



Vacuum furnaces

Optimum vacuum solutions from a single source for
your vacuum furnace applications

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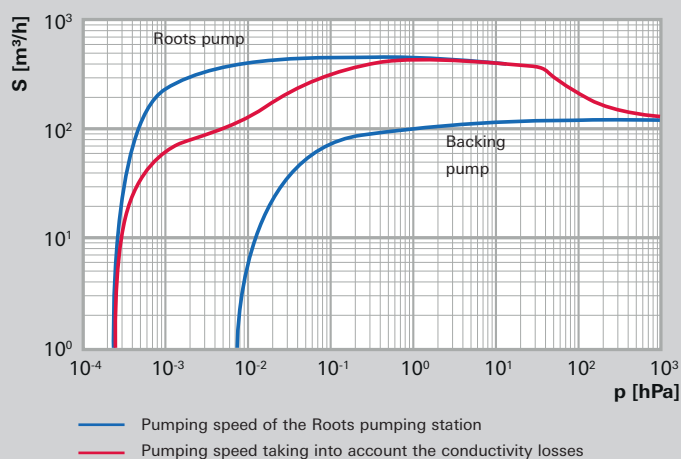
Every day we come into contact with products that were manufactured in vacuum furnaces: Gears in automotive transmissions, specially hardened drill bits for industrial or DIY applications. High strength materials are difficult to produce without vacuum.

The components to be processed are heated in a vacuum furnace while vacuum pumps generate a low-oxygen atmosphere. This prevents any oxidation of the components. Vacuum furnaces are used in many different industrial applications, such as vacuum sintering for the production of hard metals for the tool industry or vacuum soldering for the production of vacuum switching chambers for the electrical industry. Vacuum hardening is used for high-alloy steels, such as those used for gear manufacturing by the automotive industry.

The advantages of vacuum

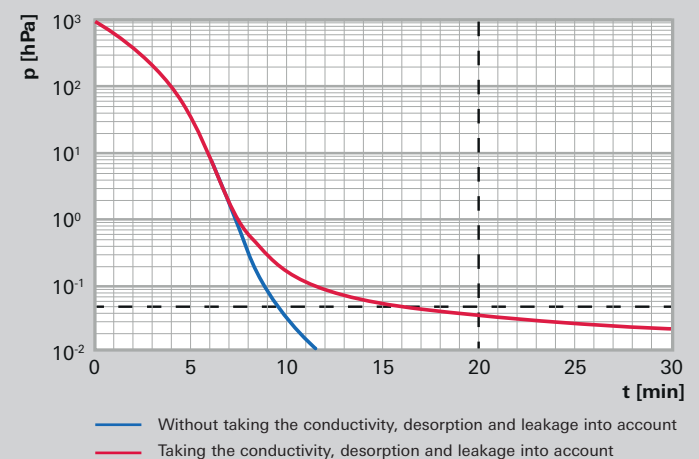
The vacuum in the furnaces acts as a protective atmosphere that prevents oxidation of the components. Vacuum sintering improves the surface quality of the components. This considerably reduces the need for mechanical reworking. The mechanical properties are also optimized through higher density, lower porosity and higher strength. In vacuum soldering, a high joint quality is achieved through the improved strength of the soldered seam. In addition, vacuum soldering ensures the high reproducibility of the process. Vacuum hardening is used to minimize distortion while also ensuring excellent surface quality. Another advantage of this process: The high surface quality allows direct nitriding after hardening.

Pumping speed curve of a Roots pumping station



The pumping speed curve clearly illustrates the performance of the vacuum system over the entire pressure range.

Evacuation curve



The evacuation curve shows to what extent the vacuum system reaches the target pressure within the required time.

Comprehensive portfolio for vacuum furnaces

Pfeiffer Vacuum offers a very large product portfolio, particularly for vacuum furnace applications. This ranges from vacuum pumps for evacuating furnaces to pressure measurement equipment, and from calibration pumping stations to leak detectors for locating leaks. With our components and valves you get the complete vacuum equipment from one source.

The process

For processes in a vacuum furnace, it is essential to reach a certain pressure within a given time. Time savings due to short pump-down times contribute to economic efficiency. Moreover, unwanted substances such as oxygen are removed from the drying chamber during evacuation.

