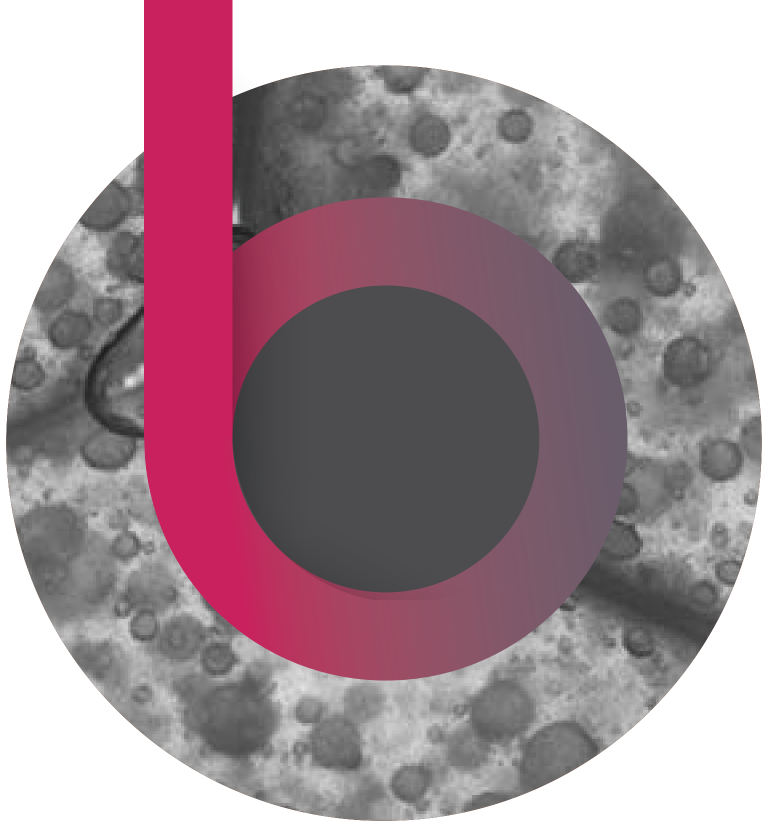
Lab Manager 2018

LAB OVENS RESOURCE GUIDE



Introduction

by Trevor Henderson, PhD

Laboratory ovens are an indispensable instrument in most laboratories as they are used across various scientific disciplines. They are used principally for drying glassware and heat-resistant equipment, regenerating desiccants and catalysts, gently heating samples, and curing or preparing materials and composites. Many labs are equipped with more than one of these devices. Although common in most chemistry, biology, pharmaceutical, forensics, and environmental labs, choosing the best lab oven to suit your particular applications may not be a straightforward task.

Questions to Ask When Buying a Lab Oven

by Ryan Ackerman

What is your sample or material type?

Depending on the intended use, there are a variety of oven types to choose from. For general drying or baking purposes, a gravity convection oven can be used. These are typically cheaper and offer a degree of temperature uniformity, but can also develop cold or stagnant spots. Alternatively, a mechanical convection oven can be used which has a blower unit to allow for increased temperature uniformity, as well as fast recovery when the oven has been opened. If the requirements for the oven are drying, desiccating, moisture determination, and outgassing, then a vacuum oven may be best.

What size or volume of samples do I need to heat?

Laboratory ovens come in a wide range of sizes—from very small personal use to large scale industrial units which have walk-in capabilities. For larger ovens, a separate power source may be required. These units can draw a lot of electricity and increase the overhead and maintenance requirements of the laboratory. Alternatively, if the sample volume is large, but the size of the samples is small, it may be wiser to invest in multiple smaller ovens as opposed to one large unit.

What is my application?

For some laboratories that have stringent compliance guidelines on samples, such as work involving semiconductors and electronic applications, a specialized variety of oven known as a clean room oven may be needed. These ovens utilize a HEPA filter system along with very precise temperature control and uniform heating. For samples which are volatile or potentially explosive, the Class A division of ovens should be used, which include safeguards against explosive or volatile samples.

How do I maintain my lab oven?

Although lab ovens can be extremely robust, working great for years, any device needs some maintenance. The general rule of thumb, if you use your oven regularly, is to calibrate it at least once a year.

