The Autoclave Knowledge Bank

your impartial guide to autoclave selection

Introduction

When specifying or purchasing an expensive and complicated piece of equipment it is essential to be able to ask the right questions in order to get the right answers and make an informed decision.

This booklet will guide you through some of the key points to consider before making that all important laboratory autoclave purchase.

It is important to think about what you are going to put into the autoclave to make sure that the autoclave you buy has the best specification to process it effectively and efficiently, especially if you are going to have to prove this to a certifying body later on.

The following points and comparisons may help you in making that ‘right’ choice.

They are not intended to give a full explanation of all the issues and technicalities but should help you in narrowing down your choices - autoclave style, chamber design, heating source, etc.

With this information you should be at least armed with some informed questions to ask of prospective laboratory suppliers and manufacturers.

Contents

What is an Autoclave?

An autoclave (from Greek auto-, ultimately meaning self, and Latin clavis meaning key—a self-locking device) is defined as “a strong heated container used for chemical reactions and other processes using high pressures and temperatures”.

As the definition would suggest, there are many types of autoclave available for a wide variety of purposes. In the chemical industry they can be used to cure coatings, vulcanize rubber and for hydrothermal synthesis like growing crystals under high temperatures and pressures - synthetic quartz crystals used in the electronic industry are grown in autoclaves.

While all these autoclaves feature as part of their operation high pressures and temperatures a variety of process media within the autoclave pressure vessel may be used. For instance, in the aviation industry and racing car manufacture they are used in the curing of composite materials in a heated nitrogen atmosphere.

This booklet refers to autoclaves that use an atmosphere of steam within the pressure vessel and that are designed to be used primarily for sterilisation.

Even within this category there are different types of autoclaves available, whose designs are optimised for specific purposes, so it is important to look carefully at what you want your autoclave to achieve as making the wrong choice could mean that you overspend on purchase price and running costs or have a piece of equipment that does not work effectively or has an unnecessarily long cycle time.

Surely steam sterilisers are all the same?

They are not.

Even within the group of autoclaves used for steam sterilisation there are a range of types.

Broadly these fall into three different types, all capable of steam sterilisation but manufactured to give the best performance for the type of operation for which they have been designed.

Firstly there are small table top instrument sterilisers commonly seen in Dentist and Doctor's surgeries. These are designed to give fast and reliable sterilisation of small batches of surgical instruments usually with one or two fixed cycles.

Another group are large hospital and pharmaceutical sterilisers designed to process large loads on an industrial scale. Because the output of these sterilisers will ultimately come into contact with patients they have a very high level of process monitoring and control built into them.

The final group between these two are Laboratory or Research Grade autoclaves. These are designed to sterilise a large range of different sterilising loads with the ability to set varied temperatures and times to suit these individual loads.

This booklet refers to this type of autoclave -

the **Laboratory or Research Grade autoclaves.**

Autoclave Types

Since most manufacturers produce a range of laboratory autoclave types to meet many differing requirements it is important to understand initially your laboratory's requirements in terms of load variation and frequency of sterilising applications.

What is the most appropriate in terms of available lab space, would a benchtop suffice or a larger capacity free-standing, top or front loading autoclave be a better option?

Autoclave manufacturers engineer their products to offer specific solutions to meet your sterilising requirements and available laboratory space.

Typical sterilisation applications cover media preparation and laboratory waste sterilisation before disposal but with the flexibility of cycle settings offered by Laboratory Grade autoclaves other loads such as glassware, instruments and porous loads can also be processed. All are critical in the maintenance of good hygiene practice and sterile working conditions.

The images below are examples of the most popular autoclave types.

The final decision on what to buy will often be a compromise between installation space, best

suited to applications and available financial budget.

Broadly the range of autoclaves available are:

Benchtop *Top loading* *Front loading* *Pass-through*

These will also be available with a range of door types, chamber configurations and heating methods. Each offers unique benefits.

Benchtop Autoclaves

If you operate a small laboratory with limited floor space, items for sterilisation are relatively small and throughput is infrequent then a Benchtop Autoclave could be the most appropriate choice.

