Priorclave North America

Is Your Autoclave Bleeding You Dry?
Medical-Grade Autoclaves and Research Lab Water Consumption

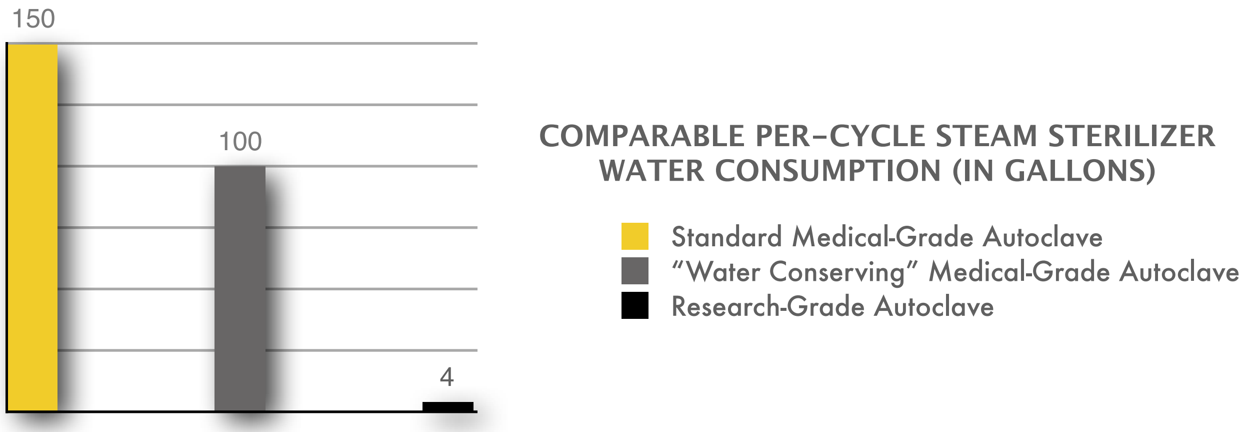
In the world of steam sterilization, US facilities are almost unique in favoring resource-intensive medical-grade autoclaves for all applications. Meanwhile, an increasing number of non-medical facilities—from research labs and startups to universities—need autoclaves for light-duty applications. All too often these labs wind up with expensive, heavy-duty medical-grade sterilizers that pour thousands of gallons of water down the drain every day. For these labs, a research-grade steam sterilizer is likely to be a much better fit.

WHAT IS A MEDICAL-GRADE STEAM STERILIZER?

Medical-grade autoclaves are high-throughput workhorses, designed for near-constant, 24-hour operation. They are built around a hefty rib-reinforced, steam-jacketed rectangular steel pressure vessel. In a hospital, most of the sterilization loads consist of either prepared trays of medical instruments or biomedical waste packed into rectangular loading cassettes. Loading these rectangular loads into a rectangular autoclave is fast and easy, which makes the rectangular pressure vessel ideal, even though this shape has serious engineering drawbacks.

Since speed is vital to hospital operations, medical-grade units are rarely permitted to fully cool, and never shut down (unless they're being serviced). Immediately after loading, the unit's steel jacket is flooded with steam, minimizing the time it takes to bring the unit back up to sterilizing temperature (around 250 degrees Fahrenheit). At the end of the cycle the steam jacket is flushed with fresh, cold water, decreasing the cooling time so the machine can be opened, emptied, reloaded, and restarted as quickly as possible.

For their medical-grade units, autoclave manufactures have chosen designs and processes that result in verifiable, high-throughput sterilization, with back-to-back cycles and minimal downtime. But a design intended for 24/7, high-throughput operation has to make trade offs, and one of the biggest is water consumption.



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THIRSTY BY DESIGN

A medical-grade sterilizer's rib-reinforced rectangular pressure vessel needs to be made from fairly thick steel in order to cope with the heat and pressure used in steam sterilization. But thicker steel is hard to heat and cool quickly. The solution is to encase the pressure vessel in a steam jacket. Flooding the jacket with steam and cold water between each cycle is inefficient, and has no impact on the sterilization process itself, but can significantly reduce the time it takes to heat and cool the pressure vessel. Unless your application demands the ability to constantly run sterilization cycles with the absolute minimum downtime between cycles, that's water wasted.

