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Fabrication and Analysis of Autoclave Sterilization Machine

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Abstract: *An Autoclave or a steam sterilizer is an important vehicle for reducing the microbial contamination of packaged final products, medicinal and food preparations etc. One of the major problems confronting healthcare professionals is the control of pathogenic organisms. This is because microorganisms are present in our environment and may contaminate healthcare instruments from time to time. An autoclave was designed and constructed to sterilize materials/items used in such healthcare institutions, the test will show a decrease in the growth of microorganisms at high temperature with less exposure time.*

Keywords: *Autoclave, sterilization, pathogenic organism, helth application, infections, wet steam, Temerature.*

I. Introduction

Sterilization Refers to any process that eliminate, remove, kills or deactivates all forms of life and other biological agent (such as fungi, bacteria, viruses, spore forms, prisons, unicellular, eukaryotic organisms such as plasmodium) Present in a specified region, such as a surface, a volume of fluid, medication, or in a compound such as biological culture media. Sterilization can be achieved Through various means, including: heat, chemicals, irradiation, high pressure, and filtration. Sterilization is not distinct from disinfection, sanitization, and pasteurization, in that sterilization kills, deactivates, or eliminates all forms of life and other biological agents which are present

There are mainly two categories for sterilization first is Heat and Chemical, heat is considered to be most reliable method of sterilization of objects that can withstand heat. Heat as moist and dry heat are the most common sterilizing methods used in hospitals and are indicated for most materials. A widely used method for sterilization is the autoclave, sometimes called a converter or steam sterilizer.

An autoclave is a pressure chamber used to carry out industrial processes requiring elevated temperature and pressure different from ambient air pressure. Autoclaves are used in medical applications to perform sterilization and in the chemical industry to cure coatings and vulcanize rubber and for hydrothermal synthesis

II. Literature Review

The first autoclave was “Chamberland’s Autoclave”. Charles Chamberland, a colleague of Pasteur, built upon Denis Papin’s work. Chamberland invented the autoclave in response to Pasteur’s requirement for a sterilization technique that utilized temperatures higher than 100 C. This was developed between 1876 and 1880. The major pioneer of the aseptic method of surgery was Professor von Bergmann of Berlin (1885) who Physical Chemical Heat Radiation Filtration Dry heat Moist heat Ionization Non-ionization Sterilization The Pacific Journal of Science and Technology introduced sterilization by steam into his clinic.

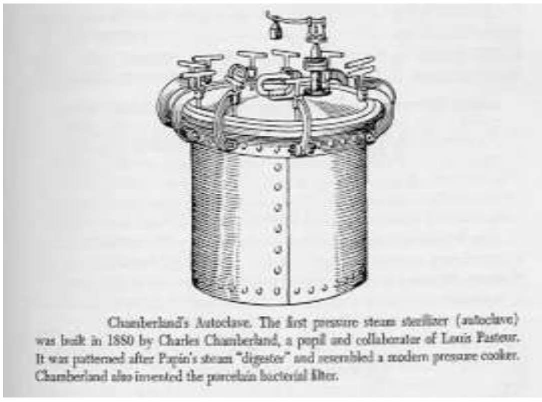

Figure1: First autoclave

A: Steam Sterilizer (Autoclave)

Most of the heating power of steam comes from its latent heat of vaporization. Steam sterilization is the most practicable method for sterilizing reusable medical devices in healthcare institutions because; it has lethality to pathogens, it is rapid; and it is nontoxic. The standard temperature/pressure-time relationship for steam sterilization is 1.05 bar (15 psi), 121^0 C (250^0 F) and 15 minutes

Steam is able to penetrate objects with cooler temperature because once the steam contacts a cooler surface, it immediately condenses to water, producing a replacement in folds, thereby resulting in decrease in steam volume. This creates negative pressure at the point of condensation and draws more steam to the area for further condensation. This condensation continues so long as the temperature at the condensing surface is less than that of steam present, until temperature equilibrium is obtained; and a saturated steam environment in formed.

The more moisture present, the more heat can be carried, so steam is one of the most effective carriers of heat. Moist heat kills microorganisms by causing coagulation of essential proteins structures that are nucleus and cytoplasmic membrane inclusive, rendering the cell non-viable. The rate at which bacterial cells are thermally inactivated depends on the temperature and time of heat exposure

B: Steam Sterilization Principles by Marcel Dion and Wayne Parker

Six factors are particularly critical to assure successful steam sterilization are time, temperature, moisture, direct steam contact, air removal, drying.

A typical sterilization cycle will include an exposure phase of at least 20 minutes at 121°C (250°F) for a Sterility Assurance Level (SAL) of 10^{-4}, assuming a starting population of one million (10^6) organisms. This means there is a one in ten thousand (10^{-4}) chance of a single viable Bst spore surviving the process. For each additional two minutes of exposure at 121°C (250°F) require 15 to 17 lbs of gauge pressure (103 to 117 kPa) in the chamber of the sterilizer

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 (180 Btu/lb.) to heat water from 0°C to 100°C (32°F to 212°F). The presence of condensation can cause re-contamination of the load when removed from the sterilizer. A steam sterilizer dries the load after sterilization by drawing a deep vacuum in the chamber .

