Practical guide to safe Autoclaving

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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., and it is the most commonly used equipment in all the biomedical laboratories. The microbial contamination is reduced by the combined effect of steam and pressure. The more is the pressure the more is the effect of the steam. Handling of Autoclave is associated with different hazards ranging from small injuries to fatal injuries. These injuries occur to the personnel because of the lack of proper knowledge on handling of the equipment and the hazards associated while working on it.When safety is concerned it is very important to provide training to the personnel on the safe use of the equipment.The intent of this guidance document is to make the personnel who are handling the autoclave and their supervisors to understand the operation, handling and to be aware of the hazards and incidents associated with the autoclave. This ensures a safe procedure for the handling of the instrument. The end users are therefore required to go through the document as part of the training programme before going to handle the equipment.

Index Terms— Energetics, Downward displacement, Dwell period, Spill management, Near Misses, Biological indicators, Personnel protective equipment, Ergonomic injuries

1 INTRODUCTION

Sterilization and decontamination are two important topics in the field of microbiology which are having a direct impact on the quality of the medicinal products. Sterilization (or sterilisation) is a term referring to any process that eliminates (removes) or kills all forms of microbial life such as fungi, bacteria, spore forms, etc., present on a surface, contained in a fluid, in medication, or in a compound such as culture media. Decontamination by autoclaving is the reduction of contamination to a level where it is no longer a hazard to people or the environment. Steam sterilization is moist heat sterilization which is one mode of sterilization. Moist heat, as the name indicates, utilizes hot air that is heavily laden with water vapour and where this moisture plays the most important role in the process of sterilization. Moist heat causes destruction of micro-organisms by denaturation of macromolecules, primarily proteins. Destruction of cells by lysis may also play a role. Steam Sterilization is the most commonly used sterilization method in the world which is achieved by using the Instrument Autoclave / Converter / Steam sterilizer. An autoclave is a device used to sterilize materials by subjecting them to high pressure saturated steam at 121 °C for around 15–20 minutes depending on the size of the load and the contents.

This guideline is designed to assist the personnel in understanding the purpose and limiting factors associated with the use of an autoclave when sterilizing the media or glassware or decontaminating the glassware and media or when cleaning the equipment.

2 OPERATING AN AUTOCLAVE

2.1 Operating Principle:

The autoclave works on the combined effect of temperature under pressure. During operation high temperature will be produced inside the chamber which will kill most microorganisms because they cannot tolerate the temperature since the proteins and enzymes can be denatured. The pressure will cause penetration of membrane walls of organisms, disrupting or breaking the walls, forcing the steam into them, and screwing up the osmotic pressure.

2.1.1 Energetics of Steam:

The boiling point of water is 100°C. In order to raise the temperature of a litre water from 23°C to 100°C, 80 kcal of energy is required and to convert the water from 100°C completely into steam requires another 540 kcal (this is referred to as the latent heat of vaporization). So when steam contacts something cool, it condenses onto the object and transfers this amount of energy (540kcal/L) into the material. This is why steam is used to transfer heat, because it does this so effectively compared to a dry air transfer of energy. It is also why a steam burn is more damaging to tissue than one from boiling water. To reach 121°C the steam must be pressurized to about 15 psi (pounds per square inch) or 103 kPa above atmospheric pressure.

2.2 Autoclave Technology and Cycles:

Air is generally trapped in the autoclave chamber. As air is a bad conductor of heat it is very important to ensure that all of the trapped air is removed from the autoclave chamber before activation. When air is present in the autoclave the steam that is generated cannot penetrate into the materials thereby fails to achieve sterility. In general the trapped air is removed by two methods by which the cycles have been described.

2.2.1 Downward displacement (or gravity-type) Cycles:

As steam enters the chamber, it fills the upper areas first as it is less dense than air. This compresses the air to the bottom, forcing it out through a drain which often contains a temperature-sensing device. Most commonly the standard cycle used for sterilization of media or liquids generally works by downward displacement.

