Hospital Steam Systems

Expert advice on critical healthcare steam applications

First for Steam Solutions

EXPERTISE | SOLUTIONS | SUSTAINABILITY

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Hospital Overview

Hospitals have been using steam for over a century, especially for sterilization, hot water, heating, humidification, and laundries.

New hospitals continue to specify and install modern steam systems, thanks to its advantages as an efficient and controllable heating medium, proven to be reliable, safe, flexible, and sterile.

Healthcare facilities are highly intensive energy users that require 24 hour working, and steam is suited to these facilities as it moves large amounts of energy very quickly and easily.

Steam should be available at the point of use in the correct quantity, at the correct pressure, clean, dry, and free from air and other incondensable gases. It is also inherently safe in ATEX identified hazardous areas, with no risks of sparks and no flammable gases or flames.

In recent years there has been a growing awareness of the need to improve steam quality in hospitals, spurred partly by the requirements and laws that govern medicinal products and medical devices, but also mitigating the patient risk from infections and unsterile equipment.

Hospital Steam Systems

Some hospitals may consider replacing a centralized steam plant with a decentralized system as a way of reducing costs, but most steam plants can be greatly improved at a fraction of the cost using advanced technology to unleash the full potential of steam.

- ✓ Steam typically contains 26 times more energy per pound than water (2200 kj/kgK steam vs 84 kj/kgK water).
- ✓ Steam requires much smaller pipes than water for the same energy.
- ✓ Steam has a much higher coefficient of heat transfer
- ✓ No electrical costs associated with water circulation pumps because steam flows from areas of high pressure to low pressure.

Benefits of choosing Spirax Sarco:

- Expert advice on critical healthcare steam applications
- Single source of supply for steam solutions from plant to high-purity applications
- Engineered packages for seamless integration and faster field installation
- The reassurance of full supporting documentation
- Global presence with local service and support
- Support for sustainable operations, from system concept to operational energy management.

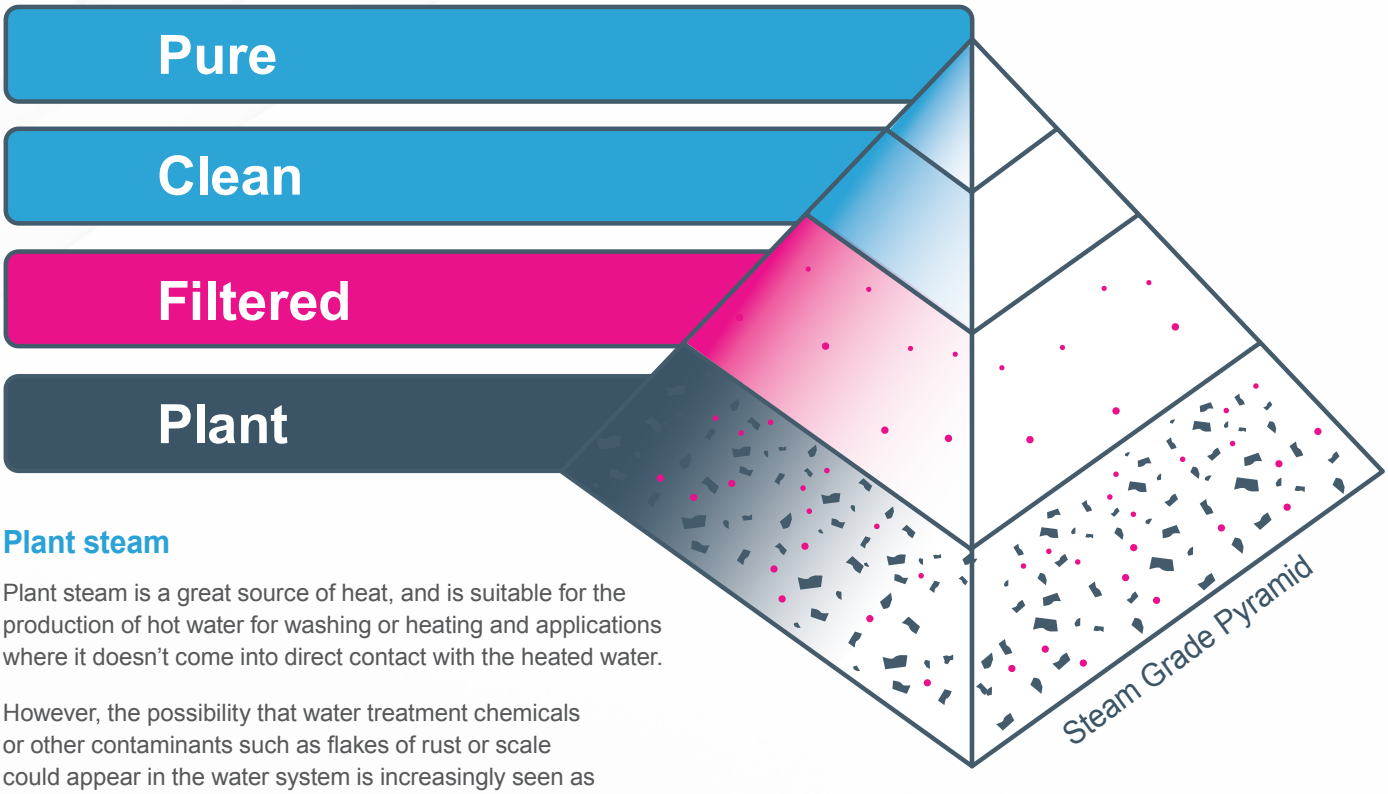
Is Steam cost effective?

