



## GUIDELINE FOR THE SELECTION OF VACUUM PUMPS

Extraction and processing of raw materials, solar energy, freeze and transformer drying, medical technology, plasma treatment, the production of batteries, technical gases - the demand for and use of vacuum technology in a variety of applications is almost endless. This variety of applications naturally poses different and often very specific requirements for the required vacuum equipment.

With over 20,000 products, Pfeiffer Vacuum offers a comprehensive portfolio with components that can be combined individually with each other and can be specifically adapted to the needs of each application. The individual conditions of use must be taken into account in order to configure the optimum pump combination.

With 125 years of experience in developing and commissioning vacuum solutions, the experts from Pfeiffer Vacuum have extensive expertise in the design and conception of customized vacuum systems. In addition to the consultation and service provided by the company, this guide provides a field-proven selection and decision-making tool for the design of an appropriate vacuum solution.

For many applications, not only vacuum pumps and systems are required, but often other accessories as well to guarantee that the pumps work properly and the equipment attains its maximum service life. A reduction in operating costs can also be achieved by using the appropriate pump accessories.

In applications such as where large quantities of water need to be pumped out, it is very important that rotary vane pumps are run at a warm operating temperature. In addition, the gas ballast valve must be open. This can prevent condensation such as it occurs during drying processes due to vapors that have not been pumped off. Insufficient lubrication of the pump due to diluted operating fluid is avoided this way.

When designing a system with diffusion pumps it must be noted that the angle valve and the water baffle reduce the pumping speed of a diffusion pump by about 40%. These components are essential for preventing the return flow of oil in the pump.

The fore-vacuum pressure or the transfer pressure of the backing pumps must be strictly maintained in order to prevent overheating of the diffusion pump and the combustion of its propellant. Otherwise it may cause failure and require a considerable cleaning effort.

Dust-loaded applications such as in metallurgy require a dust filter. It is inserted between the process chamber and the vacuum pump. It protects the rotors, bearings and mechanical seals. This way the pumps withstand the requirements of processes such as sintering, nitriding, hardening, electron beam welding and the coating of architectural glass and PVD or CVD processes.

If diffusion pumps with a nominally sized intake port of up to 630 mm are used, it is technically and economically beneficial to replace them with two turbopumps.

Compared to a diffusion pump, the acquisition of turbopumps is more expensive, but they stand out with their low energy and water consumption which means that costs are five times lower over an operating period of five years. In addition, turbopumps have a high critical backing pressure of 1-2 hPa. This means that by using turbopumps, the backing pump system can be designed ten times smaller. This allows significant cost savings to be achieved. Turbopumps are dry high vacuum pumps without a propellant. Thanks to these properties, contamination of the vacuum chamber and the process is avoided.

The total costs, including the acquisition of the vacuum pumps, are five times lower with turbopumps over a service life of five years compared to diffusion pumps.

Some load lock applications require very short lock evacuating times. This must be considered when designing the vacuum system. We recommend a gradation between the Roots and backing pump in the range of 2:1 up to a maximum of 3:1, for example, 1,000 m<sup>3</sup>/h pumping speed of the Roots pump and 300 m<sup>3</sup>/h or 500 m<sup>3</sup>/h pumping speed of the backing pump. In addition, it must be ensured that the gear chambers of the Roots pump are always under vacuum. Pfeiffer Vacuum offers the necessary accessories in its product portfolio.

The examples of the following overview show the requirements the vacuum equipment must fulfill for selected, specific applications. These criteria and characteristics of the various types of pumps can be used to select suitable pumps for the specific application. In addition, conclusions can be drawn regarding the process safety and reliability.



The efficient and energy-saving HiPace turbopumps by Pfeiffer Vacuum enable significant cost savings for many processes.



With its broad portfolio of over 20,000 products, Pfeiffer Vacuum offers the right solution for every application.

Process	Application	Pump criteria
<b>Metallurgy</b>	Annealing, brazing, sintering, casting, hardening, nitriding	Heavy dust, wax, NH <sub>3</sub> (nitriding), flux
	Electron beam welding	Metal dust, humidity, X-rays on e-gun
<b>Freeze drying</b>	Laboratory, pharmaceutical, food	H <sub>2</sub> O, solvents
	Pharmaceutical	H <sub>2</sub> O
	Food	H <sub>2</sub> O, acids, tanning agents
<b>Transformer drying</b>	Coil drying, evacuation during oil filling	H <sub>2</sub> O, tannic acid, wax, polymers
	Oil degassing	H <sub>2</sub> O
<b>Leak detection</b>	Automotive components, packaging, barrels, vacuum systems	H <sub>2</sub> O on the chamber wall at batch changes, damp plastics
<b>Medical therapy accelerators</b>	Production of UHV in beamlines and synchrotron/rotodrone	Gamma and neutron rays good H <sub>2</sub> pumping speed
<b>Plasma treatment</b>	Sterilization	Strong oxidation through H <sub>2</sub> O <sub>2</sub> , ozone
	Cleaning	Ozone, ammonia
<b>Filling systems under vacuum</b>	Automotive components such as brakes, AC, servo, refrigeration compressors	Aggressive brake fluid, refrigerants (Atex)
<b>Batteries production</b>	Drying, filling, leak detection	Corrosive electrolytes, salts
<b>Technical gases</b>	Gas cylinder evacuation, characterization/purity, filling	Corrosion, prevention of contamination
<b>Coating</b>	Glass	Dusts, glass breakage
	Load locks	Mechanical stress
	Ophthalmics	Dust
	Load locks	Mechanical stress
	Wear protection	Dust
	Load locks	Mechanical stress
<b>Solar</b>	PVD	Dust
	CVD	Dust, sublimation

