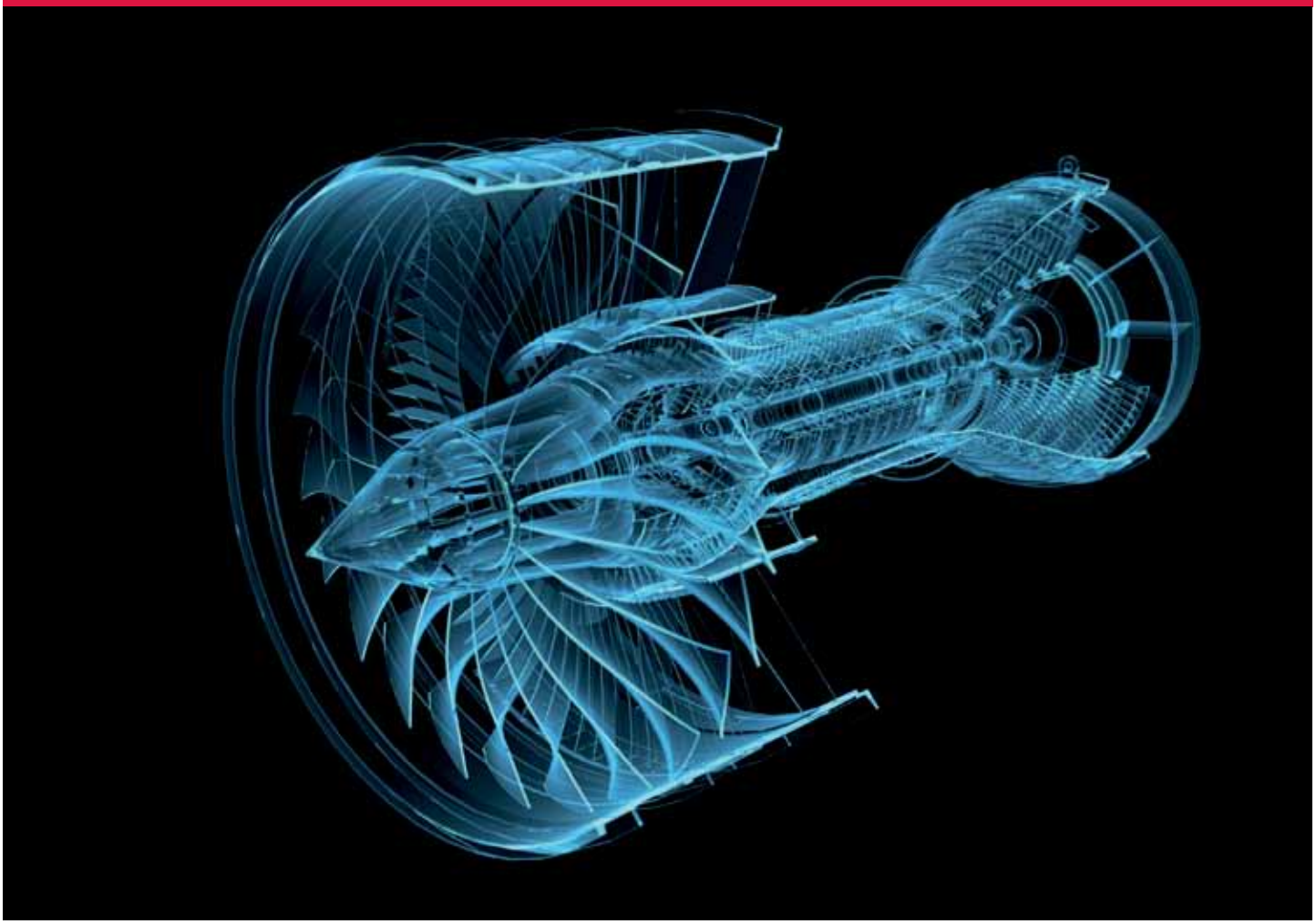
PFEIFFER VACUUM

Balancing with perfection

Vacuum systems for the evacuation of balancing systems



Balancing turbine rotors
A turbine is a fluid-flow machine. It converts the kinetic energy of a flowing fluid or gas into rotational energy and is used in the propulsion of aircraft, ships and power plants. Turbines have a rotor with regular, scoop-shaped blades, which can be arranged in multiple layers.