As the name implies this type of autoclave is designed specifically to place directly on a lab bench. For those working towards creating a Category 3 laboratory talk with your chosen autoclave supplier as they may be able to supply a benchtop autoclave with short legs. This allows easy wipe down of the bench surface beneath the autoclave.

This style of equipment is virtually self-contained, a standalone design that requires simply connecting to the appropriate power supply.

It is by far the easiest to install and probably the lowest priced of all the autoclave models.

Top Loading Autoclaves

This is a really practical choice for those laboratories with limited space yet wanting to perform high-quality steam sterilisation of taller than normal items such as fermentors and large capacity Erlenmeyer flasks and where space and budgets are restricted. The alternate may require a much larger and more expensive front-loading autoclave.

The main advantage, which is attractive to the smaller laboratory or those with low throughput is the actual ‘footprint’ of the autoclave - not requiring much additional width and depth outside that of the chamber space. Top loading models tend to only increase in height with increased capacity.

Previously a default type of autoclave for most laboratories. They have become less popular due to Health and Safety issues involving lifting of possibly heavy baskets and containers, however, they do satisfy a need therefore if buying this design consider having a load-lifting hoist fitted to reduce possible handling risks.

Choosing lower loading height models to decrease the lifting distance can also help.

Again this style of laboratory autoclave is extremely easy to install, simply plug directly into an appropriate electrical power socket. Some manufacturers include castors to enable the autoclaves to be more easily positioned.

Front Loading Autoclaves

This style of laboratory autoclave is available from some manufacturers with a choice of round or rectangular sterilising chambers.

These have the advantage over top loading models, they are easier to load but they take up a larger floor space. However some manufacturer's models take up less floor space for the same chamber capacity than others so if laboratory space is a big issue then it is worth comparing different manufacturers for the most compact models.

Due to the increased volume of medium that can be processed in a single pass, especially in larger models, consideration must be given to how the chamber is loaded/unloaded, by hand or with a load trolley.

The front loading format when combined with a rectangular sterilising chamber allows for far greater chamber capacities than are practical for top loading cylindrical models. However some manufacturers offer larger sized cylindrical format models, giving the cost advantage of a cylindrical chamber with a working volume larger than some rectangular chamber models.

The choice between round and rectangular vessels is examined in more detail later in this booklet.

Pass Through Autoclaves

Every lab is unique in what processes and procedures take place – some requiring a more sterile working environment than others, there may even be air locks for staff to pass through, extracting, cleansing and renewing the air, a system in operation where high risk conditions are the norm.

In a similar manner, some laboratories need to have a secure, clean exit path for its waste media so that it can be safely discarded.

To satisfy this requirement a number of prominent laboratory autoclave manufacturers are able to build pass-through (also referred to as double-door) steam sterilisers. Every pass-through autoclave provides a sterile path in and out of sealed laboratories.

If your requirement is for a clean room application the autoclave is used for the sterilisation of equipment entering a clean or aseptic area such as a pharmaceutical production environment.

In a containment application the autoclave is used for the de-contamination of material prior to its release from the containment suite which would typically be a laboratory handling high-risk hazardous material.

In both cases isolation of both ends of the autoclave is required.

These autoclaves tend to be a heavily modified

standard product design, effectively placing two units back-to-back but with a single chamber which is open both ends to allow for doors at either end.

All pass-through systems require safety interlocks to be fitted so that the integrity of the clean room or containment area is not compromised by both doors being opened at the same time. Generally the autoclave is set up for loads to pass through in one direction but some manufacturers can offer systems where the direction of flow can be securely reversed or even so that the autoclave can be used like a conventional autoclave from one door only.

The build also requires inclusion of a bulkhead enabling the autoclave to be built into a dividing wall separating the lab from the outside world.

Each site will have different requirement - doors to be hinged to swing left or right, location of electrical, water and drain services - final manufacture therefore requires full details of the proposed location and operation routines.

By far the best way to achieve this is to involve the manufacturer in the planning process from a very early stage, including site surveys and/or the supply of detailed drawings.

