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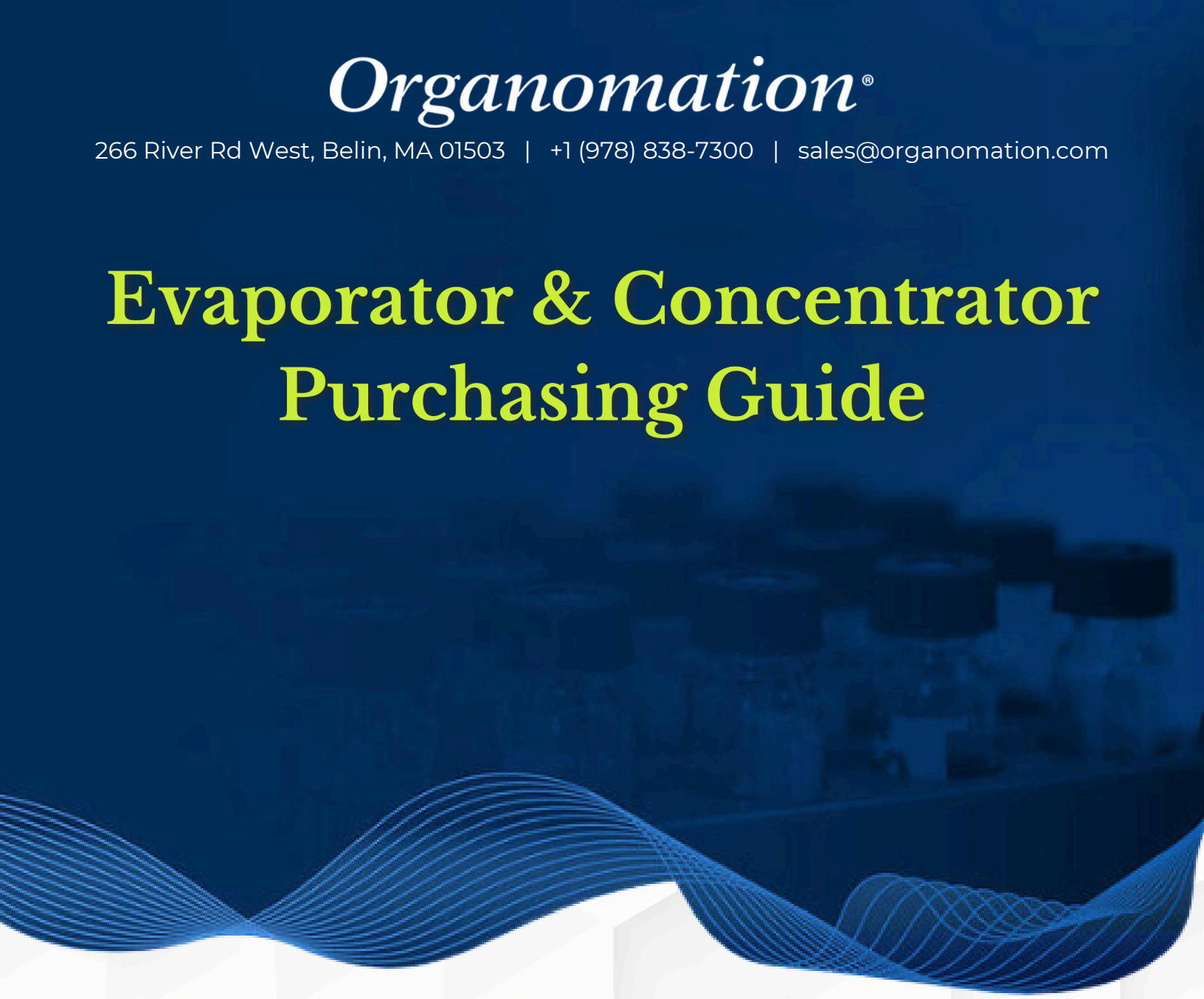
Evaporator & Concentrator Purchasing Guide



Introduction

Choosing the right evaporator or sample concentrator for your lab can significantly impact the efficiency and accuracy of your analysis. With various techniques available, such as rotary evaporation, Kuderna Danish evaporation, nitrogen blowdown, centrifugal evaporation, and freeze drying, it's essential to understand which method suits your specific needs. This guide will help you navigate the selection process by posing key questions in four critical areas: sample size and starting volume, batch size, solvent removal, and sample type. Let's dive in and determine the best approach for your lab.

Here are the concentration methods covered in this guide:

Rotary Evaporation

Uses rotation, vacuum, and heat to efficiently concentrate samples. Rotary evaporators can typically handle a wide range of sample volumes, but are limited to processing one sample at a time. When rotary evaporation is feasible, it is typically the fastest of the sample concentration methods on a per-sample basis.

