SINCE 1889

Yamato

Natural Convection and Forced Convection Incubators

What features matter when you want consistency, reliability, and confidence?

Introduction

Although incubator technology has not surged ahead like other lab technologies in the last several years, any old incubator still won't take care of what your lab needs. Choosing the right option can save precious time and budget.

Both natural convection and forced convection incubators are ideal for preserving sensitive samples in heated environments. Furthermore, forced convection incubators can create both heated and refrigerated environments.

Both methods are consistent and reliable, however, to figure out which type of incubator best suits the needs of your laboratory, use this guide to sort through the features of natural convection and forced convection incubators that matter most.

Table of Contents

Natural Convection Incubators

Natural Convection

Natural convection, also known as “free convection,” is a mechanism of mass and heat transportation in which the movement of heat is generated only by density differences across the temperature gradient, not by any external source (like a pump, fan, suction device, etc.).

In short, hot air rises.

Because they do not use an external source, natural convection incubators minimize disturbances to the items inside the incubator. This type of heat is gentle on the samples inside the incubator.

Natural convection is the most budget-friendly option, and is the best option to be 100% sure samples don’t dry out.

A classic example of a high quality workhorse, natural convection incubator is Yamato’s IC Series General Purpose Incubator with an internal capacity ranging from 37L to 567L, and options including:

- A solid door
- A door with observation window
- With communication port
- With communication port and door with observation window

Applications

Because the heat inside this type of incubator is so gentle, disturbances to the items inside are rare. General purpose natural convection incubators are used in a wide variety of thermal applications such as:

- Growing microbial cultures.
- Maintaining integrity of organisms for later use.
- Increasing the growth rate of organisms and/ or having a prolonged growth rate in the natural environment.
- The reproduction process of microbial colonies and subsequent determination of biochemical oxygen demand.
- Breeding of insects and hatching of eggs in zoology.
- Provision of controlled conditions for sample storage.

They’re broadly good for all around use in the lab where stable heat is needed over the medium to long term.

Temperature Accuracy/Control

Operating Temperature

Generally, the operating temperature range for any natural convection incubator is room temperature +5°C to 80°C, which makes it suitable for a wide range of microbiological life cycles.

Temperature Controls

Natural convection maintains a uniform temperature throughout the chamber, making temperature accuracy and control important features of a general purpose natural convection incubator.

Once a natural convection incubator reaches its set temperature, users can be confident it will stay there.

Temperature Accuracy

To be absolutely certain of temperature accuracy, some natural convection incubators incorporate a PID microprocessor.

PID microprocessor controls provide the continuous variation of output to accurately control the heating process. By monitoring the temperature in real time, it reduces the possibility of temperature variations. Proportioning the heat within the unit means that if the temperature is approaching or at the setpoint, the heater reduces its output to a “maintenance” setting, where it works to maintain that temperature precisely with micro-changes in output.

Key Features

General purpose natural convection incubators come in a variety of capacities from the tens of liters to the hundreds.

Usually, each size is built with features the manufacturer believes best suited to applications using incubators of that size.

Some of the features you'll come across include:

Observation Windows and Solid Doors

Every incubator has either a solid door, or a door with an observation window.

- Observation windows allow users to visibly monitor the samples without having to open the door, which reduces any contamination risks posed to either the user or the sample, and helps maintain temperature stability throughout the growth cycle of whatever the sample may be.

- Solid doors, obviously, do not have an observation window. They are often easier on the budget, and are preferred in some situations (if you're working with light-sensitive samples, for example).

But there are scenarios where a solid door doesn't mean you can't look at your sample without exposing it to the outside environment.

- Many models feature interior glass doors - a full length glass door set inside the first level exterior door. They are not as insulated as the main door, but provide protection to samples and the integrity of the heated (or refrigerated) environment.

- This dual door system is a standard design of the Yamato IC Series (except for the smallest capacity models). This permits contents to be viewed easily without disrupting the atmosphere of the incubator.

Self-Diagnostics

Many general purpose natural convection incubators come equipped with self-diagnostic safety features that can alert users about:

- Temperature sensor errors.
- Heater failures.
- SSR short-circuit

Some also self-diagnose overheating (due to any of the errors above, or for other unforeseen reasons) and launch a prevention function to keep both the sample and the user safe.

Key Lock

Some incubators have a basic key lock built in. Some models use keypads and codes to control access.

You might trust everybody in your lab not to interfere with your samples but that doesn't mean *you should trust* them. You also may not be aware of everybody coming and going from your lab.