2.2.2 Super atmospheric cycles:

Generally works with a vacuum pump. Here air is removed by a series of vacuum and pressure pulsing. It starts with a vacuum followed by a steam pulse followed by a vacuum followed by a steam pulse. The number of pulses depends on the particular autoclave and cycle choosen. Most commonly the HPHV cycles used for sterilization of glassware,

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accessories, garments, machine parts etc., generally works by this method.

2.3 Factors to Consider – Dwell period:

Each autoclave will have specific instruction for its own use. It is important to follow the manufactures recommendation and each user must receive hands-on training on its use. Although many factors must be considered when determining the length of time required, some general guidelines can be provided. Factors that will affect cycle times will be:

- Target process of the autoclave (sterilization or decontamination)
- Manufacturers recommendation for sterilization
- Type of material (Solid / Liquid)
- Volume of liquid
- Shape and size of containers used
- Thermo conductivity properties of the container
- Viscosity of the liquid
- Density of the material
- Position of the load within the autoclave chamber
- Load of the chamber.
- Size of the chamber.

It is important to recognize that dwell period required to achieve the sterilization temperature will be dependent upon the factors stated above.

2.4 Determining the Dwell period

As the cycle time will vary with the composition of the load, it is important to determine the appropriate time requirement. Considering the minimal time of 30 minutes, may prove to be a very costly mistake. Therefore, select the typical container and contents. Position them in the chamber and do not stack them. Place the biological indicators at the respective positions including the drain location.Tie the biological indicator into the material by a string or paste it to the material by using autoclaving tape to allow easy retrieval. Run the autoclave using the typical cycle selection. Retrieve the biological indicator and process as per manufactures instructions. If the biological indicators turn turbid the autoclave process has FAILED. At this junction increase the cycle time and retest until the biological indicator proves a successful one. PASS is indicated by no col-our change, and hence no bacterial growth. Determine the dwell period by calculating the time of the successful cycle.

2.5 Cycle Failure

At any point of time during the process of autoclaving if the autoclave cycle fails to be completed, the load must be re-autoclaved. If the failure was due to a power outage the cycle stop the process and it may not be initiated again untill power is restored throughout the whole grid system or emergency power has been activated.

3 AUTOCLAVE SAFETY AND HAZARDS:

Autoclaves generate extreme heat and high pressure. Users should understand and respect the hazards that autoclaves can create. Lack of proper maintenance or misuse will result in damage to the apparatus and facilities or injury to the personnel. Autoclave can pose a variety of hazards.

Autoclave doors and gaskets must be firmly locked into place before running the autoclave to prevent a sudden release of high-pressure steam. Most, but not all, autoclaves have safety interlocks that prevent the autoclave from running if the door is improperly closed. The exterior surfaces of autoclaves are typically very hot, particularly older models which have little or no heat shielding. Attach conspicuous warning signs to remind people of the heat hazard. Do not stack or store combustible materials next to an autoclave (e.g. cardboard, plastic, volatile or flammable liquids). Use heat-resistant gloves and appropriate Personnel Protective Equipment (PPE) when removing materials from an autoclave. Take care not to touch the inner chamber surfaces and to avoid splashes of liquid materials. If burned by contact with the autoclave or autoclaved materials, seek first aid and/or medical attention. Treat minor burns using standard first aid. Burns to the face, third-degree burns, or burns over large areas of the body are emergencies – seek immediate help and medical treatment. Regardless of the degree of severity, report the burn to your supervisor immediately.

The following are the most common hazards of Autoclave:

Electrical Hazards

- Poorly maintained electrical cables
- Water and steam near electrical systems or damaged electrical controls
- Lack of isolation during cleaning, maintenance and repair.

Slip or Trip Hazards

- Steam condensing on the floor
- Electrical cables or other items located on the floor.

Explosion

- Disintegration of pressure chamber
- Ejection of physically hazardous contents (utensils, sharps, glass etc)
- Ejection of biologically hazardous contents.
- Unexpected opening of chamber door whilst under pressure
- Corrosives or flammable liquids/gasses enter autoclave leading to damage to vessel.