Nitrogen Blowdown

Uses a stream of nitrogen gas, with or without heat, to evaporate solvents from multiple samples simultaneously, typically in test tubes or vials. Nitrogen blowdown is often the preferred evaporation method when working with volatile analytes. It is also often the cheapest in terms of total installation cost and easiest in terms of sample setup.

Centrifugal Evaporation

Uses centrifugal force, vacuum, and heat to concentrate multiple small volume samples at once. Centrifugal evaporation is typically used to concentrate biological samples such as DNA.

Kuderna-Danish Concentration

A specialized concentration method for removing organic solvents from volatile or semi-volatile analytes, commonly used in environmental analyses.

Freeze Drying (Lyophilization)

Removes liquid by freezing samples and sublimating the ice under vacuum. Freeze dryers are ideal for drying heat-sensitive biological compounds in aqueous matrices. This method is the slowest of the evaporation methods covered in this guide but results in the least thermal degradation.

Sample Size

What size are your samples? What is your starting volume?

Understanding the size and starting volume of your samples is crucial in selecting the appropriate evaporator or sample concentrator.

	Microwell plates	Small samples (1-30 mL)	Medium samples (30-100 mL)	Large samples (>100 mL)
Rotary Evaporation	No	Less common	Yes	Yes
Nitrogen Blowdown	Yes	Yes	Less common	No
Centrifugal Evaporator	Yes	Yes	No	No
Kuderna-Danish Evaporation	No	No	Less common	Less common
Freeze Drying	Less common	Yes	Yes	Yes

Microwell Plates

Nitrogen blowdown & centrifugal evaporation are optimal for microplates, with freeze drying as a less common alternative for water removal in heat-sensitive analytes. Specialized accessories are required for all methods.

Small Samples (1-30 mL)

Nitrogen blowdown is typically the fastest option for small samples, while centrifugal evaporation allows higher throughput. Rotary evaporation can handle small samples if properly adapted but is generally more efficient for larger volumes.

Medium Samples (30-100 mL)

Rotary evaporation is the most efficient method for medium-sized samples, offering speed and flexibility. Nitrogen blowdown is an alternative for thermally sensitive samples, though it is slower for this volume range.

Large Samples (>100 mL)

Rotary evaporation is the gold standard for quickly processing large samples. When preserving volatile analytes is critical, Kuderna-Danish concentration may be preferred.

Batch Size

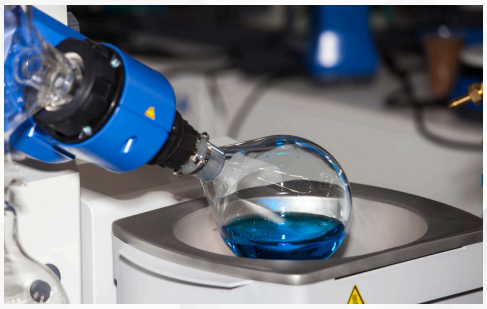
How many samples are you looking to concentrate at once? What is your standard batch size?

The number of samples and batch size are critical factors in choosing the right equipment.

	Single Samples	Multiple Samples	High Throughput (>1,000/day)
Rotary Evaporation	Yes	No	No
Nitrogen Blowdown	Yes	Yes	No
Centrifugal Evaporator	No	Yes	Yes
Kuderna-Danish Evaporation	Yes	Yes	No
Freeze Drying	Yes	Yes	Yes

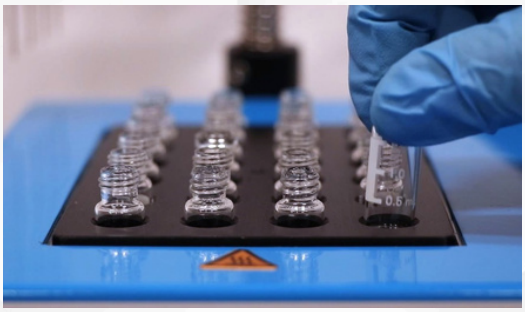
Single Sample Processing

Rotary evaporation, nitrogen blowdown, and Kuderna-Danish concentration excel for single samples. Choose rotary evaporation for larger samples or difficult solvents; for small samples (<10 mL), nitrogen blowdown is simpler and faster.



Multiple Sample Processing

Nitrogen blowdown and centrifugal evaporation handle multiple samples efficiently. Nitrogen evaporators typically accommodate 10–100 samples, while some centrifugal systems can process up to 500 at once.



High Throughput

Labs processing over 1000 samples daily benefit from automated systems integrated into the sample preparation workflow.

What solvents are you looking to remove?

Different evaporators are optimized for various solvents. Choosing the right one improves efficiency and safety.