A simple key lock is the most cost effective security feature for an incubator. While digital control panels with access control are surfacing from some manufacturers, the associated cost is rarely worth the investment.

A key lock does the job as well, if not better.

Communication

Interconnectedness in the lab makes everybody's jobs easier.

An incubator with a communication port gives users access to time saving and accountability-enhancing features, like:

- Remote control over important settings.
- Easy monitoring and tracking from any location inside or outside the lab.

A communication port and the associated functionality is especially important if samples are left overnight, or for multiple days.

Insulation

General purpose incubators are usually insulated much like a home - with simple fiberglass insulation.

Fiberglass is lightweight, strong, and a poor conductor of heat. Heat naturally wants to move to cooler areas. In the winter, it's not the cold seeping into your house. It's the heat escaping.

The same goes for your general purpose lab incubator. The heat wants to move, and the insulation stops it.

General purpose incubators are insulated using fiberglass insulation or styrene foam. Generally, fiberglass is the most affordable option. It does the job as well as styrene foam, but doesn't stand up to moisture as well. In the majority of cases, that vulnerability to moisture isn't a serious consideration, but it might be in your application.

Heating

Heating in your incubator can come in a couple of forms.

- A stainless steel heating pipe.

Stainless steel is affordable and good at maintaining moderate heat. The power draw to run on a stainless steel heating pipe is low, so it's a good choice when the cost of acquisition and operation are primary concerns.

Yamato small capacity models IC103C and IC113C are designed with a stainless steel heating pipe.

- An iron-chrome wire heater.

SIron-chrome wire heaters get hot fast and stay hot longer without damaging the heating element.They are also light in weight, can handle a high surface load, and generally have excellent service life.

Larger capacity models of IC Series are designed with iron-chrome wire heaters.

Timer

Timers, both in the form of a digital display and a winding clock are common across brands and model levels (although some incubators are still available with more basic interfaces).

The timers allow users to automate incubation periods, so users can comfortably perform other tasks in the lab without constantly checking the incubator.

In busy labs, timers are actually essential for workplace morale. Conflict has been reported in labs where equipment is shared and users aren't aware of colleagues' needs. Timers on the lab's shared incubators help maintain harmony and collegiality in the lab.

Power Consumption

Power consumption is also an important factor. In most labs, incubators draw power 24/7.

A few incubators running in the lab can cost thousands of dollars a year, so incubators with energy-saving features (which can be as simple as extra layers of fiberglass or a lower max temperature) can have a significant impact on your annual budget.

Incubators with energy saving features also often have high-performing power-outage compensation. This means your laboratory incubators can continue to function in the event of a power outage, making this feature particularly important for users who are storing critical samples and cannot afford to lose generations of samples and weeks of work.

Contamination Risk Mitigation

Contaminants can be introduced to an incubator simply by opening the door, and that contamination can go in both directions - into the samples, and into the environment from the samples.

Further, samples may be contaminated from the beginning of your incubation cycle, if the interior of the incubator is not properly sterilized between cycles.

To alleviate the risk of any type of contamination:

- Look for an incubator with few, if any, sharp interior edges. Rounded surfaces on the interior of the incubator allow for more complete sterilization after each generation of samples is removed.
- Look for an incubator with features that allow viewing of samples without exposure to the outside environment - a glass window in the exterior door, or interior glass windows, and an interior light for viewing.

Forced Convection Incubators

Forced Convection

Forced air convection ensures both optimal transfer of heat and a high precision temperature uniformity in the chamber with minimum energy consumption.

Forced convection incubators use a fan to move heated or cooled air into and around the chamber. In larger incubators, forced convection offers better temperature uniformity than natural convection.

Forced convection also achieves set temperatures quicker than natural convection - so it's a common choice for short-term applications or applications with high precision requirements, like enzymatic reactions.

Yamato offers two types of forced convection incubators, the IN Series Programmable Refrigerated Incubator and the INE800 Programmable Refrigerated Eco Incubator.

Applications

Many forced convection incubators have the capacity to raise or lower temperatures in the incubator box. Those with the capacity to lower the temperature are often called refrigerated laboratory incubators, although they are also designed to raise temperatures.

They are ideal for applications requiring a controlled environment below or above ambient temperatures. Some applications of refrigerated laboratory incubators include:

- Storage of drug substances in pharmaceutical laboratories.
- Culturing microbiology, including human and plant tissues.
- Ultra-sensitive material.
- Temperature conditioning.

Temperature Accuracy/Control

The value of an incubator comes down to one thing really. It's ability to accurately maintain set temperatures over a given period of time.