High temperature or Fire Hazards

- Steam from opening door
- Heat from contents
- Steam from pipe or source
- Heat from tray
- Steam escaping from door seal
- Heat from external surfaces
- Opening of chamber door whilst under pressure.

Other Hazrds

- Entry of solvents, volatile or corrosive substances
- Sterilization of Radioactive materials
- Inadequate ventilation to extract hazardous gases
- Contaminated sharps
- Biological contamination from waste.

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3.1 Near misses and injuries

Some examples of injuries or near misses with autoclaves,

3.1.1 An analyst was removing glass containers containing water from the autoclave so he could use it. The containers of water were placed in the autoclave by another analyst. The plastic lid on the container had melted during autoclaving. The contents which were under pressure were very hot and the analyst unknowingly touched the container. The glass ruptured and the analyst was scalded and hospitalized from the burns he received.

Recommendation:

- Lids must be vented or threaded very loosely on the top and must be autoclavable plastic.
- Don't handle glass containing liquid directly.
- Use appropriate PPE to protect from the hazards.
- Place vessels in a metal tray and lift the tray.

3.1.2 Once I was working on our Autoclave involving in validation of the system with one of the media loads. I have loaded the autoclave with glass bottles having different media which were meant for the validation. Before loading the autoclave, I have screwed up the containers very tightly and started running of the cycle. After the end of the cycle I went near the autoclave to open the door and I have pressed the switch to open. Once the door was opened, suddenly one of the media bottle inside the Autoclave blew off and the entire contents of the container spilled out and in a fraction of seconds and I have missed a major accident where these entire contents were about to fall on my body. The media spilled because of the development of pressure inside the bottle which was in turn an outcome of closing the container tightly.

Recommendation:

- Never stand in front of the door of the Autoclave while opening the door.
- Do not close the lids of the containers very tightly during autoclaving as it may create a high pressure causing to blow off the container.
- Lids must be vented or threaded very loosely on the top and must be autoclavable plastic.
- Allow the contents in the containers to cool down inside the autoclave before taking out.
- Don't handle the glass containers containing liquid directly.
- Place sterilized materials on a metal tray and lift the tray.

3.1.3 A worker was opening an autoclave door when there was still pressure inside the chamber. The autoclave had been malfunctioning since steam was always leaking into the chamber. To work around this, people would select a cycle that used a vacuum stage after the steam was released and they would try to open the door when the vacuum step ended. They misjudged the timing and a blast of steam hit the operator's forearm causing a burn that eventually resulted in a layer of skin peeling off. The leaking steam valve was repaired after this incident was reported.

Recommendation:

- Do not use an autoclave that is not working properly.
- Use a log book for tracking the operation and note any anomalies;
- Report any problems to the Engineering / Maintenance personnel as soon as possible.
- Put a on the equipment to warn others not to use the autoclave.
- Wear PPE whenever opening or closing an autoclave.

3.1.4 A person was scalded from water in the bottom of a tray that was holding bottles of liquid media. The tray was softened by the heat and buckled when being lifted spilling the hot water onto the person.

Recommendation:

- Do not use plastic trays in the autoclave, only use metal trays.
- Use the wheeled cart to move the load on metal trays into/out of the chamber.
- Always wear appropriate PPE during loading/unloading,

3.1.5 An autoclave with a malfunction in the steam trap valve accumulated hot water within the chamber. When the door was opened, a lot of very hot water dumped out onto the operator.

Recommendation:

- When opening the door, always stand behind the door.
- If any water leaks out of the door call for assistance.
- If the container/bag leaks, the material can plug the drain and prevent steam from being released from the chamber or possibly causing water to accumulate inside the chamber.