Each Pass-Through autoclave is individually tailored to meet a custom-specific application.

Chamber Style - Round or Rectangular?

Most sterilising chambers are manufactured in stainless steel and are available in a choice of two formats – round or rectangular.

Round, also known as cylindrical chambers, are the most common style of chamber since they are available in both front loading and top loading autoclaves.

If your application requires sterilising a variety of medium, in small or tall packages, this is a worthwhile design to consider.

A cylindrical chamber normally has thinner walls and therefore less metal to heat up which makes processing time faster. Also it weighs less and is the most economical to produce which ultimately is reflected in the overall cost of the autoclave.

As steam is the sterilising medium used in a autoclave it is vital that items to be sterilised come fully into contact with the autoclave steam and that all air is removed (it takes about 25 times longer to sterilise in hot air at the same temperature as the steam in an autoclave). Therefore a big advantage of the circular profile of the working chamber and the 'square' profile of most autoclave loads is that there will normally be space around the sides of the load for steam circulation.

As a result of this better steam circulation, for most loads a cylindrical chambered autoclave will not need any additional assistance with air removal such as a vacuum system or pulsed steaming.

There is less useable space than in rectangular section autoclaves for a given volume in front loading versions because of the circular profile.

Chamber Style *continued from page 12*

There is a trade off against improved steam circulation versus cost/lab space.

For heavier duty, higher capacity sterilising processes Rectangular Chambers are the preferred style. They are mostly found in larger free-standing autoclave designs.

These chambers lend themselves to holding more load, whether on a single shelf or across multiple shelves.

More careful and skilled loading is required to ensure that steam circulation is not restricted by overfilling the autoclave chamber. If the steam cannot get to the load or the air cannot escape then sterilising will not be effective. Because of the higher load volume verses chamber space, vacuum air removal is strongly advised to be fitted to Rectangular chambered autoclaves.

In order to prevent the chamber from becoming round under pressure rectangular autoclave chambers must be built with much thicker walls than cylindrical designs. They also require substantial bracing around the outside of the chamber at regular intervals. This makes them more expensive to build and heavier than cylindrical models.

They also require more heating and will cool more slowly because of the additional weight of metal and so, in the long term, can be more expensive to run as well as to purchase.

Door Type

An autoclave under pressure is potentially very dangerous but the danger does not end once the chamber is no longer pressurised. When autoclaving liquid loads in glass bottles that are or could potentially become sealed the temperature of the liquid lags behind that of the autoclave chamber during cooling so that at autoclave temperatures well below 100°C the contents of the glass bottles can still be under pressure. In the past there have been some quite nasty accidents when the influx of cold air from an autoclave door opened too early has caused pressurised bottles to shatter.

Therefore check that the models you look at offer safety interlocks that not only prevent door opening at elevated temperatures and pressures, but will also prevent door opening until the load itself is at a safe temperature. Ideally there should also be method where this lock can be overridden by authorised operators if a potentially less dangerous load is being processed.

How you open and close the autoclave door differs between models with some manufacturers offering different closure systems for the same models across their range.

The principle types are:

Hinged (swing) doors

1. Manual door with hand bolts

Less complex and so requires less servicing and is less expensive.

It is less convenient to open and close than single action or

Door Type *continued from page 14*

push-button operation as well as being slower to open and close than single action or push-button operation; however the extra time required is small in comparison to a total cycle time.

Space is required directly in front and to the door hinged side of the autoclave to allow for door swing when opening.

2. Manual door with single action closure

This is faster and easier to operate than hand bolt doors and less complex than powered door closures and so requires less servicing and is less expensive.

It is less convenient to open and close than push-button operation.

Again space is required at the front and side of the autoclave to allow for door swing.

Vertical or Horizontal Powered Sliding Doors

Where a higher capacity chamber is required suited to handling bulky items but where the laboratory does not have sufficient space to allow for the conventional hinged door opening it is time to consider the Power Door autoclave.

These have the advantage that the chamber door lowers within the body of the actual machine.

