



Neutralizing Amine Use in Hospital Steam Boilers

Technical Bulletin 1-030 Boiler Systems

Steam Use in Healthcare Facilities

Hospitals use steam boilers to meet a variety of needs including domestic hot water, sterilization, dietary, humidification, and seasonal space heating. Effective water treatment is required to protect hospital boiler systems from problems related to corrosion, deposits, and steam contamination while keeping energy, water, and maintenance costs low.

It is important to understand the regulations and standards governing the application of boiler water treatment chemicals in healthcare facilities. The use of compounds called “neutralizing amines” can be a source of confusion, especially where plant steam is used for humidification and sterilization. Recently updated standards provide clear guidance on neutralizing amine use in hospital steam boiler systems.

What are Neutralizing Amines?

Neutralizing amines are volatile compounds that vaporize with the steam and condense when the steam becomes condensate. They control corrosion by neutralizing the corrosive carbonic acid that forms in the condensate due to the thermal decomposition of the natural alkalinity in the boiler makeup water. The higher the natural alkalinity in the makeup water, the more neutralizing amine required to neutralize the carbonic acid that is formed.

Without proper treatment, condensate will become acidic and cause severe corrosion damage to the condensate system. Corrosion deposits can also block steam traps, control valves, and other critical components, interfering with steam use and equipment operation. Neutralizing amines are essential for effective corrosion control, but must be properly applied and monitored to meet regulatory guidelines.



**Condensate System Pipe Nipple
Thinned By Carbon Acid Corrosion**

Steam Humidification Applications

Healthcare facilities typically use steam to provide supplemental humidification in critical care areas to reduce the impact of bacteria and respiratory infections. Facilities generally have two options for steam humidification: plant steam or chemical-free “clean steam.” Plant steam is more economical, but requires monitoring to ensure compliance with steam purity and regulatory guidelines. Clean steam generators require distilled quality makeup water, and can be difficult to maintain.

ANSI¹/ASHRAE²/ASHE³ Standard 170-2013 (Ventilation of Health Care Facilities) specifies that the chemical additives used in steam systems serving humidifiers in healthcare facilities must comply with U.S. FDA regulations (21 CFR 173.310). These regulations define the boiler water additives (including neutralizing amines) approved for use where the steam comes in direct contact with food.

Neutralizing Amine	Max Level
Morpholine	10 ppm
Cyclohexylamine	10 ppm
Diethylaminoethanol	15 ppm

Steam Sterilization Applications

Steam sterilization requires moist heat in the form of saturated, high purity steam under pressure. ANSI/AAMI⁴ ST79:2017 (Comprehensive Guide to Steam Sterilization and Sterility Assurance in Health Care Facilities) provides recommended practices for steam quality, purity, and monitoring for effective sterilization.

**FDA Maximum Individual
Neutralizing Amine Levels (Steam)**

1. American National Standard Institute;
2. American Society of Heating, Refrigerating and Air-Conditioning Engineers;
3. American Society for Healthcare Engineering; 4. Association of the Advancement for Medical Instruments



Steam Quality

Steam quality measures the dryness fraction, non-condensable gas content, and superheat of a steam sample. Steam sterilizers require 97% or better steam quality, meaning the moisture content is <3%. Steam that is too dry can contribute to superheating and result in suboptimal steam sterilization conditions. Steam that is too wet can lead to wet packs after sterilization.

AAMI ST79 requires documenting the steam quality at the sterilizer inlet when commissioning new or relocated sterilizers, or after making changes to steam system piping. Steam quality monitoring requires specialized sampling and test equipment. Facilities often employ specialists for this work.

Steam Purity

Steam purity refers to the degree that steam is free of dissolved or solid contaminants. The most common contaminant is carryover of entrained boiler water with the steam. Mechanical causes of carryover are related to boiler design, high water level, firing method, and load swings. Chemical causes include insufficient blowdown, excessive chemicals, and other contamination.

The boiler operation and treatment program should be closely monitored to prevent the contamination of steam used for sterilization. Contaminated steam can cause pack and instrument staining and/or instrument damage. High amine levels can stain packaged items within the sterilizer. AAMI ST79 guidance for maintaining steam purity includes:

- Boiler systems should be treated with FDA approved boiler additives (21 CFR 173.310) to minimize damage the boiler system including steam lines.
- Boiler additives should be fed on a continuous or proportional basis. Boiler additives should not be added on a batch basis (once or twice a day).
- Boiler additives including amines should be injected into the feedwater ahead of the boilers.
- Amines ***should not*** be injected into the steam header or steam lines. Adding the amine to the feedwater helps provide good mixing and prevent spikes due to uneven steam distribution.
- Install in-line filters as close to sterilizer as possible and include a drip leg or trap for condensate.
- Implement procedures to monitor steam purity and document corrective actions.



**Controller for Steam Purity
(Conductivity) Monitoring**

Monitoring Steam Purity

Condensed high purity steam is nearly distilled water quality. The presence of boiler water carryover in steam can be determined by measuring the conductivity of condensate or condensed steam samples. Samples for purity monitoring should be collected at or near the steam header.

Low conductivity condensate (normally < 50 uS/cm) indicates acceptable purity steam, while a high conductivity indicates the presence of carryover. Note that where high alkalinity makeup water is used, the conductivity may be elevated due to carbonic acid formation and amine addition.

Monitoring Neutralizing Amine Levels

To confirm compliance with FDA regulations, a condensed steam sample should be periodically taken for laboratory analysis to determine neutralizing amine levels. The steps include:

- Collect steam sample directly from the steam header or a steam line before any steam traps or vented receivers. Condensate samples will not provide representative test results.
- Use a sample cooler or cooling coil to completely condense the steam sample (no flashing). Flush sample to drain for 15 minutes prior to collection.
- Fill a clean plastic sample bottle to the top allowing a slight overflow. Cap immediately taking care to assure that there is no head space of air above the liquid.
- Label sample bottle requesting amine testing. Promptly ship to testing laboratory.

Where corrosion cannot be controlled without exceeding FDA regulated maximum amine levels, it may be necessary to install a dealkalizer or reverse osmosis system to reduce the makeup water alkalinity.