6 Signs You Should Service or Replace Your Lab Oven

by Ryan Ackerman

1. Ovens should have a regular maintenance schedule to avoid unscheduled downtime and potential loss of product. Components such as gaskets, elements, blowers, etc. should be replaced or verified before they become a problem. Temperature calibration should be checked on a routine basis.

2. When your process outgrows your oven's capabilities. Ovens have very different performance characteristics such as temperature uniformity, temperature range, capacity, heat-up time, and recovery time. If your oven's performance does not match your process requirements, then it's time to upgrade.

3. If your oven is more than 7 years old, chances are it has parts that are obsolete and impossible to purchase, which could result in excessive downtime. It is better to replace the unit early and reduce the risk.

4. When the warranty period has expired. Repairs on units that are out of the warranty can be costly. When a unit is in need of repair and is out of warranty, it may be more economical to buy a new unit.

5. Your process may produce hazardous exhaust. Baking certain materials in an oven can produce flammable vapor and/or obnoxious odors. Upgrading your oven to a vented system can do more than make a better smelling workplace, it can also bring you into compliance with government safety regulations.

6. Any time you have issues such as slow to reach temperature, temperature variation, noises, reduced airflow, or problems with door alignment and gaskets, you should service or replace your lab oven.

Keeping Your Lab Oven Safe

by Erica Tennenhouse, PhD

Ovens are essential components of most labs and can be used in a variety of processes including drying glassware, drying samples, melting, and chemical reactions. But with the many potential dangers that come with the use of lab ovens, users must always remember to put safety first.

The single greatest risk associated with a lab oven is the human using it. The danger of getting hurt comes when people don't understand what they are touching. Therefore, one of the biggest safety features of the lab oven is the user manual.

Beyond reading the manual, there are certain considerations when it comes to lab ovens that can vastly improve safety. For one thing, customers should look for products with safety certifications such as COL or UL. Customers can also usually opt to receive automatic warnings that let them know what their oven is doing. Visual and audible alarms are added features that will tell the user whether the fan in a convection oven has turned off, whether the door has been open for a certain amount of time, or whether the temperature has gone higher than a specified value. However, to ensure that temperatures are kept within a certain range, independent temperature safety devices are a step up from alarms. These are essentially temperature fuses that either cut the power at a fixed temperature or can be programmed to shut the oven down at a specified temperature.

Still, something as simple as a door that automatically locks when the internal temperature is above a certain point, and can only be opened once it cools off, can make a big difference in terms of user safety. Perhaps a less obvious feature, but one that should still be considered, is insulation. The insulation of some laboratory ovens is good enough to ensure that the product, even at the maximum temperature on the inside, is safe to touch on the outside.

Users should also think about what types of materials are going into their ovens. When you have flammable solvents or combustible material, you should not operate in a regular laboratory oven to begin with. For this situation, there is a range of specialty ovens to pick from, the most basic one being a vacuum oven.

Even in a vacuum oven, experts advise users working with organic solvents to exercise caution. A small quantity of organic solvents may be used, but the vacuum oven would need to have accessory safety options in place. Also, connecting chemical-based ovens to a duct system can help prevent fumes from blowing into the lab.In general, it is recommended that users make sure that they are picking the right oven for their application.

In certain cases, an oven may not even be necessary; for example, sometimes an incubator is sufficient for drying. Using the right instrument and adding appropriate accessories will tend to keep both users and samples safe.

The vast number of safety features available for lab ovens empower customers to take safety into their own hands. And at the very least, lab oven users would be wise to make a habit of reading their safety manuals.

Energy Efficient Lab Ovens

by Mike May, PhD

The global energy crisis is growing and is driving the costs of energy higher, making energy consciousness not only a necessity in terms of the environment, but also important for cost savings. Laboratories of any discipline are extremely energy intensive, with processes and experimental instruments running around the clock. The US Environmental Protection Agency's (EPA) 5 Star initiative estimates that the energy consumption in a laboratory setting is five to ten times that of a normal office building.

Customers are increasingly concerned about the efficiency of their lab equipment. Most labs are thinking about the energy efficiency of constant-temperature equipment, and how its efficiency is affected over the equipment's life.

To make an energy-efficient lab oven, manufacturers focus on several features. Perhaps the simplest method of saving energy within heating and drying applications is to select an oven with effective use of the internal chamber space. It is crucial that the design of the shelving system provides space advantages, eliminating the need for a second oven unit.

Another key feature for energy efficiency is good-quality insulation in an oven's walls, which typically involves double or triple door seals. The door hinges and latches also help prevent temperature loss.

