ATLANTIS PRESS
Advances in Computer Science Research (ACSR), volume 76
7th International Conference on Education, Management, Information and Mechanical Engineering (EMIM 2017)

Automatic Medical Sterilizer based on ARM

Jian Li
Information Technology College of Jilin Agricultural University. Changchun 130118, China
342884220@qq.com

Keywords: Sterilizer; Automatic; ARM; Steam; Medical

Abstract: The high technology sensitive components utility model relates to a high temperature and high pressure steam sterilizer, which is widely used in the fields of Ophthalmology, Department of stomatology, operation room, clinic and laboratory, etc. The utility model can be used for fast and effective sterilization of medical instruments, parcels, liquid, utensils and other articles suitable for the high temperature and high pressure steam working conditions. The sterilization temperature can choose between 100°C and 134°C. The 23 liter cavity is provided with a tray with 4 layers, which is convenient for placing different surgical instruments, and the drying procedure can provide the additional drying after sterilization procedures are finished. The unit incorporates several safety features designed to protect both the operator and the material being sterilized.

Introduction

Steam sterilization has been used for more than a century to sterilize items that can withstand moisture and high temperature. Steam is water in the vapor state; therefore, it is non-toxic, generally readily available, and relatively easy to control. A good understanding of basic steam sterilization principles and cycles is necessary to avoid mistakes that can lead to non-sterile load items, poor performance of the equipment, personnel injury, lower productivity, higher operation and maintenance costs, and damage to load items. Steam sterilizers are used for numerous applications in the pharmaceutical and medical device industries. The focus of this article is saturated steam applications, such as laboratory media sterilization, decontamination, and general component sterilization. Low-frequency magnetic field has great impact on cells and tissues; and low-frequency high-intensity pulsed magnetic field destroys microbial cell membrane and organelles, greatly reducing microbial density [1-3].

Direct steam contact with the surface of the object to be sterilized is required for the steam to transfer its stored energy to the object. Without direct steam contact to all surfaces, the item will not be sterilized. The amount of energy stored in steam is much higher than dry air or water at the same temperature. From the saturated steam table mentioned above, one can see that it takes 419 kJ/kg (to heat water from 0°C to 100°C). This is the enthalpy of water. It takes an additional 2257 kJ/kg to create steam at atmospheric pressure [4-5]. This additional energy stored in the steam is the enthalpy of vaporization, and is the key to steam sterilization. In order for the steam to transfer its stored energy, it must condense on the surface of the object being sterilized.

System

This device is semi-automatic table–top sterilizers designed for sterilization of instruments and other materials in medical hospitals and food laboratories, research institutes and pharmaceutical test facilities.

The hardware portion of the control system consists of a keyboard and main electronic boards designed specifically to match the requirements of the autoclave. which contains the ARM microprocessor and is responsible for controlling the system and the various system components processing signals traveling to and from these areas. The power board consists of 380V AC power filters and drivers for the AC steam generator components in the system. DC 12V and 5V power for all the DC components is supplied by a switching type power supply. In addition the system is capable of direct communication with a printer over a parallel interface and/or a PC via an RS 232 port.

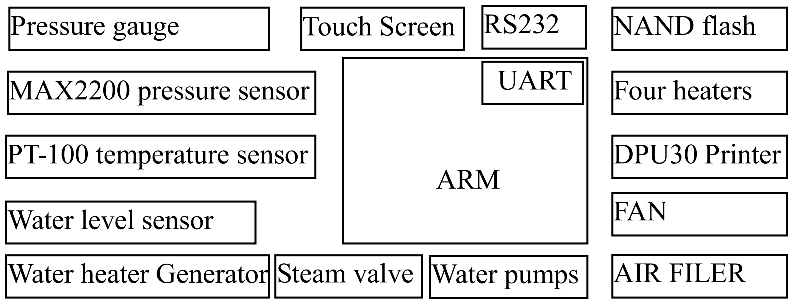

Figure 1. System overall structure schematic drawing of electronic sterilizer

The touch screen is mounted to and directly connected to the ARM LCD interface. The keypad serves as a control panel containing the command and programming keys. It also displays cycle progress updates and error messages. In addition it contains the following light indicators: START (autoclave in process), FAIL (the process failed), WATER (no water in the reservoir), DOOR (blinks with buzzer sound when START is pressed and the door is not closed).

The calibration of temperature and pressure is performed digitally. This system does not have adjustment pots. All calibrations are preformed through the touch keypad. The electronic temperature and pressure measuring circuits built into the device are designed with components having 1% accuracy. The pressure circuit produces a linear output and has an electrical output range of 100mv - 2400mv, which corresponds to a pressure range of 0 - 58 psia. The temperature circuit also produces a linear output and has an electrical output range of 100mv - 2400mv, which corresponds to a temperature range of 20°C - 150°C. The temperature and pressure circuits provide analog input voltages that are converted to digital signals by the A/D converter. The performance of the Analog to Digital converter (A/D) is limited for values greater than 2400mv or less than 100mv.

The system has a non-volatile memory in which the offset and gain data of the sensors are stored, as well as any error compensation factors that are calculated. Storage in the no-volatile memory means that even if the main power is turned off the information is saved for use the next time the machine is run. The preset parameters values will replace the last default values and become the updated default values. Calibration is performed by entering data through the keypad or a standalone computer when the PC communication port is used.

The sterilizers provide a choice of three basic programs, the operation modes and parameters have to be performed by operator, according to the type of material to be sterilized. The electronic timer used in these autoclaves, begins counting the sterilization time when the temperature reaches the preset sterilization value and cuts off the heaters when the sterilization stage is completed; this enables to shorten the total sterilization cycle. A multipurpose selector valve/programmer activated by operator through a knob mounted on the front panel, executes two series of operations.