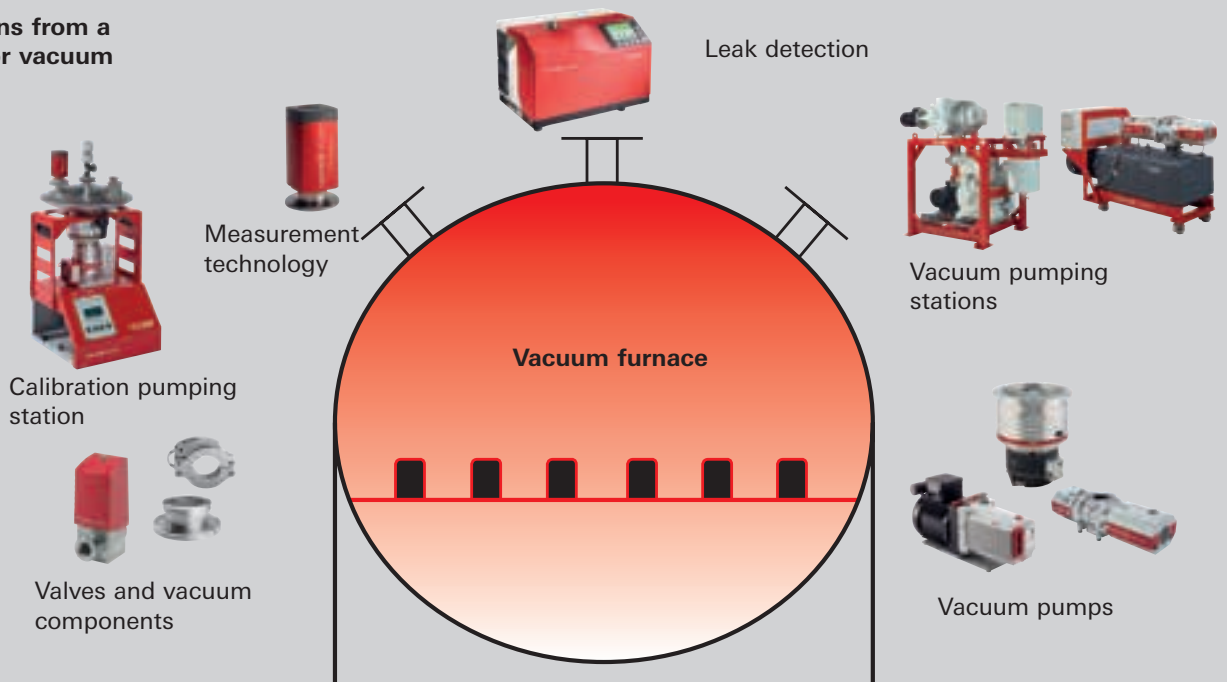
Pump selection

Criteria for selecting vacuum pumps include a sufficiently low ultimate pressure and a high pumping speed. With these criteria, the required pump-down time can be achieved and a constant pressure maintained during the process gas inflow.

Design

Pfeiffer Vacuum will support you in designing the complete vacuum system, whether in dimensioning the vacuum pumps or by recommending additional components, such as dust separators, pressure gauges, leak detectors and accessories. Individual pump characteristics, and losses through piping and leaks are taken into account. Modern calculation programs developed specially for this purpose are used in the design process.

Vacuum solutions from a single source for vacuum furnaces



Vacuum furnaces

Vacuum sintering

The requirements

The main requirements for vacuum pumps in sintering furnaces relate to the pumping speed, the necessary working pressure and sufficient robustness for the debinding process. In the course of the debinding process, the binder evaporates. The resulting substances must be pumped down quickly and reliably. Furnaces are therefore often evacuated using a combination of rotary vane and Roots pumps. With these, the required final pressure in the fine vacuum range of 10^{-1} to 10^{-2} hPa can be achieved quickly and reliably.

Pump selection

The UnoLine Plus rotary vane pump from Pfeiffer Vacuum has proven its worth especially in the HIP sintering process, and is characterized as very robust when exposed to dirt. Thanks to its low pump speed and large oil reservoir, the process gases that result are not a problem for the pump. In addition, maintenance intervals have been extended by separating the bearing and process lubrication. In addition to the UnoLine Plus, Pfeiffer Vacuum offers further oil-compressing and also dry pumping principles, such as the HeptaDry screw pump and DuoLine two-stage rotary vane pumps.

Moreover, our HiLobe and OktaLine Roots pumps, as well as the CombiLine pumping stations, are also suitable for vacuum sintering to achieve higher suction volumes. For further details, please refer to the product overview on page 7.



