Developments in bench top sterilisers

By Deborah Thame, BPharm.

"Understanding the science of sterilisation has allowed engineers to incorporate significant advancements in technology into the design of sterilisers suitable for use in office-based practices, raising the standards of sterilisation available to dental and medical professionals..."

When choosing a new steriliser, dentists are faced with a rather overwhelming selection of equipment to choose from. In evaluating the range of sterilisers on offer, some background information on what differentiates the new generation of sterilisers may prove useful.

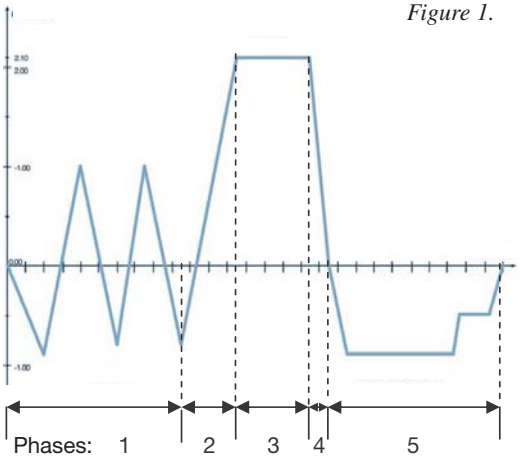
There are a number of cycle phase components that make up a sterilising cycle and these are varied by the manufacturer to produce a steriliser for different situations and professional practices. In basic steam sterilisers, water is introduced to the chamber which is then heated via elements to boil the water and produce the steam. As the steam builds up within the enclosed space, the air is displaced and forced downwards in the chamber, through the load and ultimately out of the chamber through vents in the bottom of the chamber (Hence the term downward-displacement sterilisers). All older bench top sterilisers and some new ones create steam in this way.

Developments in technology have resulted in many changes to this basic function, providing an extensive range of sterilisers from very basic through simple pre-vacuum or pressure pulsed to the premium B-class sterilisers.

Figure 1 is a graphical representation of a typical B-type cycle, which we will use as a reference point. The pressure is shown against time to highlight the action during each phase of the cycle. Chamber temperature tracks with the pressure based on the Temperature - Pressure principles of physics.

Phase 1 shows the air removal stage of a B-type steriliser. This is one of the most significant areas of improvement in the new generation of bench top sterilisers for two reasons: internal steam generators and vacuum pumps.

Figure 1.



Steam generators

A significant development introduced in the new generation of B-class sterilisers is 'pre-boiling' the water outside of the chamber by means of a steam generator and then injecting saturated steam directly into the chamber. This provides significant improvement in the speed of sterilisation. Production of steam using a steam generator also overcomes many of the technical issues previously seen with bench top sterilisers with respect to the saturation levels of the steam such as 'wet' steam and superheated steam. There is significant variation between different brands of sterilisers with respect to patented steam generator technology that result in variations in cycle speed.

Vacuum pumps

The inclusion of a vacuum pump to actively withdraw air from within the chamber and the load is a significant addition to bench top steam sterilisers.

Initially added to assist in the air removal from simple loads, new B-class sterilisers have taken the functionality of the steriliser to higher levels by improving the quality and use of the vacuum function. In a B-class steriliser, the repetition of the vacuum pulse followed by the injection of steam enables air removal and steam penetration into places within a load that cannot be penetrated by the downward displacement sterilisers or simple single vacuum pulse sterilisers, which leave air trapped within cannulated items.

The size and quality of the vacuum pump has a significant impact on the speed of the cycle, it's robustness under heavy use and its expected life. Larger, heavy duty vacuum pumps deliver the fastest cycles and improved reliability but will naturally cost more. Smaller pumps in a B-class steriliser will result in a longer cycle and increased workload on the pump which ultimately affects the working life of the pump. Many S-class sterilisers include small vacuum pumps which are very effective at removing air from simple loads (i.e. loads that do not include cannulated items). Downward displacement sterilisers have neither of these advances and will be considerably cheaper than a B type steriliser but with obvious limitations on function, particularly with respect to sterilisation of hollow instruments.

Air removal capability and load definitions

Scientific assessment of the various types of items requiring sterilisation has been carried out in conjunction with assessment of the effective vacuum levels and required repetitions of the vacuum pulse/steam injection cycle. These have resulted in the development of agreed definitions for loads and agreed standards for cycles that can effectively sterilise them. These are documented in the European Norm for Small Steam Sterilisers, EN 13060. The current Australian Standards for sterilisers in Office-based practice, AS/NZS 4815:2006 uses the load definitions and steriliser cycle types as defined in this European Norm.

Items that are not hollow do not actually need vacuum to remove the air as downward displacement is sufficient. Many new S-class sterilisers use a single vacuum pulse or positive pressure pulse for these items to improve cycle speed. Examples of these items are shown in Figure 2. Hollow B items (not normally seen in dentistry) are mathematically defined and require assisted air removal provided by a pump - this is normally a single vacuum pulse. Hollow A items, commonly called cannulated items, are also mathematically defined and include such dental instruments as handpieces and re-useable aspirator tips as shown in Figure 3. This category generally requires multiple vacuum pulses to ensure adequate air removal and steam penetration for effective sterilisation. Porous items also require a higher level of air removal and while a longer downward displacement cycle will eventually remove the air from a porous item, vacuum sterilisers utilise multiple vacuum pulses for this load also. Items that are outside of the most stringent Hollow definitions (i.e. beyond Hollow A) cannot be sterilised properly in any bench top steriliser.

