



Clean Steam

Which grade of steam is right
for your application?

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First for Steam Solutions

EXPERTISE | SOLUTIONS | SUSTAINABILITY

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1.0 Executive summary

There is a growing trend for steam users to switch to clean steam.

Plant steam is fine for applications where it doesn't come into direct contact with the product, as well as in many applications where the product would be unaffected by low levels of contamination. However, the possibility that water treatment chemicals or other contaminants such as cross contamination from Cleaning In Place (CIP) could end up contaminating the product, is increasingly seen as unacceptable.

Many food and drink manufacturers are therefore looking to up their game by switching to cleaner forms of steam. It's a move that other, high-purity operators such as pharmaceutical manufacturers, healthcare providers and electronics companies have already made, either for regulatory/guidance or product quality reasons.

This white paper looks at the different grades of steam available, and considers where they might be most applicable. For instance, some food manufacturers are happy with filtered steam, while others are opting for steam generated by a dedicated clean steam generator thus eliminating the risk of process contamination.

Finally, it considers the potential advantages of switching to clean steam, and the ability to demonstrate the use of best practice to demanding customers such as supermarkets.

2.0 The demand for clean steam is growing

Standard plant steam is a convenient and cost efficient way for moving heat around a huge variety of processes and premises. Yet there's a growing recognition that plant steam is simply not clean enough for some applications. While this has long been understood in pharmaceutical production, healthcare and electronics, demand for clean steam is now on the rise in other industries.

The most obvious is food and drink, where improved hygiene naturally promotes greater food safety. However, the quality of other products may sometimes benefit from the use of clean steam to prevent contamination, even where there is no regulatory requirement relating to steam quality. In fact, any process that has steam coming into direct contact with the product has some potential to benefit from a switch to clean steam, although industries such as food, drink, pharmaceuticals and healthcare will undoubtedly remain the biggest users.

2.1 Food and drink companies are waking up to clean steam

Food and drink are the industries where the trend towards clean steam is undergoing the biggest shift. This is mainly because manufacturers want to **eliminate** any potential risk of contamination to their process. It's also partly because of pressure from customers such as the major supermarkets, who have their own responsibility to ensure the safety and quality of the products they sell.

There is little in the way of specific legislation governing the quality of steam in food and drink applications even though concerns over issues relating to taste and taint are becoming more prominent. However, manufacturers are legally bound to ensure the quality of the final product by identifying potential hazards and controlling them, typically by using a Hazard Analysis and Critical Control Point (HACCP) approach.

This means manufacturers should ensure suitable controls are established and adhered to for all possible hazards. The risks of process contamination occurring from steam should therefore be considered as part of the HACCP procedure, if steam is added directly into the product or as a stage in the food production process.

The standards commonly referred to when considering food hygiene include:

Europe:

- Regulation (EC) No 852 / 2004 of the European Parliament and of the Council of 29 April 2004 on the hygiene of foodstuffs. (Chapter VII, Section 5).
- Codex Alimentarius.
- European Hygienic Engineering and Design Guidelines (EHEDG).
- Regulation (EC) No 1935 / 2004 of the European Parliament and the Council of 27 October 2004 on materials and articles intended to come in contact with food and repealing Directives 80 / 590 / EEC and 89 / 109 / EEC.

USA:

- 3-A Accepted Practices for A Method of Producing Culinary Steam, Number 609-04.
- FDA Code of Federal Regulations, 173.310, Title 21, Volume 3, Revised as of April 1, 2005.
- National Organic Standards Board (NOSB), Steam Generation in Organic Food Processing Systems TAP Review.

International:

- PAS 220 Prerequisite programmes in food safety for food manufacturing
- Hazard Analysis Critical Control Point (HACCP)



Figure 1 HACCP Food Safety logo

3.0 The four grades of industrial steam

There are four grades of steam commonly used in industry today, from basic plant steam, through filtered (culinary) steam, clean steam and pure steam. While plant steam is great for heat transfer applications in industries such as petrochemicals or pulp and paper, food companies should use filtered steam as a minimum, or choose clean steam to eliminate the risk of contamination. Pure steam is the highest grade option and is required in pharmaceutical and biotech applications.