Carbide tool (turning tool), manufactured by sintering



Vacuum soldering furnaces built by PVA TePla
Courtesy of PVA TePla

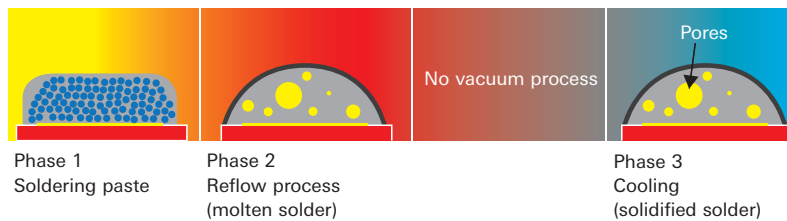
Vacuum furnaces

Vacuum soldering

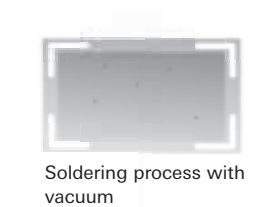
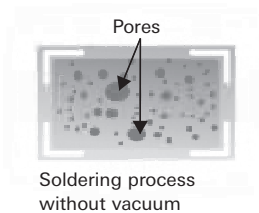
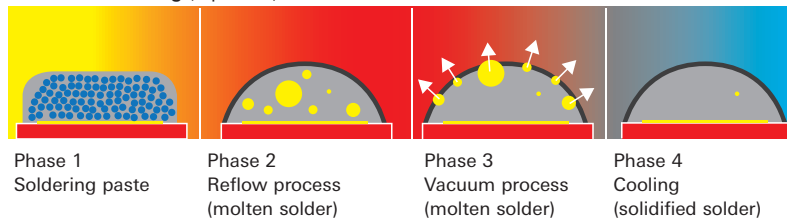
The requirements

Vacuum soldering places high demands on the vacuum system. The challenges start even in the medium vacuum range, where the carrier gas argon used to flush out the furnace is pumped down. At this stage, too, the water vapor that is a by-product of the component washing process also needs to be pumped down. In addition, the solder that is used poses a challenge for the vacuum pump since the binder degasses from the solder. If active solders are used, titanium degasses from them. Furthermore, any hydrocarbons produced must be pumped down. In view of this, pumping speeds in the high vacuum range (10^{-5} to 10^{-6} hPa) are an important requirement for the pumps. The pumps used are screw pumps or rotary vane pumps in combination with Roots pumps. High vacuum is usually generated with oil diffusion pumps and turbomolecular pumps.

Normal soldering process (3 phases)



Vacuum soldering (4 phases)



Pump selection

The DuoLine as a two-stage rotary vane pump is suitable for this process. The two-stage design achieves a low ultimate pressure, which predestines the DuoLine for vacuum soldering. Furthermore, a long service life is one of the outstanding features of this pump. The DuoLine covers a pumping speed range from 1.3 to 300 m³/h. DuoLine pumps in a version with a magnetic coupling dispense with the need for shaft seal maintenance. Pfeiffer Vacuum additionally offers dry pumps like the HeptaDry screw pump as backing pumps for this application.

Vacuum furnaces

Vacuum hardening

Basics

Uniform heating up and through-heating as well as quenching are indispensable in vacuum hardening to prevent distortion of the components. Since heat transfer by radiation can lead to irregularities in the lower temperature range, heat convection with high-purity nitrogen is used. The nitrogen introduced into the process must then be pumped down by vacuum pumps. Furnaces are therefore often evacuated using a combination of rotary vane and Roots pumps. Due to this combination, the final pressure required in the medium vacuum range up to 1 mbar is achieved quickly and reliably.

Pump selection

The HenaLine from Pfeiffer Vacuum has especially proven itself as a rotary vane pump. It features a single-stage design and has long been among the most widely employed products for processes in the medium vacuum range. It is characterized by its long service life. With its pumping speeds, the HenaLine series covers virtually all industrial applications. If dry pumping principles are required, the HeptaDry screw pump is recommended.

Roots pumps

Suitable Roots pumps are available in the OktaLine and HiLobe series. With its integrated overflow valve, the OktaLine prevents thermal overload. The HiLobe works with a new drive concept that enables an around 20% shorter pump-down time compared to conventional Roots pumps.





As a result, operating costs can also be reduced by up to 50% compared to conventional Roots pumps. The intelligent interface technology enables condition monitoring and increases the service life and operational safety.





