Hot Dry Oven Definition

A hot air oven is a type of dry heat sterilization consider laboratory instrument that uses dry heat to sterilize laboratory equipment and other materials.

Dry heat sterilization is used on equipment that cannot be wet and on material that will not melt, catch fire, or change form when exposed to high temperatures. Moist heat sterilization uses water to boil items or steam them to sterilize and doesn't take as long as dry heat sterilization. Examples of items that aren't sterilized in a hot air oven are surgical dressings, rubber items, or plastic material. Items that are sterilized in a hot air oven include:

- Glassware (like petri dishes, flasks, pipettes, and test tubes)
- Powders (like starch, zinc oxide, and sulfadiazine)
- Materials that contain oils
- Metal equipment (like scalpels, scissors, and blades).

Hot air ovens use extremely high temperatures over several hours to destroy microorganisms and bacterial spores. The ovens use conduction to sterilize items by heating the outside surfaces of the item, which then absorbs the heat and moves it towards the center of the item. The commonly-used temperatures and time that hot air ovens need to sterilize materials is 170 degrees Celsius for 30 minutes, 160 degrees Celsius for 60 minutes, and 150 degrees Celsius for 150 minutes.

Hot air ovens sterilize equipment over long periods of time, so she has to be organized in determining what items will be sterilized at what time. This depends on when the equipment needs to be available again.

Purpose of the Hot Air Oven

The drying oven is used for sterilizing or drying glassware and metal materials used for examinations or tests performed in the laboratory. Dry heat sterilization of clean material is conducted at 180 °C for two hours in the oven. Upon being heated by high temperature dry air, humidity is evaporated from glassware and thus the possibility of any remaining biological activity is eliminated.

Principle of Operation

Generally, drying ovens have an internal and an external chamber. The internal chamber is made of aluminum or stainless steel material with very good heat transference properties. It has a set of shelves made of stainless steel grids so that air circulates freely around objects requiring drying or dry heat sterilization. It is isolated from the external chamber by insulating material which maintains high temperature conditions internally and delays the transference of heat to the exterior. The external chamber is made of steel laminate, covered with a protective film of electrostatic paint. Heat is generated through sets of electrical resistors transferring this thermal energy to the chamber. These resistors are located in the lower part of the oven and heat is transferred and distributed by natural or forced convection (in oven with internal ventilators).

The power (energy by a unit of time) dissipated by an electrical resistor can be calculated by means of the following equation:

$P = I^2 R$

Where:

I = Intensity of the electric current in amps [A]

R = electrical resistance in ohms [Ω].

Given that the energy is neither created nor destroyed but transformed, it is possible to calculate the thermal energy equivalent to the resistive elements. In the case of a resistive wire, the quantity of heat [q] dissipated can be calculated by the following equation:

$I^2 R = q^{\cdot} \pi r_0 2 L$

Where: R = resistance of resistive wire.

I = intensity of the electrical current.

r_0 = outer radius of the wire.

L = length of the resistance wire

$q^{\cdot}$ = is the heat generated per unit volume.

Resistance [R] can be calculated by the following equation:

$R = \rho L / A$

Where:

ρ = resistivity of the resistor's material.

A = surface of the resistance wire.

The oven has a metallic door with its own thermal insulation equipped with a similarly insulated handle to prevent burns on hands. The door is installed on the front part of the oven by a set of hinges which allow it to open at a 180° angle. The modern oven is controlled by a module with a microprocessor. It allows selection of the equipment's operation parameters and its alarms; and the programming of cycles or thermal processes through which are controlled, not only the temperatures but also the way in which they need to vary in time through phases of heating/cooling (natural) or through stable temperatures maintained within certain time intervals. Ovens operate normally from room temperature up to 350 °C. Some models have limited ranges of operation. Older ovens simply have a set of resistors, whose operation is controlled by a thermostat. The following table features the temperature/time relationship required for dry heat sterilization in drying ovens.

Table of temperature/sterilization time by dry heat

Temperature °C	Time in minutes[2]
180	30
170	60
160	120
150	150
140	180
121	360

The Parts of Hot Air Oven:

1. Mechanical part.
2. Electric part.

First Type: Mechanical part:

1. The Coat (outer shield). 2. Fiber glass

3. The chamber.

4. The shelves (mesh).

1. The Coat: the coat is made of aluminum or stainless steel because it is characterized by the following:

a) resisting the mechanical shocks.

b) Resisting the oxidation.

c) Rectangular solid shape to be easily placed anywhere in the laboratory.

d) The coat consists of several surfaces an isolator material prevents heat from getting outside.