In addition, the electronics make a difference. For instance, a sophisticated controller can ensure that an oven turns off when it reaches the desired temperature, so that it doesn't use more energy than necessary. Low-wattage circulation fans also make an oven more efficient, but the fans must be powerful enough to do the job.

Getting the most efficient energy use from an oven comes from a combination of technology and know-how. Users must decide whether to leave the oven on or pull juice to reheat it every time it's needed. If the oven gets used throughout the day, it might make more energy sense to leave it on, instead of turning it on and off, which pulls more current. Likewise, if an oven radiates lots of heat into a lab, the facility's overall energy efficiency might improve by running the oven at night or during off-peak kilowatt hours, if possible.

Insights into ...

by Mike May, PhD and Angelo DePalma, PhD

Oven Accuracy

The choice of a lab oven depends on how much accuracy a user needs and whether that accuracy needs to exist throughout the oven. This is called "spatial temperature accuracy," which means that the temperature is really what the indicator displays, and not just in one spot. Providing such spatial accuracy depends on a combination of insulation and the approach to heating. The way you heat is the root cause for introducing the same temperature across the entire oven, and the controller algorithms need to react quickly to changes to keep the same temperature.

Even the door on an oven greatly affects spatial temperature accuracy. Doors on many lab ovens are so poorly adjusted that a piece of paper can be slipped through at the edge. That problem arises because people think of a lab oven as a commodity that they can use for a dozen years without any maintenance, and that's simply not the case.

Experts recommend oven maintenance at least every two years, or sooner if you start seeing door seals go or the door needs adjustment. Ovens will also require calibration if they've been mistreated, for example, if something banged against the sensor.

High-Temperature Ovens

The market for high-temperature ovens, operating between around 400ºC and 600ºC, is heating up. High-tech materials manufacturers use large ovens in this temperature range to produce high-tech materials and coatings. The R&D labs supporting new materials development employ much smaller units, with volumes of 30 to 60 liters, to test product ideas and troubleshoot manufacturing.

Heat distribution and temperature uniformity are not as problematic for common laboratory ovens as for high-temperature "process" ovens, where samples are often sensitive to temperatures and heat distribution. Phase changes that occur during materials curing, particularly for large-area samples, are highly dependent on reaching and holding a particular temperature.

That is why buyers should validate both the uniformity of the "heating envelope" in high-temperature ovens and the recovery time for re-establishing heat uniformity when the unit is opened. For materials processing, proper venting of volatile organic compounds is an absolute must. Otherwise it will not be safe to open the door.

Users should also get some idea from the vendor about radiant heat from the oven shell. This is a function of efficiency and directly affects lab comfort and operating costs. Units should follow standards for maximum external case temperature.

Customers should also consider their desired process temperature, controller functionality, and overall processing conditions. There are many different options for temperature control based on the required process—for example, if a customer needs to ramp and soak or if a customer is running at uniform temperature.

Ovens for HPLC

Beyond drying glassware, lab ovens play important roles in analytical processes, such as high-performance liquid chromatography (HPLC). There are two categories of HPLC ovens: One is block heaters, where you clamp the column between pieces of metal; in essence, such heaters protect the column from temperature variations. The other is forced-air ovens, which include a chamber in which air circulates at high velocity, resulting in much better heat transmission between the air and the column. The second category of HPLC ovens provides better temperature control.

In many modern HPLC applications, researchers want to replace largely organic solvents with water that includes some organic modifiers. This is called 'green chromatography, and it requires ovens that go higher than 150 degrees Celsius. Today, there are more columns that can withstand those high temperatures.

Additionally, many researchers now use ultraHPLC, which uses even smaller particles in the separation column. If you want to use standard equipment for high resolution, you can use core-shell particles, which are only superficially porous and higher temperatures from the oven. The grouping of a higher temperature for separation and core-shell particles is a nice combination for high-resolution chromatography with a traditional HPLC system.

LINDA Says...

When using the oven to dry glassware and plasticware, always make sure that these items can withstand the high temperatures of the unit, otherwise they can melt and ignite, potentially spreading fire to the rest of the lab. To avoid burns when operating the unit, make sure you wear heat-resistant gloves, eye/face protection, and a lab coat. You may also want to wear a face shield, rubber sleeve protectors, 6 and a rubber apron.

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