They usually feature a simple and

Door Type *continued from page 15*

fast push button operation with no physical effort required by the operator.

However they are more complex and expensive due to the additional controls and mechanisms required to move the door into position and then seal it.

Many autoclaves have ‘inflatable’ or moving door seal which can be prone to wear. An autoclave with a fixed seal design is often a better option since the door physically moves onto the seal, causing less wear and tear.

Regular maintenance of these systems is essential.

On horizontal closing versions the door requires space for at least the width of the autoclave chamber on one side. On vertical closing versions the door requires space for at least the height of the autoclave chamber below at the front.

How will Steam Be Generated

There are three main methods of generating steam (two electric and one direct steam).

Heating Elements

The first electrically heated method uses heating elements inside the chamber. Water is poured into a reservoir to the correct level. It is the simplest of all the heating options, and since it is less complex it makes the actual autoclave less expensive and requires less servicing.

The drawback is of longer cooling times, as there is a reservoir of hot water in the bottom of the autoclave which must be cooled down along with the load. Some autoclaves can be drained to improve cooling times, although this would require an automatic filling system to re-fill before the next cycle.

Although chamber heat up time is slower compared with steam heated autoclaves, but with bulky liquid loads, the load heat-up time is actually not very much slower. And for those laboratories that have infrequent sterilising requirements it is by far the most energy conscious – hence cheaper to operate.

This makes for the lowest cost option both in terms of capital outlay, installation and running costs.

However there are potential drawbacks. For example, loads will always be wet at the end of the cycle, and breakages/spillages need to be cleared away as soon as possible, which can be messy and time-consuming. This can be improved by fitting auto-drain and auto-fill options.

Built in electrically heated steam generator

The other electrically heated method is to fit a separate steam generator, which on most lab autoclaves is fitted directly beneath the chamber and within the overall frame. This is a more expensive option but has the advantage of giving a cleaner work space and dryer loads at the end of the cycle. It can also speed up the cycle times considerably.

Electrical heaters are fitted into a separate chamber directly attached to the main autoclave vessel. As with the 'in chamber' system, steam generation is controlled by the autoclave temperature controller. It offers slightly faster heat up times and slightly better steam penetration than 'in chamber' electrically heated models.

It also achieves faster cooling than 'in chamber' electrically heated models since there is no reservoir of hot water in the bottom of the autoclave to be cooled down along with the load.

Built in electrically heated high pressure 'on demand' type generator.

This type of generator maintains a high-pressure steam supply available on demand and is generally comparable in performance with an external steam supply or a 'standalone' steam generator.

For a busy laboratory with a constant flow of work for the autoclave this set-up would be ideal.

Although it is more complex and requires more servicing it is also more expensive to run as the heaters will be operating all day to maintain the supply of readily available steam.

During a 10 hour day they will be running for 2-3 times longer than the heaters in a comparable electrically heated model and even longer if the generator is left running overnight.

As with the previous description, the ‘on-demand’ type, because the steam generator is physically closer to the autoclave chamber and the generator steam pressure is lower than a ‘standalone’ type generator, reducing valves and condensate-returns are not usually required.

What it does offer is faster start up and faster cooling compared with ‘in chamber’ electrically heated models.

Steam heated from an external steam source

Some large organisations may operate their own boiler room and providing it is sufficiently close to the autoclave installation it could be used as the steam source.

An autoclave requires good quality dry steam to function correctly and whilst connection to an already available steam source sounds ideal unfortunately some in-house supplies can be unreliable. To cater for this some manufacturers can supply autoclaves with ‘back up’ electrical heating to cover for when the steam supply is not available

Advantages of drawing steam from an in-house steam room include faster chamber heat-up times as high temperature steam is instantly available inside the autoclave and because steam is injected into the chamber at pressure there is better circulation and penetration of steam than with electrically heated models.

Also faster cooling is achieved since there is no reservoir of hot water in the bottom of the autoclave to be cooled down along with the load.