Pumping stations

With pumping stations from the CombiLine series comprising rotary vane and Roots pumps, Pfeiffer Vacuum offers an all-in-one solution for every application. The pumping stations of the CombiLine series cover a wide range of achievable pumping speeds and final pressures. Pumping stations can also be designed and built individually to custom requirements to meet demanding applications.



Gears hardened under vacuum

Rotary vane pumps			Screw pumps
UnoLine Plus	HenaLine	DuoLine	HeptaDry
			
<ul style="list-style-type: none"> Very low final pressure compared to other single-stage rotary vane pumps Process-compatible through temperature control Integrated oil regeneration device for processes with high dust content Unrivaled long maintenance intervals thanks to separate lubrication of the bearings and pump chamber 	<ul style="list-style-type: none"> Reliable and powerful rotary vane pump Clean exhaust air due to integrated oil mist separator 	<ul style="list-style-type: none"> High operating reliability through integrated high-vacuum safety valve Complete series from 1.25 to 300 m³/h Optionally available with wear-free magnetic coupling, thus extended maintenance intervals and no unplanned breakdowns due to oil leaks 	<ul style="list-style-type: none"> Dry screw pump with strainer Water cooling with thermostatic valve and thermometer Temperature switch in housing Non-contact dynamic labyrinth seal

Roots pumps		Turbopumps	Pumping stations
OktaLine	HiLobe	HiPace	CombiLine
			
<ul style="list-style-type: none"> Unmatched high compression values Integrated overflow valve No cooling water consumption Optionally available with wear-free magnetic coupling, thus extended maintenance intervals and lower operating costs 	<ul style="list-style-type: none"> Dry-sealing High pumping speed at atmospheric pressure reduces the pump-down time Energy-efficient drive concept Intelligent interface technology Durable 	<ul style="list-style-type: none"> High pumping speeds for light and heavy gases High process capability Resistant to particle intake High gas throughput, even for heavy gases Maximum operating reliability by monitoring all operating data 	<ul style="list-style-type: none"> CombiLine stands for a wide variety of Roots pumping stations with different backing pumps, gradations and accessories In addition to the standard range, customer-specific pumping stations can also be designed to meet individual requirements

Selection guide

	Vacuum furnaces		
	Hardening	Sintering	Soldering
UnoLine Plus / HenaLine single-stage rotary vane pumps	●	●	●
DuoLine two-stage rotary vane pumps	○	○	●
HeptaDry screw pumps	○	○	○
OktaLine / HiLobe Roots pumps	●	●	●
HiPace turbopumps	○		●
CombiLine pumping stations	●	●	●

- Recommended
- Optional

Vacuum furnaces

Pressure measurement

An accurate and repeatable pressure measurement is essential for any vacuum application. This safeguards the development and control of processes. Pfeiffer Vacuum covers a wide pressure measurement range with a variety of measuring principles. Examples of frequently used measuring principles are: Pirani, Pirani/cold cathode and capacitive vacuum gauges.

Pirani vacuum gauges (pressure range up to $1 \cdot 10^{-3}$ hPa)

Thanks to their pulse technology, the innovative vacuum gauges from Pfeiffer Vacuum offer better accuracy than conventional Pirani gauges. The pressure measuring range is between 10 hPa and $1 \cdot 10^{-3}$ hPa. Pirani vacuum gauges are among the most cost-effective vacuum gauges.

Capacitive vacuum gauges (pressure range up to $1 \cdot 10^{-3}$ hPa)

Capacitive vacuum gauges offer a much higher accuracy than Pirani vacuum gauges. They can also be used independently of the type of gas. The absolute pressure is determined by the deflection of a diaphragm. Capacitive vacuum gauges therefore offer the best performance in a measuring range between 1,000 hPa and $1 \cdot 10^{-3}$. The appropriate choice must be made depending on the working pressure.





Pirani/cold cathode vacuum gauges (pressure range up to $1 \cdot 10^{-9}$ hPa)

Pirani/cold cathode vacuum gauges belong to the FullRange gauges. With two sensors in one housing, this type of gauge stands out with a very wide measuring range and is especially suitable for medium and high vacuum. For pressure measurement inside furnaces, PKR gauges have distinguished themselves with their reliability and robustness.

Pirani/capacitive vacuum gauges (pressure range from $1,500$ hPa to $5 \cdot 10^{-5}$ hPa)

Since they are also equipped with two sensors in one housing, Pirani/capacitive gauges are also FullRange gauges. This combination offers the advantage of being less expensive than the Pirani/cold cathode gauge. However, in contrast to Pirani/cold cathode gauges, it is not possible to measure pressures that are lower than 10^{-5} hPa. Pfeiffer Vacuum's portfolio includes these vacuum gauges under the name PCR.

