# MEDICAL INSTRUMENTATION
# SECOND YEAR
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# LECTURE NO.(5)
# OVENS

DR. SAIF AL-SABTI

# 1. Introduction

Hot air ovens are laboratory and scientific equipment which uses dry heat (hot air mixture) for sterilization of laboratory equipment. The dry heat sterilization process is developed by Louis Pasteur to sterilize the equipment using the hot air ovens. Dry heat sterilization is the heating process in which the material which is placed inside the oven has the characteristics which will not melt, catch fire or changes its form while heating at high temperature. A hot air oven is a laboratory instrument that uses dry heat to sterilize laboratory equipment and other materials.

That equipment cannot be wet or material that will not melt, catch fire, or change form when exposed to high temperatures are sterilized by using the dry heat sterilization method. Hot air oven also known as forced air circulating oven. Some examples of material which can not be sterilized by employing a hot air oven such as surgical dressings, rubber items, or plastic material.


Figure 1: Hot air ovens

To destroy microorganisms and bacterial spores, a hot air oven provides extremely high temperatures over several hours. The widely used temperature-time relationship in hot air ovens to destroy microorganisms are 170 degrees Celsius for 30 minutes, 160 degrees Celsius for 60 minutes, and 150 degrees Celsius for 150 minutes. Most of the medical industries use hot air ovens to sterilize laboratory instruments and material due to its simple standard operating procedure and low price. It also provides quick-drying processes. The process of dry heat sterilization using a hot air oven Originally developed by Louis Pasteur.

The temperature range of a hot air oven is 50 to 300 ° C. It can be controlled by using a temperature regulator. The forced air circulation provided by the oven ensures the temperature uniformity throughout the oven. In a hot air oven first, The surface of the material is sterilized then the temperature slowly enters the center of the item.

## 2. Working Principle of Hot air oven/Hot air oven principle

The hot air oven is based on the principle method of dry heat sterilization. Since conduction is the basis of dry heat sterilizations, thus the temperature first reaches the surface of the material to be sterilized, and then it gradually moves towards the core of the material. Thus, dry heat sterilization makes sure to sterilize every part of the material. Then, the whole material gets a uniform supply of heat, and if this heat is employed for a certain amount of time, then it helps in the sterilization of all different kinds of microorganisms, such as bacteria, viruses, fungi, and even the resistant Endospores, which escape most of the sterilization procedures.

Dry heat sterilizes the material by inducing oxidizing the particles inside it and damaging their primary component, which results in the ultimate death of the organism. Usually, the temperature that is set for efficient sterilization is about an hour. Since hot air is lighter than cold air, thus increasing the temperature inside the chamber results in the flow of hot air up to the roof of the chamber while cold air comes down. Thus, it facilitates the circulation of hot air inside the chamber.