3.2 Prevention of Hazards:

- Make sure autoclave doors and gaskets are firmly locked into place before operating the autoclave. These interlocking mechanisms help to prevent a sudden release of high pressure steam.
- If the autoclave does not have interlocking mechanisms, take additional precautions to ensure the door is closed.
- Post a warning sign stating, "Hot Surfaces, Keep Away" on or next to the autoclave to remind people of the heat hazard as older autoclaves may have little or no heat shielding around its exposed sides.
- Never stack or store combustibles near an autoclave.
- Never autoclave toxic chemicals including residual Trizol, bleach, etc., volatile, or radioactive material.

3.3 Emergency Shutdown of an Autoclave:

There are some situations where you need to shutdown the autoclave before it has completed the cycle. Some of these include,

- Steam entering the chamber before the door is closed and sealed; this can happen if the operating wheel is turned to sterilize either manually or by pressing the cycle selector button. This may happen if the autoclave does not have any safety interlock to prevent steam from turning on when the door is open.
- Leakage of steam around the door after the door is shut and the cycle started, because it was not tightened sufficiently. Escaping steam is considered less of a hazard than a partially sealed door under pressure.

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4 CLEANING:

Cleaning of the Autoclave should be done to enhance the functioning of the system. For the effective functioning of the autoclave cleaning should be ensured on daily and weekly basis.

4.1 Daily

- Daily clean the external surface and chamber of the Autoclave with a clean dry cloth followed by cleaning with a clean cloth dipped in a validated disinfectant solution. Clean the door gasket with a mild detergent, water and a cloth or sponge.

4.2 Weekly

- Once in week clean the external surface and chamber of the Autoclave with a clean dry cloth followed by cleaning with a clean cloth dipped in a validated disinfectant solution. Clean the door gasket with a mild detergent, water and a cloth or sponge.
- Open the front and side panels of the Autoclave and clean the floor with a dry mopping cloth. Then the surface should be cleaned with a disinfectant soaked mopping cloth.
- Clean the panels with a cloth soaked in disinfectant solution.
- Remove the tray / trolley from the Autoclave and clean them first with a moistened cloth followed by a clean dry cloth. Apply disinfectant solution by mopping with a clean cloth soaked in the disinfectant solution.

4.3 Spill Management:

Spillages are the most common problems in an Autoclave program. These spillages occur because of breaking of glass bottles, media boiling over and etc., whenever a spillage occurs in the Autoclave, clean the chamber immediately. Allow the Autoclave to cool to room temperature. Wear appropriate PPE for handling the spills. Wear cut resistant gloves and remove broken glass pieces from the chamber surface. Collect these glass pieces in a container meant for sharps. After removing the sharp items clean the surface and side walls first with a moistened cloth followed by dry cloth. Collect the clothes in a container meant for decontamination. For cleaning the surface and side walls use a mopping cloth dipped in a validated disinfectant solution.

5 AUTOCLAVE LOADING

Loading an autoclave is an important task for attaining proper sterilization. This section will address the various steps to be undertaken when preparing and autoclaving the material to be decontaminated or sterilized. The following factors will be discussed:

5.1 Autoclave Verification:

Verification should be undertaken to ensure that the autoclave has been functioning correctly and has been meeting the validation requirements. This verification can be performed by:

- Reviewing the previous cycle log recordings,
- Thermographs,
- Examining the results of the daily verification records like Bowie Dick Test, VLT etc.,
- Timely review of Validation Data.
- Timely performing performance verification tests.

5.2 Cleaning of Materials:

The materials used for sterilising must be cleaned after their use before going for sterilization. Clean the articles first with soap solution and then followed by washing with purified water.

5.3 Material Preparation:

Decontamination / Sterilization is entirely dependent on the penetration of heat. Heavier the penetration heavier is the success of the Decontamination / Sterilization process. This penetration of heat to the target materials is dependent on the material preparation. Importance must be given to the container, volume / amount of the material.

5.4 Consideration of the Container:

The structural integrity of the container is an important consideration. Not all containers withstand the demands placed on them during the autoclave process. Desirable characteristics are heat resistance, good thermal conductivity, puncture proof and impervious to water.