Product overview

TPR 270	CMR	PKR	PCR
			
<ul style="list-style-type: none">■ Pulse-Pirani principle ensures higher accuracy■ Gas-dependent measurement (may be used in conjunction with capacitive vacuum gauge for comparative pressure measurement)	<ul style="list-style-type: none">■ Precise pressure measurement independent of gas type■ Transmitter for connection to TPG control units	<ul style="list-style-type: none">■ FullRange® gauges with two sensors in one housing■ Optimized for applications in the medium vacuum range■ Very low external magnetic field	<ul style="list-style-type: none">■ For precise measurement of aeration processes independent of gas type■ Two sensors in one housing

Vacuum furnaces

Calibration

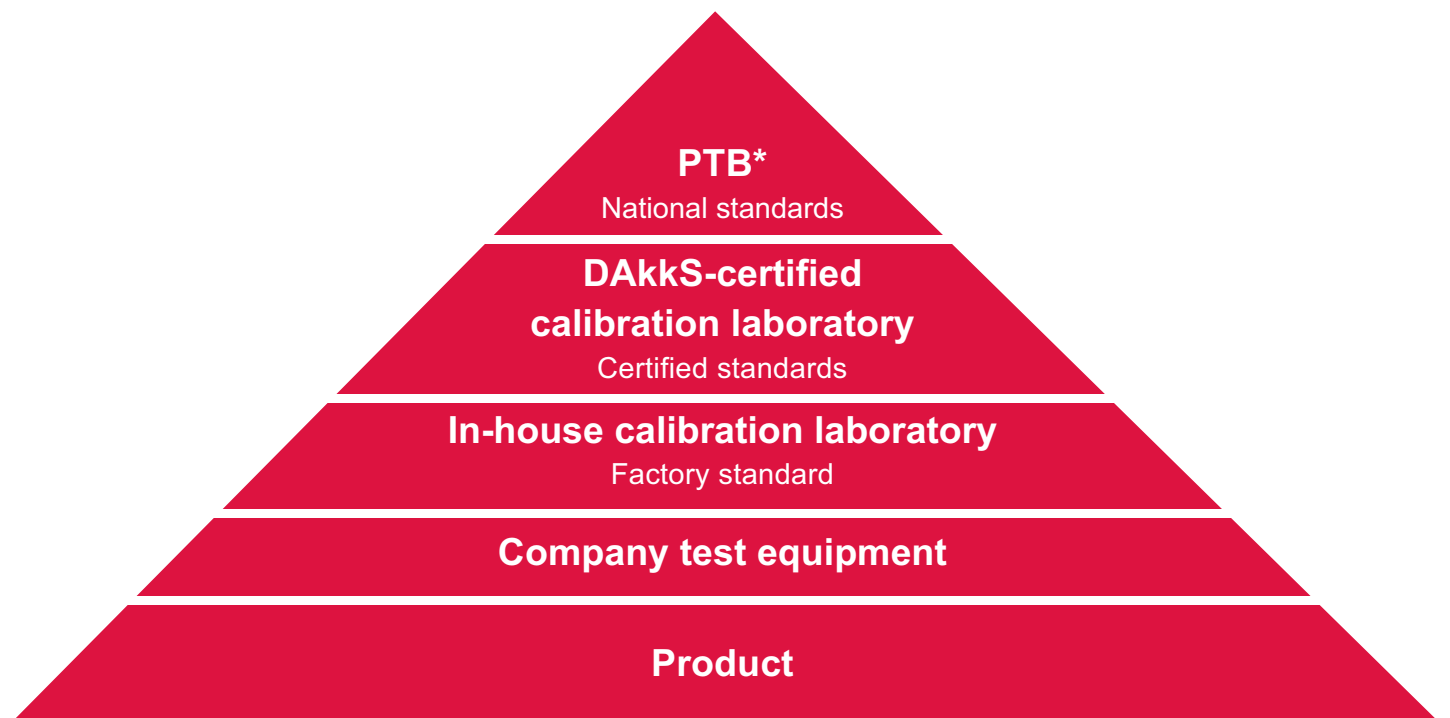
Calibration

In order to ensure the accuracy and repeatability of the pressure measurement and thus the process stability in the long term, it is essential to regularly calibrate the vacuum gauges. The measuring signals can shift due to the contamination of the sensors through particles or condensate as well as due to long-term aging. An integral part of quality assurance is therefore calibration, in which the measuring signals of the measuring instruments used are compared with a reference gauge. The reference vacuum gauge must have been calibrated by a certified laboratory (e.g., DAkkS [Deutsche Akkreditierungsstelle GmbH = German accreditation agency] certified in Germany, NIST certified in the U.S.) and be traceable to a national standard.