**Vacuum pumps used**

Low/medium vacuum			High vacuum		
Pump types	Pumping speed	Vacuum	Pump types	Pumping speed	Vacuum
Rotary vane pumps or dry pumps/ Roots combinations	500 – 8,000 m <sup>3</sup> /h	1 – 10 <sup>-3</sup> hPa	Turbopumps Diffusion pumps	700 – 3,000 l/s 5,000 – 100,000 m <sup>3</sup> /h	10 <sup>-3</sup> – 10 <sup>-8</sup> hPa 10 <sup>-4</sup> – 10 <sup>-7</sup> hPa
Rotary vane pumps or dry pumps/ Roots combinations	500 – 8,000 m <sup>3</sup> /h	10 <sup>-2</sup> – 10 <sup>-4</sup> hPa	Turbopumps Diffusion pumps Polycold	300 – 1,000 l/s 13,000 – 20,000 l/s up to 200,000 l/s for H <sub>2</sub> O	up to 10 <sup>-7</sup> hPa up to 10 <sup>-7</sup> hPa
Two-stage rotary vane pumps	2 – 20 m <sup>3</sup> /h 1,000 – 2,000 m <sup>3</sup> /h	< 10 <sup>-2</sup> hPa			
Two-stage Roots/ dry pump combinations	1,000 – 2,000 m <sup>3</sup> /h	< 10 <sup>-3</sup> hPa			
Multi-stage Root/rotary vane/dry pump combinations	500 – 4,000 m <sup>3</sup> /h	< 10 <sup>-2</sup> hPa			
Multi-stage Roots/rotary vane/ dry pump combinations	1,000 – 12,000 m <sup>3</sup> /h	< 10 <sup>-2</sup> hPa			
Two-stage rotary vane pumps, multi-stage Roots/ rotary vane combinations	150 – 250 m <sup>3</sup> /h 500 – 2,000 m <sup>3</sup> /h	< 10 <sup>-2</sup> hPa			
Two-stage rotary vane pumps, multi-stage Roots/ rotary vane combinations	5 – 65 m <sup>3</sup> /h 1,000 – 2,000 m <sup>3</sup> /h helium leak detector	10 <sup>-2</sup> – 10 <sup>-3</sup> hPa	Turbopumps	70 – 700 l/s	< 10 <sup>-6</sup> hPa
Diaphragm pumps, single-stage rotary vane pumps, ion getter pumps	2 – 4 m <sup>3</sup> /h < 100 m <sup>3</sup> /h	2 – 3 hPa < 1 hPa	Turbopumps Ion getter pumps	70 – 700 l/s 300 l/s	< 10 <sup>-6</sup> – 10 <sup>-8</sup> hPa < 10 <sup>-9</sup> hPa
Two-stage rotary vane pumps	5 – 20 m <sup>3</sup> /h	< 10 <sup>-2</sup> hPa			
Dry pumps	25 – 40 m <sup>3</sup> /h	< 10 <sup>-1</sup> hPa			
Single and two-stage rotary vane pumps as a special version	10 – 65 m <sup>3</sup> /h	< 10 <sup>-2</sup> hPa			
Single-stage rotary vane pumps, two-stage rotary vane pumps, dry pumps, helium leak detectors	200 – 600 m <sup>3</sup> /h 10 – 250 m <sup>3</sup> /h 25 – 600 m <sup>3</sup> /h	0,1 – 10 <sup>-2</sup> hPa			
Rotary vane pumps, Roots pumps, dry pumps, mass spectrometers, helium leak detectors	20 – 65 m <sup>3</sup> /h 250 – 1,000 m <sup>3</sup> /h 15 – 40 m <sup>3</sup> /h 1-300 amu	10 <sup>-2</sup> – 10 <sup>-3</sup> hPa			
Single-stage rotary vane/ Roots combinations	600 – 2,000 m <sup>3</sup> /h	< 10 <sup>-3</sup> hPa	Turbopumps	2,000 l/s	10 <sup>-3</sup> – 10 <sup>-4</sup> hPa
Single-stage rotary vane pumps, dry pumps	500 – 600 m <sup>3</sup> /h	> 5 hPa			
Single-stage rotary vane/ Roots combinations	650 – 2,000 m <sup>3</sup> /h	< 5 · 10 <sup>-2</sup> hPa	Diffusion pumps Turbopumps	13,000 – 20,000 l/s 1,500 – 2,000 l/s	10 <sup>-3</sup> – 10 <sup>-5</sup> hPa
Single-stage rotary vane/ Roots combinations	500 – 600 m <sup>3</sup> /h	< 5 · 10 <sup>-2</sup> hPa			
Two-stage rotary vane/ Roots combinations	600 – 1,000 m <sup>3</sup> /h	< 1 – 5 hPa	Turbopumps	1,500 – 2,000 l/s	10 <sup>-3</sup> – 10 <sup>-6</sup> hPa
Single-stage rotary vane/ Roots combinations	500 – 600 m <sup>3</sup> /h	< 5 · 10 <sup>-2</sup> hPa			
Dry pump/Roots combinations	600 – 2,000 m <sup>3</sup> /h	10 <sup>-3</sup> – 10 <sup>-5</sup> hPa	Turbopumps	1,200 – 2,000 l/s	10 <sup>-3</sup> – 10 <sup>-5</sup> hPa
Dry pump/Roots combinations	600 – 4,000 m <sup>3</sup> /h	< 200 hPa			



Pfeiffer Vacuum offers extensive vacuum solutions for multiple requirements.

## **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:

**Pfeiffer Vacuum GmbH**  
Headquarters · Germany  
T +49 6441 802-0

[www.pfeiffer-vacuum.com](http://www.pfeiffer-vacuum.com)

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