- ✓ A centralized system will normally comprise of two or more large boilers (duty & standby) of the same design. Decentralized plants have individual boilers, often different sizes, and can be a solution when additional infrastructure would be too costly.
- ✓ The latest automated monitoring systems and automated boilerhouse controls mean steam systems are easier to maintain and need minimal manpower to maintain peak operating efficiency.
- ✓ For the same heat capacity, steam needs smaller bore pipes than hot water or thermal oil systems. This results in easier installation, and less costly pipework, and insulation.
- ✓ Unlike hot water systems, steam systems do not require expensive electricity to run circulation pumps.
- ✓ Modern steam systems give easy and accurate temperature control. No system balancing and no differential pressure controls are needed.
- ✓ Steam systems are flexible to accommodate additional plant easily.
- ✓ For humidification, steam offers low maintenance costs and peace of mind. Not only do water humidification systems suffer scaling and corrosion, but Legionella is an ever-present concern that does not arise with steam.

The four grades of Industrial Steam

Not all steam is the same, depending on the use it has different characteristics.

There are four different grades of steam commonly used in industry today, from basic plant steam, through filtered steam, clean steam, and pure steam.



Plant steam

Plant steam is a great source of heat, and is suitable for the production of hot water for washing or heating and applications where it doesn't come into direct contact with the heated water.

However, the possibility that water treatment chemicals or other contaminants such as flakes of rust or scale could appear in the water system is increasingly seen as unacceptable. Many hospitals are therefore looking to eliminate potential uncertainty by switching to cleaner forms of steam.

Filtered steam

Filtered 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. Filtered steam has better characteristics concerning entrained detritus, but it could have volatile contaminants. With filtered steam, water treatment, boiler carryover and cross-contamination still pose a risk, because the filter may not remove all potential contaminants.

Clean steam

Hospitals rely on clean steam for sterilizing surgical instruments and sometimes for humidification. Clean steam is different to filtered steam as it relies on a secondary generator and tightly controlled feed water quality to eliminate many of the potential issues. Raw feed water, Reverse osmosis (RO), deionized/demin (DI), and continuous electro deionized (CEDI) water are all good possibilities, but cannot run in steel pipes. treatment by removing most of the particulates, inorganics and dissolved solids at the pre-treatment stage.

The risk of water treatment chemical contamination is eliminated when using clean steam. In addition to the quality of the clean steam leaving the generator.

Clean steam is aggressive, so grade 316 or 316L stainless steel is typically used on contact surfaces throughout the system. Similarly, a clean steam distribution system should be designed to meet sound engineering practices.

Clean steam is often used in applications such as sterilization to eliminate contaminants and ensure the quality control of critical attributes such as dryness, superheat, and production of non-condensable gases. These issues could all adversely affect the process and equipment. This has been largely driven by standards such as EN285 & AAMI ST79 sterilization standards in Europe and the USA.

Pure steam

Pure steam is pure, dry, and pyrogen-free. When it condenses it should comply with international pharmacopeia requirements for water for injection (WFI). In other words, it must be pure enough to be injected into the human body with no ill effects.

Again, a supply of highly purified feedwater is essential, using the same principles as for clean steam. However, this time the standard is higher, with the resulting condensate meeting WFI standards. A dedicated pure steam generator then distills the water either once or multiple times to produce the purity of steam required, mainly for Pharmaceutical applications.

