

AUTOCLAVE:

Principle, components and working

Autoclave

The autoclave is a sealed device (similar to a pressure cooker) that kills microorganisms using saturated steam under pressure. The use of moist heat facilitates the killing of all microorganisms, including heat-resistant endospores which is achieved by heating the materials inside the device at temperatures above the boiling point of water.

Gk. *Auto*- self, and Latin *clavis* – key, a self locking device.

- The word **sterilizing** means the destruction or elimination of all forms of life (microbial, including spores) present in inanimate objects by means of physical, chemical or gaseous procedures.

What is an Autoclave?

In 1879, Charles Chamberland developed the autoclave as a sterilization alternative to open flame techniques. While autoclaves (also called steam sterilizers in some settings) exist in varying shapes and sizes, the basic principle of autoclave sterilization is the same.

Regardless of size, autoclaves are self-sealing steel vessels which can be found in a variety of industries to perform sterilization or other scientific processes best carried out in high-pressure and high-temperature environments. Typically, the innards of an autoclave are cylindrical since this shape more easily withstands high pressures than a box or cube.



Operation Principle



- When water is heated in a closed container, saturated steam is produced under pressure.
- According to Boyle's Law, when volume of the steam, is kept constant, the temperature is directly proportional to pressure.
- If the pressure is reduced it boils at a lower temperature. If the pressure rises, it boils at a greater temperature.
- At 15 lbs pressure 121⁰ C temperature can be obtained.
- Moist heat coagulates cell proteins of the microorganisms and thus kills all the living entities (including spores) in 15 to 20 minutes.
- Hot saturated steam is efficient means of destroying microorganisms, since it penetrates rapidly and gives up its latent heat as it condenses on the cooler objects.

Working of Autoclave

The functionality of an steam sterilizer can be simply compared to a pressure cooker. By utilizing steam to create a high-pressure environment and maintaining a temperature too high for microbial survival, autoclaves are capable of successfully eliminating pathogens which may be resistant to soaps and detergents. The pervasiveness of the steam created within the autoclave allows for thorough sterilization within hollow instruments and other minuscule crevices which could be missed during cleaning with detergent.

While the extraordinarily high pressures automatically create a seal from the outside world (the word "autoclave" is derived from "auto" and "clave," literally meaning "automatic locking"), external latches also exist to maximize safety.

Depending on the objects being sterilized, autoclave cycles must be manually set by a technician in order to produce the safest and most optimal sterilization parameters for the given load. In autoclave temperature increases as pressure increases. The relationship between temperature and pressure is as below.

The Relationship Between the Pressure and Temperature of Steam at Sea Level*

TABLE

Pressure (psi in excess of atm pressure)	Temperature (°C)
0 psi	100
5 psi	110
10 psi	116
15 psi	121
20 psi	126
30 psi	135

The Stages of Autoclave Sterilization

The sterilization process includes several different phases, listed below.

1. Purge Phase: During the purge phase, steam displaces air within the autoclave chamber. Both temperature and pressure begin to increase.

2. Sterilization Phase: The exhaust remains closed, allowing the temperature and pressure to rapidly rise to the desired values. It is during this phase that the autoclave's harsh conditions destroy bacteria, spores, and other pathogens.

3. Exhaust Phase: Pressure is released from the chamber, but temperatures remain fairly high. Technicians should take care when removing hot contents from the autoclave.

Purpose of the Autoclave



- In the laboratory, materials and objects are sterilized for the following purposes:
 1. To prepare materials for bacteriological cell cultures (test tubes, pipettes, Petridishes, etc.) in order to avoid their contamination.
 2. Prepare elements used for taking samples. (All must be in sterile conditions: needles, tubes, containers).
 3. Sterilize contaminated material.

What can be Autoclaved?