Steam purity versus steam quality

It's worth noting that steam purity and steam quality mean different things. While steam purity is a measure of the dissolved solids, volatiles and/or particles in the steam, steam quality refers only to the amount of water in the steam. A more correct term is dryness fraction.

$$\text{Dryness Fraction} = \frac{\text{Mass of steam}}{\text{Mass of steam} + \text{entrained water}}$$

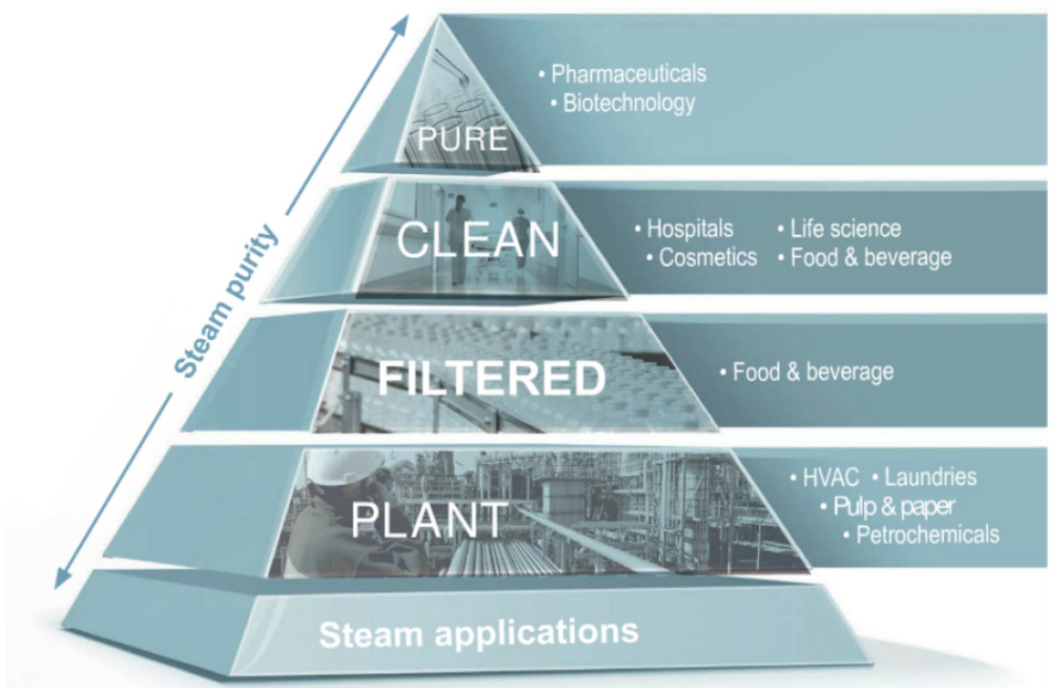


Figure 2 Steam grades and their market applications

3.1 Plant steam

Plant steam is the starting point for most steam users. It can certainly be used anywhere it doesn't come into direct contact with the process or product. If it is used directly, users should consider whether the quality and purity of the steam are fit for purpose or whether any possible contaminants could present a problem.

Contaminants can be chemical, physical or microbiological.

The most common source of chemical contamination in plant steam arises from treating the feed water as it enters the system. Boilers generate steam from water and that water is typically treated with chemicals to prevent a range of problems such as corrosion or the build-up of scaly deposits. Traces (and in some operating situations significant quantities) of those treatment chemicals can end up in the steam supply, especially if users do not follow best practice in the operation of their boiler and the design of their steam and condensate system.

If chemicals do end up in direct contact with the process, they have the potential to taint products with an unwanted taste or smell. In the case of food and drink applications, there may also be safety concerns or consumer perception issues associated with their presence.

Carryover is a potential source of contamination. It may result from priming (where the distribution system draws off a large quantity of steam quickly and boiler water is entrained in the steam line) or foaming. Carryover can contain potentially high levels of water treatment chemicals.