Energy saving

Innovation in steam plant control and monitoring technology in recent years provides new ways for hospitals to substantially improve the efficiency of existing systems, to help reduce energy use and lower carbon emissions.

AAMI ST79 Standard

Steam for sterile processing

The system for steam delivery should be designed, monitored, and maintained to ensure that the quality, purity, and quantity of the steam provided are appropriate for effective sterile processing.

Rationale: Steam quality, purity, and quantity can be affected by the design, use, and maintenance of the overall steam system, which includes the boilers and steam distribution lines.

Steam quality

Facility engineering personnel should ensure steam quality by:

- steam dryness between 97% and 100%,
- noncondensable gases (e.g., air) at a level (less than 3.5% v/v condensate) that will not impair steam penetration into sterilization loads,
- maintaining steam traps and boilers/generators.

Rationale: Steam that is too dry can contribute to superheating and, consequently, to suboptimal steam sterilization conditions. Steam that is too wet can lead to wet packs after sterilization and compromise sterility.

Steam purity

To maintain steam purity and minimize the presence of potential contaminants in the steam, facility engineering personnel should:

a) treat the feedwater with boiler additives and/or feedwater conditioners so that its condition and/or chemistry do not damage the boiler or steam lines;

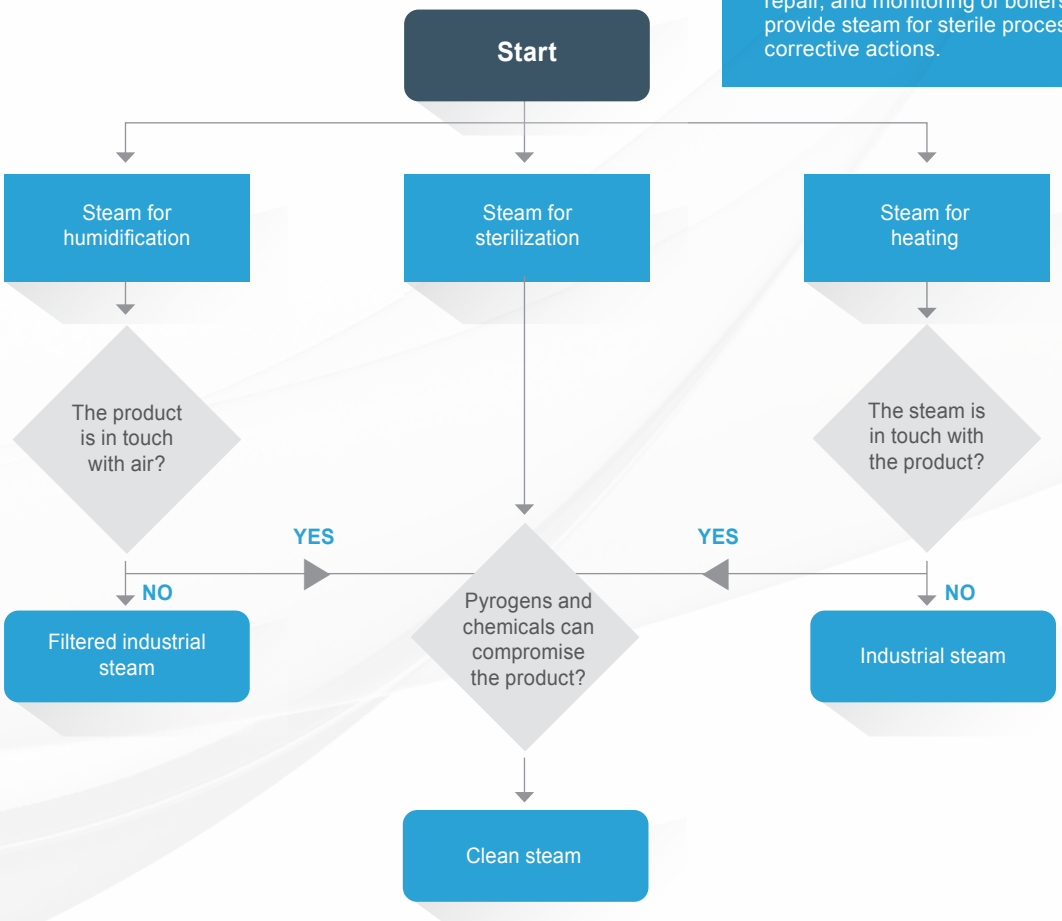
b) use only additives and conditioners approved for use in the food and drug industries (21 CFR 173.310 and 21 CFR 200.11);

c) install in-line filters that are as close to the sterilizer as possible and include a drip leg or trap for condensate material; and

