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Continuous Effluent Decontamination:

Innovative Technology Raises the Bar on Safe Decontamination of Hazardous Biologically Infectious Waste

The decontamination of liquid hazardous infectious waste streams in research and production laboratories has taken a leap forward in safety and efficacy with the introduction of a new technology. The new Continuous Effluent Decontamination (CED™) System from STERIS Corporation has been tested in the laboratory and in the field and is validated for use in multiple types of research, production, and bio-containment environments (see sidebar *Who Can Use It*).

The new compact CED system is designed to replace the larger multi-step kill tank system and offers a number of critical advantages that result in dramatic improvements in efficacy, reliability, safety, and cost effectiveness.

Who Can Use It

Whether for manufacturing pharmaceuticals, developing biotechnology, or researching new products, the CED system is validated to integrate with required processes in any of the following:

- BL-3 and BL-4 labs
- biological containment facilities
- vaccine production facilities
- animal production facilities
- comparative medicine laboratories
- pharmaceutical facilities

Beyond kill tanks?

When discussing waste disposal for high-level containment labs—where waste may contain organisms that could pose serious health hazards such as the recent SARS outbreak—operational safety and system efficacy are paramount.

Several issues must be addressed when considering effluent decontamination technology, including the following: the need to develop industry validation standards and to standardize components and manufacturing processes; the quick and safe diagnosis and repair of problems; ease of use; and the hidden costs associated with system installation and maintenance.

Kill tank technology offers safety checks, but systems may lack advanced controls to ensure that their components are working properly. They may also fail to continually measure the effectiveness of the decontamination process itself. For these reasons, kill tank systems can also

be challenging to use correctly. Improper use may result in unwanted discharge of hazardous effluent, thus exposing operators and repair personnel to unsafe conditions.

Because kill tanks are built differently for each facility, the lack of consistency in design can result in slower, less efficient repair and replacement. Service staff can encounter unforeseen obstacles because valves and other critical components—even between two tanks in the same facility—are not in predictable and consistent locations.

Cost is another consideration. Hidden costs are inherent in the kill tank design. The large space demanded by the system and containment basin, the need for generous spare parts inventories, and the requirement for high efficiency filtration for ventilating the area all add significantly to the cost of a kill tank system.

The new alternative: continuous effluent decontamination

The CED technology addresses the flaws of the kill tank method with features that include built-in diagnostic controls, redundant processing systems, and independent safety zones. Following is a description of how the system works and a discussion of critical issues that pharmaceutical, research, and biocontainment industries need to know about the new technology.

How does the CED system work?
Does it work *without question*? How do we know?
How is it tested?
How does it handle peak levels of need?
Why is it safer?
What about space considerations? What if our needs increase?

How it works

The CED System processes effluent through a continuous system consisting of a heating zone and two independent cooling zones. Waste is fed to the CED system through a buffer tank that buffers the peaks and valleys of flow throughout the day.

1. Buffer tank
   Incoming biologically contaminated effluent is stored in a tank custom-specified to handle that particular location's needs even at their highest effluent levels. Tanks are manufactured of AISI 316L stainless steel and are automatically steam sterilizable in place if required. The buffer tank operates at atmospheric pressure, and is equipped with a filtered vent (for sterilizing air to the room), an inspection port, and openings for CIP (Clean-In-Place) media. Level controls monitor tank contents and automatically begin the CED operation at predetermined levels.

2. Decontamination system
   Effluent is pumped into multiple heat exchangers, in series with one another, which are steam-heated to 302°F (150°C). A length of pipe immediately downstream of the first set

of heat exchangers is monitored at two check points to assure that the temperature reaches and holds at the prescribed setting. Dual magnetically coupled pumps ensure uninterrupted processing.

3. Cooling system
   Decontaminated effluent is cycled through one of two sets of cooling exchangers. If the desired temperature has not yet been reached, the waste is recirculated, cooled and reheated. Once the desired temperature has been reached at the check points, the waste is diverted to the second set of cooling exchangers and cooled to below the required 140°F (60°C) before being safely discharged.

Life Science professionals need to know:

Does it work *without question*? How do we know?

The CED is a closed and sealed system with independent zones for each function—pre-filtering, buffering, venting, and decontaminating—each with controls that provide continuous confirmation that the system is working properly. Separate sensors monitor water temperature at two different locations in the CED system to ensure that the proper temperature is achieved throughout the system before waste is discharged. And in the unlikely event of a failure, a hard-wired circuit shuts down the system and closes off all outlet valves.

How is it tested?

In addition to several years of virtually trouble-free use in the field, the CED system has been lab tested for performance and biologically tested with both vegetative and spore-forming organisms—the same organisms used to test traditional steam sterilizers. It meets European Union directives and conforms to ASME standards for design, manufacture, and testing of pressure vessels and to accepted standards for electrical and software designs.

How does it handle peak levels of need?

The CED system is sized and configured to meet each facility's specific needs. Every facility receives an individual assessment of waste flow characteristics to determine the optimum size for the required buffer tank and CED system. The buffer tank can be sized to hold 1000 to 8000 liters. The CED processing system can be sized from 100 liters/hour to 1000 liters/hour.

Why is it safer?

A series of built-in features in the CED system offer additional safety checks.

- Water levels are monitored in the buffer tank and the system shuts down automatically if the level rises above a predetermined point.
- Automatic self-testing of the entire system occurs each time the system is started after a shutdown or alarm condition. Once activated, the system does a complete check of all valves and scans for leaks. The decontamination cycle will not start if all tests are not completed successfully.
- Two unique design features protect against leaking: Because the dual pumps are magnetically coupled, no penetration is required through the pipes. And in the unlikely

event of a system leak, a capture basin safely contains the liquid within the safety cabinet and a level sensor shuts down the system and activates an operator alarm.

- The system's Programmable Logic Controller (PLC) automatically controls the CED to a safe state in the event of any mechanical failure or loop fault.
- Prior to any maintenance procedure, automatic valves isolate every section of the system for steam sterilization.
- During routine cleaning, the control system prevents CIP procedures unless the buffer tank and associated piping have first been sterilized.
- To perform I/O testing and calibration, operators must have a password. Multiple levels of access allow operators, supervisors and service personnel to view, configure, and edit processes and/or calibrate instruments, modify inputs and outputs, and change passwords according to their authorized responsibilities.
- Multiple alarms (text, visual, audible) notify appropriate personnel of disturbances in any part of the system.

What about space? Growing needs?

The CED system's compact footprint (average diameter 5 ft.) occupies approximately two-thirds to three-fourths of the space required for a kill tank system. In addition, the placement of service panels on two adjoining sides allows the decontamination module to be placed in tight spaces and easily accessed. And because the buffer tank can safely be located in a remote location, the CED provides much greater flexibility in allocating valuable lab space.

Expansion options

Options include choices of flow volume capacity, buffer tank size, configuration combinations, and accessories such as alternate control panel mounts, magnetic coupled mixing systems, and a CIP cleaning package.

Conclusion

The new continuous effluent decontamination technology offers decided advantages over kill tanks and allows research, production, and bio-containment facilities to safely process nearly any biologically contaminated liquid effluent before discharge. Because of the system's compact and flexible design, its consistency of design, and its manufacture to recognized standards, CED users will experience significant improvements in safety, efficacy, serviceability, and space utilization.

About the Author

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