Lowering Steam Sterilisation Cost – by Significant Reduction in Energy Costs

By Lee Oakley – Sales Director, Priorclave Ltd

During the past decade the status of global economies has led to a greater push to reducing costs, improving efficiencies and lowering carbon emissions. Legislation, namely the Climate Change Act of 2008, (where the UK became the 1st country worldwide to commit to legally binding emissions targets) has led to the 'carbon tax', whereby organisations are required to pay £12 per tonne of CO_2 produced per year. This rate is set to rise to £16 per tonne this year, equally the use of water is metered in most organisations these days; therefore, it is a priority to produce more efficient, environmentally friendly products.

Leading autoclave manufacturers have taken this on board and have the opportunity to advise autoclave purchasers on how best they can maintain and achieve consistent performance whilst lowering the actual cost of ownership by extending the life of their autoclave as well as reducing running costs.

Outside of the initial purchase one of the largest on-going costs is energy consumption in steam generation. By reviewing this actual process one UK University has achieved a signification reduction in direct energy costs and a massive overall saving in water usage of nearly 90%, resulting in an average overall saving of 56%. The very significant savings came about by upgrading to an autoclave equipped with an in-built steam generator rather than continue with direct-steam input from a separate external steam generation plant.

Steam Generation Methods

It is important to appreciate the different methods of creating the steam, matching the source to the laboratory's requirements, such as - does sterilisation take place virtually non-stop or is there a less demanding need such as once or twice daily, what is the quantity of media to be sterilised in a single pass and what type of media? It can be a complex equation therefore it is always best to speak with an autoclave company that designs and manufacturers as they have a wealth of know-how.

If we consider the steam source alone, there are three standard methods of generating steam:

1. Electrically heated – much like an electrical kettle heating elements are contained in-chamber within a water reservoir, this can be manually or auto-filled.
2. In-built steam generator – this is normally mounted directly beneath the sterilising chamber.
3. Direct steam – the autoclave has steam fed directly from a customer's own in-house steam supply.

If we consider the **Electrically Heated Autoclave**, this design tends to be the lowest cost option both in terms of purchase and installation. Smaller autoclaves such as laboratory benchtop models can be operational within minutes by simply plugging into a standard 230V socket, manually covering the elements with water and you are then ready to proceed. Larger autoclaves often require a plumbed water supply feeding through an auto-fill arrangement to ensure the elements covered at the start of steam generation.

The big plus factor in favour of electrically heated autoclaves, which contributes significantly to lowering running costs, is that they are only powered up when required. This does not incur much time delay as modern autoclave designs are extremely fast to heat up.

Autoclaves with **In-Built Steam Generators** are obviously more expensive to purchase and installation cost is higher as they require plumbing and drainage facilities for the water supply. Ideal for laboratories that have a high throughput since steam is always on tap, this is also a disadvantage if chosen for sites with infrequent use since the generator may be operational 24 hours non-stop. Even if a short cycle is selected at say 17.00hrs to run for 2 hours, after 19.00hrs the generator will continue to run all night to top-up steam ready for the next cycle, whenever that is. This is a constant drain on electrical power and water consumption. To overcome this problem some manufacturers will fit a time switch or have some sort of stand-by low level running arrangement.

The third method is **Direct Steam**. Similar pros and cons as with autoclave equipped with in-built steam generators although installation could be considerably more expensive due to additional pipework, regulators and drying equipment, etc. between the steam generator plant and autoclave. However it is rare to find a steam generator house built solely to run autoclaves, and where direct steam is available it is usually because it is used for other, larger plant within the facility. There can be significant losses of energy on long pipe runs

from the boiler house to the autoclave and if the boiler is shut down or at low pressure for repair or routine maintenance then the autoclave will be out of use. However, some autoclaves are available with dual-heating arrangements allowing electrical heating to be used when boiler steam is not available.

University Improved 'Green' Credentials

The Department of Biology at York University is internationally renowned for the strength and quality of its research, teaching and state-of-the-art facilities, and is consistently ranked as one of the top biology departments in the country. The spacious modern teaching provide outstanding research facilities and opportunities for studying diverse subjects such as cancer, immunology and tissue engineering, to novel agricultural products, environmental studies and bio-archaeology.

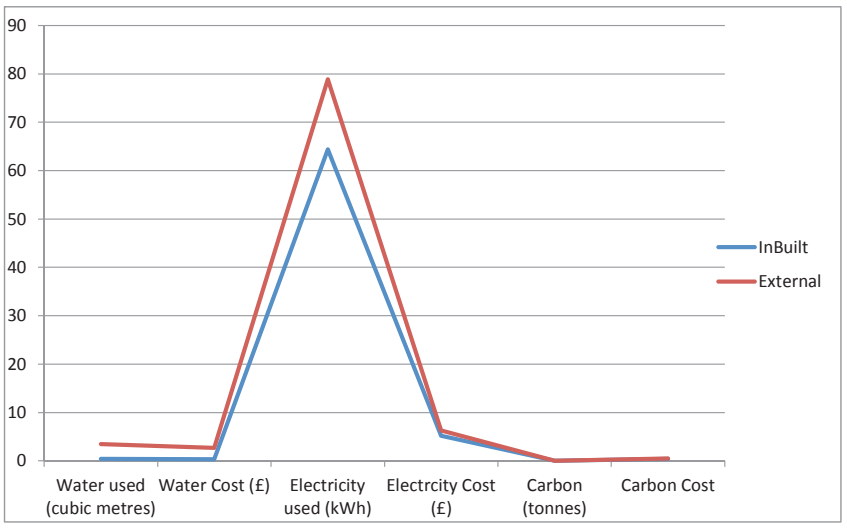
The 'plant' teaching laboratory is attended by undergraduates and those studying for a PhD, researching and tackling fundamental problems across plant biology including physiological adaptation, plant nutrition, primary and secondary metabolism, and intracellular and intercellular signalling. Within the laboratory they use a diverse approach, spanning classical molecular genetics and biochemistry through to post-genomic and advanced imaging technologies. Results have contributed to a wide range of applications from improving production of the anti-malarial drug, artemisinin to increasing the yield of bioenergy crops.