2. Fiber Glass: There are two types of fiber glass:

a) Brown fiber glass: be somewhat cheap, but it is a dangerous substance because it causes inflammation in respiratory system and should be careful in dealing with.

b) Yellow fiber glass: available by variously and it is less dangerous than the brown, the skin is sensitive to it and should wear gloves when dealing with. The advantage of fiberglass is a good insulator of heat and it is used in the oven to prevent the transfer of heat from inside the device to the outside and maintain the internal temperature.

3. The Chamber: The chamber is completely made of aluminum or stainless steel because it has the following characteristics:

a) Rectangular solid shape to suit dealing with various objects.

b) It has thermally insulated from all other parts of the oven to prevent effective on them.

c) It has ribs to put shelves in the wanted levels.

d) It is made from materials characterized by oxidations' resisting.

4. The Shelves (mesh): they are plates on which the objects are placed, the number of shelves is varying according to the number and size of objects, the oven capacity. It characterized by:

a) They are made of aluminum which is considered as oxidation resisting material.
b) When they are placed in their locations on the ribs some area is lifted to allow movement of air, some shelves contain openings to help this purpose.

Second Type: Electric part:

1. The power supply.

2. The heater.

3. Thermostat.

4. Temperature indicator (thermometer).

5. Timer.

6. Fuses.

7. Control panel.

1. Power Supply: The used supply in the oven is 220v – 50Hz transformer and rectifying circuit (AC to DC convert) to run the control panel if the parameters, numeric or other departments in the modern fashion.

2. The Heater: The electric heating system is the system in which heating produce by rising of temperature caused by the passing of electric current through a conductor having a high resistor to current flow. Generally, they can be operated from 50 to 300 °C. The heaters can be used for hot air oven applications with the following voltages:

- 347 volts/1 phase.
- 600 volts/1 phase.
- 600 volts/3 phases.
- 208/240 volts/1 phase.
- 208 volts/3 phases

The heater element has the following characteristics:

1- High resistance.
2- Electrical insulation.
3- Thermal conductivity.

There are 6 types of heaters used in dry oven:

1- One side circular type heater.
2- One Side U type heater.
3- One side wave type heater.
4- One side square type heater.
5- Three sides type heater.
6- Four sides type heater.

3. Thermostat: is a semiconductor made of ceramic, it characterized with having thermal resistance with a high negative temperature coefficient, this means the resistance of thermostat decrease as temperature increases and vice versa. So it is a sensor of heat connecting directly with heater and the separation of heater in certain degrees so as to obtain the temperature we need as needed and also used to protect the device.

4. Temperature Indicator: Twos way are used in temperature indicator there are thermometer and thermocouple & Identified for the internal temperature.

5. Timer: There are two type of timer electrical or mechanical at range 5-60 min given period of time required for sterilization.

6. Fuse: To protect the circuit from high current due to the high loads or short circuits.

7. Control Panel: (oven door) contains several elements and the most important about indicator power lamp usually green & indicator heater lamp usually red & contain switch on-off and timer & knob.

Electric circuit of Hot Air Oven

Figure (38) shows the basic electrical circuit of the drying oven. The following elements are outlined:

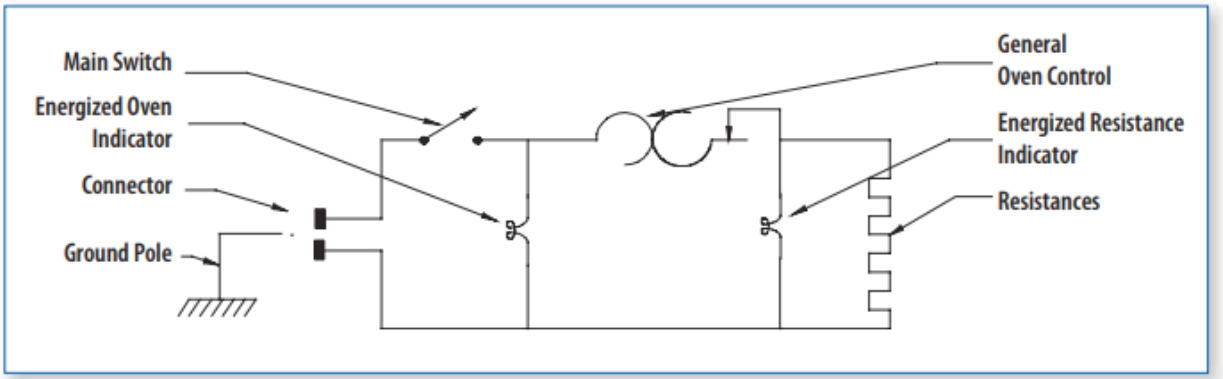
1. Main switch. It energizes or turns off the oven.

2. Control. It controls the oven's functions (temperature, time, type of heating and cooling, selected operation modes such as preheating, sterilization, dehydration, preparation, drying and even baking).

