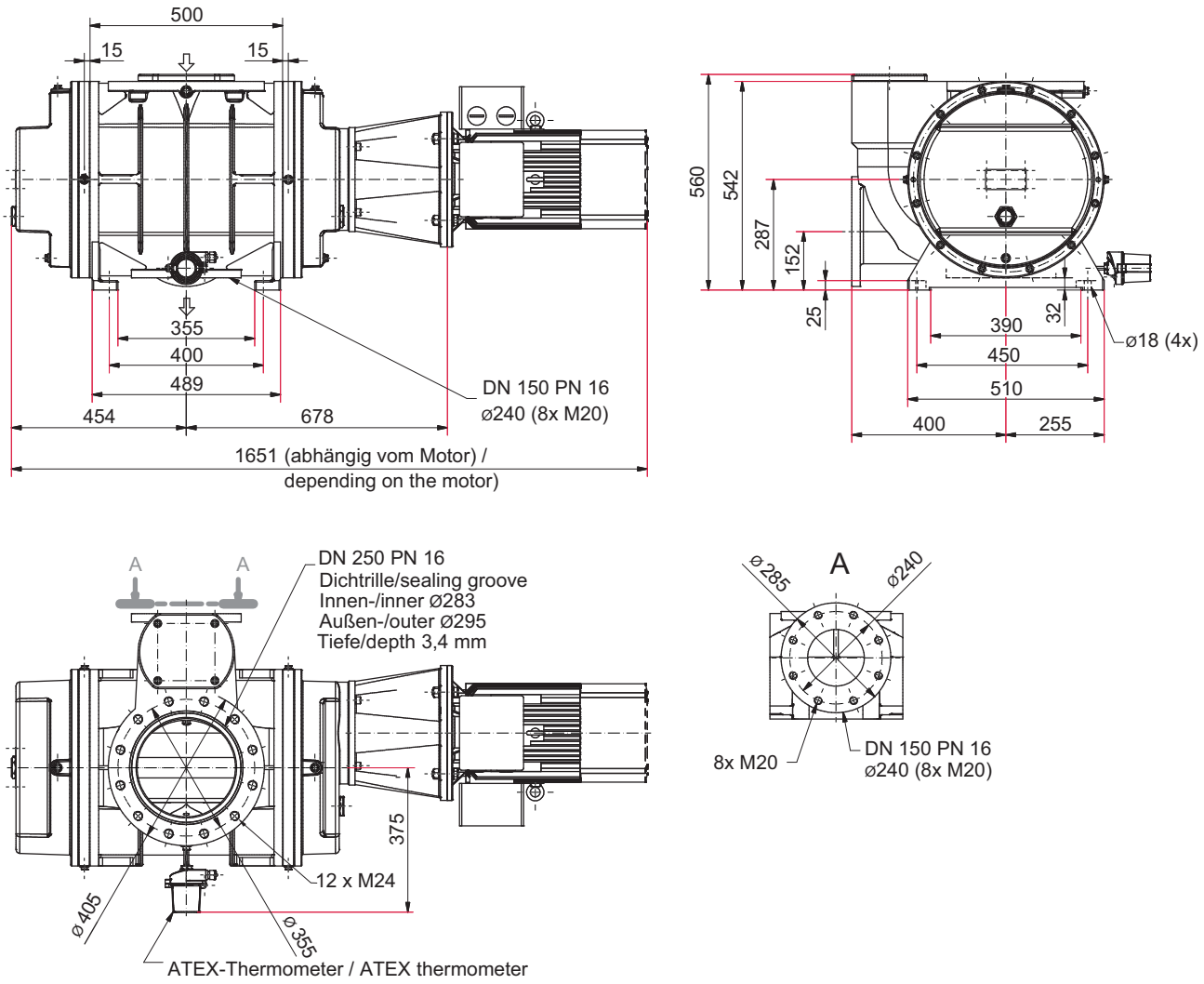


Fig. 18: Okta 4000 ATEX

Declaration of Conformity

Declaration for product(s) of the type:

Roots pump
Okta 4000 ATEX
Ⓔx II 3/3G Ex h IIB T3 Gc X +5 °C ≤ Ta ≤ +40 °C
Ⓔx II 3/3G Ex h IIB T3 Gc X -20 °C ≤ Ta ≤ +40 °C
PP W73 3XX
PP W73 9XX

We hereby declare that the listed product satisfies all relevant provisions of the following **European Directives**.

- **Machinery 2006/42/EC (Annex II, no. 1 A)**
- **Electromagnetic compatibility 2014/30/EU**
- **Explosion protection 2014/34/EU according to article 13 (1) c)**
- **Restriction of the use of certain hazardous substances 2011/65/EU**
- **Restriction of the use of certain hazardous substances, delegated directive 2015/863/EU**

Harmonized standards and applied national standards and specifications:

DIN EN ISO 12100: 2011
DIN EN 1012-2: 2011-12
DIN EN ISO 2151: 2009
DIN EN 1127-1: 2019
DIN EN ISO 80079-36: 2016–12
DIN EN ISO 80079-37: 2016–12
DIN ISO 21360-1: 2016
ISO 21360-2: 2012
DIN EN ISO 13732-1: 2008
DIN EN ISO 13857 : 2008
DIN EN 61000-6-2 : 2006
DIN EN 61000-6-4 : 2011
DIN EN IEC 63000: 2019

The authorized representative for the compilation of technical documents is
Dr. Adrian Wirth, Pfeiffer Vacuum GmbH, Berliner Straße 43, 35614 Asslar, Germany.

Signature:

Pfeiffer Vacuum GmbH
Berliner Straße 43
35614 Asslar
Germany

(Daniel Sälzer)
Managing Director

Asslar, 2021-12-15

PFEIFFER VACUUM

Declaration of Conformity

Declaration for product(s) of the type:

Roots pump
Okta 4000 ATEX
Ⓔx II 2/2G Ex h IIB T3 Gb X +5 °C ≤ Ta ≤ +40 °C
Ⓔx II 2/2G Ex h IIB T3 Gb X -20 °C ≤ Ta ≤ +40 °C
PP W73 4XX
PP W73 8XX

We hereby declare that the listed product satisfies all relevant provisions of the following **European Directives**.

- **Machinery 2006/42/EC (Annex II, no. 1 A)**
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Signature:

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Berliner Straße 43
35614 Asslar
Germany

(Daniel Sälzer)
Managing Director

Asslar, 2021-12-15

PFEIFFER VACUUM

Notizen / Notes:

VACUUM SOLUTIONS FROM A SINGLE SOURCE

Pfeiffer Vacuum stands for innovative and custom vacuum solutions worldwide, technological perfection, competent advice and reliable service.

COMPLETE RANGE OF PRODUCTS

**From a single component to complex systems:
We are the only supplier of vacuum technology that provides a complete product portfolio.**

COMPETENCE IN THEORY AND PRACTICE

**Benefit from our know-how and our portfolio of training opportunities!
We support you with your plant layout and provide first-class on-site service worldwide.**

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Are you looking for a perfect vacuum solution? Please contact us

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