Cross contamination is also a possibility, since most manufacturers will recover condensate from around the factory in order to save water and energy. If there are any pinholes or other leaks in the system, the returning condensate may be contaminated by process media or by the chemicals used for cleaning- in-place, for instance.

Although effective water treatment should minimise problems such as scale and corrosion if carried out correctly, plant steam may still carry solid contaminants, such as flakes of rust or residual scale from inside the boiler and steam distribution system.

Of course, the temperature and pressure of steam kills common microbial hazards such as Salmonella, Listeria or E. coli. In fact, heat is a most effective and convenient physical control agent for destroying microbes, which is why clean steam is used to sterilise medical instruments, for example. Even so, dead microbiological debris (pyrogens) can still induce an adverse reaction if injected, which is why many pharmaceutical applications demand pure steam. In addition, any solid residue deposited by plant steam as it contacts the process or product could potentially provide a home for future microbiological growth once the product has cooled down.

3.2 Filtered steam

Filtered or culinary steam is plant steam that has passed through a filter, typically 5 microns. This removes 95% of all particles larger than 2 microns. A pre-filter (typically 25 microns) is placed upstream of any 5 micron filter to prevent rapid blinding (blocking) of the main culinary filter.

While EU Regulation (EC) No. 852 / 2004 says: 'Steam used directly in contact with food is not to contain any substance that presents a hazard to health or is likely to contaminate the food', it doesn't specify the acceptable quality or purity of steam. In practice many European operators refer to the US 3-A practices for producing culinary steam.

3-A Accepted Practices for a Method of Producing Culinary Steam, Number 609 - 4, is the US standard that establishes requirements for producing culinary steam. It stipulates the materials used, surface finishes, installation and boiler operation with regard to the use of culinary steam.

Note that water treatment, boiler carryover and cross contamination still pose a risk, because the filter will not remove all the potential contaminants. In fact, the 3-A Practice specifically stipulates that boilers should be 'operated in such a manner as to prevent foaming, priming, carryover, and excessive entrainment of boiler water into the steam'. $\text{Dryness Fraction} = \frac{\text{Mass of steam}}{\text{Mass of steam} + \text{entrained water}}$