3. Resistors. Heating elements transforming electrical energy into thermal energy.

4. Indicator systems. Devices complementing the general control. These indicate if the oven is ON and in operation.

Figure 38. Electric circuit of the oven



Oven Controls

A diagram of controls regulating modern drying ovens is shown in Figure 37. It is possible to identify the following elements:

1. The main switch.

2. Screens for controlling the current and selected temperatures.

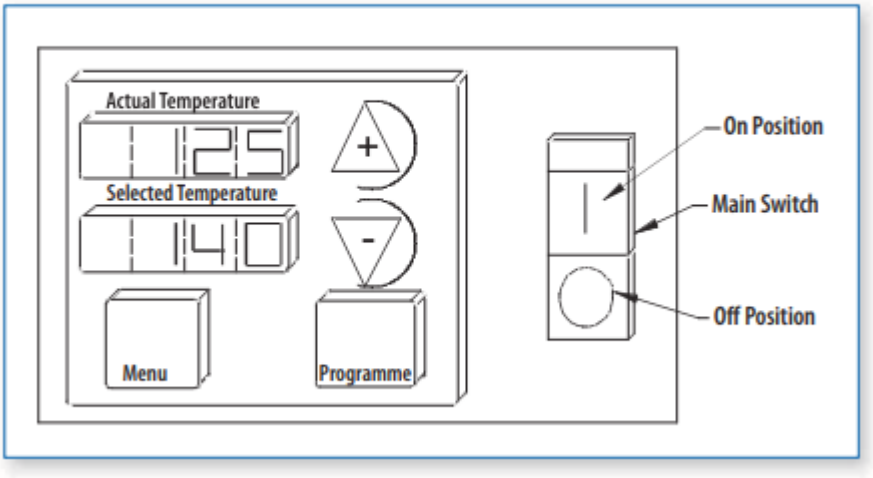
3. The parameter selection button (menu).

4. The button for programming operation cycles.

5. Buttons for increasing and decreasing the temperatures. Each manufacturer supplies detailed instructions to operate these controls. In general, they are located

on the lower part of the oven and are cooled by a ventilator which circulates ambient air inside the assembly space where other electronic components are installed.

Figure 37. Electronic control of the oven



Types of Hot Air Oven

There are present different types of hot air oven such as;

1. Gravity Convection Air is distributed by spontaneous convection. As hot air flows up, a gentle flow holds temperatures moderately uniform inside a container and wholly uniform in any distinct position.

2. Forced Convection

- These ovens carry a fan that gives limited air circulation within the heating container.
- This method provides very fast heat up and restoration times, mixed with especially low-temperature differences inside the working chamber.
- Flexible vents and semi-forced exhaust deliver it a conventional sample-drying oven.

3. Mechanical Convection is a gravitation convection oven served with a re-circulating fan in a working container.

4. Forced Exhaust Ovens

- In these ovens, air is pushed into the working container by a fan and scattered through an adaptable vent.
- This variety of oven is especially helpful in purposes where the heating process provides vapors or fumes that require to be immediately and continuously discharged from the working container.
- All of the forced air ovens consume at a higher percentage than a convection oven. Though, much larger forced exhaust velocities can be accomplished by adding an air channel and a flexible outlet.
- This adjustment takes an extra $100 and is totally achievable with forced convection ovens.

5. Side Draught Ovens

- Certain ovens produce airflow from one side to the other i.e. left to right.
- Speedy heat up and restoration time make this type of oven prototype for preheating plastic cloths (hospitals, etc.) or any profession where smooth sheets or plates are used.

Hot Air Oven Advantages

- No need to water to sterilize the material.
- Not much pressure is created like autoclave which creates it easy to manage and also makes it safer to work with.
- In a laboratory environment, it is more fitting to use as compared to other sterilizers.
- Hot air oven is much smaller in size as compared to autoclaves and also more effective.
- A hot air oven can be more speed than an autoclave and higher temperature can be achieved as compared to other means.
- The operating procedure is simple as compared to other sterilization methods
- Its price is low as compared to autoclave.

Hot Air Oven Disadvantages

- According to the principle of thermal inactivation by oxidation, it cannot slaughter some living organisms, such as prions due to the use of dry heat rather than wet heat.
- Most of the materials are not fit with hot air ovens such as surgical dressings, rubber items, or plastic material; they can be a meltdown at low temperatures.

Hot Air Oven Application

- It is used to dry glassware, sterilize N95 masks, general instruments, and packaging items in life science, microbiology laboratory.
- It is also used in chemical and pharmaceutical industries, food and beverage industries, textile industries.
- In certain laboratories and hospitals, it is used to store materials at a constant temperature.