Figure 2. Examples of solid items as per AS/NZS 4815:2006.

Figure 3. Examples of "Hollow A" items as per AS/NZS 4815:2006.

Phase 2 involves increasing the pressure and temperature within the chamber to reach the levels required for sterilisation. This is achieved by a combination of heating elements and steam injection, where available, or heating alone in the case of basic sterilisers.

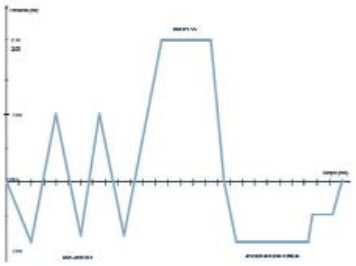
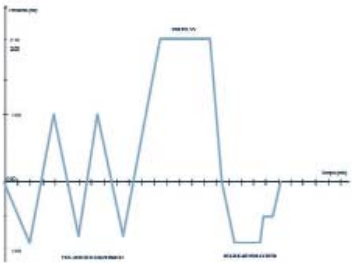
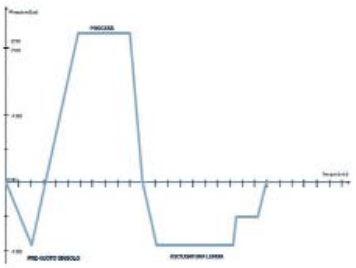
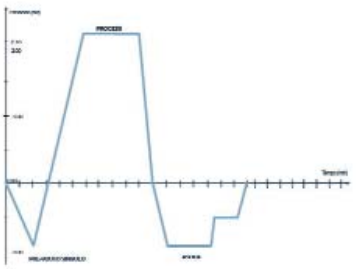
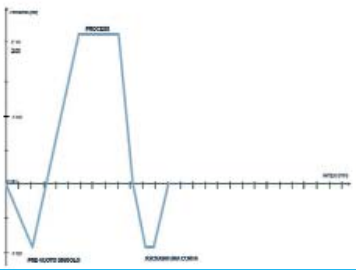
Phase 3 commences once the chamber pressure and temperature have reached the point required for sterilisation, 121°C/103 kPa or 134°C/204 kPa. The steriliser will hold the chamber and its contents at this temperature for a defined minimum period - the "holding period".

Phase 4 involves the removal of the steam. In downward displacement sterilisers this usually means the noisy venting of water and steam from the chamber into the room in which the steriliser is located. The new sterilisers condense the steam within cooling coils, collecting the waste water in an internal tank or directly into a sink drain. This quieter function reduces the safety hazard of venting and also the problems caused by the increased humidity in the environment of the steriliser.

Phases 2 to 4 are common to all sterilisers.

Phase 5 involves drying the load prior to removal from the chamber. Not all downward displacement sterilisers are designed to dry the load, but those that can, do so by heating the chamber to drive off any moisture from the load. The introduction of vacuum pumps into sterilisers also provides significant improvement in the function of this phase of the cycle. B-class sterilisers dry under vacuum; lowering the pressure within the chamber to allow thorough drying at significantly lower temperatures. This results in much faster drying and also reduces the potential for heat-related damage to instruments. Drying time can often be varied for different loads; unwrapped solid instruments needing less drying time than wrapped loads, which in turn need less drying time than porous loads.

As can be seen in Figure 4, by using various combinations of Phase 1 (one or three vacuum pulses) and 5 (long, short or extra short dry), steriliser manufacturers can design their cycles for the fastest, effective

Figure 4. Program	Cycle Type	Suitable to sterilise	NOT suitable for
	**B-Type**	Wrapped packs of Hollow A items and/or solid items Unwrapped Hollow A items and/or solid items Porous items	
	**S-Type unwrapped hollow instruments**	Unwrapped Hollow A items and/or solid items	Porous items Wrapped packs
	**S-Type wrapped solid instruments**	Wrapped packs of solid items Unwrapped solid items	Hollow A items Porous items
	**S-Type unwrapped solid instruments**	Unwrapped solid items	Hollow A items Porous items Wrapped packs
	**S-Type unwrapped solid instruments - Emergency Load**	Unwrapped solid items	Hollow A items Porous items Wrapped packs

sterilisation of any particular load. This is a sample of cycles only, as many manufacturers utilise positive pressure pulses instead of vacuum in Phase 1 and 5 and these cycle profiles will be different again. It is also clear from these examples that not all S-Type cycles are the same; they are a category that includes a wide range of cycle profiles which are suitable for different loads.

The technology of modern sterilisation equipment has come a long way in the past 10 years. Understanding the science of sterilisation has allowed engineers to incorporate significant advancements in technology into the design of sterilisers suitable for use in office-based practices, raising the standards of sterilisation available to dental and medical professionals.

About the author

Deborah Thame is the co-founder and Managing Director of STS Health, an Australian company specialising in the sale and maintenance of steam sterilisation equipment. STS Health imports the Mocom range of Millennium sterilisers available through Henry Schein Halas. For more info, call (08) 9244-4628 or visit www.stshealth.com.au