Unless you are replacing an existing steam heated autoclave speak with the autoclave supplier as a reducing valve and steam traps to dry any condensate from the supplied steam will be needed to reduce the steam line pressure and moisture content down to that suitable for the autoclave. There are other considerations to take into account such as condensate return.

With the faster chamber heating of steam heated models the lag between chamber and load temperature must be taken into account when setting up the autoclave. What is saved in the heat-up time can end up being added to the sterilising time with bulkier liquid loads.

What am I Sterilising?

What features to look for to achieve better sterilisation?

For Bottled Liquids - Bottled Growth Media, Buffers or Bottled Waste

Thermal/Cooling Lock - prevents the autoclave from opening before the load inside has cooled to a safe temperature.

Free steaming - allows time for the load temperature to 'catch-up' with the autoclave temperature.

Load Sensed Process Timing - guarantees sterilising times by starting process time when the load reaches sterilising temperature. (Not advised for growth media which can be 'overcooked' whilst the whole load gets up to process temperature.)

Rapid Cooling - reduces cooling time before the thermal lock allows the door to open, some systems allow a delayed cooling start for loads which may be sensitive to faster de-pressurisation.

Air Ballasting - for sealed or semi-rigid containers where very rapid cooling i.e. spray or water jacket is used. This maintains the chamber at sterilising pressure with air preventing breakages or boil-over during the rapid de-pressurisation caused by rapid cooling methods. It requires a compressed air supply unless an air compressor is already fitted as part of the autoclave.

Load/Performance qualification testing - requires recording cycle temperatures with multiple recording probes to ensure that the autoclave settings will achieve sterilising conditions in all

parts of a specific load. Provided that the tested cycle is set for each particular load then assurance of sterilisation is provided. After initial testing regular calibration of the autoclave is required to confirm continued correct operation.

Testing requires specialist staff and equipment and can take several days, depending on the number of load sizes and types to be tested. To be effective as an assurance of sterilisation, consistent loads must be run.

Often if this process is carried out by the manufacturer then it also allows the settings to be optimised for the loads tested, making for consistent, faster and more effective sterilisation.

<u>For Glassware, Equipment and Porous Loads (textiles and wrapped instruments)</u>

Pre-Cycle Vacuum - improved air removal as repeated vacuum pulses draw trapped air out from difficult loads to be replaced by steam.

Pulsed Steaming - assists with steam penetration. Repeated pressurising and de-pressurising of the chamber during heat up creates turbulence helping to remove air to be replaced by steam. Often used in conjunction with a vacuum system.

Post-Cycle Vacuum Drying - helpful with removal of residual moisture in the load. Traditionally this requires a steam jacket but other methods are now available.

Air Intake Filters - air drawn into the autoclave as it

cools is filtered with a microbial filter to protect the contents from contamination.

Load/Performance qualification testing is strongly recommended as with bottled liquids.

Plastic Discard and other Laboratory Waste

Pre-Cycle Vacuum – especially recommended for rectangular profile autoclaves, this gives improved air removal as repeated vacuum pulses draw trapped air out from difficult loads to be replaced by steam.

Free Steaming - by venting the autoclave at low pressure turbulence is created within the autoclave helping to remove air to be replaced by steam.

Pulsed Steaming – assists with steam penetration. Repeated pressurising and de-pressurising of the chamber during heat up creates turbulence helping to remove air to be replaced by steam. Often used in conjunction with a vacuum system.

Post-Cycle Vacuum - available on some autoclaves. Repeated post sterilising vacuum cycles can be used to rapidly cool the load contents, improving cycle times.

Load Sensed Process Timing – not advised for plastic wastes as remote probes can become encapsulated in melting plastics and are often damaged on removal.

Exhaust Filtration - where high category pathogens are being autoclaved this system prevents them from leaving in the autoclave exhaust. Many manufacturers also offer effluent

retention where the condensate or water in the bottom of the autoclave is only released to the drains at the end of sterilisation.

Discard Containers - protection from spills and leakage when plastic containers and dishes melt during autoclaving.

Deodorants, Room air extraction - combats the odours generated when autoclaving waste materials.