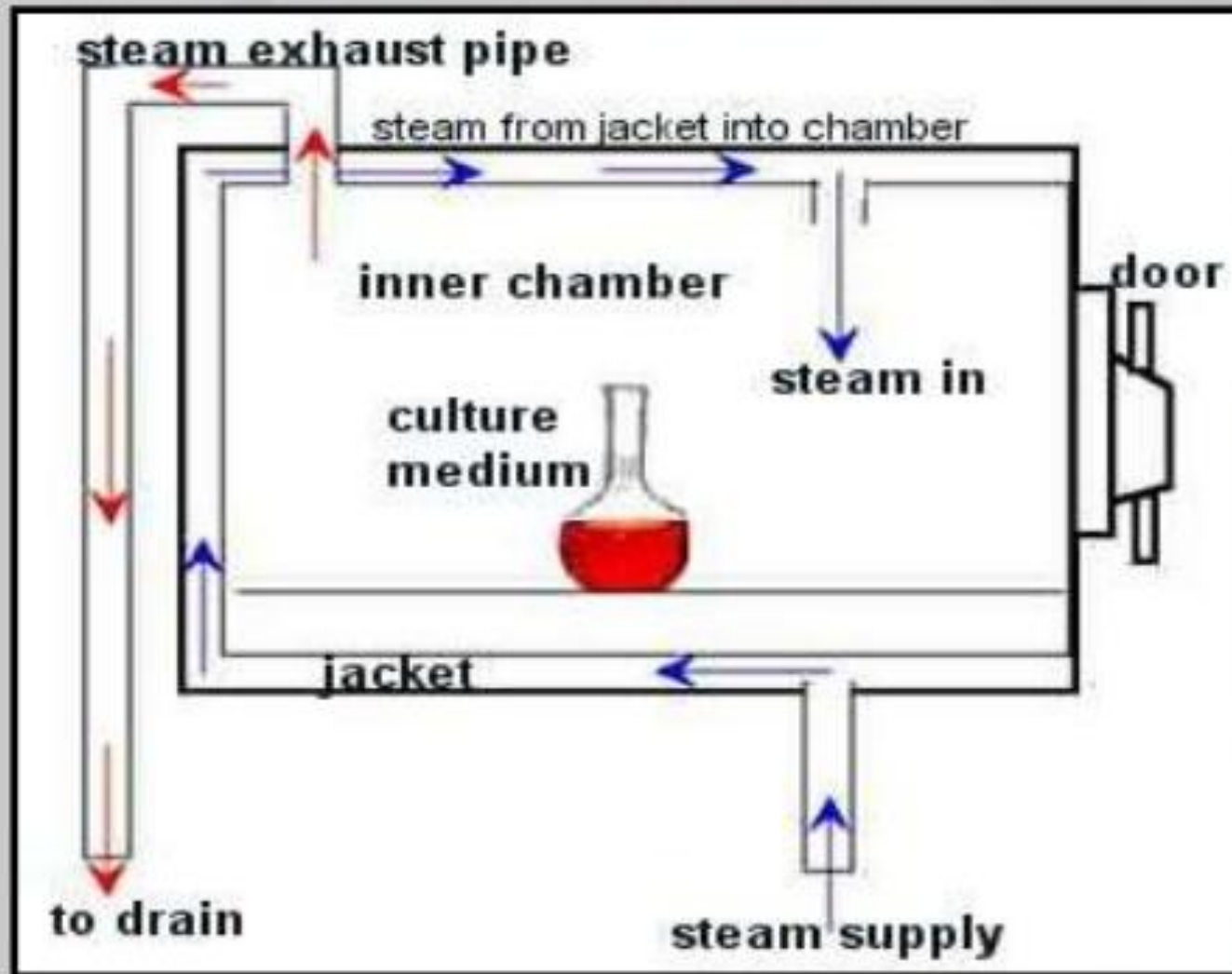


- Surgical Instruments
- Glassware
- Plastic tubes and pipette tips
- Culture and stocks of infectious material
- Discarded Live and attenuated vaccine
- Media and solutions
- Waste

Pressure Regulating Device



Schematic Diagram Of Autoclave



Components of Autoclave

Autoclave comprises of three parts: a **pressure chamber**, a **lid** and an **electrical heater**.

Pressure chamber consists of –

- Large cylinder (vertical or horizontal) in which the materials to be sterilized are placed. It is made up of gunmetal or stainless steel and placed in a supporting iron case ay through
- A steam jacket (water compartment)

The lid is fastened by screw clamps and rendered airtight by an asbestos washer. The lid bears the following-

- A discharge tap for air and steam discharge
- A pressure gauge (sets the pressure at a particular level)
- A safety valve (to remove the excess steam)

An **electrical heater** is attached to the jacket; that heats the water to produce steam.

Procedure

- Place the material to be sterilized inside the pressure chamber and fill the cylinder with sufficient water
- Close the lid and put on the electrical heater.
- Adjust the safety valve to the required pressure.
- After the water boils, allow the steam and air mixture to escape through the discharge tap till all the air has been displaced
 - This can be tested by passing the steam-air mixture liberated from the discharge tap into a pail of water through a connecting rubber tube.
 - When the air bubbles stop coming in the pail, it indicates that all the air has been displaced by steam.

- Close the discharge tap. The steam pressure rises inside and when it reaches the desired set level (e.g. 15 pounds (lbs) per square inch in most cases), the safety valve opens and excess steam escapes out.
- Count the **holding period** from this point of time, which is about 15 minutes in most cases.
- After the holding period, stop the electrical heater and allow the autoclave to cool until the pressure gauge indicates that the pressure inside is equal to the atmospheric pressure.
- Open the discharge tap slowly and allow the air to enter the autoclave.
- Open the lid of the autoclave and remove the sterilized materials.

Precautions

The following precautions should be taken while using an autoclave.

- Autoclave should not be used for sterilizing waterproof materials, such as oil and grease or dry materials, such as glove powder
- Materials are loaded in, such a way that it allows efficient steam penetration (do not overfill the chamber). It is more efficient and safer to run two separate, uncrowded loads than one crowded one.
- Wrapping objects in aluminium foil is not recommended because it may interfere with steam penetration. Articles should be wrapped in materials that allow steam penetration.
- Materials should not touch the sides or top of the chamber
- The clean items and the wastes should be autoclaved separately.
- Polyethylene trays should not be used as they may melt and cause damage to the autoclave.

Autoclave Limitations

While autoclaves remain extraordinarily versatile tools, some materials and substances are not compatible with autoclaves and could be dangerous if included within a load and entered into a sterilization cycle. For example, certain chemicals such as acids and bases should never be autoclaved, nor should materials made of polyethylene, polyurethane, or polystyrene.

It is critical that autoclave technicians thoroughly understand the principle of autoclave sterilization to avoid safety hazards during use.