	Volatile Organic Solvents	High Boiling Solvents	Aqueous Solutions
Rotary Evaporation	Yes	Less common	Less common
Nitrogen Blowdown	Yes	Less common	Less common
Centrifugal Evaporator	Yes	Less common	Yes
Kuderna-Danish Evaporation	Yes	No	No
Freeze Drying	Less common	Less common	Yes
Non-Evaporative Methods	Less common	Yes	Yes

Volatile Organic Solvents

Organic solvents are well-suited to removal via evaporation and can be evaporated using most of the methods discussed in this guide. The exception is freeze drying; not all organic solvents can be lyophilized, and those that can often require a specialized model.

High Boiling Solvents

Solvents with high boiling points, such as DMF, DMSO, and NMP, are typically challenging to remove through evaporation. Common removal techniques are washing, extraction, or other non-evaporative removal methods like chromatographic separation. These solvents can sometimes be removed under high vacuum, such as in a rotary evaporator or other specialized vacuum concentrator. DMSO can sometimes be lyophilized. While slow, nitrogen blowdown can also be an effective option for small volume samples.

Aqueous Solutions

Freeze drying is excellent for removing water from heat-sensitive samples while preserving their integrity. Centrifugal evaporation is another common method for evaporating water, especially when concentrating proteins or DNA. Nitrogen blowdown and rotary evaporation can be used as well, but each have challenges. Nitrogen blowdown of water is extremely slow without the application of heat, which can be an issue for solutes prone to thermal degradation. Rotary evaporation requires a relatively strong vacuum, which can lead to challenges with bumping.

Mixed Solvent Systems

Mixed organic solvents and azeotropes can typically be evaporated using the same methods as a single organic solvent. For aqueous-organic mixture, a combination of concentration techniques is typically most effective. Consider evaporating off the organic component first and then removing the remaining water in a freeze dryer, or alternatively removing the water with drying agents before evaporating the organic solvent.

Sample Type

What type of samples are you concentrating?

The nature of the sample being concentrated is a crucial consideration, especially for those sensitive to heat.

	Volatile or semi-volatile analytes	Heat sensitive samples	Thermally stable non-volatile analyites	Complex biological structures
Rotary Evaporation	No	Yes (to an extent)	Preferred	No
Nitrogen Blowdown	Yes	Yes	Preferred	No
Centrifugal Evaporator	No	Yes	Yes	No
Kuderna-Danish Evaporation	Yes	No	No	No
Freeze Drying	No	Yes	Waste of time	Yes

Thermally Stable Analytes

Samples with thermally stable, nonvolatile analytes are the easiest to concentrate because the solvent can simply be boiled off without concern for the analyte. Evaporation speed can be increased by applying vacuum (rotary evaporation) or a stream of nitrogen gas. Unfortunately, most analytes are either volatile or thermally unstable to some extent.

Volatile & Semi-Volatile Analytes

Nitrogen blowdown evaporation and Kuderna-Danish concentration are the leading methods for retaining volatile or semi-volatile analytes when concentrating samples. The two methods are frequently used in tandem, with large volume samples being concentrated using the Kuderna-Danish technique before being moved to a nitrogen blowdown evaporator for a final (controlled) concentration to a specific endpoint.

Heat Sensitive Samples

The best concentration method for heat-sensitive samples depends on how heat-sensitive they are. Rotary evaporation allows for efficient removal of solvents at 40-60 °C, well below the temperature that would be required to boil most common solvents. For samples that cannot be heated but that are stable at room temperature, nitrogen blowdown and centrifugal evaporation can both be operated effectively without the application of heat. For extremely heat-sensitive samples, freeze drying may be the best choice since it allows the sample to remain below room temperature during concentration. Some advanced centrifugal evaporators have a refrigeration option to achieve a similar effect.

Complex Biological Structures

Freeze drying is often preferred for complex biological samples such as proteins or cells if the molecular or cellular structure needs to be preserved.

Conclusion

By considering the size of your samples, your batch processing needs, the solvents you aim to remove, and the type of samples you are concentrating, you can make an informed decision about the most suitable evaporator or concentrator for your laboratory. Whether it's the versatility of rotary evaporation, the advantage of vacuum through centrifugal evaporation, the high-throughput capability and gentle nature of nitrogen blowdown, or the ability to remove water efficiently through freeze drying, each method has its strengths.

Take a moment to try out the "Which evaporation method is best for me?" tool. This quick and easy tool can further assist you in determining the best evaporation method tailored to your specific needs, helping you make the most informed decision for your lab's requirements. Optimize your lab's evaporation and concentration processes for maximum efficiency and accuracy today.

Contact Our Experts

If further assistance is needed to determine which sample concentration method is best for your lab, our experts are happy to help. Contact our team today!

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