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ceta.org/members-covid-19/

Incorporating Dry Vapor Steam into Disinfection Processes Against COVID-19

Introduction to Dry Vapor Steam

A dry vapor steam cleaner or generator is designed to generate saturated and superheated steam between 60~145psi (307~363°F respectively) for a typical operating pressure (and temperature) range. Dry vapor steam is essentially water boiled beyond the 212°F/100°C temperature into a gaseous state. It has relatively low pressure, but high temperature ratings.

Dry vapor steam is widely used in food, beverage, and other manufacturing industries for its natural (thermal) sanitizing effects and gaining popularity among mobile washers thanks to its (water) runoff-free cleaning process.

While high temperature accompanied by dry vapor steam can remove or inactivate most known microorganisms including viruses, there are certain limitations to its applications stemming from unique characteristics of dry vapor steam.

Understanding the novel coronavirus (SARS-CoV-2)

Viruses are protein cells that can only grow inside a host such as humans. They are not technically "alive" on their own and cannot be "killed." However, a virus can be inactivated, or its infectivity can be affected by chemical and other disinfectants as well as environmental factors such as temperature and humidity. Viruses can survive on surfaces from a few hours to a few days depending on the type of surface. It travels in droplets of saliva between human to human, and recent studies suggest it is also airborne.† Based on its structure, SARS-Cov-2 is believed to be highly sensitive to heat and moisture, but highly contagious. SARS-Cov-2's viral envelopes are of lipid layers: Enveloped viruses like SARS-CoV-2—which rely on a protective lipid coating—are the easiest type to deactivate. In contrast with many gastrointestinal viruses like norovirus which have a tough protein shell called a capsid, viruses with this fatty wrapping are relatively vulnerable.††

†New coronavirus may spread as an airborne aerosol, like SARS from [Live Science](#)

†† "How we know disinfectants should kill the COVID-19 coronavirus" from [Chemical & Engineering News](#), "Viral Envelope" from [Wikipedia](#))

Thermal removal or inactivation of pathogens

Temperature of 80°C (176°F) or higher on contact surfaces is known to remove most bacteria and inactivate most viruses. With extended exposure time from a few seconds to 30 minutes (depending on the pathogen), even 60°C (140°F) temperature is able to remove or inactivate pathogens. WHO recognizes viral inactivation by heat and recommends boiling drinking water in the regions where communicative

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diseases are common.†

Steamerics' validation reports show that dry vapor steam generated by the Optima Steamer was able to remove *listeria*, *e-coli*, *salmonella*, *staphylococcus* among other common pathogens.††

† [WHO Technical Brief: Boil Water](#)

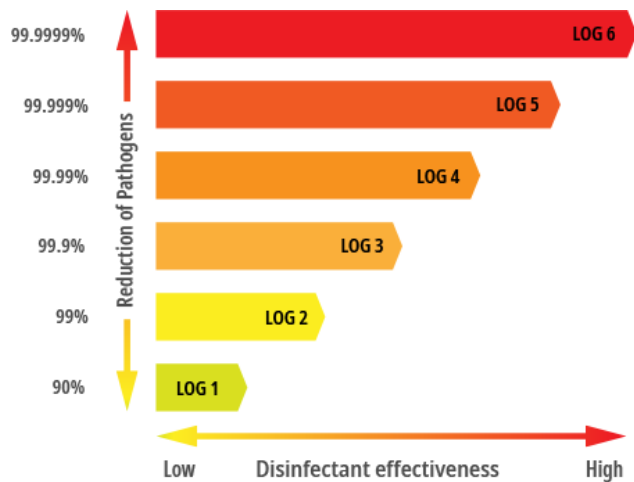
†† [Lebrun Labs Efficacy Studies](#) on the Optima Steamer

Understanding differences among Cleaning, Sanitizing, Disinfecting and Sterilizing

