

Al-Mustaqbal University.

College of Engineering

Biomedical Engineering Department.

**Subject:** laboratory instrumentation

**Class :** 4<sup>th</sup>

**Lecture:** 1

***By: Zainab Sattar Jabbar M.SC. IN BME***



# Autoclave



# Autoclave: function

**What is an autoclave ?** The autoclave or **sterilizer** is a **pressure chamber** used to sterilize equipment and supplies by subjecting them to **high pressure, saturated steam**. Sterilizing means the **inactivation of all forms of life** (bacteria, viruses) present in inanimate objects.

**Why is high pressure used ?** Because under pressure you can increase the temperature of water to **higher than 100° C**, destroying life quickly.

# Autoclave: used in hospitals, laboratories

The autoclave or sterilizer is equipment designed with the aim of reliably eliminating microorganisms, which would otherwise be present on objects used in diagnostic or therapeutic activities in health institutions, including **surgery** and **dentistry**.



Stovetop autoclaves—the simplest of autoclaves

In the **laboratory**, materials and objects are sterilized for the following purposes:

1. To prepare materials for bacteriological cell cultures (**test tubes**) 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.**

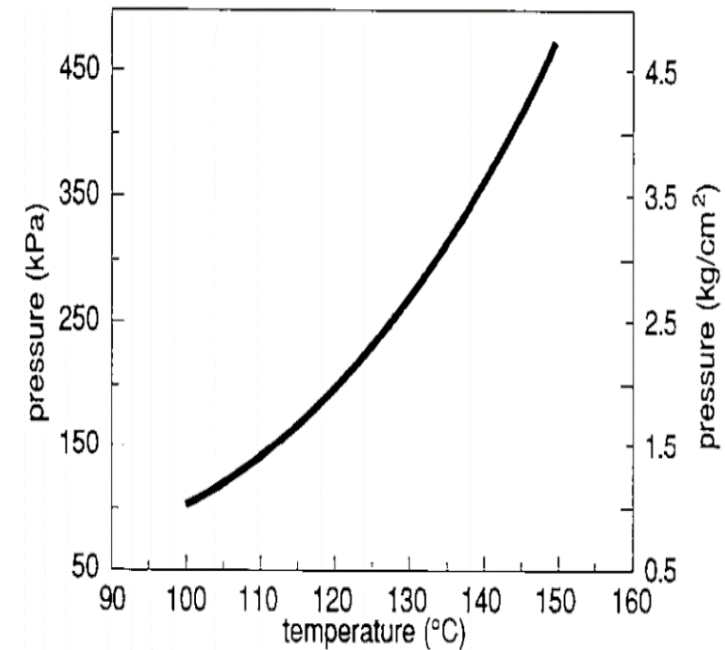


# Autoclave: scientific principles

Autoclaves work by taking advantage of the **thermo-dynamic properties of water**. In normal conditions (at sea level and pressure of 1 atmosphere) water (in liquid phase) boils and is converted into vapour (gaseous phase) at a 100 °C.

If the pressure is reduced, it boils at a lower temperature (98.6 °C at 1250 m. altitude). **If the pressure rises, it boils at a higher temperature.**

Through the control of water vapour pressure, the autoclave can, in its sealed chamber, reach temperatures higher than 100 °C; or inversely, by controlling the temperature, can achieve pressures greater than atmospheric pressure.



Fixed relation between steam pressure and temperature

# Operation of the autoclave

1. Turn the autoclave **ON**.
2. **Open the door** of the autoclave. In large capacity autoclaves, this process is done electromechanically.
3. **Place** the sterilization containers with the prepared material (cleaned, washed, dried) into the sterilization chamber.
4. **Close the door** of the autoclave.
5. Select the required **sterilization cycle** depending on the type of objects or materials to be sterilized.

# Operation of the autoclave

From this moment on, the process proceeds as indicated next:

- a) The **pre-treatment phase** is initiated. In this phase, short alternate cycles of emptying and injecting of vapour into the sterilization chamber are performed so that **air is extracted** from it and packets protecting the material are sterilized.
  
- b) When the air has been removed, **filling and pressurization** of the sterilization chamber is initiated. At this time, the vapour enters into contact with objects to be sterilized and a process of heat transference is initiated between high temperature vapour and articles to be sterilized. Upon transferring thermal energy, a portion of vapour is converted into liquid water (**condensed liquid**) in the exterior layers of the material used for packing, simultaneously decreasing its volume in a significant way. More vapour can then enter the sterilization chamber, which penetrates even further inside the packages to be sterilized. Vapour eventually completely surrounds these and the pressure and temperature are established.