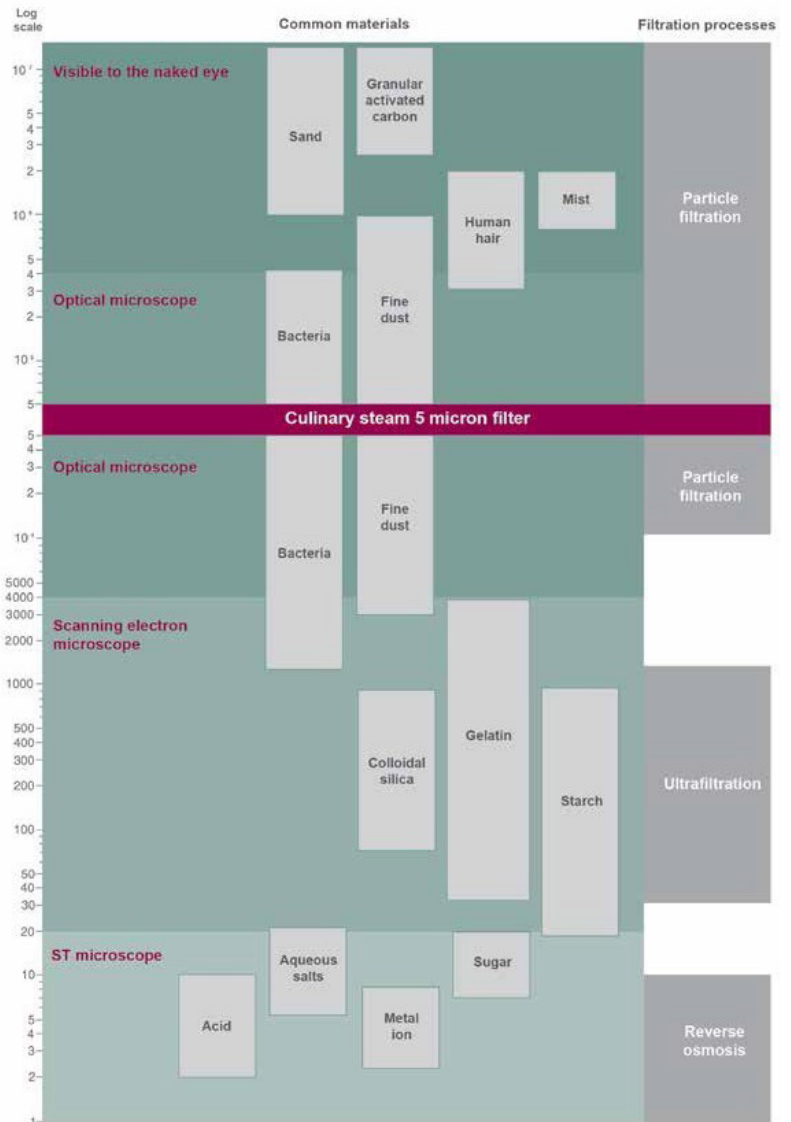


Figure 3 The filtration spectrum

3.3 Clean steam

Clean steam is different because it relies on a secondary generator and tightly controlled feed water quality to eliminate many of the potential issues already outlined.

It's critical to start with the right water quality. Raw water is not adequate and will require pre-treatment. Reverse osmosis (RO), deionised/demineralised (DI) and continuous electrodeionised (CEDI) water are all good possibilities. They all remove the need for chemical treatment by removing most of the particulates, inorganics and dissolved solids at the pre-treatment stage. The risk of water treatment chemical contamination is therefore eliminated when using clean steam.

In addition to the quality/purity of the clean steam leaving the generator, there are other factors that should be considered when installing a clean steam system.

Clean steam is very aggressive, so grade 316 or 316L stainless steel is typically used on contact surfaces throughout the system to protect against rouging. In addition, even though the temperature of the steam will keep most bacteria at bay, the surface finish of equipment should minimise any crevices that could encourage microbial growth. Similarly, a clean steam distribution system should be designed to good engineering practices. Guidance can be sought from 3-A Sanitary Standards.