Load/Performance qualification testing is strongly recommended as with bottled liquids.

Why Freesteaming?

An effective autoclave or steriliser must contain dry saturated steam. In order to achieve this, air must be removed from both the load and the chamber which can be accomplished in a number of ways.

Air removal from high mass low surface area items (i.e. comprising mainly solid areas that contain little or no air pockets such as bottled media) will need little air removal and this can be facilitated by automatic air purging. Here air is allowed to leave the chamber through a vent as steam enters the chamber either from an integral source (upward displacement) or an external supply (downward displacement) with the vent only closing when all of the air is removed from the chamber.

This method can be further advanced by 'free-steaming' when the vent is allowed to stay open for a set length of time once the autoclave is above 100°C. The turbulent steam then passes through the vent forcing any trapped air out of the autoclave.

In some systems this can also be pulsed by repeatedly allowing pressure to build and then releasing it.

Freesteaming of liquid loads is useful in a different way as it effectively holds the autoclave chamber at 100°C so that the liquid load temperature can catch up with it. Pulsed Steaming is not suitable for liquid loads however.

For more stubborn loads that contain a number of air pockets such as wrapped instruments or fabrics, a more effective method of air removal such as a vacuum system is essential.

Why Vacuum Systems?

Effective sterilisation to destroy micro-organisms requires direct contact between the saturated steam and every surface of the load.

The presence of air in the load can prevent direct contact with micro-organisms which are held inside tubes, deformed petri dishes, etc., by applying a vacuum at the start of the cycle greatly improves air removal, assisting with full steam penetration.

If a vacuum cycle is selected the autoclave will forcibly remove residual air from within the chamber and load usually using multiple vacuum phases programmed with interspersed heating. This highly efficient process allows the steam to circulate freely, ensuring deep penetration into the load for highly effective sterilisation.

Most manufacturers will offer a vacuum pump of some description on some on all of its ranges, but is it right for your application or needs?

In essence there are two types of vacuum pump available. The first is a diaphragm vacuum pump. These are relatively inexpensive, but do have limited performance. When vacuum levels reach around 500-600mbarA their use is limited to providing improved air removal at the beginning of the cycle, plus it will help to dissipate heat in some load types at the end of the cycle. If that's all you need it for, then this is ideal.

For more effective air removal (important when sterilising bagged goods such as waste media or hollow-ware, such as pipette tips, tubing etc.), choosing an autoclave with a liquid ring vacuum pump may be more appropriate. These pumps

will achieve a much higher vacuum (typically 30-100mbarA), which offers enhanced air removal, but, more importantly will flash off much of the residual water from deep inside the load during the cooling stage, which can be very important with hollow-ware loads. These however require a more powerful electrical supply, a water supply and drainage.

A vacuum assisted cooling cycle is also available for use with suitable load types, reducing the dead-zone whilst waiting for the autoclaves to reach a safe temperature and pressure.

Drying

When sterilising loads such as pipette tips, tubing, instruments and porous loads vacuum alone (even using liquid ring pumps) will not achieve totally dry loads. The only way to dry loads effectively is by adding a steam jacket to the chamber.

The heating effect of the steam jacket plus the high vacuum flashes off all residual moisture from the load, whilst minimising cycle times.

Where absolute dryness is not essential, some manufacturers can offer systems that avoid the expense and complexity of a jacket by heating the walls of the autoclave chamber to achieve the same effect.

Why Steam / Water Jackets?

Steam/Water jackets are not part of the usual configuration of a Research Grade or Laboratory autoclave although they are nearly always fitted to the large hospital type sterilisers. Usually unless you are regularly sterilising loads requiring full drying or are looking to maximise throughput by pre-warming the chamber and rapidly cooling it with water, the additional initial outlay and running costs seldom make it a worthwhile proposition.

However Steam / Water Jackets are optionally available on many laboratory autoclaves and are effectively another pressure vessel surrounding the main sterilising chamber. Within the void, steam or cold water is run to heat or cool the outside of the autoclave chamber.

