LABROTORY INSTUMENTATION AND TECHNIQUES

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LECTURE FOUR
AUTOCLAVE

An autoclave is essentially just a large steel vessel through which steam or another gas is circulated to sterilize things, perform scientific experiments, or carry out industrial processes. Typically the chambers in autoclaves are cylindrical, because cylinders are better able to withstand extreme pressures than boxes, whose edges become points of weakness that can break. The high-pressure makes them self-sealing (the words "auto" and "clave" mean automatic locking), though for safety reasons most are also sealed manually from outside. Just like on a pressure cooker, a safety valve ensures that the steam pressure cannot build up to a dangerous level.

A medical autoclave is a device that uses steam to sterilize equipment and other objects. This means that all bacteria, viruses, fungi, and spores are inactivated. However, prions, such as those associated with Creutzfeldt-Jakob disease, may not be destroyed by autoclaving at the typical 134 °C for three minutes or 121 °C for 15 minutes[citation needed]. Although that a wide range species of archaea, including Geogemma barosii, can survive at temperatures above 121 °C, no archaea are known to be infectious or pose a health risk to humans; in fact their biochemistry is so vastly different from our own and their multiplication rate is far too slow for microbiologists to worry about them.

Autoclaves are found in many medical settings, laboratories, and other places that need to ensure the sterility of an object. Many procedures today employ single-use items rather than sterilizable, reusable items. This first happened with hypodermic needles, but today many surgical instruments (such as forceps, needle holders, and scalpel handles) are commonly single-use rather than reusable items (see waste autoclave). Autoclaves are of particular importance in poorer countries due to the much greater amount of equipment that is re-used. Providing stove-top or solar autoclaves to rural medical centres has been the subject of several proposed medical aid missions.

Because damp heat is used, heat-labile products (such as some plastics) cannot be sterilized this way or they will melt. Paper and other products that may be damaged by steam must also be sterilized another way. In all autoclaves, items should always be separated to allow the steam to penetrate the load evenly

Working Principle

Why is an autoclave such an effective sterilizer? An autoclave is a large pressure cooker; it operates by using steam under pressure as the sterilizing agent. High pressures enable steam to reach high temperatures, thus increasing its heat content and killing power. Most of the heating power of steam comes from its latent heat of vaporization. This is the amount of heat required to convert boiling water to steam. This amount of heat is large compared to that required to make water hot. For example, it takes 80 calories to make 1 liter of water boil, but 540 calories to convert that boiling water to steam. Therefore, steam at 100… C has almost seven times more heat than boiling water. Steam is able to penetrate objects with cooler temperatures because once the steam contacts a cooler surface, it immediately condenses to water, producing a concomitant 1,870 fold decrease in steam volume. This creates negative pressure at the point of condensation and draws more steam to the area. Condensations continue so long as the temperature of the condensing surface is less than that of steam; once temperatures equilibrate, a saturated steam environment is formed.

Achieving high and even moisture content in the steam-air environment is important for effective autoclaving. The ability of air to carry heat is directly related to the amount of moisture present in the air. The more moisture present, the more heat can be carried, so steam is one of the most effective carriers of heat. Steam therefore also results in the efficient killing of cells, and the coagulation of proteins. When you cook beef at home, for example, it can become tough when roasted in a covered pan in the oven. But just add a little water in the bottom of the pan, and you will find that the meat will be tender! The temperature is the same and the time of roasting is the same, but the result is different. Now (as in an autoclave) add another parameter, pressure. By putting this same roast in a pressure cooker you can reduce the time it takes to cook this roast by at least three quarters, and you still get just as tender a finished product

How does killing occur? Moist heat is thought to kill microorganisms by causing coagulation of essential proteins. Another way to explain this is that when heat is used as a sterilizing agent, the vibratory motion of every molecule of a microorganism is increased to levels that induce the cleavage of intramolecular hydrogen bonds between proteins. Death is therefore caused by an accumulation of irreversible damage to all metabolic functions of the organism.

Death rate is directly proportional to the concentration of microorganisms at any given time. The time required to kill a known population of microorganisms in a specific suspension at a particular temperature is referred to as thermal death time (TDT). All autoclaves operate on a time/temperature relationship; increasing the temperature decreases TDT, and lowering the temperature increases TDT.

Application of autoclave

Sterilization autoclaves are widely used in microbiology, medicine, podiatry, tattooing, body piercing, veterinary science, mycology, funeral homes, dentistry, and prosthetics fabrication. They vary in size and function depending on the media to be sterilized.

Typical loads include laboratory glassware, other equipment and waste, surgical instruments, and medical waste.A notable recent and increasingly popular application of autoclaves is the pre-disposal treatment and sterilization of waste material, such as pathogenic hospital waste. Machines in this category largely operate under the same principles as conventional autoclaves in that they are able to neutralize potentially infectious agents by utilizing pressurized steam and superheated water. A new generation of waste converters is capable of achieving the same effect without a pressure vessel to sterilize culture media, rubber material, gowns, dressing, gloves, etc. It is particularly useful for materials which cannot withstand the higher temperature of a hot air oven.

Autoclaves are also widely used to cure composites and in the vulcanization of rubber. The high heat and pressure that autoclaves allow help to ensure that the best possible physical properties are repeatably attainable. The aerospace industry and sparmakers (for sailboats in particular) have autoclaves well over 50 feet (15 m) long, some over 10 feet (3.0 m) wide.

Other types of autoclave are used to grow crystals under high temperatures and pressures. Synthetic quartz crystals used in the electronic industry are grown in autoclaves. Packing of parachutes for specialist applications may be performed under vacuum in an autoclave which allows the parachute to be warmed and inserted into the minimum volume.