

## Portable autoclave and pressure cooker buying guide

Consideration	Explanation
<b>Fit for purpose?</b>	Autoclaves are built for sterilising, and will have a safety and effectiveness guarantee. Pressure cookers are not built to sterilise media, though some will work at temperatures suitable for this. Check the temperature/pressure specifications. They will be used outside the manufacturer's remit, so guarantees will not apply.
<b>Cost</b>	Pressure cookers are cheaper than autoclaves. A large autoclave can save money (if technician time is included) because fewer runs are needed. Autoclaves with integral or external automatic controls can also be cost-effective as less supervisory time is required.
<b>Minimum sterilising temperature and time</b>	121°C for 15 minutes of steam is essential for sterilising water-based materials (note: pressure cookers require 5 minutes of free steaming to vent the air before you start the timer). Autoclaves working at higher temperatures for shorter times will also sterilise, but may denature some media. For very sensitive media, e.g. for fungal cultures, it may not be possible to use 121°C. See the technical notes below. <i>All</i> microbe-containing material and equipment must be exposed to the full sterilisation temperature and time. Test that sterilisation has been achieved, particularly if using a fixed cycle automatic autoclave as the load may not reach the required temperature for the full time. See technical notes below.
<b>Minimum operating pressure</b>	15psi/103kPa/1.04bar ensures steam at a temperature of 121°C. Setting different pressures allows variation in operating temperature.
<b>Construction material</b>	Large portable autoclaves made from cast aluminum or stainless steel can be very heavy and may prove unwieldy use.
<b>Chamber capacity</b>	In general, the larger the chamber the more can be sterilised in a single cycle. A sensible minimum is a class set of Petri dishes or media bottles. Some autoclaves have a larger capacity than pressure cookers; however, they may be difficult to accommodate in a small prep room.
<b>Chamber shape</b>	Is it tall and wide enough to accommodate the largest flasks or bottles to be sterilised? Look out for non-usable space, particularly in tall models with no internal shelf. Tall thin microbiological media bottles may enable sterilisation of large volumes in relatively small pressure cookers/autoclaves.
<b>Heat source</b>	This should be stable and efficient e.g. an electric hotplate or large gas burner (which will need to be professionally installed), not a Bunsen. Autoclaves generally require a larger gas burner; pressure cookers can be heated effectively with a hotplate. Autoclaves with a built-in electrical element are more expensive, but easier to operate.
<b>Ease of set up and operation</b>	Can the autoclave/pressure cooker be easily set up? For instance, does it require judgement of whether wing-nut screws are tightened appropriately, and does the locking device enable easy removal of the lid?

<b>Operating time</b>	<p>A short operating time allows more frequent runs.</p> <p>Operating time of externally heated pressure cookers/autoclaves can be reduced using water (distilled/deionized) that has been heated in advance.</p> <p>Check the total load to unload time. Some autoclaves cannot be opened for a considerable time after sterilization is complete.</p>
<b>Level of supervision</b>	<p>Autoclaves/pressure cookers heated that are externally must be closely supervised during operation, because the heat source can only be switched off manually.</p> <p>Internally heated autoclaves cut off the electricity if the unit over heats. Automatic controls ensure that the safe period of heating is not exceeded, as the device switches itself off at the end of the cycle. However, even electrical autoclaves must be checked while operating</p>
<b>Additional safety features</b>	<p>All autoclaves and pressure cookers have at least one safety valve which prevents the equipment exceeding the safe operating limits.</p> <p>There is also at least one additional valve/feature that will allow the steam to escape safely if the safety valve fails to operate.</p> <p>All autoclaves operating at 15psi or higher have an interlock that prevents the lid being removed when pressure inside is greater than atmospheric.</p> <p>Some autoclaves have a catch on the lid to prevent opening until the temperature is below 80°C. This helps stop glass bottles shattering on rapid cooling.</p> <p>Gauges or indicators may also be fitted that monitor conditions inside the vessel.</p>
<b>Repair and spare parts</b>	<p>Check cost and availability of spare parts e.g. gaskets.</p> <p>Pressure cooker spare parts are cheap and easily obtainable, despite this replacement may be cheaper than repair.</p> <p>Autoclave spare parts are more expensive and are generally only available from the manufacturer. Repair costs will also be higher.</p>
<b>Servicing</b>	<p>Regular autoclave servicing extends working life.</p> <p>To ensure a long operating life, only use deionised or distilled water in the autoclave/ pressure cooker.</p>
<b>Inspection</b>	<p>Autoclaves and pressure cookers require periodic examination under the Pressure Systems Safety Regulations 2000.</p> <p>The examination of non-thermostatically controlled equipment can be carried out by a technician/teacher using a Written Scheme of Examination drawn up or certified by a suitably qualified engineer. See CLEAPSS Guide 214b Examining autoclaves, pressure cookers and model steam engines written schemes of examination for a list of pressure vessels where a written scheme of examination has been prepared by CLEAPSS.</p> <p>All other autoclaves must be examined by a suitably qualified engineer, who is also experienced in the use of the autoclave in question.</p> <p>The potential cost of the periodic examination should be considered before purchasing the equipment.</p> <p>See CLEAPSS Guide L214 Examining autoclaves, pressure cookers and model steam engines.</p> <p>For the full legal position, see the ACOP on Pressure Systems Safety Regulation 2000 published by the HSE and available in the free publications on the CLEAPSS website.</p>