The rotors generally rotate at a very high speed and must therefore be optimally balanced to ensure that the rotation does not impose an additional load on the bearings. However, it is generally not possible to produce rotating bodies without small unbalances. These unbalances occur when the mass of a rotating body is not spread symmetrically during rotation.

An unbalance can lead to vibrations and resonance vibrations that cause an increased wear on the rotors and the bearings. In extreme cases, the unbalance of a rotor can destroy the entire system.

To prevent such damage, it is essential that the rotors are balanced. For this purpose, mass is attached or material is removed in specific areas to compensate for the unbalance. Various bearing pedestals are available that also allow balancing at a low speed. Testing the state of balance takes place at the operating speed, the strength test is even performed at excess rotation speed.

Figure 1: CombiLine pumping station with HenaLine

With bladed rotors, high ventilation output occurs at high speeds and is accompanied by performance and heat problems. High-speed balancing and centrifugal testing is therefore conducted under vacuum. The tests are carried out at 0.5 to 2 hPa. The entire area around the rotor is evacuated, including the high-pressure oil lubricated bearings.

Small air bubbles are trapped in the lubricant oil which expand rapidly in vacuum. If there is 1 ml of air in the oil before evacuation, for instance, it will expand to 1 l at 1 hPa. This process leads to the formation of oil foam. To prevent the oil from foaming, it must be degassed. This is done by continuous degassing using a separate vacuum unit.

Cost-effective alternative to special chambers
The process of balancing and centrifugal testing under vacuum can either be done in a special vacuum chamber made exclusively for the rotor or, alternatively, the entire centrifuge chamber can be evacuated. Since the first option requires a vacuum chamber with an appropriate size to match each rotor, this solution is only expedient for standardized rotor sizes.

If different rotors in a system are to be balanced and centrifuge-tested under vacuum, it is recommended that the entire accessible centrifuge chamber is evacuated.

The Pfeiffer Vacuum solution
Pfeiffer Vacuum has developed a complete system that is suitable for evacuating an entire centrifuge chamber.
This special vacuum system consists of up to three different parts:
1. A pump system for the main chamber
2. A pump system for the shaft feedthrough
3. Optionally, a pump system for oil degassing

The first subsystem serves for evacuating the area for balancing the turbines. Depending on the requirements, it consists of a varying number of units. Each unit is composed of a Roots pump, as well as a rotary vane pump as a backing pump.

The second subsystem is supposed to compensate the leakage rate of the drive shaft, which leads out of the evacuated area and therefore constitutes a leak. For example, two small rotary vane pumps can be used for this purpose.

Optionally, a vacuum unit for oil degassing can be fitted as a third subsystem. This vacuum unit consists of a small Roots pump and a supporting rotary vane pump. The oil flows in a closed circuit through the bearings and into a container, where it is then degassed. This ensures the optimal lubrication of the bearings.

Advantages of this system:
- Low energy costs and compact system size, thanks to the integrated rotary vane pumps that compensate the leakage rate almost completely
- Small number of pumps
- Low maintenance costs

The characteristics of the integrated pumps are perfectly suited for the use in systems for balancing turbines.

Achieving the goal with competent partners and the right products
With its broad product portfolio, Pfeiffer Vacuum offers tailor-made solutions of highest quality for balancing rotors. Over 40 years of expertise in cooperating with clients of the industry sector and designing vacuum systems for balancing chambers up to 2000 m^3 makes Pfeiffer Vacuum a competent partner. The range of services we offer includes designing new systems as well as refurbishing existing vacuum systems.