Good Choices:

- Borosilicate glass has very low thermo expansion property and therefore resistant to breaking due to heat.
- Polypropylene (PP) and polycarbonate (PC) are heat resistant plastics
- Stainless steel is a good heat conductor and thus facilitates sterilization.

Poor Choices:

- Polystyrene (PS), polyethylene (PE) and high density polyethylene (HDPE) do not resist heat well.

Note: If there is a risk of material melting ensure they are placed in a seondary container that is resistant to heat.

Importance must also be given to the final weight of the materials subjected for sterilization. To avoid accidental injuries that occur during handling of autoclave this total weight must not exceed the load pattern of the specific load. Exceeding the total weight more than the specified limit also causes ergonomic injuries as a result of transferring this material in and out of the autoclave.

Add some water to the contents of bags containing solids. This will create additional steam which will displace the dry air from the bag, increasing the rate of heat penetration.

5.5 Primary Container for sterilization / decontamination:

The primary container is the container which comes into direct contact with the material to be sterilized. This may include items such as flasks, bottles, test tubes or vials holding liquids (either media or infectious material), instruments wrapped with wrapping paper, and biohazard bags containing the microbiological generated waste. This packaging must permit heat (steam) penetration, and ensure pressure differentials are not created as this will result in breakage. This may be accomplished by using techniques such as, loosening screw caps, creating head space in plastic bags slightly prior to loading them into the autoclave.

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5.6 Autoclave Bags:

The classic autoclave bag is made of polypropylene (PP) and is strong and puncture resistant. These bags come in a variety of sizes and with or without labelling. Although these are excellent, there is a drawback. Polypropylene does not have good steam permeability. To facilitate the steam transfer open the bag prior to autoclaving and add water to the contents to generate steam from within.

Although not recommended for general use, polyetheylene (PE) may also be used for autoclaving, as it has greater steam permeability. PE packaging accelerates load heat-up, which in turn increase the efficiency of the sterilization. But care and diligence must be demonstrated when using this material for packaging as it has very poor heat resistance and will melt. To address this PE bag can be used as a primary container and then doubled using an outer PP bag.

In addition a tray must be used to hold both bags to prevent any mishap with melted PE collecting in the base of the autoclave chamber.

In conclusion, PP bags are the preferred selection of bag for most material. When special circumstances arise and the load composition is taken into account, PE bags inside PP bags can be used to increase steam penetration.

5.7 Volumes / Amounts

As volume and density will impact the heat transfer and steam penetration it is important not to fill the containers beyond the 75% of the holding capacity. This also allows for liquid expansion, preventing overflow. Similarly with solid material, the additional available volume will allow the contents to shift during transfer into a secondary container or the autoclave without spilling out of the bag. Avoid packing or compressing the contents to achieve volume limits as this will restrict steam penetration.

5.8 Identification / Marking / Labelling:

It is necessary to label all material being placed in the autoclave. This is important for the following reasons:

- The material may be subsequently sorted out for different works
- If a spill occurs the risk may be assessed based on the contents involved.
- Labelling can differentiate sterilized materials from unsterilized materials.

5.9 Transfer of materials to be sterilized

When transporting material to be autoclaved, use a trolley with guard rails to protect from accidental falling of materials from the trolley. Wear proper PPE while transporting the material. Use a direct route instead of going through a populated route for the safe transfer of materials from the area of cleaning and packing.

5.10 Loading of Materials:

As much attention must be applied to loading the autoclave, as was given to packaging. Again the determining factor is ensuring heat/steam penetration. Therefore care must be given to avoid overloading the chamber, placing bags in the chamber which are too large, or adding too much weight which will change the design elements of the autoclave. Consideration must also be given to ergonomic factors. Simple measures can be used to ease the flow of heat and steam thorough the contents of the containers. Here are some fundamental rules:

- Load the material in such a fashion to present the least resistant passage of air exchange through the load, from the top of the chamber to the bottom.
- Avoid crowding or stacking.
- Place packages on their edges to enhance steam penetration, place a rack or other item against these items to prevent them from slipping.
- For loads which are mixed (fabric and hard goods) place the hard goods on the bottom to prevent possible condensation from dripping on to the fabric.
- Place empty flasks, test tubes or other non-porous containers on their sides with loose covers. This provides a horizontal pathway and prevents trapping air pockets.
- Ensure containers do not touch each other, this will ensure all surfaces are sterilized.
- No items should touch the top or sides of the autoclave container as the container is pushed inside.
- Liquids and dry goods are processed separately as they require different cycle selections.
- Run material to be sterilized must be separated from those to be decontaminated if a single equipment is using for both the purposes.