Additionally, medical-grade autoclaves must be run 24-hours per day, seven days per week, even if no loads are being sterilized. Since the units are designed for constant operation, they cannot tolerate being regularly permitted to fully cool, or being left idle for an extended period. Shutting down a medical-grade autoclave results in sediment build-up, metal fatigue, and corrosion, which can culminate with stress corrosion cracks compromising the pressure vessel.

If a medical-grade sterilizer is to be idled, the normal procedure is to keep its steam jacket warm and water flowing through the unit. This is inconsequential in a hospital—where autoclaves rarely rest—but can be stunningly wasteful in a research setting, where a sterilizer might be run for only a single 45-minute cycle every other day.

HOW MEDICAL-GRADE STERILIZERS WASTE WATER

Working with extremely high-temperature pressurized steam poses some obvious risks to operators and plumbing. At various points throughout the sterilization cycle steam naturally condenses inside the drain system, where it can then be flushed into the sanitary sewer system for treatment. Since this water has just condensed—and often done so under extreme pressure—the condensate can be well over 200 degrees.

In order to safely flush the condensate down the drain, it needs to be cooled to 140 degrees Fahrenheit. Most medical-grade autoclaves accomplish this by "bleeding" a constant one-gallon-per-minute (abbreviated "gpm") flow of cold tap water into the condensate as it drains from the pressure vessel. In most medical-grade steam sterilizers these "bleeder valves" are open whenever the unit is powered, even if no cycle is running.

In a hospital, where sterilization cycles run back-to-back all day, this solution makes sense. But most research, university, and industrial settings have hours of idle time between sterilization cycles. Some large facilities—such as public universities—can have dozens of medical-grade steam autoclaves spread across their campus, each constantly pouring gallons of water down the drain in empty labs. That's under ideal operating conditions. In the real world bleeder valves tend to "drift" over time. Upon inspection, it's not unusual to find needle valves supplying significantly more water than safety demands.

Additionally, many medical-grade sterilizers use a Venturi device (also called an "ejector") to create a vacuum within the pressure vessel. This allows for more thorough steam penetration during sterilization and speedier steam evacuation at the end of the cycle. A Venturi-based ejector creates its vacuum by harnessing a constant jet of running water, consuming roughly 5 to 15 gpm. For the pre-cycle evacuation, an ejector runs for several minutes. At final exhaust phase, the Venturi ejector might run for up to two hours on a large autoclave (although common times hover around twenty minutes). All told, medical-grade steam autoclaves relying on Venturi ejectors can easily consume an extra 70 to 1800 gallons of water with every cycle.

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For their intended purpose—constant operation and high-throughput sterilization—medical-grade sterilizers are excellent devices. But what are the alternatives for education, research, and industrial labs uninterested in sending so many gallons of water needlessly down the drain?

AFTER-MARKET WATER SAVINGS KITS

If you're stuck with one of these water-consumptive medical-grade autoclaves, all is not lost. Most manufacturers and some third-parties offer after-market water conservation kits that can be bolted onto existing, medical-grade steam autoclaves. These kits include vacuum pumps to replace the Venturi-driven ejectors and "trap cooling" water conservation kits. Trap cooling kits replace the constant-flow bleeder valve with a thermocouple-controlled valve that only passes cooling water when condensate is collected or temperatures exceed a set threshold.

There are various degrees of difficulty inherent in installing and maintaining these electromechanical after market kits (some of which are themselves proprietary or rely on specialized parts). Various kit designs perform to varying degrees, with some systems proving fairly erratic, in terms of water savings, when tested independently. These modifications are often expensive—trap kits run several thousand dollars each, and after-market pump units hover around $5,000. All told, it isn't unusual to pay almost $10,000 for a "water conservation kit" that may reduce water consumption by up to 70 percent. But after-market kits are subject to the same wear and fatigue as the autoclaves themselves, and do nothing to address inherent problems that arise from using a medical-grade autoclave in a research setting.

