

Hold the Steam

Dry heat sterilization systems use forced air convection technology for reduced energy consumption.

David Waldrab

Animal lab sterilization has recently seen a demand for greener technologies that require less maintenance. This puts the pressure on equipment engineers to develop innovative ways to approach sterilization. While traditional steam autoclaves use water more efficiently, dry heat sterilization provides an alternative to steam that uses no water, less energy, and requires less maintenance.

The incumbent technology in today's bulk sterilization marketplace for animal cages utilizes steam as the heat transfer method to raise the temperature of the product load to the level needed to sterilize the cages. However, bulk sterilizers that use dry heat are gaining ground.

Physics tells us that the heat transfer rate of steam is greater than that of air, which seems to imply that steam is more efficient. Why consider the dry heat alternative?

Compared with steam, dry heat is a greener technology that eliminates water usage, provides more flexibility for installation locations, and costs less to own and operate.

Greener

The newer steam autoclaves in general are designed to be more efficient with water usage but the required amount of water used in a typical cycle is considerable. The water needs to be heated to generate steam for sterilization, and then it must be cooled for disposal. Conversely a dry heat sterilizer uses one utility, electricity.

The dry heat sterilization systems are providing a high degree of thermal efficiency and present very low skin temperatures. This combined with the fact that there is no steam present to infiltrate the work environment when the door is opened, provides for a more comfortable environment.

Cycle Time

Modern dry heat sterilization systems using focused forced air convection technology are consistently decreasing the cycle time. Depending on the load configuration and cool down requirements, the typical cycle lasts 2.5 hours.

The sterilization cycle consists of three segments: heat up, soak, and cool down. During the heat up segment, the oven and its load of cages are raised to the pre-set sterilization temperature of 300°F. The cages soak for a pre-determined time period in order to facilitate complete sterilization, after which a forced cool down segment rapidly brings the oven and product down to a manageable temperature.

Flexible Installation Options

A critical logistical point to consider when installing a bulk sterilizer is the task of getting a large piece of equipment into the building and placed in the desired position. For labs that want to replace their old

equipment, navigating bulky equipment through an existing building layout may prove difficult and/or expensive.

Dry heat systems can be designed in a modular fashion where the individual modules can be fitted through most corridors, service elevators, and doors. The modules can be reassembled at the required location of use.

Cost of Ownership

A fundamental factor in deploying any technology is cost, including dry heat sterilization systems. How much will it cost me today, next week, and next year to maintain and operate?

- **Initial Cost:** The initial cost of available dry heat systems is about 60% of equivalent sized steam autoclaves.
- **Rigging:** A dry heat sterilizer is two to three times lighter than an equivalent steam system. Because the dry heat sterilizer can be rigged in place as modules, there are a considerably less rigging challenges and costs.
- **Installation:** The dry heat sterilizer does not need to be pit mounted. Instead, a steel plate floor in the sterilizer allows the load of animal cages to be rolled into the oven from plant grade.



Sterilizer shown with three of the four bays loaded.

Sterilization

- **Operations:** A recent study at Rutgers University showed that their 139ft³ bulk dry heat sterilizer loaded with 180 pre-assembled cages plus bedding has a cycle utility cost, (preheat, sterilize, cool down) of \$4.71 based on electricity costs of \$0.13kw/hr.
- **Maintenance:** The dry heat systems operate at ambient pressure eliminating many of the maintenance considerations of high pressure steam units. This is not to say that no problems can be expected with a dry heat sterilizer, but the simpler technology means issue can be addressed with more ease and less expense.

- **Extended cage life:** In life cycle simulations, cages showed zero visible cage defects after simulating six years of usage with weekly dry heat sterilization cycles.

Cycle Validation

The cycle validation process for a dry heat sterilizer is similar to a typical steam autoclave. Once your dry heat sterilizer is installed, the sterilization process should be validated using biological indicators (BI). Generally, the manufacturer will validate the system in the following manner:

1. Thermally map an empty chamber and tune pressure ducts to achieve the correct chamber temperature uniformity.
2. Load the chamber with animal cages.
3. Thermally map the cages to determine the slowest point to reach temperature.
4. Place the BIs in selected cages and operate the sterilizer cycle.
5. Incubate the BIs for any signs of growth.

A temperature mapping should be included with periodic preventative maintenance procedures that the manufacturer performs on your system.

Controls

New sterilizers provide control options using a programmable logic controller (PLC) and human machine interface (HMI) based control systems. These controls are simple to use, and allow the technician to configure and record the temperature of the sterilization cycle. Technicians can control various processes, such as start/stop, fault indicators, temperature displays, timers, and alarms based in a secure way that prevents accidental changes to stored sterilization programs.

Control technology has evolved to a point where technicians need not be in the same room as the sterilizer. Remote control ability makes it possible for the technician to operate, monitor, and diagnose problems afar using a computer or device with web access.

Design Options

Dry heat sterilizers come in two basic design options that include various sizes and configurations.

The first design utilizes a closed, hermetically sealed container that houses the rodent cages. The container is docked into the circulation system of the oven, which forces heated air up through the cages to achieve sterilization. Once the cycle is complete, the container of sterilized cages can be



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removed from the oven and moved to the point of usage while maintaining sterility and cleanliness of the product load.

The second design loads rodent cages via a standard open truck that you might be using currently in your facility. A typical loading truck size is 24.5"W x 60"L x 70"H. Oven designs can accommodate up to six such trucks.

Both design configurations utilize a unique focused forced air convection airflow design that has been developed to minimize the cycle time of these units while maximizing the product throughput capability.

Dry Heat Success Story

Robert Harris, D.V.M, Director of Laboratory Animal Services, Rutgers, the State University of New Jersey needed to increase cage processing capability within his existing facility. However, the quote to run steam to the proposed sterilizer location proved to be cost prohibitive for Harris. Dr Harris noted, "A dry heat sterilizer has proved to be the perfect solution to our need for increased cage processing capability in an existing facility. Upon receiving an astronomical quote to just get steam to the proposed sterilizer location we had all but given up on being able to afford a new sterilizer. Without much of a track record for this technology in the lab animal field, we knew we were taking some risk and exploring new ground. It turned out to be an excellent decision. I initially assumed that dry heat from electricity could not be cost effective. I also had a preconceived notion that dry heat sterilization could not be as effective as steam sterilization. I changed my mind on both accounts. In the end we were able to site and afford a sterilizer twice the size of the steam autoclave we had first considered."

Summary

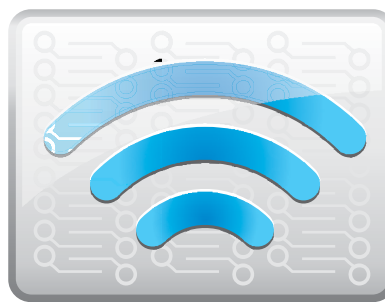
Dry heat sterilization is not a new technology as it has been widely used in pharmaceutical manufacturing and other industries for years. Now, units designed specifically for rodent cage sterilization are commercially available from manufacturers who offer custom design services, installation assistance, and after-sale support.

Compared to steam, dry heat sterilizers provide many cost-effective benefits to laboratories. The technology is greener and requires less energy and maintenance to sterilize rodent cages. The cages can be reused for a longer period of time and the washroom environment is generally more comfortable. Also, custom design services, installation assistance and after-the-sale support and maintenance are typically provided by the equipment manufacturer.

David Waldrab is the NE Regional Manager at Thermal Product Solutions, a part of SPX Corporation. More information about dry heat sterilizers is available at the TPS website, at www.thermalproductsolutions.com.

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