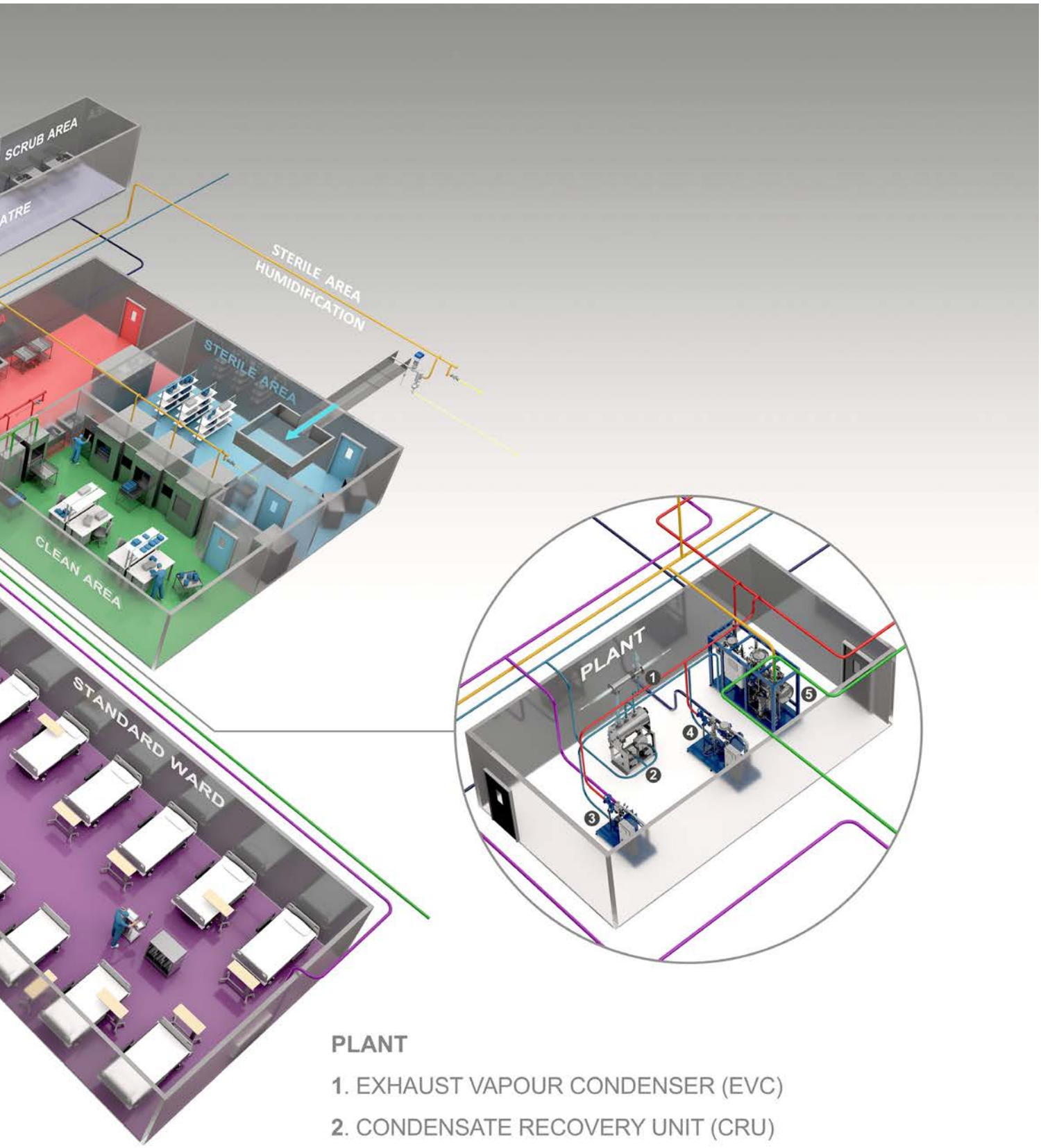
d) develop procedures to monitor steam purity and provide corrective action.

Monitoring steam systems

Health care facilities should provide for the preventive maintenance, repair, and monitoring of boilers and steam distribution lines that provide steam for sterile processing and for the documentation of corrective actions.