Factory and DAkkS calibration

Pfeiffer Vacuum offers both factory and DAkkS calibration of vacuum gauges. The calibration is carried out according to high quality standards and in compliance with ISO 3567. The test conditions and discrepancies recorded are documented in the calibration certificate issued.

Hierarchy of the calibration chain (decreasing accuracy)



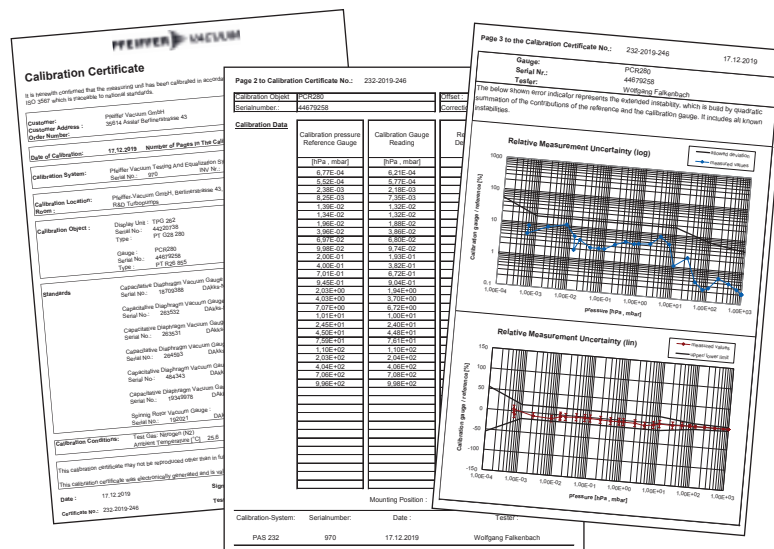
*Physikalisch-Technische Bundesanstalt
(National Metrology Institute of Germany)

Vacuum furnaces

Calibration



Pfeiffer Vacuum calibration systems

When a large number of vacuum gauges are used, direct in-house calibration can be more cost-efficient than external calibration. With its Basic and Pro models, Pfeiffer Vacuum offers calibration pumping stations specially developed for this purpose. These systems incorporate an integrated turbopumping station to provide the pressure necessary for accurate zero adjustment. A vacuum chamber in accordance with ISO 3567 ensures homogeneous pressure distribution and a symmetrical arrangement of the vacuum gauges at the same height. Gas inlet and pump input are also located on an axis of symmetry. With the Pfeiffer Vacuum calibration systems and a corresponding reference vacuum gauge, the calibration can be carried out easily, particularly for the relevant pressure range.



Example of a calibration certificate

Product overview

Basic calibration system	Pro calibration system
 <ul style="list-style-type: none"> ■ Compact system with up to six flange connections for vacuum gauges ■ Calibration range 1,013 – 10⁻⁴ hPa ■ Easy to use ■ Recipient according to ISO/TS 3567 standard ■ For static and dynamic calibration ■ Customized solutions available ■ DAkkS reference vacuum gauges optionally available 	 <ul style="list-style-type: none"> ■ Mobile system with up to eight flange connections for vacuum gauges

Vacuum furnaces

Leak detection

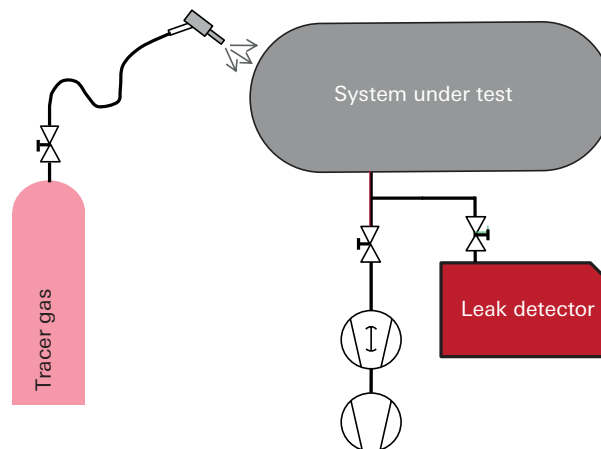
Localization of leaks

If the leak rate exceeds the desired threshold, it is important to locate and correct the leakages. Their high detection sensitivity, short test time and easy operation make helium leak detectors ideal for localizing leaks. The vacuum furnace is evacuated. From the outside, helium is sprayed locally on sealing points, welds and other potential leaks using a spray gun. In the event of a leak, the helium flows into the evacuated vacuum chamber, and is sucked in and detected by the leak detector. In order to realize short response times, the leak detector is used in large systems in partial flow to the existing vacuum system (see the leak detection diagram).