REAL-WORLD EXAMPLES

Over the last several years both Stanford University and the University of Washington have undertaken extensive projects to reduce the water consumption of the medical-grade steam sterilizers they have installed in their research facilities.

Stanford, as just one example, had 60 medical-grade autoclaves on its Santa Clara County campus as of 2008. Although they only operated these autoclaves 8 to 12 hours per day during the work week, the sterilizers used constant water-cooling bleeds, which often ran for 24 hours per day. An audit discovered that these medical-grade autoclaves were wasting just over 93,000 gallons of water per day—or 3 percent of the university's daily water ration, as set by it's General Use Permit from the county. It cost Stanford several thousand dollars per unit—for a total of $113,000—to eliminate this annual waste of 34 million gallons of potable water.

In a 2006 report, Roger E. van Gelder and John Leaden of the University of Washington found that in U-W's five year program to reduce water usage in their research facilities (bringing it down 20 percent during that period), "the most dramatic and cost effective savings can be attributed to the addition of trap cooling water conservation kits to the [medical-grade] steam sterilizers." U-W additionally found that the bleeder valves on most of their medical-grade sterilizers were no longer outputting the factory specified one gallon per minute, but instead were bleeding two, three, and even five times as much water as they should; across their campus, the average bleeder valve was putting out 2.6 gallons per minute—almost three times the necessary amount of water. After installing trap kits "Constant idle water consumption was measured for 16 of the existing sterilizers

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and fell between 1 gpm and 5 gpm." In their situation (with 16 hours of work per autoclave), that reduction alone meant a daily savings of 2500 gallons per sterilizer.

RESEARCH-GRADE AUTOCLAVES

A more recent entry into the US marketplace is the research-grade steam autoclave. These units rely on more efficient cylindrical pressure vessels. At less than one-third the mass of a comparable-volume rectangular vessel, they require less time and energy to heat and cool, and thus require no steam jacket or gallon-per-minute bleeder valve for operation. The cylindrical vessel permits superior steam circulation, reducing the need for a Venturi ejector. In contrast to their medical cousins, research-grade autoclaves are designed for intermittent use; they don't need to be kept warm, don't require a constant flow of water to provide condensate cooling, and won't be harmed if completely shut down for an hour, a night, a week, or a year.

While large medical-grade steam sterilizers are, and will continue to be, the gold standard in demanding, high-throughput hospital sterilization, most labs are going to find themselves better served by the newer, more efficient research-grade steam autoclaves.

Medical vs. Research Grade Steam Sterilizers	
Medical-Grade	**Research-Grade**
Heavy rib-reinforced rectangular vessel	Cylindrical vessel—needs no reinforcement; one-third the mass for the same volume
Vacuum pumps	**No** vacuum pump necessary
Inefficient steam jacket	**No** steam jacket necessary
Must be run 24/7 or risk harm to the unit	Can be powered-down for long periods
Constant maintenance expense	Maintenance only relative to usage
"High-throughput"—designed for 24/7 hospital use, over a dozen cycles per day	"Light duty" —less than five cycles per day
Consumes up to 150 gallons of water per cycle ("water conservation kits" can reduce this 50 gallons per cycle)	Consumes as little as 4 gallons per cycle

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SOURCES

California Urban Water Conservation Council. California Potential Best Management Practices—Year One—Chapter VI. Steam Sterilizer Retrofits. Sacramento, CA: 2004. Rigoglioso, Marguerite. "Against the Flow." Stanford Magazine. Jan/Feb 2008.

van Gelder, Roger E., and John Leaden. Field Evaluation of Three Models of Water Conservation Kits for Sterilizer Trap Cooling at University of Washington. Seattle, WA: 2003.

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