

Vacuum sources for rotary evaporators

Buyer's Guide



Vacuum sources for rotary evaporators

A rotary evaporator offers a multitude of advantages, which make this technology the most important tool within solvent evaporation on a laboratory and pilot scale. Gentle and efficient evaporation, which is caused, among other things, by the uniform distribution of the substance mixture on the inner wall of the evaporator flask, can take place with a low supply of heat thanks to a vacuum. It is the main argument that speaks in favor of this proven technology.

This document is intended to help identify the correct vacuum source for the desired application.

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① What is the task of vacuum in the evaporation process?

Vacuum is the most important parameter in the evaporation process. While rotation and heating bath often remain constant, the vacuum is the parameter used to achieve the desired boiling point. Compared to temperature, the vacuum can be changed flexibly and quickly and does not have a negative effect on thermolabile substances. Despite this extremely important role in the evaporation process, the vacuum pump is often only viewed as an incidental

accessory to which little attention is paid, although the pump can also be essential for some applications. For example, when evaporating high-boiling solvents such as DMSO. If an incorrect pump with too low power is selected for this purpose, evaporation becomes difficult or impossible.

② What technologies are there?

In terms of different technologies, not only performance, but also electricity consumption, control accuracy and other factors such as noise level and maintenance intensity play a role.

The most common technologies include:

A house vacuum connection

is often found at universities and large research centers. A correspondingly generously dimensioned vacuum pump is used as a central source for vacuum supply in an entire working group, floor or even building complex. The rotary evaporator is connected to this usually non-regulated vacuum source via the connections on the glassware. The vacuum control usually takes place via a valve controlled by the rotary evaporator or a separate controller.

An non-regulated vacuum pump

is a commonly used alternative that can typically be used for one to three rotary evaporators. These usually cheap vacuum pumps run according to the maximum performance required by the customer. They also generate an initially uncontrolled vacuum, which then, analogous to the house vacuum, regulates the negative pressure inside the glassware of the rotary evaporator via an interposed vacuum valve.

A speed-controlled vacuum pump

is fundamentally different from the other two alternatives. The basic principle of this pump is to flexibly adjust the speed to the signal of the rotary evaporator or the control unit of the pump and operate on demand. Due to the very precise and dynamic regulation of the speed,

these pumps can be brought very accurately to a desired boiling point. For example, if a set value of 160 mbar is set, the pump will slowly reduce the speed at 200 mbar to achieve precise regulation. As soon as the pump has reached the setpoint, it goes into a kind of pause mode and only becomes active again as soon as the leak in the overall system leads to the setpoint or a set hysteresis being exceeded. In this case, the pump is briefly awakened from standby mode and the speed is usually only increased for one to two seconds in order to bring the system vacuum back to the setpoint.

3 A consideration of the factors: Process behavior, operation, sustainability, and costs for the present technologies

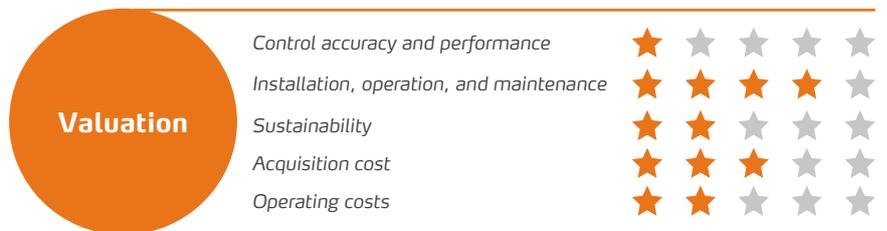
A house vacuum connection

has an advantage for the user, for example, in the maintenance of the pump. This is often a task of central technology and is limited to a large system. However, various consumers are also dependent on the functionality of the vacuum source. In the possible scenario of a defect, there can be high efficiency losses in the daily workflow up to standstill and thus delays in research.

The advantages are that the central supply is usually a very space-saving variant in the laboratory itself and the noise level is hardly increased by the decentralized pump. In addition, the total electricity consumption at a well-calculated capacity utilisation is lower than that of several non-regulated pumps, but is still significantly higher than that of demand-oriented speed-controlled systems.

A major disadvantage of a central supply are power fluctuations in the system, which can occur due to a large number of consumers or have a negative impact on the suction power and achievable ultimate vacuum. The latter is usually lower than with a solution with one vacuum pump per evaporator. The process accuracy also suffers from the fact that a valve switch is necessary in order to regulate the fixed vacuum value of the house vacuum to the desired setpoint by venting.

