

Choosing the Right Orbital Shaker for Your Application

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KEY WORDS

- Orbital Shakers
- Platform Shakers
- Bacterial Growth
- MaxQ Shaker
- Forma Shaker
- Incubated Shaker
- Refrigerated Shaker
- Stackable Shaker
- Bench Top Shaker
- Floor Shaker

Introduction

Orbital shakers are a critical piece of equipment in almost every lab. They are found hiding in corners in common rooms, sharing prominent space on lab bench tops, living in hallways, shaking away, quietly growing your cultures while other research work is being performed. Shakers are so commonly used that little thought is given to them until one stops working or a new lab is being set up, then selecting the right shaker to meet your needs can become a daunting task. The intention of this article is to guide you through the shaker selection process answering important questions that will make selection easy and ensure that you purchase the right shaker to meet your needs for many years to come.

There are several key questions that you should ask yourself before beginning the search for the right shaker.

- 1) **How much space do you have available? Will the shaker be placed on the bench top or on the floor?**
Units typically range from the



Figure 1. Thermo Scientific MaxQ 2000 shaker with 11" x 13" dual tiered platform

smallest being approximately 18"L x 14"W x 7"H for a bench top up to the largest at approximately 34"L x 47"W x 25"H for a large stackable floor model and a variety of sizes in between. Various options are available to accommodate a wide range of vessel sizes such as Erlenmeyer flasks, microwell plates, beakers, separatory funnels and centrifuge tubes.

- 2) **What temperature range/s do you need?**
Orbital shakers offer a wide range of temperature capabilities to meet specific growth requirements from refrigerated models that will go down to 4°C for protein expression applications to high temperature units that will go up to 80°C for growth of thermophiles.
- 3) **What shaking speed/s do you need?**
Some models will shake as slow as 15 rpm for slow speed staining applications and go as high as 500 rpm. Speed ranges can vary depending on user interface type (analog or digital) or have speed limitations if stacked.
- 4) **What type of vessels do you need to shake?**
There is a wide variety of clamps available for Erlenmeyer flasks, separatory funnels, microwell plates, beakers, and test tubes. For oddly shaped vessels such as volumetric flasks and media bottles, adjustable vessel platforms with roller bars sandwich containers between them to hold them in place. For slow speed applications under 250 rpm adhesive mats and tapes are available to accommodate various vessel sizes. It is important to list out all of the labware you want to shake.
- 5) **Will you be shaking only one size vessel or a variety?**
Most manufacturers offer dedicated platforms which are designed to shake only a single vessel size such

as a flask. These platforms provide maximum capacity and come with clamps installed versus universal platforms that provide maximum flexibility for using a mix of different size labware on a single platform. The universal platform comes with numerous mounting holes to allow you to add and interchange clamps and test tube racks at your discretion.

- 6) **How many vessels of a given size do you need to shake at one time?**
Sometimes this dictates what size shaker you will have to consider. Some manufacturers offer creative solutions such as one shaker that can accommodate multiple sizes of platforms or platforms that stack to double capacity, not the footprint.
- 7) **How much weight will be placed on the shaker?**
All shakers have weight limits for maximum performance. Consider a shaker with a triple eccentric drive mechanism. Triple eccentric drives permit handling of heavy workloads versus shakers that use single eccentric drive mechanisms.
- 8) **How important is speed and temperature accuracy?**
If speed and temperature accuracy are important, steer towards digital shakers as they are more precise. Data is displayed through an LED screen as opposed to analog controls. This feature may be important if repeatability is required.
- 9) **How many people will be using the shaker?**
If several individuals are using the shaker in the lab, it may be beneficial to purchase additional platforms for quick vessel changes. In this way if one researcher grows bacteria in a centrifuge tube and another grows yeast cultures in Erlenmeyer flasks, then having their clamps attached to different platforms may save valuable time.

10) What is your budget?

Shakers range in price from approximately \$1,500 for small open air bench top models to \$15,000 or more for large stackable shakers.

Once you have answered these questions you should have a good picture of what you need and are ready to begin shopping. Below is an overview of the basic types of orbital shakers available on the market today and their common applications.

Open air bench top orbital shakers

Open air bench top shakers have no temperature control so they are ideal for protocols that only require ambient temperatures such as staining, some solubility studies, extraction procedures, and washing procedures. These types of shakers operate in temperature ranges of 0°C to 40°C and humidity conditions from 20% to 80% non-condensing, enabling them to be used in incubators, warm rooms, environmental chambers and refrigerators. Typically, open air bench top models can be found in multiple sizes with a variety of platforms as large as 36" x 24" and even stackable platforms in order to double shaking capacity.