For further guidance and information about training refer to the CLEAPSS website: [www.cleapss.org.uk](http://www.cleapss.org.uk)

**See Technical notes on following page.**

## Technical notes

### Sterilisation temperature and time

In Microbiology experiments, containers and food media given to the bacteria and fungi must be completely free of any living organisms at the start of the experiment. All living organisms, either in materials or on equipment, must be killed at the end. The destruction of living organisms is called sterilisation.

**121°C for 15 minutes** is the minimum temperature and time to destroy microbe spores and cells (note: pressure cookers require 5 minutes of free steaming to vent the air before you start the timer). Without this all microbes will not be completely destroyed, causing contamination and misleading results in any microbiological investigation. It might also be dangerous, as disease-causing microbes may be left alive.

Temperatures below 121°C will not sterilise effectively even if the time is longer than 15 minutes.

### Media for fungal cultures

Media for growing fungal cultures may be damaged by prolonged exposure to temperatures as high as 121°C. Therefore partial sterilisation by exposure to a lower temperature is a satisfactory compromise. This will not kill some microbes/microbial spores, but as only fungi can grow well in this media they should out-compete any contaminants.

### Obtaining temperatures above 100°C in water-based materials

Heating water-based materials to 121°C in a dry oven will not sterilise them. This is because the water in the materials needs to be at 121°C. Only superheated water can break down all microbial materials.

Normally water boils at 100°C and water vapour remains at that temperature, because it is not directly heated. In a dry oven, any water-based materials will be at 100°C, even if the air in the oven is at a higher temperature.

If the container is put under pressure, the water boils at a higher temperature and the steam (water vapour) is also raised to this higher temperature. This is how temperatures above 100°C are achieved.

To achieve a temperature of 121°C, a pressure of 15psi/103kPa/1.04bar above atmospheric pressure is required. Normal atmospheric pressure is 1bar, so this is like doubling the atmospheric pressure.

### Checking that the pressure cooker/autoclave will sterilise a given load

Test the unit before use. Sterilisation testing strips or vials show a colour change on exposure to the specified sterilisation temperature and time.

Place the strips or vials in water inside a typical load of containers used during a cycle. If the colour change is not complete at the end of the operating cycle, change the load parameters or extend the duration of the heating phase of the cycle if this is possible.

### Bottles/containers for sterilising media

Conical flasks and bottles used in schools may not make best use of the capacity of the unit. Microbiological media bottles which are tall, thin and flat-sided (medical flats) are efficient for pressure cookers and small autoclaves. In tests at CLEAPSS, a 6L pressure cooker commonly used in schools held 1600 ml in medical flat bottles, but only 750 ml in conical flasks.

There must be space between bottles or other containers for the steam to circulate.

### Components of autoclaves and pressure cookers

**Robust metal container** to hold items to be sterilised together with some water. The internal dimensions of containers determine the size and volume of equipment to be sterilised. This is particularly critical if tall fermenters are used.

Total capacity is important but less critical. It is always possible (if time-consuming) to sterilise material in several batches. A large autoclave is more efficient.