6 UNLOADING AN AUTOCLAVE

Unloading an Autoclave is the main source for getting a person injured. A great care must be applied by every personnel while going through this process. As the autoclave has finished off its process the walls and floor produces a great amount of heat. This heat accounts to personnel injuries like burns or scalding. Also one may be exposed to the vapours and gases generated by the inadvertent autoclaving of the materials. Super-heated liquids also pose a risk of exploding if they are shaken or moved during the unloading process. In addition glassware can break if the autoclave door is opened too quickly, and sufficient time is not provided for them to approach room temperature. To avoid injuries while unloading the following procedures can be followed.

- Wear all necessary personal protective equipment.
- Ensure zeroing of the pressure gauge before opening the door.
- To minimize the risk of accidents caused by steam escape, the person who opens the autoclave door should stand directly behind it.
- Never allow the door to open very quickly as it may result in breakage of the glassware or steam to flow off through out the area.
- If boiling or bubbling is present inside the containers, wait until it subsides. Disturbing these containers causes them to blow off.
- Carefully transfer the containers to the trolley by using tongs and heat resistant gloves. Be careful not to allow the containers to touch each other as it could result in breakage.
- Carry the autoclaved material only in a guarded trolley to the designated areas. Never carry the materials with empty hands.

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- Allow the liquid material to cool down for some time before going for disposal or usage.

7 DISPOSAL OF AUTOCLAVED WASTE:

Once the waste has been successfully autoclaved, the waste is no longer considered bio hazardous. Segregate the material depending on the type of waste. Dispose off the liquid waste generated within the lab in to the into the drain or sink which directly connected to the effluent treatment plant. Solid waste generated due to autoclaving should be sent out for the safety team for incineration. Label the waste generated by providing details like,

- Type of the material
- Date and time of generation
- Location of generation
- Name of the person to be contacted

8 MAINTENANCE OF RECORDS:

The documented evidence of the autoclave usage, maintenance, qualification and requalification data, performance records and calibration of critical instruments should be made available. These records act as historical proof that the autoclave has been meeting the regulatory requirements and/or industrial standards. The following are the records that should be maintained along with the equipment.

8.1 Autoclave Log:

This contains name of the load and particulars of the materials loaded into the chamber, Usage time of the autoclave, sterilization hold time etc.

8.2 Maintenace Records:

These records contain the deatials of the preventive maintenance programs or any other programs done with the Autoclave.

8.3 Qualification and requalification data:

Record the results of the validation activities undertaken. This would include the results of the microbiological tests and thermometric tests.

8.4 Performance Records:

Record the dates that problems were encountered, remedial action taken and any service calls required. In addition, annual service reports should be kept. This record will permit a general assessment of the condition of the autoclave.

8.5 Calibration Records:

Record the dates of calibration of the critical instruments like pressure gauges etc.,

9 QUALITY CONTROL:

A number of tools are available to assess the performance of the autoclave. These include physical, chemical and biological indicators. It is important to note that these indicators will only respond to time, temperature and moisture conditions, and not to organic load.

9.1 Physical Indicators:

Pressure and temperature recording devices. Thermocouples can be placed inside the load to determine the temperature achieved in the containers itself.

9.2 Chemical Indicators:

These indicators change colour after being exposed to specific temperatures, for example: heat sensitive tape. Upon exposure to the given temperature the change will occur; it is not time related. Therefore these indicators can only attest to the temperature attained and not to exposure time and hence success of sterilization.