Owing to the nature of the research work undertaken, this area of the University is classified as a Containment Level 1, so only those with authorisation can gain access to the laboratory. In order to maintain the highest level of decontamination risk-potential, after experimental procedures involving seed and GM investigation, all waste is carefully sterilised for safe disposal using steam autoclaves.

Recently it replaced a 350 litre powerdoor autoclave with a Priorclave SH450 machine. The previous smaller capacity machine required a separately housed 45kW generator that ran constantly 24/7 to provide the required level of steam for sterilisation.

Independent Review
Running cost for internal generation V's external steam generator

Capacity (L)	311	450
Water used (cubic metres)	3.493	0.402
Water Cost (£)	£2.69	£0.31
Electricity used (kWh)	78.875	64.375
Electricity Cost (£)	£6.31	£5.15
Carbon (tonnes)	0.042908	0.03502
Carbon Cost	£0.51	£0.42
Total cost per cycle	£9.51	£5.88
Cost per year (720 cycles)	£6,850.73	£4,233.77



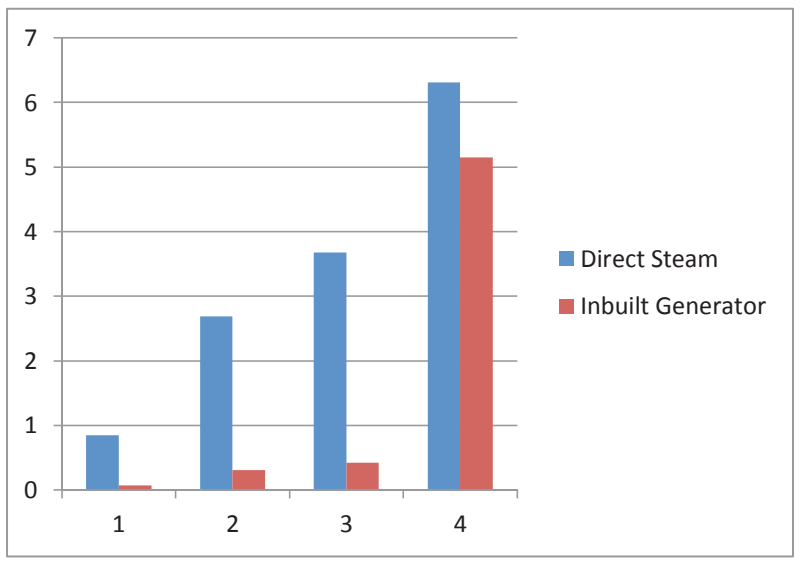
Side by side analysis of running costs between the new autoclave and the original model fed with steam via the external generator show an overall saving of 56%, the major contribution to this massive saving is associated with cost of water supply and disposal, amounting to a reduction of 88% and 89% respectively. Since the University is in a hard-water area the autoclave manufacture recommended the fitting of a water softener, this resulted again in a very big reduction of salt requirements – a 92% cut compared to the previous operation.

Contributing to the efficiency of the new autoclave is inclusion of a vacuum system for Air Removal at the start of the process with an evacuation capability down to approximately 300mb absolute.

Results of University of York

		Direct Steam	Inbuilt Generator	Actual Savings	Saving as %
	Autoclave capacity litres	311	450		
1	Salt (£)	0.85	0.07	0.78	92
2	Water - cost to supply (£)	2.69	0.31	3.28	88
3	Water - cost to dispose (£)	3.68	0.42	3.26	89
4	Electricity per 3 to 3.5 hr run (£)	6.31	5.15	1.16	18

Energy Savings



During the steam generation process multiple vacuum stages can be programmed and are interspersed with heating stages to achieve faster and better steam penetration of the load. After the required sterilisation cycle Assisted Cooling is programmed to take over, rapidly reducing the pressure in the chamber, causing fluids present in the waste load to evaporate more quickly. By initiating a cooling action in solid items, in particular, this process phase can be reduced.

General Consideration

In addition to carefully identifying the most appropriate Steam Source there are many other questions and parameters to consider. It is essential to ask the right questions, get the right answers and to understand the real purpose of the autoclave, being sure the autoclave has the right specification to perform effectively and efficiently, especially if ultimate proof to a certifying body is procedural.

Consideration has to be given to whether top or front loading is desirable, would a cylindrical or rectangular chamber be more appropriate, where is it to be positioned, is there easy access to install the autoclave.

What will be sterilised; bottled liquids, glassware, laboratory equipment, porous loads, waste? How much space is required? What services are required? How will the cycle be controlled? How do you prove sterilisation?

Put together a written specification, this will help a supplier offer the right equipment, either from a standard range of autoclaves or a bespoke build. Ask the supplier to explain why a particular model is being recommended and discuss steam generation options as this can have a big impact on daily running costs.

Financial Gain - £6000 p.a.

When York University's Biology Department made the change to the new autoclave the laboratory acquired a machine with a larger capacity but with a smaller footprint creating more free-space within the actual laboratory as well as totally freeing up a room, which previously housed the generator.

Since the new autoclave has an inbuilt generator which heats water on demand, costs are cut significantly compared with the previous autoclave design. The new autoclave is called into action two to three times a day, five days a week and by heating water-on-demand it is estimated to save the University £7.58 per run. Based on this there is a potential energy cost-saving of nearly £6,000 pa.