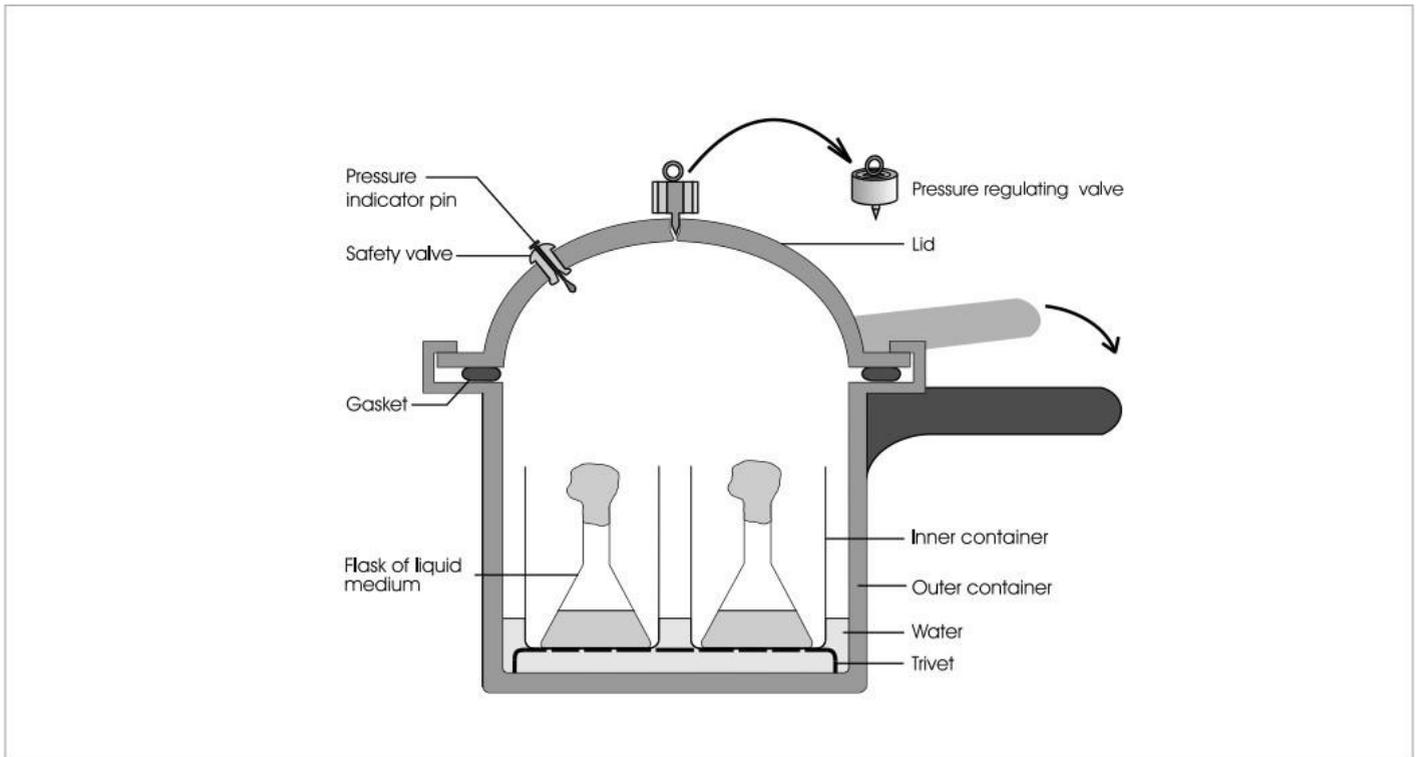
**Construction material:** portable autoclaves are often made of cast aluminium which is attacked by some minerals in tap water. Extensive corrosion makes an autoclave unsafe to use.

Large commercial autoclaves and some pressure cookers are made of stainless steel to reduce corrosion, but a higher quality stainless steel makes the equipment expensive for schools.

**An inner container/basket** often separates items being sterilised from boiling water. Baskets are usually perforated and on a trivet.

When filling the unit, ensure the water level is no higher than the trivet, so bottles do not topple over. If there is no trivet, follow the manufacturer's guidelines about the water level.

A flat-bottomed basket means that bottles etc. will be more stable. If supports are needed to stabilise equipment during sterilising, it should not prevent hot steam penetration. For example, when sterilising water in test tubes use a small rack rather than a high-sided beaker.



**Lid** with a mechanism for holding it in place. The lid cannot be accidentally released while the autoclave contents are under high pressure. Lids retained by wing nuts have two of them held on the lid, so the lid must be pulled partly open before these nuts are released.

**Gasket** to prevent steam under pressure from escaping around the lid. This seal must be flexible and elastic, this can be affected by repeated heating. This slow deterioration means that gaskets may begin to leak. A defective gasket allows steam to escape around the seal, resulting in insufficient pressure being developed for proper sterilisation. Suspect gaskets should be replaced before the equipment is used.

**Air-release valve** to allow air or steam to be expelled rapidly.

**Pressure-regulating valve** to release excess steam once working pressure (and hence temperature) is reached. The valve may be adjustable to allow different working pressures (and hence temperatures) to be selected. This is useful for sterilising delicate media, such as for culturing fungi. In pressure cookers, the pressure-regulating valve doubles as an air-release valve.

**Safety valve** to prevent the build-up of excess pressure. The pressure-regulating valve may do this. Some pressure cookers and smaller autoclaves have a valve in the lid which should open if pressure in the vessel approaches safety limits.

**Gauges or indicators.** A pressure gauge detects when the vessel is under pressure. Such gauges are not very accurate, and are not an essential part of the safety mechanism. Pressure cookers often have a metal pintle (referred to as a 'ready to serve' indicator); this lifts when the container is under pressure and drops back again when the pressure returns to atmospheric.

**Heat source** can be an external gas or electric heater, or a built-in electrical element. For safety reasons, an external heater must provide a stable base on which to stand the equipment. Hotplates, electric rings and gas rings provide an inherently stable base, a tripod and Bunsen burner does not. Large gas ring burners need to be professionally installed (as per a gas oven) and not connected to a laboratory gas tap.

Autoclaves with built-in heat supplies are convenient, and enable various degrees of automatic operation to be achieved, but are initially more expensive.

**Sterilisation cycle control** method varies from manual control in which each step is initiated and timed by the operator, to programmable microprocessor control.

A fully automatic autoclave is convenient to use, but only those specifically designed for sterilising media can be relied on to provide a sufficiently high temperature for long enough for microbiological work.



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