9.3 Biological Indicators:

Biological indicators are used in the efficacy testing of the autoclave process to effectively sterilize the contents being treated. Geobacillus stearothermophilus spores are used, as they are the most resistant organism to steam autoclaving. To determine the effectiveness of the autoclave process the biological indicator must be placed in a typical test load (solid or liquid) and exposed to the typical cycle conditions. This is the standard method of validating the effectiveness of the autoclave procedures.

9.4 Observations:

Check for colour change at regular intervals during the incubation period. If media is turbid the autoclave process has FAILED. Immediately upon noting turbidity inform to the officials and re-run with new biological indicators.

Note: The autoclave cannot be used again until validations procedure indicates that autoclave is now adequately sterilizing the material. Record all results (Positive and Negative). Record biological indicator information: brand, lot #, expiry date, date of operator, cycle time, cycle temperature of the test run.

Record results: colour change noted (Failure), no colour change (Pass).

10 TRAINING:

Training for autoclave users is an essential component for a successful autoclave program.

Training should be given to all the concerned personnel regarding the operation, cleaning and maintenance of the Autoclave. Especially training should be given to operators regarding the handling of materials for autoclaving meant for sterilization / decontamination. Each autoclave user must undergo operation and safety training prior to using the autoclave. Training must address the specific autoclave model(s) to be used. Familiarity with the manufacturer(s) operations manual is an essential element of use and maintenance training. If you cannot locate the manual, contact the manufacturer or search the manufacturer's web site to obtain a copy.

Training elements for autoclave use and safety should include:

- Proper use of Personal Protective Equipment (PPE)
- Minimization of aerosol formation
- Proper usage including loading and unloading recommendations

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- Burn prevention
- Prevention of spills and accidents
- Procedure to manage spills and accidents

Providing training to all the concerned will minimise the risk of personnel being harmed and the risk of damage to the equipment. All operators must have successfully completed an authorized training session on the safe operating procedures of the autoclave. This training session should be propagated to all the new and experienced personnel. A list of authorized users of autoclave should be made available near the equipment.

Thus training will help to promote,

- Safety,
- Cleaning,
- Quality and
- Optimal use and care of equipment.

11.0 PERSONNEL PROTECTIVE EQUIPMENT:

Personnel protective equipment means equipment or instruments that are used to protect the end user from injuries. As autoclave is a high risk equipment working with it causes different injuries ranging from a moderate injury to a fatal injury. As the autoclave involves steam, heat and pressure it is likely to cause injuries to the personnel. In due respect of this one must wear appropriate PPE while working on it. The following are the PPE while using the autoclave.

11.1 Eye and face protector:

To protect the eye and face from the risk of facial steam burns, the personnel who is handling the autoclave should wear a face shield. The face shield minimizes the risk of facial steam burns.

11.2 Hands Protector:

To protect the hands from contaminated materials latex or nitrile gloves shall be used.To protect the hands from burns heat resistant gloves must be used when loading and unloading the autoclave since the walls and floor of the autoclave will be hot even though the equipment has been switched off a while ago.

11.3 PVC aprons:

To protect the personnel from accidental spill hazards PVC aprons should be worn over the lab apron.

11.4 Tongs:

Although the autoclave trays may be cool, the door and walls of the chamber may still be hot enough to cause a burn during loading and un-loading the materials. These burns usually happen during pushing of the material into the hot chamber as the personnel performing loading of the material and dragging the material out of the autoclave after opening the door.

11.5 Closed Toed Shoes:

Accidental falling of materials may happen during transport of the materials to the autoclave area, loading of the materials into the autoclave and unloading of the materials from the autoclave.

12 CONCLUSION:

Autoclave Training is mandatory for users in the Department:

You cannot learn how to use an autoclave safely and effectively without some practical instruction from someone who is knowledgeable and experienced with that model.

The instructions and notes presented here and posted near the autoclave are for reminding people about the do's and don'ts for using an autoclave. Reading these is not sufficient to allow you to operate the autoclave safely. Contact your supervisor to get the training needed.

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