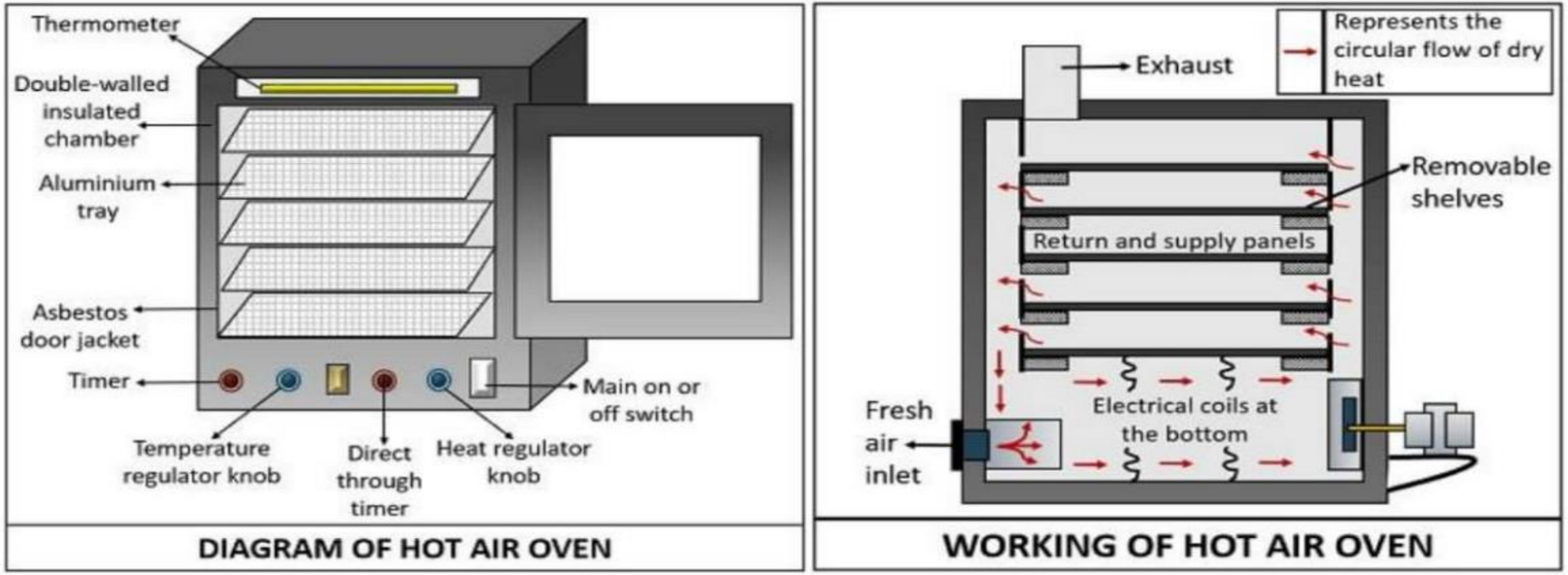


Figure 2: Working principle of hot air oven

## 3. Parts/ Components of Hot Air Oven

There are many components of hot air oven as follow:

- External cabinet: It is made up of stainless steel, and it also covers the inner chamber.
- Glass wool insulation: Glass wool is fitted between the inner and external chamber, which provides insulation to the system.
- Inner cabinet: This is also made up of stainless steel, and the material to be sterilized is kept inside it.
- Tubular air heaters: Heat inside the inner chamber is created using tubular air heaters, and they usually present in a pair of two on each side of the inner chamber.
- Motor-driven blower: It helps in the uniform circulation of the hot air within the chamber.
- Temperature sensor: It is a temperature display present on the screen which measures the inside temperature of the chamber.
- Tray slots: They are used to hold multiple trays
- PID temperature controller: during the entire cycle of circulation of hot air, this temperature controller helps in maintaining the accurate temperature. It also helps in controlling the temperature and displays it on screen.
- Load indicator: Indicates the overload of material inside the chamber.
- On/off switch: helps turn the hot air oven on/off.
- Safety thermostat: aka over-temperature protection device, which helps keep the oven and specimen inside it safe in case of any malfunctioning عطل, thus avoiding damage.

## 4. Types of hot air oven

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

a) Gravity Convection: 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.

b) Forced Convection Ovens: 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.

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

d) 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.

e) 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.

## 5. The uses of hot air oven

There are many application and uses of hot air oven such as:

- Annealing: The process of annealing involves heating and then cooling material, such as glass or steel, in order to reduce hardness and increase ductility. High-temperature ovens are used in this process, often in the application of metallurgy, medical device manufacturing and material science industries. These annealed materials can be cut and shaped more readily to be used in the production of things such as syringes and catheters.
- Die-bond curing: Through a combination of drying and baking, lab ovens cure substances in order to harden their chemical composition. This is a means of creating epoxies, glues, plastics and rubbers used in polymer research, nanotechnology and semiconductor industries. The increased bond strength is also exceptionally useful in adhering components directly onto circuitry, many of which are used in military, space and medical systems.
- Drying: A necessity for many environmental, biological and clinical labs; gravity convection, forced air and vacuum ovens are used in the drying of samples to remove moisture from them. Forced air and vacuum ovens are best suited to samples that are easily broken down, as these remove moisture and lower the boiling point of water, letting the sample to be dried at a lower temperature. Gravity convection ovens, meanwhile, are often used to dry fine particles as these are liable to scatter with high air flow and need a more natural airflow in order to protect these delicate samples.
- Polyimide baking: Added to the oven in liquid form, the polyimide is then thermally baked to create a thin film or a layer for various uses, including stress buffer coating for redistribution layers, adhesion, chip bonding and much more.

- Sterilizing : At their most basic, laboratory ovens can also be used to sterilize lab equipment and glassware. Carried out in a hot air oven, the ideal temperature needs to be at least 160 °C, with contents monitored at this heat for 45 to 60 minutes. A slow cooling period is needed, as removing items from the oven straight away can cause them to crack, while the gradual cooling prevents potentially harmful air, containing contaminating organisms, from entering the oven. Additionally, all items that need to be sterilized also have to dry – using a temperature of 60 °C is thought to be acceptable when routinely using glassware.

- Other uses: Additionally, lab ovens are employed to perform material testing, analyzing attributes such as determine tensile strength, deformation and resiliency of manufactured products, solder strength in circuit boards and more. Lab ovens are also used in biological, forensic and environmental labs where their uses are more specialized. In forensic labs, specially configured vacuum ovens are used to develop fingerprints, while biological labs use gravity convection ovens to remove microbiological contaminants in lab equipment, along with vacuum ovens in order to adhere substrates to the surface of filters. Elsewhere, environmental laboratories weigh specimens before and after drying to determine their moisture content.

## 6. Advantage and disadvantage of hot air oven

There are many Advantage and disadvantage of hot air oven as follow:

- The 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 speedy 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.

- The disadvantages

- It is unable to sterilize some living organisms, such as prions, because it uses dry heat rather than using wet heat because it uses the principle of thermal inactivation by oxidation.
- Surgical dressings, rubber items, or plastic materials are some of the materials that do not fit with a hot air oven because they can melt down even at lower temperatures.