Ideal solution from Pfeiffer Vacuum

With the ASM 340, Pfeiffer Vacuum offers a powerful leak detector for universal use. The compact and portable ASM 310 is the first choice for mobile use, such as for service engineers.

Leak detector in partial flow to the existing vacuum system for locating leaks



Product overview

ASM 340	ASM 310
	
<ul style="list-style-type: none">■ Fastest response time thanks to high helium pumping speed■ Easy handling, intuitive menu navigation and large color touchscreen■ Fastest operational readiness in its class	<ul style="list-style-type: none">■ Dry pumping system, fore-vacuum pumping speed 1.7 m³/h■ Ultralight, only 21 kg and portable■ Smart design with retractable handle■ Removable control panel■ SD card for data storage

Pfeiffer Vacuum Service

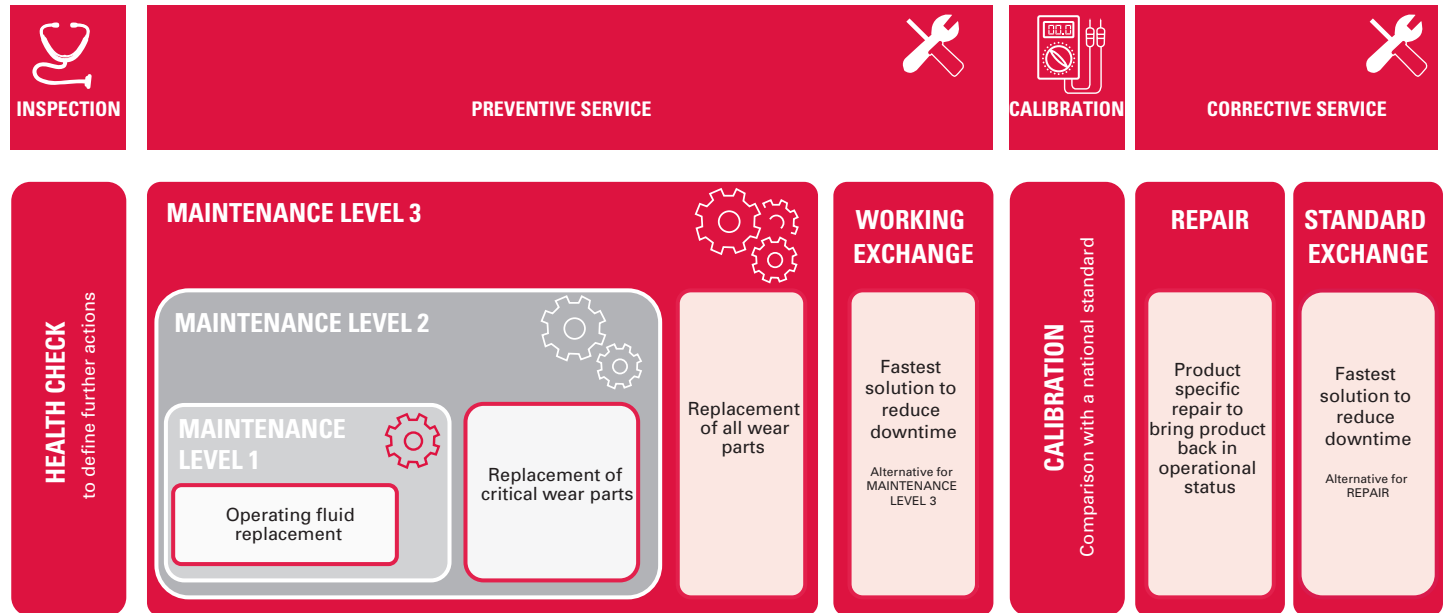
Our services – your advantages

Each customer places its own particular demands on its products, and these may also be influenced by application-specific parameters. Our flexible service concept, with a focus on preventive services, offers just the right solution for you.

