TIPS AND TRICK FROM THE EXPERTS

The most common errors when using Roots pumps and how to avoid them

The ideal vacuum solution at the best price is very often the main decision criterion. But this fact poses the danger that a less optimal pump solution is selected for cost reasons – a decision which could eventually cause less uptime and higher maintenance cost. Selecting reliable vacuum pumps and the corresponding accessories as well as sensible monitoring and operating modes will pay off in the long run.

When selecting and operating a Roots pump, it is not rare that considerable errors are made. They can easily be avoided by considering the specific parameters valid for the individual pump type. In the following, a summary of the most important information and insights for the operation, equipment selection, and maintenance of commonly used Roots pumps is presented.

Roots pumps – compact design, high pumping speed

The Roots pump operates on a purely volumetric level and, in comparison to the rotary vane pump, does not have internal compression. It compresses against exhaust pressure. All parts in contact with the media are oil-free.

This is why a Roots pump is also called “dry-running pump”. The main characteristics are its compact design and high pumping speed. It is called a Roots pump after its inventors, the brothers “Roots”.

Figure 1 and 2: Roots pump seized by switching to ultimate pressure and the resulting local overheating

Operating at ultimate pressure

It is not recommended to bring a Roots pump that runs on maximum differential pressure directly to ultimate pressure without allowing it to cool down first. At ultimate pressure, the minimal or zero gas throughput does not dissipate any heat through the gas or through the casing surface because of the fast speed. Due to the sudden rise in temperature, the air gap between the rotor and casing is too small and the pump will seize. In extreme cases, this leads to a total failure.

Improper temperature fluctuations

Suddenly occurring, strong reductions of the ambient temperature result in contraction of the pump housing while the Roots pistons are still hot. This causes seizing of the pump. As seen in Figure 1, this is especially critical during operation at ultimate pressure. Temperature shocks like this must be avoided at all costs. In addition, the operator must take care that no rolling shutters or other doors in the vicinity are opened suddenly, especially in winter, and that free-standing pumps are protected from the rain with a roof or canopy.
If, in case of fire, water is directly aimed at the pump, the housing could explode, especially the pump housing made of grey cast iron. The pump version in nodular cast iron is better suited to withstand such thermal fluctuations due to the higher strength of its material.

Temperature control

If Roots pumps are operated around their maximum differential pressure, a temperature sensor must be attached to the exhaust in order to protect the pump against overheating and any resulting damage. This will generate a warning at a defined temperature and will turn the pump off when it reaches the maximum permitted gas temperature.

Rapid evacuation

In applications where cycle times of just a few seconds must be achieved, the operator has to make sure that the ratio of the Roots pump to the backing pump is at 1 : 2. This is necessary as most of the pump down time is required by the backing pump to evacuate the atmosphere to about 100 hPa. The Roots pump will only operate effectively beginning at 10 hPa. For this reason, the backing pump has to be correspondingly generous in size.

Switching the pump on

Sudden fluid inrush can destroy the pump because it leads to abrupt cooling. This deprives the gas of the heat needed to evaporate the liquid. The additional quantity of vapor cannot be pumped away quickly enough as the backing pump is overloaded and the fore pressure may rise to excessive levels. To prevent this, it is useful to install a receiver between the process chamber and the Roots pump so the liquid is absorbed before reaching the pump.

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Dust accumulation

During processes that generate particles and are laden with dust – such as in metallurgy and crystal pulling – it would be useful to install dust filters on the intake side of the pump to protect the Roots pump as well as the downstream pumps. So-called splinter protection should be installed in the Roots pump's intake ports. They serve as a protection against larger solids and beads of welding that could be emitted from the welded joints due to inadequate cleaning during the first use of a system. In this case, it is recommended to use the pump manufacturer's accessories because the splinter protection is designed so that its free cross-section corresponds to the nominal diameter of the pump. This ensures that the pumping speed is not compromised due to undesired amounts of conductance losses.

Pumping off critical gases

When pumping costly, pure gases such as Helium 3 or Helium 4, an exchange with the ambient air during the process has to be avoided at all costs. A high level of tightness with a low leak rate in the area of less than 10^{-5} to 10^{-8} hPa l/s is required for the pump. Pfeiffer Vacuum offers a permanent magnetic coupling instead of the usual shaft feedthrough to the motor. This turns leaks in the shaft sealing rings into a thing of the past.

It is also possible to use a canned motor. However, the operator must rely on the pump manufacturer when servicing as the canned motor is especially developed for the pump. In case of magnetic coupling, cost-efficient standard motors can be used. Pfeiffer Vacuum offers magnetic couplings for two-stage rotary vane pumps up to 250 m^3/h and Roots pumps up to 12,000 m^3/h.

We would be happy to assist you in optimizing your vacuum solutions for specific applications – go ahead and ask us: http://www.pfeiffer-vacuum.com/contact

Figure 3: Magnetic coupling with can chamber (Pfeiffer Vacuum)

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