In summary, a house vacuum is not optimal and inaccurate for the process of evaporation, while it offers highlights and lowlights in terms of operation, costs and sustainability and performs overall on average.

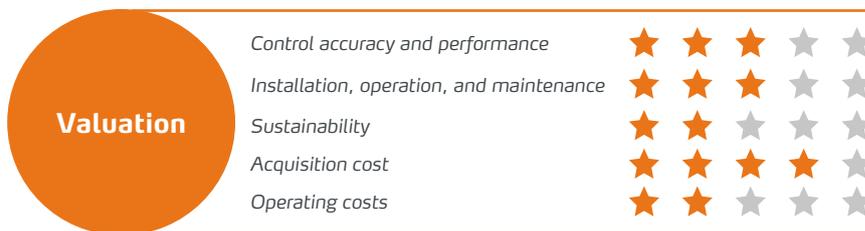


An non-regulated vacuum pump

is usually a single pump that can be used for various applications that require a vacuum. On the process side, these pumps, with their sophisticated technology, offer a reliable vacuum supply for the rotary evaporator, but are subject to the same limitations as the house vacuum. Here, too, the desired vacuum value is balanced out via a vacuum valve, which allows the compensation of the pump's fixed vacuum value and the ambient pressure.

This method of operation leads to an average precise vacuum control and a certain hysteresis in the evaporation process. Sustainability and the resulting permanent costs are probably the biggest weak point of this technology. The fact that the pumps work continuously at full power – even if the target vacuum in the rotary evaporator has already been reached – leads to increased power consumption, which would be unnecessary with an increasing tightness of the rotary evaporator.

In addition, it should be taken into account that maintenance intervals and the replacement of wear parts largely depend on the actual operating performance of the pump and are therefore more frequent here. Such a pump is usually the best alternative if you are looking for a flexible system that is used sporadically rather than frequently.



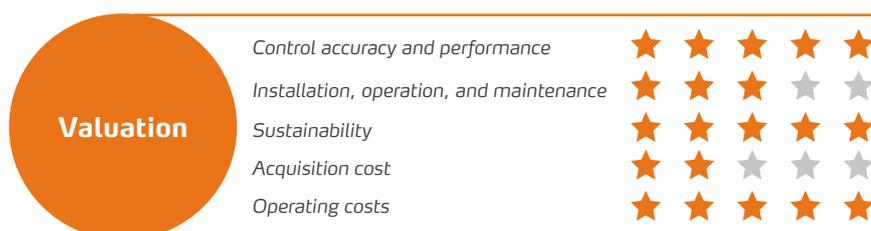
A speed-controlled vacuum pump

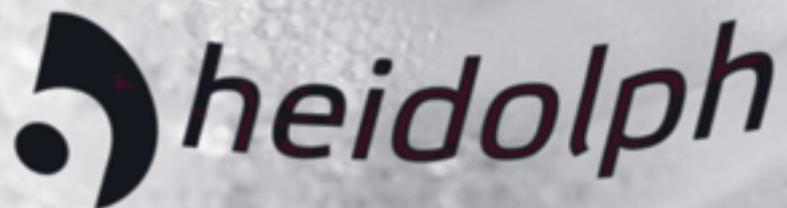
is the most technically sophisticated solution for rotary evaporation. The advantage here lies in the gentle regulation of the vacuum and the almost precise, overshoot and hysteresis-free control to a set vacuum. Due to the fact that the target vacuum value keeps the set value very precisely and with only gentle readjustment, this system impresses with the most precise vacuum control as well as significantly lower or almost no hysteresis during the evaporation process, which in turn minimizes the danger of delays in boiling, foaming media and enables purer material separation. A high-quality pump also has the option to deliberately reduce the pump performance. As a result, a system can be evacuated more slowly and gently, which in turn has advantages in terms of preventing foam and boiling pressure.

Another advantage: Automatic evaporation programs such as Heidolph's AUTO_{accurate} can reach their full potential and identify boiling points more reliably thanks to the extremely precise vacuum supply. In addition, the fact that the pump operates actively only when required reduces the energy requirement to up to 90%, especially in combination with low-leakage, sealed rotary evaporators.

Similar positive effects are achieved with regard to maintenance intervals and the need for wearing parts. The only negative point is the comparatively high price of the pump and the limitation that the systems can usually only be used for a rotary evaporator.

Although these pumps do not require a vacuum valve, which also usually costs several hundred euros and the annual savings in terms of electricity costs and wearing parts extend to up to 100 EUR, this system is an expensive solution due to the high purchase price, but which pays for itself over several years. In addition, it should be taken into account that these advantages do not fully develop until the rotary evaporator is operated regularly.





Any questions?

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