Preventive maintenance – avoid downtimes

With our preventive service concept, we can recommend service intervals tailored to each product. The aim is to avoid failures and to carry out planned and predictable servicing.

Maintenance level 1 includes fluid changes and contributes significantly to the good working order of the product. **Maintenance level 2** also includes replacement of all wear and tear parts. In **maintenance level 3**, all wear and tear parts of the product are replaced and the product is overhauled. In order to keep downtimes to a minimum, we offer temporary replacements for many of our products for the duration of maintenance. We provide an equivalent **replacement product** that our customers can start using immediately.



Services at a glance

- User training and product training
- Pfeiffer Vacuum original spare parts and tools
- Troubleshooting and advice from our technical support team
- Comprehensive on-site service by our service technicians
- Maintenance and repair in our service centers worldwide
- Individual service agreements
- Replacement products
- Calibration service for measuring devices and helium test leaks

Spare parts – original parts increase life expectancy

Pfeiffer Vacuum's spare parts and tools are defined as early as at the product development stage. This ensures their tailor-made fit and quality.

Every improvement to our serial products is also transferred to our spare parts. This means products are brought up to state of the art status after undergoing maintenance level 3 or a repair.



Advice – to assist you with any questions you may have

In addition to our individual concepts and the quality of our replacement parts, it is our employees and personal contact that give our service its special touch.

Technical support – competent advice from the experts

Since not everything about our products is self-explanatory and questions can arise both before and after purchase, Pfeiffer Vacuum's Technical Support is available to assist our customers.

Each member of our team specializes in a specific area of our portfolio to enable them to assist our customers competently with technical questions relating to our products. Our team also works closely with our developers and application experts.

Field service technicians on site

From commissioning new vacuum components and systems to troubleshooting, and from maintenance to repairs, we offer our customers a comprehensive range of on-site services. Our service locations ensure customer proximity and short-term assistance in emergencies.

Service agreements – individually tailored to your project

We offer project-specific service agreements so that our customers can plan maintenance or service interventions over a long term. These agreements can be made at a later date or as early as during the project planning stage. In order to take our customers' differing needs into account, agreements may include all or just some of the services we offer.

Components and valves

The connection in your vacuum system



A vacuum system is made up of a variety of individual parts which are combined to form a single unit. Pfeiffer Vacuum also offers more than standard solutions. Components can be modified to meet your requirements or a customized solution can be produced to fit your needs perfectly.

- Your advantages and benefits**
- A direct contact for you and your projects
 - Proactive support and competent advice
 - Make ordering more convenient
 - Short delivery times
 - High delivery reliability
 - High security of supply
 - More than half a million parts in stock
 - High uptime
 - Cost saving - no own stock keeping necessary
 - Vacuum components available in online shop
 - Convenient online ordering at any time
 - Information about your prices, delivery times and terms

www.vacuum-shop.com



Components



Valves



Feedthroughs



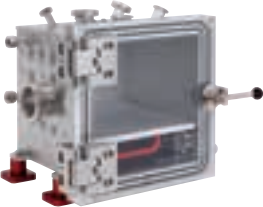



Manipulators

Custom vacuum chambers

Individually designed chambers for your vacuum applications

Due to our many years of experience we are familiar with almost all possible tasks and can provide professional guidance for system specifications, design and engineering.

Our physicists, designers, project managers and production specialists have extensive experience in many applications from all market segments. The tasks are based on your requirements: our starting point on the path to a finished product can range from a rough sketch to a complete set of blueprints.

High vacuum chambers	Advantages	Benefits
	■ Preconfigured design	■ Cost and time savings due to lower design expenses
	■ Proven, tough design	■ Reliable and safe
	■ Customized ports	■ Individual adaptation to your processes
Medium vacuum chambers	Advantages	Benefits
	■ Preconfigured design	■ Cost and time savings due to lower design expenses
	■ Proven, tough design	■ Reliable and safe
	■ Customized ports	■ Individual adaptation to your processes
Modular vacuum chambers	Advantages	Benefits
	■ Preconfigured design	■ Cost and time savings due to lower design expenses
	■ Modularly expandable	■ Maximum flexibility at all times
	■ Customized ports	■ Adaptable individually to your application
Custom vacuum chambers	Advantages	Benefits
	■ Individual design	■ Can be adapted optimally to your process
	■ High quality materials	■ Best quality and long life
	■ Robust design	■ Reliable and safe
	■ Project engineering and construction by qualified and experienced project managers	■ Time saving

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.

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

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