Naturally when cold water is run around the external jacket it helps achieve faster cooling times.

Heating the outside of the chamber wall reduces condensation onto the load during heat up and for drying it is proved still to be the best system particularly for achieving the maximum dryness in porous and textile loads.

Since a jacket requires additional valves and control gear it makes the autoclave build more complex and costly and increases the need for regular maintenance.

Introduction of a water jacket creates the need for a reliable steam/water supply. If water-cooling is required a large amount of water is used or an external re-circulation and cooling system is required.

Why Steam / Water Jackets? *continued from page 28*

When cooling liquid loads 'Air Ballasting' is required to protect the load from damage by rapid falls in chamber pressure.

Some manufacturers provide either full or partial jackets depending on the operational requirements.

A steam jacket can only be run from an autoclave using external steam or a steam generator.

Power Supply

Most large autoclaves and steam generators require a 415V, three phase supply whilst for smaller autoclaves a 230V single phase supply is ideal. Should you have special requirements talk with the autoclave manufacturer – often they can accommodate special power supply ratings reasonably easily.

Water Condition

In hard water areas it may be beneficial if not advisable to install a water softener, particularly for electrically heated autoclaves or steam generators. Calcium build-up in the copper pipes will restrict water flow and reduce performance of the autoclave over time.

For specialist "clean steam" applications using RO water is sometimes a requirement to adapt the autoclave as ultra pure water is corrosive to copper piping and conductivity based water level detectors do not work with it.

Do I Need a Drain?

Autoclaves used for processing laboratory waste must be provided with a drainage connection if the autoclave is fitted with any freesteaming or vacuum options.

The purpose of a drainage system from the autoclave should prevent dispersion of splashes and steam into the working area.

For autoclaves designed for a make-safe process, discharge should be directed to a sealed discharge system; the system should lead by direct connection to a building drain or catchment tank.

The drain system should be capable of with-standing 134°C – not only must the pipework be heat resistant, it also applies to any joint seal, etc.

For heat sensitive drains a water cooled condenser can often be fitted to cool the autoclave exhaust to a suitable temperature.

The drain must also vent at high level outside the building to prevent pressure build-up.

Compressed Air

Required for door seals and control valves on some autoclaves and for air ballasting systems. On many autoclaves an air compressor may already be built–in.

Hygiene and Environmental issues

Inhibiting the growth of harmful bacteria and minimising the threat of cross-contamination is vital in hygiene critical areas within agricultural, pharmaceutical, food processing, educational and health care laboratories.

Bacteria commonly encountered in these areas are capable of prolonged survival on most surfaces, in optimal conditions they can reproduce every twenty minutes, spreading rapidly where they dwell.

In busy, multi-user laboratories there is always the risk of cross-contamination on lab surfaces including that of the autoclave cabinet. There is the possibility that the exterior of the autoclave may come into contact with bacteria – whilst opening the autoclave door staff may place the load on the top of the cabinet, people may inadvertently lean on the autoclave - bacteria transfer is easy.

Responsible autoclave manufacturers will take precaution to prevent such transfer by coating frames and panels during production with an anti-microbial coating.

Look for an autoclave manufacturer where the coating provides effective protection for the life-time of the product, helping to keep surfaces clean, hygienic and reducing the threat of cross-contamination. Some tough epoxy finishes are proven to reduce bacterial growth by up to 99.99% and are highly effective against MRSA, E.coli, Listeria, Legionella, Campylobacter, Salmonella, and Pseudomonas and many more species.

Record Keeping and Proving Sterilisation

Most laboratories require some form of cycle record and historical data for internal traceability and audit trails. The options available here are many. The most popular is to fit a data printer, which should be capable of printing load and chamber temperatures, load pressures, cycle data and cycle status (pass/fail).

More recently people have been able to download data to a computer however for more instantaneous results a printer is still extremely popular.

Data download is ideal for archiving records but also very useful for data-exchange with the autoclave service company, often the actual machine manufacturer.

In addition to this there are on the market an array of autoclave accessories, such as tapes for quick visual indication that your materials were exposed to the steam process, not that the process was successful.