* RETURN PIPEWORK ON DOMESTIC HOT WATER & HEATING SYSTEM NOT DISPLAYED



PLANT

1. EXHAUST VAPOUR CONDENSER (EVC)

2. CONDENSATE RECOVERY UNIT (CRU)

3. EASIHEAT LOW TEMPERATURE HOT WATER (LTHW)

4. EASIHEAT DOMESTIC HOT WATER (DHW)

5. CLEAN STEAM GENERATOR (CSG)

Applying innovation to steam systems

Steam systems are capable of being operated with limited supervision and with high energy efficiency. The latest technological developments such as accurate temperature control, advanced water treatment and sophisticated energy utilization and recovery ensure that steam meets ever-more demanding energy efficiency requirements.

Steam plant offers unrivalled lifespan, with up to 30 years of operation being common. Throughout operational life, automatic monitors and controls continuously check the health of the entire system and free up skilled personnel for other duties, such as proactive maintenance.

A range of innovations can be applied to healthcare steam and condensate systems to improve energy efficiency and lower greenhouse gas emissions. In this section we look at the most cost effective:

1. Heating water using less energy

One of the most common upgrades in hospitals is to replace traditional hot water systems that use steam to heat water in large shell-and-tube calorifiers. These either store the water in the body of the vessel or additional hot water storage tanks. Storing hot water is inherently inefficient because heat is being lost continually.

Replacing these calorifiers with steam-heated hot water on-demand systems that use compact plate heat exchangers can deliver energy savings of up to 20%. Further benefits of such an upgrade include less maintenance, because calorifiers tend to be large pressure vessels that require regular strip-downs for insurance inspections.

Calorifiers take up valuable floor space and unlike compact plate heat exchanger systems cannot be resized in response to demand changes, for example when a ward closes.

Plate heat exchangers are easier to control for greater water temperature accuracy than is usually possible with shell-and-tube calorifiers. Eliminating the need to store heated water also reduces the Legionella risk, if the system is not managed and maintained carefully.

On-demand steam-to-hot-water systems can be delivered as a complete skid-mounted assembly. This makes installation quick and easy because the complete package only needs to be hooked up to the site's services and commissioned, saving time and costs involved in building conventional heating systems on-site. Additionally, the whole package is factory tested and guaranteed to work as specified, eliminating the risk of compatibility problems between components.

The energy-saving benefits of packaged steam-to-hot-water solutions can be further boosted by precise control technology to ensure all the useful energy is extracted from the steam before the condensate is returned to the boiler.

2. Closed systems achieve maximum energy recovery

The recovery of condensate and flash steam are two of the best ways to see substantial savings in energy and water costs. Using the heat from condensed steam to preheat boiler feedwater saves energy. However, many boilerhouses use a boiler feedtank at atmospheric pressure, and there is a limit to the amount of energy that can be recovered by feeding hot condensate and flash steam into the tank. The water in such a system cannot exceed 212°F.

The boiler feedwater is usually maintained at 185°F or 194°F to avoid cavitation, remove non condensible gases (NCG's) and prevent rust.

A 42.8°F rise in boiler feed temperature equates to a 1% energy saving in boiler fuel cost

Up to 50% of the recoverable energy in the condensate can be lost as flash steam, which is generated as condensate leaves the pressurized steam system and returns to atmospheric pressure.

A solution to resolve these issues is a closed system that recovers the energy from both the condensate and the flash steam. By transferring the recovered energy into the high-pressure side of the boiler feed pump, the water entering the boiler can be raised to well above 212°F without causing pump cavitation, as this is after the pumping point.

3. Steam-to-hot-water packaged solutions

Spirax EasiHeat for delivering hot water and heating on-demand deliver up to 14% energy savings compared to conventional steam-to-water heating systems.

EasiHeat is a ready-to-install solution that uses steam in a compact, plate-and-frame heat exchanger to provide instant hot water for domestic hot water (DHW) and space heating. The resulting supply of hot water is available on-demand, without the need for a buffer vessel or storage tank. The controls are matched to the system, enabling an EasiHeat unit to control output temperatures to within +/- 2°F (±1°C) on stable loads.

EasiHeat features optional Spirax Intelligent Monitoring System (SIMS™). SIMS™ is an advanced communications platform enabling remote monitoring, performance trending and fault diagnostics that makes it easy to save energy and control critical applications. SIMS uses a touchscreen interface to deliver key performance data to operators, such as steam use, fuel consumption and temperature. This helps operators to monitor energy use closely and automatically adjust the system to optimise efficiency. The interface is intuitive and can be used by operators with limited controls experience.