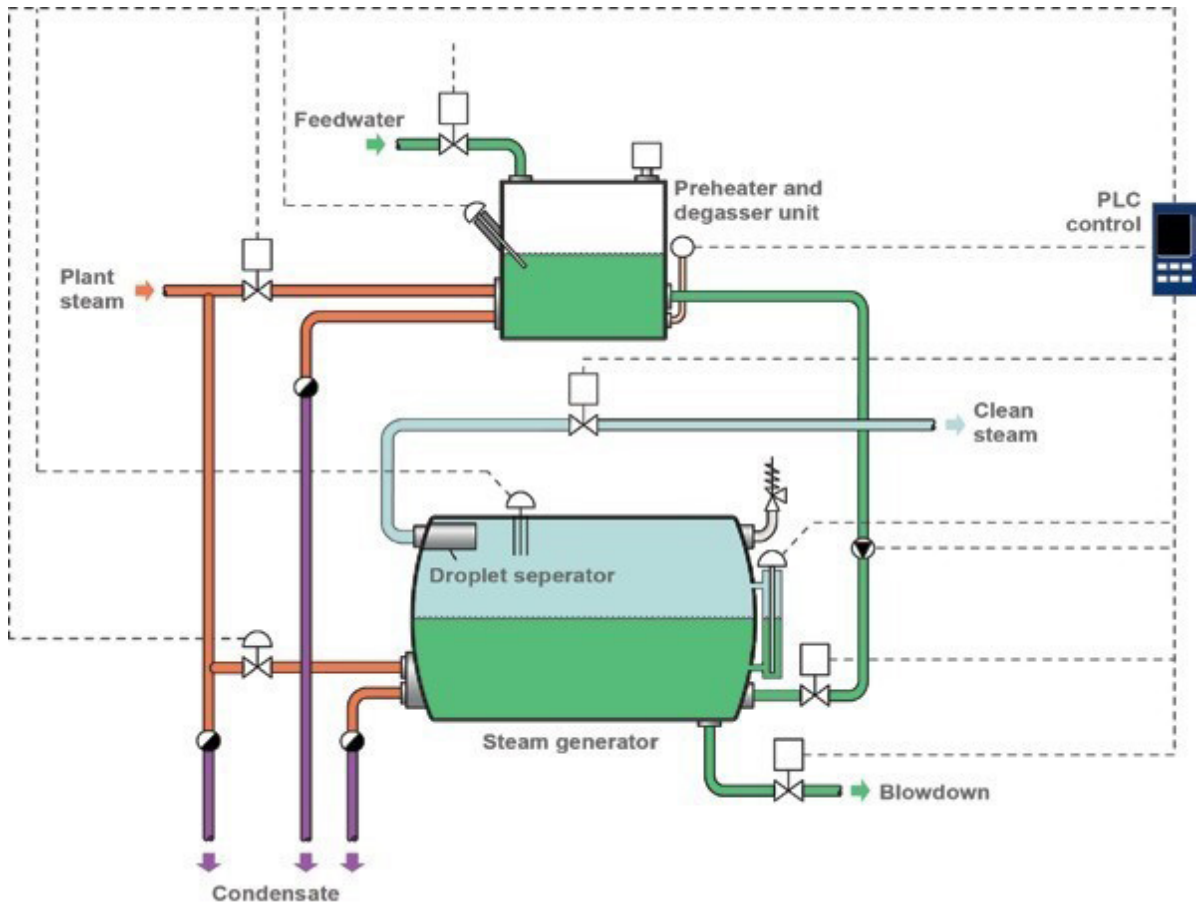
Clean steam is often used in applications such as sterilisation not only to eliminate contaminants, but also to ensure the quality control of critical attributes such as dryness, superheat and production of non- condensable gases, all of which could adversely affect the process and equipment. This has been largely driven by standards such as HTM/EN285 sterilisation standards in the UK and Europe.

Soft drinks maker uses clean steam to protect quality

When a major soft drinks maker required expert support for a clean steam project, it contacted Spirax Sarco. After investigation it was found that the existing clean steam boiler was running inefficiently and unreliably, leading to inconsistencies in the company's quality control results.

The project's aim was to improve the quality results by reducing bacterial counts and eliminate taste and taint. Spirax Sarco replaced the existing boiler with a compact clean steam generator, reverse osmosis water treatment system, blowdown vessel and ancillary equipment, all supported by Spirax Sarco expertise and service support.

The new system has met all quality control requirements, substantially improving process efficiency and reliability, as well as providing the manufacturer with the capacity to meet its future expansion plans.



Schematic of a Clean Steam Generator



High Capacity Clean Steam Generator (CSM-K)

4.0 Why opt for cleaner steam?

The direct benefits of opting for steam with a higher standard of purity than plant or filtered steam vary, depending on the industry and the particular application. In industries such as pharmaceuticals, healthcare and electronics, the patient safety, regulatory and product quality requirements make the decision to use high-purity steam extremely clear-cut. Quite simply, it's an essential prerequisite for a successful operation.

On the other hand, some operators in the food and drink industries still view the use of clean steam as discretionary because of the lack of concrete regulatory requirements. However, it can be crucial in helping manufacturers to demonstrate that they are applying an effective food safety regime according to HACCP principles. This is increasingly a requirement from major retailers who, along with manufacturers, are responsible for ensuring the safety and quality of the products they sell.

A recommended approach to applying HACCP involves the following steps:

1. Determine quality of raw boiler feed water
2. Determine levels and types of dosing chemicals
3. Identify other potential sources of contamination arising from the use of an inappropriate grade of steam
4. Assess any risks associated with 'product' contamination, for the complete steam system
5. Devise and adopt an effective steam quality testing regime
6. Adopt best practice in the design, maintenance and testing of the steam system to ensure that the correct quality of steam reaches the process.