# Operation of the autoclave

c) Once these conditions are attained, the countdown for completing the sterilization (depending on the type of objects or materials being processed) is initiated. The higher the temperature and pressure, the lesser the time required for sterilizing.

d) Once the programmed sterilization time has ended, post treatment process is initiated. This includes depressurization of the chamber .

e) Finally, controlled entry of air through valves with high efficiency filters will be allowed until the pressure in the sterilization chamber is equal to the atmospheric pressure.

6. Open the door of the autoclave.

7. Unload the sterilized material.

8. Close the door once the sterilized material is unloaded to conserve the heat

in the sterilization chamber and facilitate the next sterilization cycle.

9. Store the sterilized material appropriately.

# Autoclave: Construction

Autoclaves are available in many sizes. The smallest are the table-top type and the largest are complex equipment that require a great amount of pre-installation for their operation. The volume of the sterilization chamber is taken as a reference in litres [l] in order to measure the autoclave's size.



Pressure Cooker Type



Common Laboratory Autoclave



Horizontal Autoclave

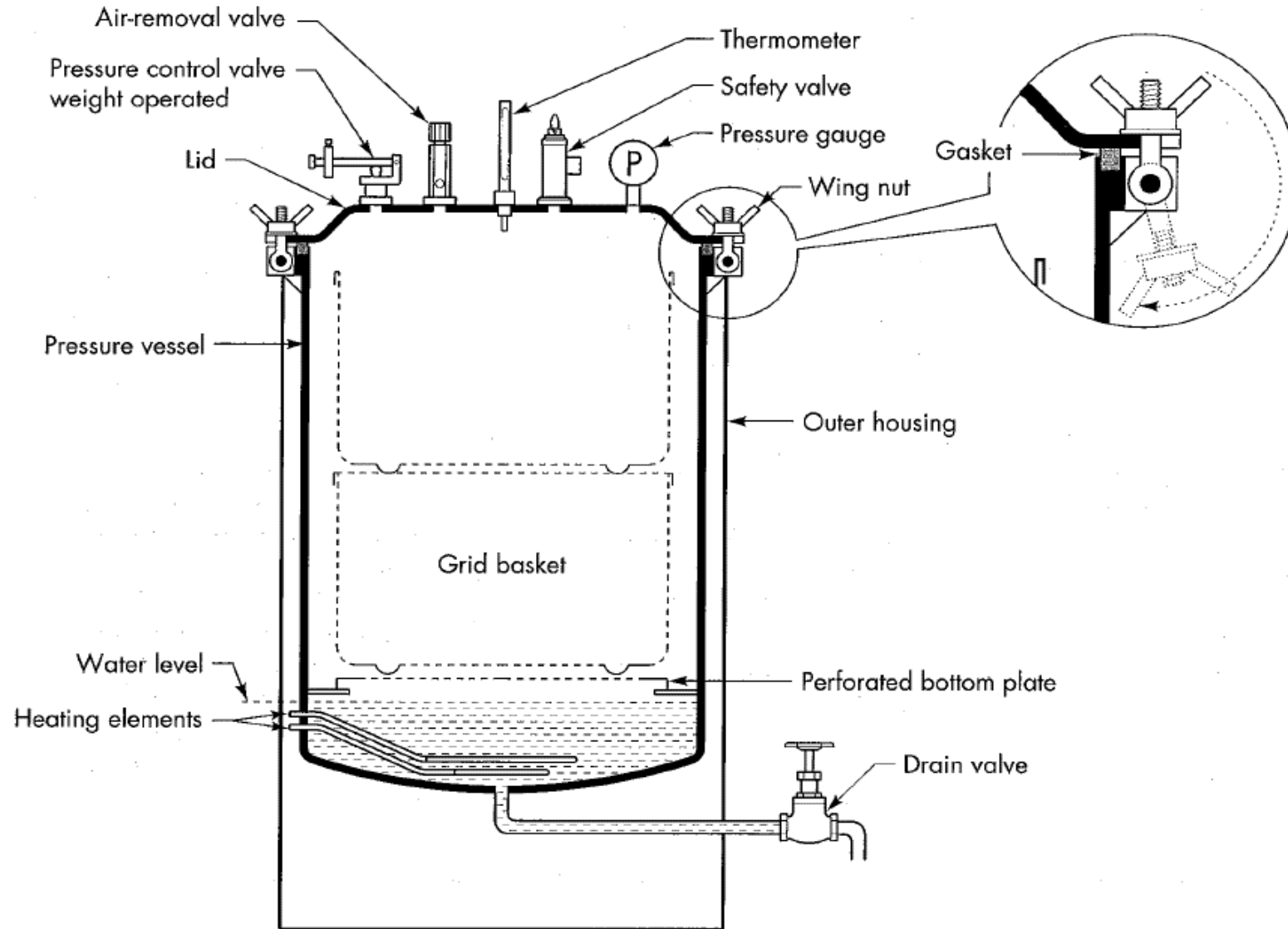


Vertical Autoclave



Large Automatic Hospital Autoclave

# Autoclave: Construction



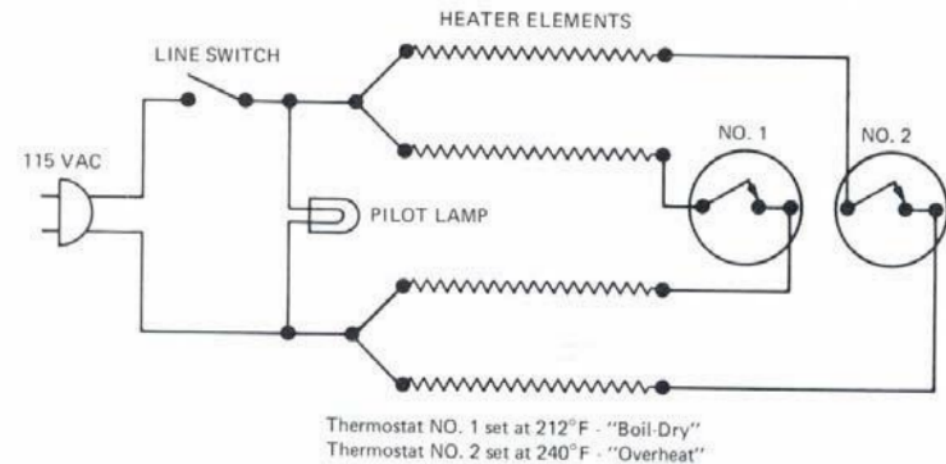
# Autoclave construction: thermostats

There are often two thermostats.

One is a **boil-dry safety thermostat** connected in series with one of the elements and set to open at 100 °C. This will reduce the violence of boiling once 100 °C is reached.

The second thermostat, often called the **overheat relay**, is set to turn off the electricity going to the nicrome elements when the temperature is excessive, usually meaning that **the water has boiled away**.

Circuit of a simple, electric autoclave.



# Autoclave: Trouble shooting

- If you hear a **hissing noise**, then there is a **leak in the pressure vessel or valve**.