4. Sub-cooling condensate can save 10% in energy

A technique that is becoming increasingly beneficial to a healthcare industry faced with the growing need to reduce emissions is sub-cooling condensate, which allows steam system users to extract more energy before returning condensate to the boiler. Energy savings of up to 10%, per year in the steam system are possible.

Sub-cooling works by reducing the temperature at which steam traps remove the condensate from the steam line, often by changing the type or rating of the traps.

Sub-cooling can also improve the plant's overall steam balance by, for example, eliminating excess flash steam and dealing with choking problems.

However, sub-cooling condensate may not be suitable for every installation because the condensate will be at a lower temperature when it eventually returns to the boiler feed system, so any energy-saving benefit must be balanced against the need to augment feedwater heating in the boiler room.

With multiple factors to consider, it can be complex to get the right balance and users are advised to seek expert support if they're trying to decide if sub-cooling is right for their installation.

5. Flash steam and energy recovery

The Spirax Flash Recovery Energy Management Equipment (FREME) creates a completely closed steam system under constant pressure that can recover all the energy from returned condensate and flash steam without wastefully dumping or venting surplus energy. The system feeds the energy from the returned condensate into the high-pressure side of the boiler feed pumps.

FREME is proven to achieve energy savings of up to 26% per year, delivering an attractive return on investment. Heat and water previously lost from the system can be recovered fully, reducing utility bills, water treatment chemical costs and CO2 emissions.

6. Clean Steam Generation

Spirax Sarco offers a range of Clean Steam Generators designed specifically for centralized sterilization departments. The CSG-HS is a clean steam generation system designed to guarantee steam quality across all load requirements of the sterilization processes.

Designed and verified to outperform the requirements of EN285 and other similar global standards, the CSG-HS offers guaranteed performance.

The CSG-HS includes a range of innovative design features and is supplied packaged and ready to install with simple commissioning. It provides:

- Central clean steam generated at sterilizer ready conditions, reducing the need for additional in-line equipment, in a compact packaged solution
- High thermal storage for multiple sterilizer applications

- Configurable options to suit individual requirements
- Digital integration with compliance and traceability.

7. Surveys and system audits

Spirax Sarco offers steam system audits that are tailored to each hospital's requirements, whether that's energy efficiency, Health and Safety or achieving best practice. Audits range from a check-up for a single plant room, to benchmarking an entire steam system and from the water treatment plant right through to condensate return.

Audits identify achievable energy savings with calculated return on investment, highlight Health and Safety shortfalls, detect water treatment issues such as corrosion and scaling, identify system improvements and advise on good engineering practice.

Tier 1. Steam System Audit – Initial Assessment

- Steam Quality Testing to EN 285 Standard to understand steam's thermal energy transfer attributes at critical test points.
- Recommendations based on steam system engineering best practice, legislation, and health & safety.

Tier 2. Steam System Audit – Comprehensive Assessment

- Complete steam system overview, from boiler to all plant & process points of use.
- Identify energy saving possibilities with immediate and future solutions.
- Recommendations based on steam system engineering best practice, legislation, and health & safety.

Tier 3. Steam System Audit – Energy Assessment

- Full steam energy mapping to discover overall plant & process steam optimization possibilities.
- Complete steam system deep dive to understand energy demand reduction possibilities.
- Recommendations based on steam system engineering best practice, legislation, and health & safety.

8. Maintenance

Preventative maintenance is proven to help hospitals meet Health and Safety requirements, lower energy consumption, maintain steam quality and cut operating costs. Spirax Sarco Service teams can support preventative maintenance as well as covering faults, inefficiencies and breakdowns. Typically lasting from one to five years, a Service Agreement can include unplanned service call-out days with rapid response.

9. Training

Well trained personnel are crucial to achieving the most efficient and safest steam system performance. Spirax Sarco provides training for healthcare personnel involved in the design, installation, operation, optimization and maintenance of steam systems.

Many of the courses are accredited and result in recognized qualifications. All are delivered by highly knowledgeable trainers, with years of practical steam system experience behind them.

We offer our customers:

- ✓ Audits focused on specific site challenges.
- ✓ Best practice steam engineering system design.
- ✓ Steam & thermal energy efficiency review of boilerhouse, steam generation, steam distribution, and points of use, across the plant and process system.
- ✓ Comprehensive savings opportunity register with clearly defined cost and benefits.
- ✓ Ongoing support – refining solutions.
- ✓ A road map of the next steps and potential timeframes

Spirax Sarco can help maximize the efficiency of hospital steam systems, from the boiler house through steam distribution to the condensate return system. We offer innovative solutions to help the healthcare sector lower its energy consumption and cut greenhouse gas emissions, as well as reduce risks. Ensuring that each system is designed and built to match healthcare needs is a core advantage of partnering with Spirax Sarco.