Open air bench top shakers are typically the lowest cost options available. There is no cost associated with compressors or heating mechanisms but your samples must be able to perform at ambient conditions. Alternatively, some manufacturers allow their shakers to be placed into environmental chambers but always verify if this is allowable with the manufacturer (if not allowed it could void your warranty). Most manufacturers require a special reinforced shelving kit if you choose to do this due to the weight and rotation of the shaker. Some manufacturers allow their shakers to be placed into CO₂ chambers for mammalian cell growth applications. Open air shakers for use in CO₂ incubators are treated to protect the electrical and mechanical components in the shaker from high humidity and CO₂ which proves to be a very corrosive environment. In this type of environment, the electrical components react with high humidity and CO₂ forming carbonic acid which can cause the shaker to malfunction if not properly protected. Shakers placed

into CO₂ chambers offer a nice option for flexibility between shaking in the chamber or on the bench top, but again, verify if it is acceptable with the shaker manufacturer and check for requirements such as special reinforced shelving.

Incubated/refrigerated bench top and floor orbital shakers

Incubated/refrigerated shakers are more versatile than open air orbital shakers. They offer a wide variety of temperature options including ambient, incubation and refrigeration. Even if you just need incubated temperature ranges today, in the future you may want to perform protein studies where refrigerated temperatures of 16°C are required.

Many customers opt for an incubated/refrigerated shaker to grow with their needs. With these versatile units you can grow bacteria and yeast at 37°C or hold temperatures at 4°C or 15°C below ambient making them ideal for protein expression studies, plasmid purification and insect cell culture. These shakers can be found in different sizes ranging from bench top to floor models and will accommodate platform sizes from 11" x 13" for holding a small amount of vessels up to 18" x 30" for accommodating a large quantity of vessels. Platforms in specific incubated/refrigerated shakers such as the Thermo Scientific MaxQ 6000 can be stacked to double the shaking capacity making them more efficient than shakers that can only hold a single platform. Most platforms in incubated/refrigerated shakers cannot be stacked because they are limited by the size of the chamber.

Within the floor model orbital shaker ranges there are console type models that look like large freezers that can be used to shake large Erlenmeyer flasks 4 L and up. These units are not stackable and therefore can take up a significant amount of floor space. If using smaller vessels, such as 2 L Erlenmeyer flasks or if floor space is limited, most manufacturers offer stackable shakers that can double or triple the processing capacity in the footprint of one unit.

You will need to look to the future regarding new applications to

determine if you want to invest in a cost conscious open air shaker that requires no temperature control or an incubated refrigerated shaker that can grow with your laboratory needs.

Analog or digital shaker?

There are several differences between analog and digital orbital shakers. If your lab is analog and you intend to keep it that way, analog orbital shakers are an economic alternative to digital units. Typically analog shakers will save you 20% in price versus a digital shaker. Be aware that some analog shakers contain different types of drive mechanisms. Make sure the analog shakers you choose contain a long lasting, durable drive mechanism such as triple eccentric drive to handle heavy workloads and are intended for 24-hour operation, especially if they function as the workhorse in the lab.

Next, you need to make sure the speed range is sufficient for your needs. Analog shakers tend to have a more limited speed range versus digital shakers. They may not go down as low or up as high in speed as you require. Speed settings on analog shakers are adjustable with easy-to-use rotary dials. In some shakers, the analog speed is tracked by a traditional tachometer which monitors and displays the speed in rpm (revolutions per minute) to guarantee an accurate setting. Most analog and digital shakers will have an LED display for temperature. Temperature control is typically monitored by a PID (Proportional Integral Derivative) temperature controller to maintain temperature



Figure 2. Thermo Scientific MaxQ 4450 incubated bench top shaker



Figure 3. Thermo Scientific MaxQ 6000 incubated/refrigerated shaker

accuracy within $\pm 0.1^{\circ}\text{C}$ over the entire temperature range. Be cautious of PI (Proportional Integral)

temperature controllers which are not as accurate as PID temperature controllers across the entire temperature range.

How the time function is set is another factor to consider when deciding to purchase an analog over a digital shaker. With analog shakers time can be set in continuous mode or time can be set for a limited number of minutes or hours. Digital shakers have timers that allow you to count up or down permitting time studies to be performed.

Analog shakers tend to require yearly maintenance as compared to maintenance-free digital models. This can be due to the analog operating system which may contain a brushed motor. Brushes in the motors need to be changed by the lab every three to six months depending upon how much the shaker is used. If

not properly maintained the shaker motor can be damaged if the brushes are not replaced.

Finally, digital shakers contain more features and benefits versus analog shakers. These extras range from over/under speed and temperature alarms, unbalanced load sensors, set point retention, soft start feature, speed calibration to a known value and RS232 interface to allow temperature, speed or time to be transferred to a computer.

Conclusion

There is a wide range of shaker options available to meet a wide range of application requirements. Selecting the right unit for your work is important so answering the questions up front, then reviewing the options, is a great place to start the process of purchasing a new shaker.

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