- Try to isolate the problem by looking for **steam escaping** and by using your ear. If the problem is a valve, you probably need to replace the valve. If the problem is **the vessel**, it is impossible to fix and the autoclave should be discarded.
- The **seal on the vessel** is also a common source of leaks. Check to see that there are no obstructions (dirt) along the seal. Some machines use a **plastic or rubber seal**. For these machines, run your fingernail into the seal. It should be pliable. If **the seal is hard, or worse cracked, then it must be replaced**.

# Autoclave: Trouble shooting

Several types of seals and gaskets are used in the construction of the autoclave, from door seals to generator gaskets. Made from quality grade silicone, these seals keep moisture from escaping the autoclave, as well as protecting the contents from the outside atmosphere.



# Autoclave: Trouble shooting

- If the **seals are working** and there are no leaks or clogs, the manual autoclave should work.
- The automatic autoclave may still not reach the proper temperature. The cause may be the **thermostat or the heating element**. In the most sophisticated autoclaves, the **controller** can be suspected.
- If there is no heat generated, it could be the **heating element or the thermostats**. The typical heating element consists of **two coils of nickel-chrome resistance wire**, each of which has approximately 14 ohms of resistance. If the resistance across a coil is significantly higher, it is probably **broken**.



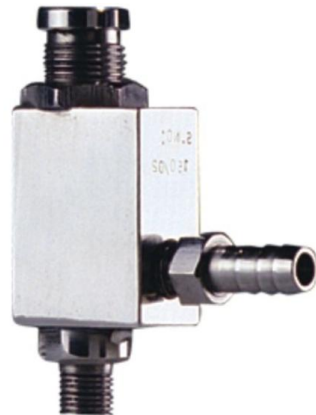
# Autoclave: Safety considerations

- ❑ Autoclaves can injure the operator or leave the equipment undetectably contaminated.

Therefore, testing should be done before releasing the device for use.

- ❑ If possible, check the temperature inside the vessel during sterilization. Most US hospital users put **test strips** with each sterilization pack. These strips verify that the temperature reached the required level for the required time and that humidity was present.

- ❑ Check the safety valve on the vessel. If it is dirty or corroded, try to replace it



$\pi$

THANK YOU