Contact your local steam expert for more information or visit **spiraxsarco.com/global/us**.

Important factors for Humidification

What is important?

1. Air changes/hour
2. Precise Temperature Control
3. Precise Humidity Control

Air humidification with steam humidifiers generate an absolutely germ-free atmospheric air humidity, as the water used is heated to temperatures of 212°F, which no germ or disease-causing agent can withstand. Steam air humidifiers can be integrated into any existing central air conditioning system or, in most cases, retrofitted. They are easy to clean and maintain.

Why is Humidity important in Hospitals (patients)

- Minimize the risk of airborne infections.
- Reduce the risk of respiratory issues in new-borns.
- Reduce premature drying and formation of scabs from coagulated blood.
- Prevention of electrostatic damage to medical equipment.
- Patient and staff overall comfort and virus protection.
- Lower employee absence rate.

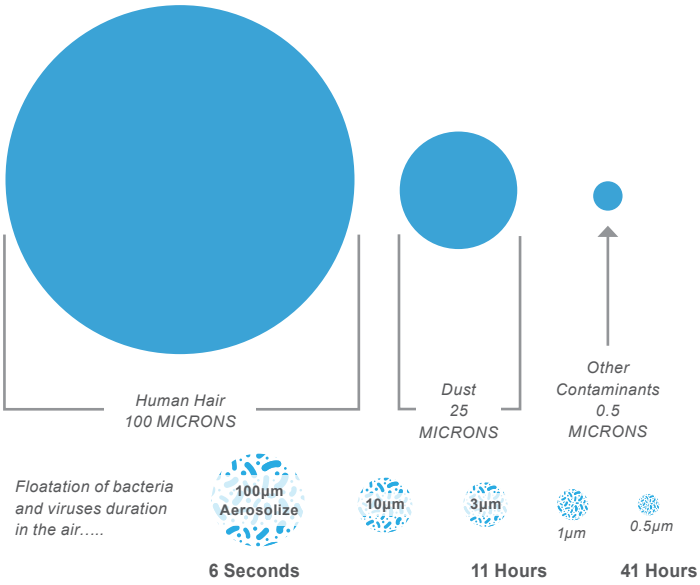
Why is Humidity important for people?

- To combat the effects of dry air, which:
  - Reduces immune system
  - Headaches
  - Sore eyes and throat
  - Nasal stuffiness
  - Tiredness
  - Skin issues
  - Airbourne viral transmissions (Including Influenza and Covid)
- Reduce Nosocomial infections (HAI's)
- Some (medical) equipment depend on it (MRI Scanners – static charge)

Bacteria and Virus information

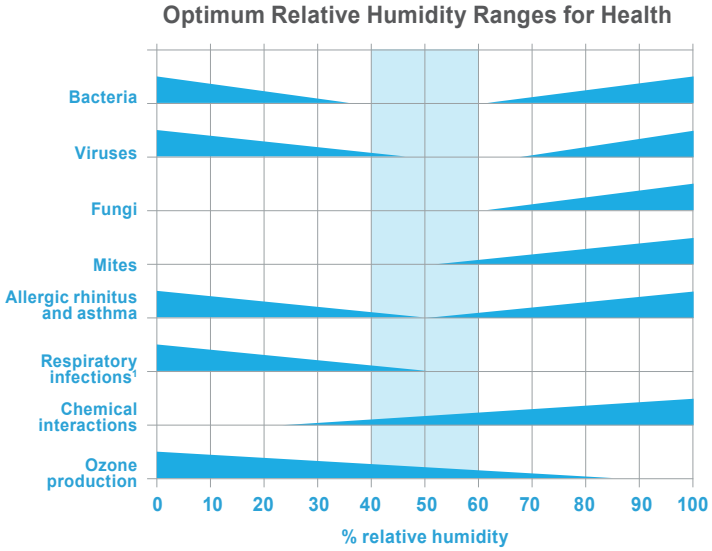
Bacteria and viruses can travel through the air

- They both get into the air easily.
- When people talk, cough or sneeze they continually emit droplets carrying the normal bacterial and viral microbes. If the person is sick, these droplets also carry disease-causing microbes, called pathogens.
- These tiny droplets can travel as far as 6 feet and can spread germs by landing on surfaces or in another person's clothes, eyes, nose, or mouth.
- The droplets can remain in dry air for many hours.