Good news on energy savings

While product safety and quality are likely to be prime reasons for choosing clean steam, some hygienic options provide significant additional benefits.

For example, using reverse osmosis (RO) strips out 99% of dissolved solids before the feed water reaches the boiler. This drastically reduces the need for boiler blowdown, slicing as much as 3% off the fuel bills of typical steam users.

5.0 Spirax Sarco clean steam solutions

As well as being the leader in general purpose steam, Spirax Sarco delivers filtered and clean steam systems for more specialised applications.

Filtered steam

Spirax Sarco offers a range of clean steam filters that will remove 95% of particles from plant steam. This solution should be combined with optimised water treatment and best practice steam and condensate system design in order to minimise the chances of contamination.

Clean steam

Spirax Sarco also offers dedicated systems for generating clean steam. For example, our reverse osmosis (RO) technology can remove almost 99% of the dissolved solids from raw feed water, without the use of chemical treatment. Our dedicated clean steam generators typically use plant steam to generate a source of clean steam that's suitable for a vast majority of hygienic environments, including food and drink manufacture and healthcare.

Global brewer relies on Spirax Sarco clean steam

A major brewer uses two Spirax Sarco Clean Steam Generators and a Spirax Sarco Reverse Osmosis water treatment system to provide clean steam for beer keg sterilisation. Directly injecting clean steam into the beer kegs ensures that the process will not taint the product's taste, which could happen if only plant or filtered steam was used.

The Spirax Sarco generators were supplied as pre-assembled compact skid-mounted packages for minimal installation time. The systems included precision automated controls, PLC control with a touch-screen interface and remote monitoring capabilities. They were built for low maintenance with all wetted secondary parts in stainless steel 316L and are supported by a support service with 24-hour response.

Spirax Sarco offers a range of products and services for clean steam applications:

Clean Steam Generators

All Spirax Sarco clean steam generators are supplied with certification as standard to demonstrate they are manufactured in accordance with hospital sterilisation requirements and the PED Directive.

Compact Clean Steam Generator (CSM-C)

CSM-C is a compact modular design combined with pre-heat and degassing systems made to fit through plant room doors and saving on floor space. The pre-assembled, skid-mounted package arrives ready to be connected to your utilities with an option of multiple units side by side.

The standard range covers clean steam duties up to 640 kg/h at 3 bar(g). It comes with a programmable control panel and colour touch screen mounted on the control panel, for easy parameter setting, monitoring, remote diagnosis and maintenance.



High Capacity Clean Steam Generator (CSM-K)

The CSM-K is ideal for use on larger loads where steam purity and quality consistency is critical to the process. The pre-heat degassing system is separate on this model and circulates the feedwater, ensuring the removal of soluble gases prior to entering the boiler.

The standard range of outputs is up to 3,800 kg/h at 3 bar(g) but bespoke units can be manufactured to client requirements and needs.



Clean Steam Components

Spirax Sarco is natural partner to help design and provide solutions and components for your clean steam system requirements. These include our sanitary range of products, heat exchangers and control systems to provide the efficient and safe steam distribution of steam to the point of use.



BT-6 balanced pressure thermostatic steam trap for use in hygienic environments



CS10 Clean Steam Separator



BTS7.1 Balance Pressure Clean Steam Trap



CVS 10 Sanitary Check Valve

Services

Steam Quality Audit (HACCP)

A steam quality audit based on HACCP principles will review your complete steam and condensate plant or filtered steam system with a view to identifying any potential contamination risks to the process.

Clean and Pure Steam Systems Training

This training course provides knowledge on all aspects of filtered and clean steam and associated water quality.

Spirax Sarco is a world leader in steam and energy solutions. You can contact your local representative for advice on which grade of steam is right for your process. Alternatively, head to the website for more information.

Find us at www.spiraxsarco.com

Not all solutions are available in all markets.

Please contact your local Spirax Sarco representative for further information.

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