Porous load autoclaves

Graham Stanton, Senior Decontamination Engineer at Welsh Health Estates discusses operational problems with loading methods and steam.

❖ Background

Many Sterile Services Departments (SSD) are finding that a number of instrument trays are being rejected by operating theatre teams due to the packs being "unsuitable for their intended use". Why should this be the case? After all, changes in SSD practices over the years were designed to improve standards, as the following list illustrates:

- More rigorous adoption of departmental procedures
- Introduction of Quality Assurance systems
- Increased testing methods to ensure products meet user specification
- Increased documentation to verify decontamination processes
- More emphasis on staff training and awareness
- Improved tray wraps, containers and storage
- Improved environmental conditions
- Controlled handling and transportation of products

❖ Steam sterilization - porous load autoclaves

A porous load autoclave is a pressure vessel that processes porous items with a steam injection system, with cycles containing a series of negative and positive pressure pulses, some of which are held on timers to achieve the desired effect at the stage required.

To achieve a dry load the energy absorbed by the load from the steam is utilized to flash and dry the load in the drying stage. It is critical that the condensate made by each load item (including loading furniture and wraps) must not migrate to other objects. Failure to achieve this is usually the main cause of "wet loads".

Problems associated with porous load autoclaves today are generally due to a combination of many complex issues all too often 'explained' in very simplistic terms, like, "the steam is wet." The truth, in fact, may be found in a number of operational issues listed below:

- Steam condition – This should be of a suitable dryness in accordance with the HTM 2010 guidance;
- Condensate carry over – Due to insufficient condensate being removed from the distribution system, resulting in water lying around in the system and drawn into the sterilizer when the cycle demands it (pulsing), or due to inadequate maintenance of the system and steam traps not functioning correctly;
- Poor pipework, incorrectly sized distribution systems - This can cause many problems, from too high steam velocity in the system to too slow. Incorrect steam pressure control from generation to the actual sterilizers can also be a problem;
- Insufficient steam trapping – This can cause condensate build-up in the system resulting in poor dryness of the steam at the point of use;
- Poor pressure control, causing variations in steam velocities - Maintenance of the pressure-regulating valves (PRV) in the system should always be carried out so that the valves work as intended. These PRVs can change the condition of the steam and, in theory, can actually dry the steam as it passes through the valve;
- Sterilizer carriage design, types of metals used and condensate shields – Care should be taken over these items. For example, a stainless steel carriage shelf creates more condensate than an equivalent aluminium one. What is needed near the load? More condensate. However, the stainless steel shelf will contain more heat in the drying process and will greatly assist in the drying process;
- Operating issues on the sterilizer (frequency of use) - The more a sterilizer is used, the better it performs and the heat is retained in the total machine;
- Chamber designs, materials and capacity - The shape and size of the chamber can greatly affect the outcome of the load and yet, very often, the manufacturer will fit the same valves, vacuum pump/condenser onto 600 litre and 800 litre sterilizers, which will affect their performance;
- Jacket volumes and control issues - Larger steam jackets contain more heat and assist in the drying process (Some machines today have minimal jackets);
- Loading patterns of carriages - This is a key area for the user, and condensate must not be allowed to migrate from one load item to others as this will hinder the drying stage and process;
- Wrap materials used - Many materials today are non-absorbent and can play a significant part in drying problems. In fact, many materials are now water repellent and will cause wetness on their own;
- Ability and performance of the wraps to process the actual load items, steam in, condensate out;
- Operator control - Consistency of operator control of the sterilizers and loading patterns;
- Variety of needs and materials - SSD have severe multi-loading needs for the autoclaves and have to contend with a large variety of materials.

Any one of these factors, on its own, may not be sufficient in itself to be clearly detrimental. Experience has shown, however, that, when two or more factors come together, they can create a problem. SSD managers and engineers must try
to evaluate and correct the problems. In many cases, the solution lies in designing out the problem at the outset, at the time of installation of new machines and equipment.

All the porous load autoclaves currently in use in Wales have been validated by Welsh Health Estates. Most of the factors listed above are included in the validation process and problems identified are eliminated, whenever possible, during the installation and testing procedures. Sterilizers are validated against the recommendations of HTM 2010. It is important to state that when the validation tests are carried out they are based on certain loads, materials, cycle parameters etc. These must not be changed without being evaluated by the SSD manager and/or engineer. Responsibility for the control of the machines and materials must rest with the SSD department, not others.

![Production load being loaded into the porous load autoclave in Bronglais Hospital HSDU](image)

The steam supply is also tested to the recommendations of HTM 2010 for dryness values above 0.9 to 1.0 (above 0.95 for metal loads), and non-condensable gases. Water carry over can be a major problem. As previously stated, this occurs when condensate lies in the system and can be picked up by the steam supply when the sterilizer pulses. This usually manifests itself by water spotting visible on the tops of the load items and not wet within the wrapped loads. The solution to these problems can be found by investigating the steam traps and pipework.

When problems with wetness are discovered, the solution is usually found in a combination of the factors listed above. Most can be eliminated very quickly from report results or visual inspections.

The new standards employed in SSDs have removed the general use of linen and other absorbent materials from tray sets and packs. Therefore, with the advent of a greater proportion of metal and plastics in the load, condensate migration is very common. Plastics do not have the same thermal capacity as metal, and can add problems, as the drying capacity is not within the material. Most of the new wraps are water repellent and will not retain the condensate in the same way as linen.

The metal box system of containing sets can be a problem as the boxes have large voids within them and do not have absorbent materials adjacent to the instruments. Great care must be taken when processing such items and a team decision must be taken with the SSD Manager leading the process with Welsh Health Estates to assess the results.

Experimentation of loading patterns and materials is crucial to the correct outcome of sterilization with the required dry loads. This also means that, when materials or packing methods are changed to different manufacturers or suppliers, evaluation tests and loading patterns must be re-established. Sometimes, if a tray is over wrapped with these new materials, (i.e. too many folds and layers) this can cause wetness. Again, a re-evaluation of the packing methods must be carried out.

It is recommended that logbooks are utilized within SSDs to record any wetness found so that a more robust investigation can be carried out. The logs should include:

- Sterilizer number;
- Cycle number;
- Time of day;
- Type of load;
- Number of shelves utilized on the carriage;
- Known steam header pressure;
- Location on the carriage (i.e. middle of top shelf);
- Number of machines in cycle (if known).

❖ What can be done to resolve problems of wet loads?

Sterilizer cycles have not changed much in the last twenty five years as the objective has always been to remove air from the load items, replace it with steam (condensate) for sterilization purposes and then creating a vacuum to reverse the heat process for the drying effect. Perhaps, autoclave manufacturers, in conjunction with the Service, should develop new cycles that achieve this objective whilst creating less condensate in the initial stages of the cycle, thus improving the likelihood of achieving the desired sterile dry loads.

Perhaps a working group could be set up with manufactures to discuss the issues raised in this article and agree a way forward.

❖ Conclusions

SSDs often face an impossible situation: on the one hand they are required to deal with increases in throughput and complexity of instruments and, on the other hand, they do not have adequate resources to run the service as it should. Nonetheless, the SSD is still deemed to be responsible for solving problems as they arise, with little co-operation from other users.

When things go wrong it is important to understand the problem as a whole. It is also important not to attach blame to any individual or machine without first carrying out a careful and controlled investigation. Continuous improvement is a requirement that every SSD has to work towards. Teamwork with all users of the service, under the leadership of the SSD Manager, is essential to achieve the desired standard.