Without accuracy, your results won't be consistent. Your data will be skewed. Your work will be wasted.

A good forced air convection incubator should have a temperature variability of no more than 1.0°C, making conditions consistent, reliable, and reproducible. Generally, refrigerated forced air incubators work in temperature ranges from -10°C to +50°C, such as Yamato's IN Series Programmable Refrigerated Incubator.

Some manufacturers offer models with lower power consumption, and reduced refrigeration capacity. These may operate in the range of 0°C to +50°C, but offer significant energy savings over other units when running at minimum or maximum temperatures. If the cost of operation is a consideration in your lab, look for a model with eco-friendly branding, like Yamato's INE800 Programmable Refrigerated Eco Incubator.

Key Features

There are a few key features that can make working with microbiological samples in your lab easier. When shopping for a forced convection incubator, refrigerated or not, the following features can make your life at work easier.

Dual Doors

Dual doors are valuable for a few reasons.

1. The second, interior door is always made of glass, so it allows you to view your samples without compromising the cleanliness of the internal environment or the temperature.
2. Multiple door layers contribute to temperature stability and reduce the energy burden in your lab.
3. Multiple doors provide a layer of security - if a user opens the exterior door without first checking whether the incubator is in use, your sample won't be compromised.

Interior Lighting

If the samples you work with aren't light sensitive, an interior viewing light can make monitoring samples more user friendly, and help maintain the integrity of the incubator interior.

Some models use LED lighting, which draws low power. LED bulbs also last tens of thousands of hours - sometimes the lifetime of the incubator.

Other models use halogen lighting. While halogen bulbs draw more energy and have shorter service lives, you are used to viewing your samples under the soft lighting of a halogen bulb. The familiarity of looking at your samples under halogen lighting is often a good reason to choose this type of interior lighting. You can easily recognize if things are going right or going wrong inside the incubator based on the familiar appearance of your samples.

Self-Diagnostics

Like many natural convection incubators, forced convection incubators also benefit from self-diagnostics. This gives them the internal capacity to monitor technical issues that could impact your sample negatively, like:

- Temperature sensor errors.
- Heater disconnections.
- Internal short circuits.
- Errors in the relay system due to power errors.
- Unexpected overheating (caused by temperature sensor errors or other external factors).

Self-diagnostic capabilities keep your samples and users in the lab safe.

Locks

Sometimes it's important to be able to prove a chain of ownership for your data to be valid. A simple lock on the incubator door maintains that chain of ownership, and also protects samples from inadvertent exposure to the outside environment.

Some locks are digital, with key cards or passcodes. These are good in situations where:

- Multiple users are working on the same sample group.
- Clean room measures are in place.
- User access tracking is part of the lab workflow.

Digital locks come at a significant expense. Unless there are specific conditions in your lab that require digital access, a key lock is often the most secure and economical choice.

Insulation

Some forced convection incubators are insulated with styrene foam, which is an energy efficient, easy-to-install, and lightweight method of insulation.

It's a poor conductor of heat and maintains its performance even when moisture is present, so it's an ideal choice for refrigerated forced air convection incubators.

Other types of insulation, like fiberglass, are used in forced air convection incubators, but with more moving parts and connections in the incubator unit, moisture is more likely to work its way into the insulation (it's not common, but it does happen). This is why styrene foam is recommended in forced air convection.

Yamato's IN Series and INE800 Refrigerated Incubators are insulated with styrene foam.

Operation

Because of the applications forced air convection incubators are used in, many of them feature programmability.

Maybe you have a biological sample that needs to be heated in increments, like:

- 2 hours at +10°C.
- 2 hours at +30°C.
- 4 hours of cooling.
- 8 hours at +50°C.
- 2 hours at -5°C.

Rather than returning repeatedly to set your temperature, you can program in the steps and return the next work day.

If programmability is a primary concern, lay out your workflow before choosing an incubator model. You don't want to choose a model that can be programmed with 20 steps when your process actually needs 30. Yamato's IN Series is programmable up to 32 steps while INE800 can be programmed up to 99 steps.

An incubator is the entire world, as far as your samples are concerned. Making the right choice is the difference between success and failure.

Now you're equipped

Lay out your workflow on paper, record the most important features from this buying guide, and spend some time talking to manufacturers about your application. Maybe an affordable natural convection incubator is all you need, or perhaps your application calls for something with a little more power, like a forced convection incubator.

For more information on our incubators, visit Yamato Scientific America at https://yamato-usa.com/ or contact us at 1-800-292-6286. You can also email our customer service support at customerservice@yamato-usa.com