The unit incorporates several safety features designed to protect both the operator and the material being sterilized. A door switch prevents the operation of the unit, if the door is not properly closed. A pressure activated locking device prevents opening of the cover, if the chamber is under pressure. A safety relief valve blows off at a predetermined steam pressure, to avoid build up of overpressure in the sterilization chamber. The control unit is protected electrically by fuses against short-circuit or overload and against overheating by a cut-off thermostat.

Performace Testing

The purpose of packaging and wrapping of items for sterilization is to provide an effective barrier against sources of potential contamination in order to maintain sterility and to permit aseptic removal of the contents of the pack. Packaging and wrapping materials should permit the removal of air from the pack, penetration of the sterilizing water vapor into the pack and removal of the sterilizing vapor.

The basic principle determining the size, mass and contents of instrument and hollowware packs is that the contents are sterile and dry immediately on completion of the drying cycle and removal of the pack from the sterilizer chamber.

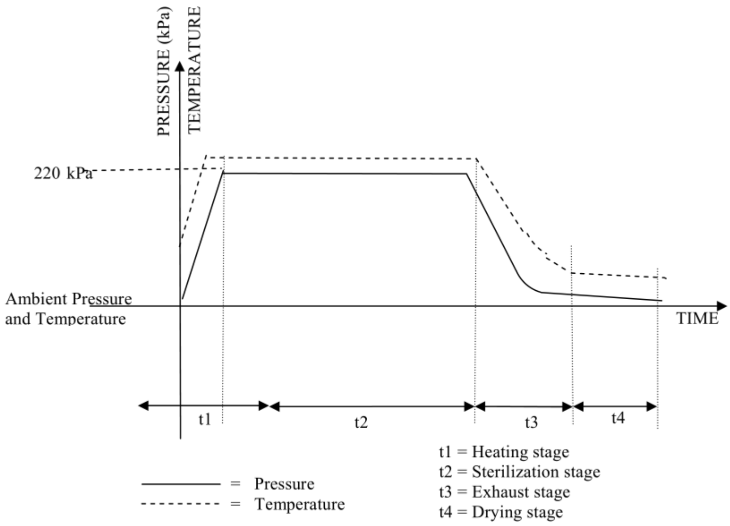

Figure 2. Shows the operations sequence

Mechanical operations, WATER FILL, EXHAUST and DRAIN; Electrical operations, by activating microswitches that transmit commands to the electronic timer circuit for the operations of heating, sterilization and dry.

Fill Water flows from the water reservoir into the chamber.

STE. Sterilization cycle activates the heating elements.

EXH. & DRY Exhausts the steam from the chamber into the water reservoir.

Ster Temp – Required sterilization temperature for the process.

Ster Time – Required sterilization time for the process.

Dry Time – Required drying time for the process.

Water Time – Time for entering water to the autoclave.

Heat T.O. - The maximum time allowed for the heating stage.

EndTemp - The ending temperature of the process.

Table 1 Sterilization time for different material

Item	Sterilization Time [min]	
	121°C	126°C
Tousse	15	10
Rubber glove	25	20
Dressing bag	30	20
Dressing drum	45	30
500ml bottled liquid	20	15
1000ml bottled liquid	25	20
2000ml bottled liquid	40	35
5000ml bottled liquid	50	45

Is a capillary thermostat with the tip of the bulb sensor open, which converts it into a pressure sensitive device. This sensitive element is connected to the chamber and transmits the pressure to the thermostat, through a capillary copper tubing. The switching device is mounted on the front panel and can be set through a knob with a pointer that indicates the set point on a circular scale on the panel with pressure/temperature divisions. This device automatically disconnects the heating elements in case of a rise in temperature. The heating power is automatically reconnected when the chamber cools down.

Conclusions

The unique characteristics autoclave was designed and constructed from locally available materials to make the cost of purchase affordable and to control infectious diseases. The device has a high potential for sterilizing items both wrapped and un-wrapped. The result of the test carried out shows that for sterilization to be more effective and efficient, higher temperature is required together with more time of exposure. A satisfactory result was achieved when the operating temperature was set at 126°C for 10 minutes. We therefore conclude that the rate at which microorganisms are thermally killed depends on the temperature, pressure, and time of heat exposure.

References

[1] Gonzalez M.E. and Barrett D.M. Thermal, High Pressure, and Electric Field Processing Effects on Plant Cell Membrane Integrity and Relevance to Fruit and Vegetable Quality. Journal of Food Science. Vol. 75 (2010) No.7, p.121–130.

[2] Raichenko O., Mosienko V., Shlyakhovenko V., Derev'yanko O, Yanish Y. and Karnaushenko O. Combined action of low temperature and magnetic field of different intensities on growth of some bacterial species in vitro. Health. Vol.4 (2012) No.4, p.249–252.

[3] Derev'yanko O, Raichenko O. , Mosienko V. Shlyakhovenko V., Yanish Y. and Karnaushenko O. Comparative analysis of magnetic fields,low temperatures and their combined action on growth of some conditionally pathogenic and normal humane microflora. Open Journal of Ecology. Vol.3 (2013) No.7, p.469–472.

[4] van Doornmalen Gomez Hoyos JPCM, van Wezel RAC, van Doornmalen HW. Case study on the orientation of phaco hand pieces during steam sterilization processes. J Hosp Infect. Vol.90 (2015), p.52-58.

[5] Schneider PM. New technologies and trends in sterilization and disinfection. Am J Infection Control. Vol.41 (2013), p.81–86.