The individual system components at a glance

The rotary vane pump
Rotary vane pumps transport gas through the rotation of the rotor and the radially turned vanes from the inlet to the outlet valve. Since the rotor is eccentrically installed, the inlet and outlet areas are always separated from each other.
If the rotor revolves, gas flows through the inlet valve into the working chamber until it is closed again by the second vane. The gas is then compressed until the pressure opens the outlet valve.

Inside the pump, there is oil. It seals the narrow gap between the two valves, the outer wall and the vanes, and also the outlet valve. Due to the heat transfer, it provides an optimal temperature. Rotary vane pumps can be used for low and medium vacuum applications, and are often used as backing pumps for turbopumps and Roots pumps.

Advantages of Pfeiffer Vacuum rotary vane pumps:
- Complete range with pumping speeds of up to 1600 m^3/h
- Integrated oil mist separator for clean exhaust air
- Low ultimate pressure (up to 0.1 hPa)
- Compact, reliable and powerful
- Easy to service
- Operating and process reliability
- Quiet, low-vibration operation

Roots pumps
Roots pumps convey gas through two counter-rotating rotors, which neither touch each other nor the exterior walls. They have no internal compression and no outlet valve. An overflow valve prevents overheating due to the pressure differential between the inlet and outlet valve. Therefore, they cannot discharge against atmosphere and require a backing pump.

Due to the different pumping speeds and versions, they can be perfectly tailored to customer-specific requirements. The pumping speeds range from 250 to 25000 m^3/h in low and medium vacuum. The vertical direction of flow renders this pump largely insensitive to dusts and liquids.

Advantages of Pfeiffer Vacuum Roots pumps:
- Short pump-down times due to the high compression ratio
- Protection against thermal overload
- Components available according to RC 94/9 EC (ATEX)
- Maintenance-free, robust
- Low operating costs due to air cooling and magnetic coupling
- Reliable, low pressure

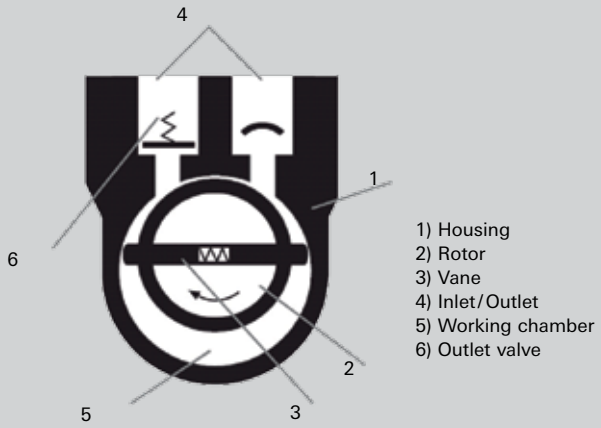


Figure 2: Operating principle of the rotary vane pump

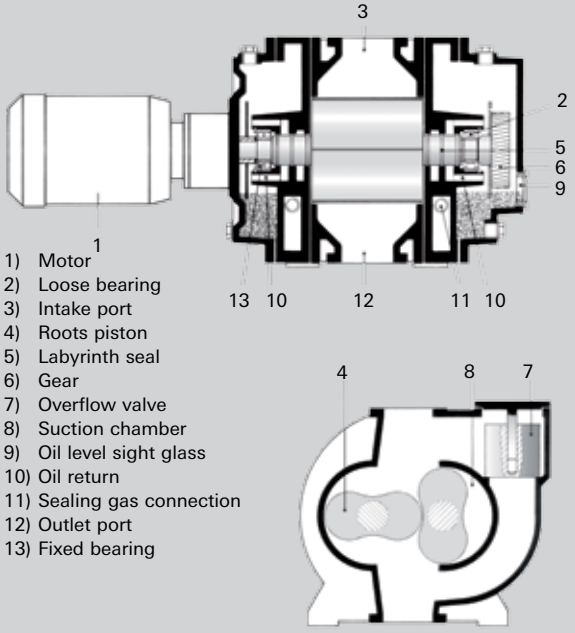


Figure 3: Operating principle of Roots pumps

PFEIFFER VACUUM

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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