Premium Laboratory Equipment

Cooling options for rotary evaporators

Buyer's Guide

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Cooling options for rotary evaporators

Choosing the right cooling method suitable for the evaporation process has a greater impact on the performance, economy and handling of the entire system than you initially believe. When purchasing a new rotary evaporator system or process changeover, the choice of the cooling system is one of the key decisions that not only determines the subsequent throughput but also the work processes in the laboratory. Economic factors such as payback period and running costs, as well as sustainability should also be considered and taken into account when deciding for or against a variant for cooling.

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① What is the role of cooling in the evaporation process?

The structure of a classic rotary evaporator can be roughly divided into two areas: The heating area in which the steam is generated by heat input, vacuum and rotation, and the cooling area, in which the steam is condensed back into a liquid and captured (Fig. 1).

For a high-performance process, it is therefore important that the two areas are balanced: If more steam is generated than can be condensed, solvent is lost and the vacuum pump or the environment is contaminated. If the cooling is oversized, the existing cooling surface is not used and the process runs too slowly - or not at all in the case of high-boiling media.

Choosing the right cooling system is therefore essential for a stable, safe and high-performance evaporation process.

Fig. 1: Evaporation process on rotary evaporator

2 What cooling options are available for rotary evaporators and what are their advantages and disadvantages?

If you consider the options for cooling in rotary evaporators, there are three main variants:

2.1 Glass condenser with dry ice cooling

2.2 Class condenser with cooling coils with water cooling

2.3 Glass condenser with cooling coils, combined with a recirculating chiller

Since all variants have their advantages and disadvantages, they are considered individually in terms of safety, handling, sustainability and costs.

2.1 Glass condenser with dry ice cooling

Fig. 2: Ice crystals from humidity form in the dry ice chiller between applications

Installation, operation, and maintenance:

The installation of a glass condenser with dry ice cooling is very easy: It is screwed onto the rotary evaporator, connected to the vacuum source and is then ready to be filled. You have to be patient here because the solvent tends to splash when dry ice is added, especially at the beginning of the filling process.
Once you have finished filling the glass condenser, it is ready for use. You can work quite inflexibly with only one initial cooling temperature, -78 ° C. This is advantageous when working with extremely low-boiling solvents such as diethyl ether or pentane. When evaporating higher-boiling media such as water or even DSMO, the dry ice chiller reaches its limits: Either the cooling medium is consumed extremely quickly and needs to be constantly refilled, or the low boiling substance does not even reach the receiving flask, because it already condenses before. If the system with the dry ice chiller is left open for a longer period of time, air humidity is deposited in the form of ice crystals on the glass condenser (Fig. 2), which can lead to undesired contamination of the distillate with water. In terms of handling, the dry ice chiller therefore only scores satisfactorily.

Safety aspects:

When looking at the safety of dry ice chillers, one thing that is noticeable is the risk originating from the cooling mixture. The mixture, usually consisting of dry ice and isopropanol or acetone, has a temperature of –78°C. Appropriate protective equipment is necessary when handling the medium to prevent burns. Due to the large temperature difference in the system, the glass condenser must first of all be supplied with caution with dry ice pellets during the process, as the vibration in the vacuum glass can otherwise lead to cracks. If a dry ice chiller is operated unattended or with unsuitable solvents, the solvent may even evaporate from the glass condenser.

Sustainability and costs:

Compared to condenser with cooling coils, the purchase of a dry ice chiller is slightly more expensive, but it is still cheaper compared to a system with an external recirculating chiller In terms of sustainability and costs, the consumption of dry ice and solvents is particularly important for glass condenser. The solvent used for cooling is often disposed of at the end of the working day. These costs can quickly add up with frequent use of the rotary evaporator. Due to the constant consumption of both components for cooling, the dry ice chiller does not perform optimally in terms of sustainability.

In terms of sustainability and costs, the dry ice chiller cannot convince despite the comparatively low acquisition costs.

Valuation

Safety	★☆☆☆☆
Installation, operation, and maintenance	★★★☆☆
Sustainability	★★☆☆☆
Acquisition cost	★★★★☆
Operating costs	★★☆☆☆

2.2 Glass condenser with water-cooled cooling coils

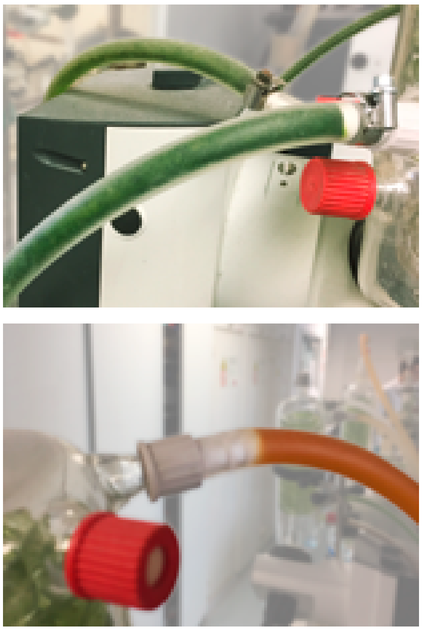

Fig. 3: Algae formation in the cooling coils and cooling water hoses

Installation, operation, and maintenance:

Compared to the glass condenser with dry ice, the installation of the water-cooled condenser requires more effort: In addition to fixing it to the rotary evaporator and connecting it to the vacuum source, the inlet and outlet of the coolant must be connected to hoses As a result, the structure also takes up a little more space and requires a water connection in the immediate vicinity. However, commissioning is easy: The cooling water is turned on and the rotary evaporator is ready for use immediately. Since it cannot be temperature-regulated, however, there is little room for manoeuvre to adapt it to the process.

Evaporating high-boiling media such as DMSO can be a challenge. In terms off maintenance, the main issue of algae formation in glass condensers and hoses is a frequent nuisance: Once they get into the circuit, they get stuck in the cooling coils and on the inner walls of the hose and are very difficult to remove again. (Fig. 3)

Overall, the water-cooled glass condenser performs well in terms of installation, operation and maintenance.

Safety aspects:

In terms of safety, the glass condenser with cooling coils requires less attention than one with dry ice cooling. For unrestricted continuous operation, however, a water monitor should be installed which, in the event of a hose jumping off or bursting, stops the water supply in order to prevent the water being supplied from running unnoticed. The hoses often jump off when the water from the pipe hits the hose nozzle with too much pressure because the tap has been turned on too far.

This case is particularly critical when the rotary evaporator is connected directly to the water pipe or a central cooling circuit with a large volume and, in the worst case, the water continues to run overnight.

Glass breakage due to excessive temperature differences is not to be expected here, as the cooling water usually has a temperature between 15 and 20°C.

Sustainability and costs:

Glass condensers with cooling coils are available in many variants. However, as a rule, their price is lower than that of a dry ice chiller. The largest cost point when using water as a cooling medium is when the glass condenser is connected directly to the water pipe because there is no cooling circuit. The water consumption of standard condensers is about 8 l/min. Over a working day, the amount of water consumed thus adds up to 3,840 liters.

This is not only a cost factor that should not be underestimated, but also extremely questionable with regard to the sustainability of this solution.

Valuation

Safety	★★★☆☆
Installation, operation, and maintenance	★★★★☆
Sustainability	★☆☆☆☆
Acquisition cost	★★★★★
Operating costs	★☆☆☆☆

2.3 Glass condenser with cooling coils, combined with a recirculating chiller

Fig. 4: Rotary evaporator system with recirculating chiller

Installation, operation, and maintenance:

The installation of the glass condenser with a recirculating chiller does not differ significantly from the water-cooled variant. Instead of connecting the inlet and outlet hose to a water pipe, the hoses are installed here on the recirculating chiller, which is then filled with the coolant. Substances that prevent the growth of algae are often added to these coolant. A huge advantage of using a recirculating chiller is the ability to regulate the cooling temperature. If a particularly wide range of high and low boilers is processed, the temperature can be adjusted as required in order to ensure optimum utilization of the glass condenser and thus the best possible performance at all times. Some systems even allow the central control system of the recirculating chiller via an interface to the rotary evaporator. This makes working especially convenient. A small disadvantage is the lead time required by the chiller to cool down to the desired cooling temperature. The evaporation process should only be started when the required temperature is reached.

Overall, this solution is a good alternative in terms of installation, operation and maintenance.

Safety aspects:

In terms of safety, the glass condenser system with cooling coils in combination with a recirculating chiller can be assessed similarly to the water-cooled system. However, this has the advantage that in the event of a hose jumping off or bursting, a finite, smaller volume of liquid leaks. In addition, with recirculating chillers there is also the option of determining the delivery pressure. This reduces the risk of a hose jumping off due to excessive pressure of the cooling medium.

Sustainability and costs:

Of course, the acquisition of a system with a recirculating chiller is significantly more expensive than that of the other two variants. However, the running costs are comparatively low. Since the cooling medium is in a closed circuit, it can be used for a long time before it has to be replaced. The electricity costs for operation are usually well below the operating costs of the other two systems, so that the purchase will soon be amortized.

For example, when a powerful 1200 watt recirculating chiller is combined with three rotary evaporators and a high capacity, amortization can be achieved within 4 months.

Valuation

Safety	★★★★☆
Installation, operation, and maintenance	★★★☆☆
Sustainability	★★★★☆
Acquisition cost	★★☆☆☆
Operating costs	★★★★★

Any questions?
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