A better sterility check should be frequently carried out using Biological Indicators (Geobacillus stearothermophilus), typically these indicators consist of a plastic container with a cap and a crushable glass ampoule with recovery media and a disc inoculated with spores.

There is also the well-known Bowie & Dick test for porous loads where the colour of the indicator sheet changes from blue to pink confirming that steam penetration has been effective up to the centre of the sterilisation pack. Many autoclaves will have the ability to set up and retain a specific cycle for this test.

Positioning and Installation

Can you get the autoclave into the suggested location via any steps, corridors, tight corners and doors? If on an upper floor, is a suitable lift available?

Will there be enough space around it for service access?

Is access to a drain available and if so is the drain vented? Will the drainpipes and joints stand the temperature of the exhaust from the autoclave?

Room size - just how much space do you really have?

Will heat extraction be required, especially if installation is planned in a separate small autoclave room?

Although many people do not have the luxury of a large amount of available space around the autoclave the following dimensions are advised if possible. Typical space allowance for floor-standing autoclave is 1m to the sides, 300mm at the rear and 2m to the front or twice the length of a loading trolley.

Small and medium sized autoclaves are often castor mounted and with flexible connections can be moved to enable service work to be carried out.

Most manufacturers and sellers of autoclaves are more than happy to carry out a site survey as part of the purchasing process which can save a lot of expense later on in some cases. Also if issues are identified during the survey with getting the autoclave into the room or the desired position the autoclave can often be adapted during manufacture to get around this.

After Sales

Once you have chosen your autoclave and it is installed you are likely to be using it for many years.

It is important to keep your autoclave well maintained and looked after so that it keeps running effectively over the years ahead.

Although the autoclave will inevitably come with a 12 month warranty this only protects you against breakdowns so it is worth considering regular maintenance for your autoclave, especially if it is going to get a lot of use.

Some manufacturers offer discounted preventative maintenance contracts as part of the purchase package and in future years a variety of options for maintenance are available, ranging from a single maintenance visit per year, a recommended two visits per year for autoclaves with average use, up to all-inclusive contracts where for a one off payment per year all servicing and maintenance costs are covered.

Often additional services such as an annual calibration can be included as part of the contract.

If you look to a company other than the manufacture to carry out the servicing it is advisable to check that they are suitably experienced in autoclave servicing as a poorly serviced autoclave is potentially dangerous.

Additionally the autoclave is an item of pressure equipment and in many jurisdictions a periodic insurance safety inspection is required (within the UK this is within 13 months from commissioning or since the previous inspection). A regular service visit can be co-ordinated with this inspection to ensure that everything goes smoothly.

Other Things to consider

1. Take time to consider your options. The working life of an autoclave is upwards of 5 years and with the capital expenditure involved you may not be able to replace what you have chosen for some time to come.

2. Look at what you have already.

3. Discuss it with the people who will use the autoclave and find out what they want. An operator who feels left out of the specifying process can often be the cause of many unnecessary and costly service visits and ‘faults’.

4. Discuss with the Finance Department what budget is available. Some manufacturers’ options and accessories are easily fitted later, so if there is not quite enough budget for all that you want, you can still upgrade inexpensively at a later date.

5. Initially getting budget prices from manufacturers will help you achieve the best balance between cost and functionality.

6. Take into consideration aspects of hygiene and cross contamination when specifying and installing your autoclave.

7. Have you considered leasing the autoclave rather than outright purchase? Usually your chosen manufacturer or seller will be happy to put you in touch with companies that you can arrange this with.

Help is at hand

Any reputable supplier, particularly dedicated autoclave manufacturers will provide FREE assistance, advice and information to help you make an informed choice, it's in their interest after all as a poorly specified or installed autoclave will be trouble for them too.

As mentioned previously, often you will require a site survey to make sure that everything is going to fit both the autoclave and its associated equipment.

In the end it's your choice. Of course price is an important factor but sound research and reliable backup to ensure trouble free installation and operation may very soon turn out to be a wise investment.

notes

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