C: "Development of a compact induction-heated autoclave with a dramatically shortened sterilization cycle in orthodontic clinics" Takashi Kameda, Natsuki Sano Nomintsetseg
Batbayar, Yukari Terashima `, Kazuto Terada
Orthodontic Waves journal ISSN :1344-0241

This article reviews the development of a compact autoclave with a dramatically shortened running time that did not compromise the quality of its sterilization properties including orthodontic appliances, orthodontic mini-implants instruments and other dental items.

Induction heating (IH) mechanisms were employed to produce a more compact machine and shorten sterilization sufficiently so that it could be used at chair-side. Intravessel pressure was estimated by a pressure gauge mounted in the lid of the sterilization vessel. A digital multimeter with a K thermocouple set in the lid of the vessel was used to monitor this intra vessel temperature. The level of sterilization achieved with a conventional autoclave and an IH autoclave was quantified by the biological indicator

Figure2: Induction heated autoclave with dramatically shortened sterilization cycle.

He found that the minimum effective sterilizing time after reaching the operating pressure was 25, 15, 12.5, 10 and 5 min at 0.20, 0.25, 0.30, 0.35 and 0.50 mpa with a compact IH mechanism, respectively. Combining the values with (i) the time taken to achieve the operating pressure and (ii) ∼2–3 min for cooling and removal of sterilized items gave the total sterilization cycle time, which were, on average, 30, 22, 19, 18 and 13 min at 0.20, 0.25, 0.30, 0.35 and 0.50 mpa, respectively. IH mechanism is useful for compact and speedy autoclave, which reduce total sterilization time by 40–80% compared with conventional autoclaves.

D: "Design of a Low-cost Autoclave for Adoption in Rural
Health Posts of the Developing World" by Gregory Tao submitted to the Department of Mechanical Engineering on May 11, 2012 low-cost autoclave has been developed for RHPs in Nepal and the wider developing world to meet not only the technical requirements for sterilization, but also relevant social and business factors

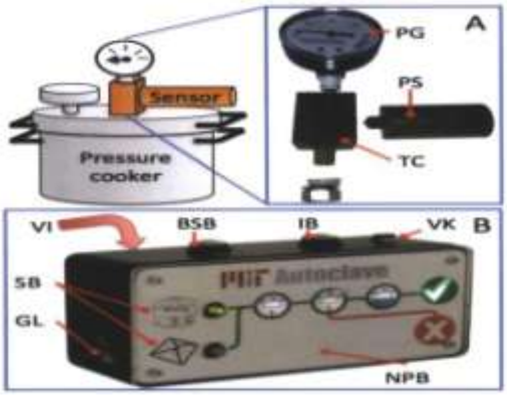

Figure3: Low cost autoclave for RHPs in Nepal

III. Problem Defination

The incidence of surgical-site infections (SSIs) ranges from 5-20% in developing world hospitals, dramatically higher than the SSI incidence of 2-3% in US and European hospitals'. The World Health Organization (WHO) estimates that the incidence of SSI is even greater in rural, resource-constrained clinics of the developing world, nearing 30% in some settings. These infections place an acute economic burden on poor patients who must repeat or prolong their hospital stay and absorb not only the living and travel expenses but also lost income from not being able to work during their trip and stay.

The way in which reusable instruments are cleaned between invasive procedures is of particular importance to the risk of SSI. The WHO states that inadequate equipment, lack of basic infection control knowledge and implementation, and unsafe procedures elevate the risk of SSI.

Many cleaning methods exist with varying degrees of efficacy. Decontamination is appropriate for hospital surfaces. High-level disinfection (HLD) kills 95% of microbes but fails to kill endospores that cause tetanus and gas gangrene because the strains are particularly robust to heat and chemical exposure. Currently, HLD is the best alternative and commonly used in 7 rural health posts (RHPs) where sterilization equipment is unavailable. Sterilization eliminates 100% of microbes, which is required for invasive surgical instruments. It is achieved by a multitude of methods, the simplest of which is steam autoclaving.

The design process presented here seeks to improve autoclave adoption by creating an autoclave that meets not only the technical specifications, but also the social and business factors that are critical to sustained adoption and scalability.

IV. Limitation Of Existing Model

1. High initial, operation and maintenance cost of equipment.
2. Many materials are strictly not allowed to do the autoclave for sterilization.
3. Its very time consuming and take around 30 minutes for completion one cycle.
4. Safety of operator not consider many time at the time of operation of autoclave sterilization.
5. Robust and heavy construction which is not portable.

V. Objective

1. Provide high efficient autoclave machine
2. Analysis of suitable material used for steam circulation inside the autoclave

3. Provide portable machine for sterilization in remote place at very less cost Small autoclaves designed for small healthcare facilities in a variety of sizes from 4L to 60L and are robust.
4. Make a machine which can have less maintenance and easy to use for anyone.
5. Increase the safety level of operation of autoclave.

VI. Conclusion

The autoclave will design and constructed from locally available materials to make the cost of purchase affordable and to control infectious diseases

All urban hospitals already had a large autoclave, and although the large autoclave was frequently broken, it was not more convenient, high-volume, and high-throughput compared to my autoclave.

I am try to give the solution to this problem by providing the best portable sterilization machine with better efficiency in very less price for rural and urban hospitals.

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