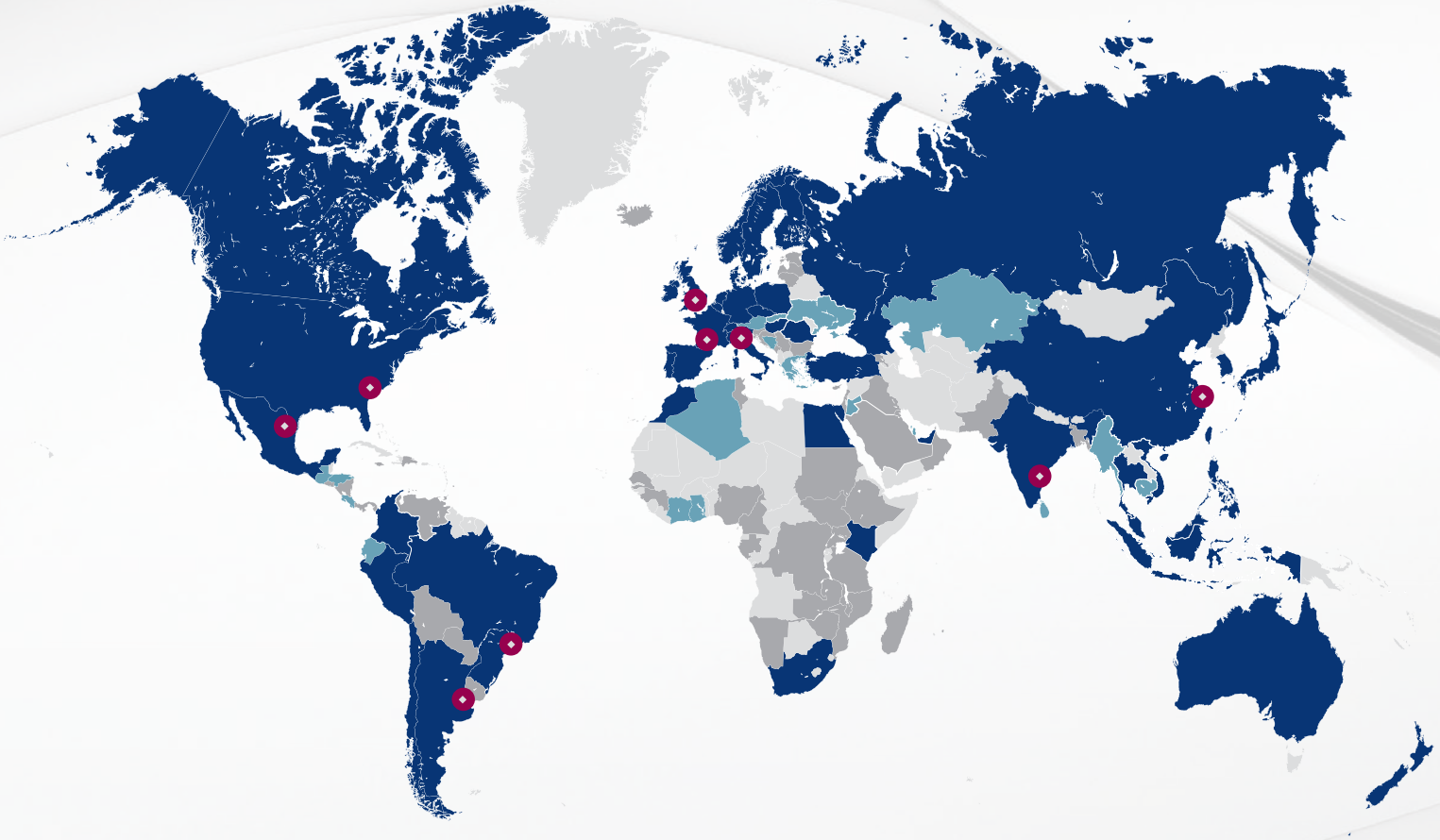


Infection control

- Many scientific studies have concluded that humidity between 40-60%RH is the optimum range to reduce the risk to health from airborne viruses, bacteria and other pollutants to health.
- Maintaining this optimum level in wards and waiting rooms significantly reduces the infectivity and survival rates of airborne viruses, which in turn reduces airborne infection rates.



[1]Insufficient data above 50% RH.
E.M. Sterling, Criteria for Human Exposure to Humidity in Occupied Buildings, 1985 ASHRAE.



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