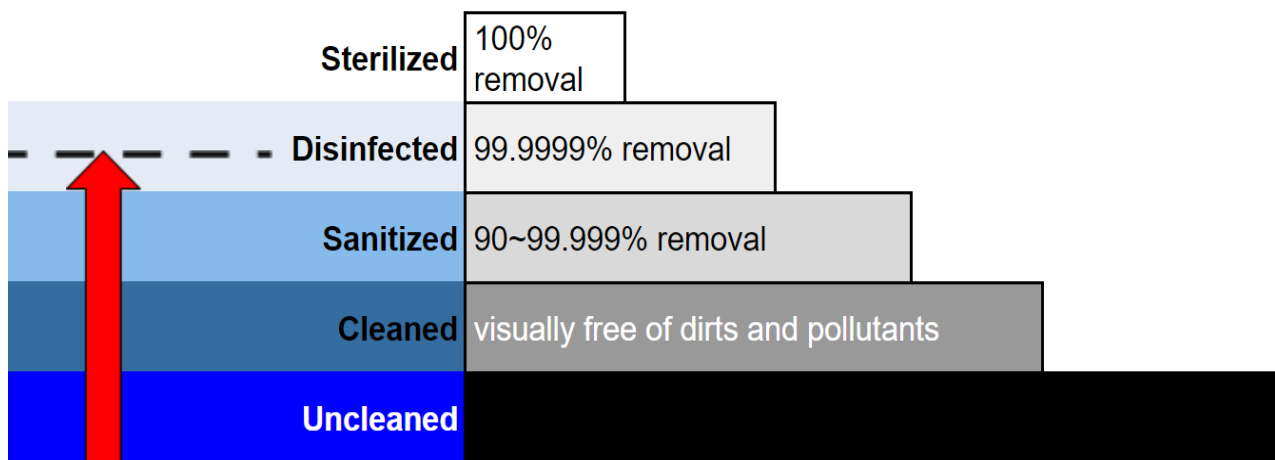
There is often a confusion among these terms, particularly between sanitizing and disinfecting. It is paramount for a sanitation professional to understand the differences and what a particular sanitation protocol is expected or intended to achieve. The COVID-19 pandemic is caused by a virus, and "disinfection" is the main goal.

These are simple definitions of each process:

- Cleaning: removing visual particles from surfaces
- Sanitizing: removing or deactivating pathogens down to an "acceptable" level, often by 1 to 5 log reduction (90-99.999%).
- Disinfecting: removing or deactivating unwanted microorganisms down to 6 log reduction (90-99.9999%).
- Sterilizing: 100% removal or inactivation of microorganisms



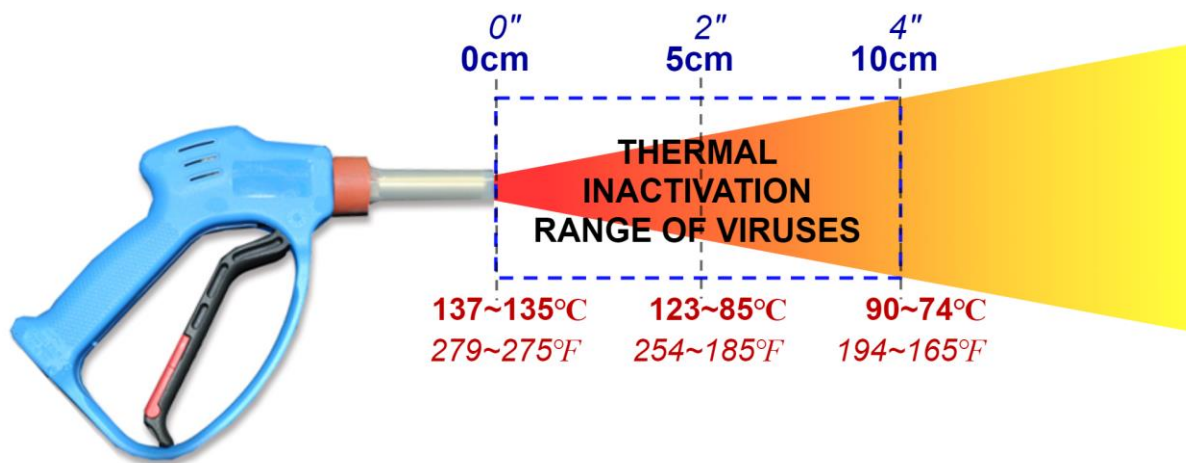
Dry Vapor Steam is proven to clean and sanitize. Dry vapor steam is capable of disinfecting in controlled environments only where a lethal temperature can be guaranteed.



Dry vapor steam penetration

Dry vapor steam temperature

To maintain temperature above saturation (212°F/100°C), steam must be pressurized or contained. Again, dry vapor steam is in the state of gas, and it acts like air. Steam temperature and pressure cannot travel as far as a hot water jet for example. Its temperature and pressure drop exponentially once it exits from a pressurized vessel. In reality, unless steam is being fed into a contained space or used in controlled environments, it is very difficult to predict the temperature on the contact surface. Below illustration is an example of steam temperature decrease based on the distance between the steam gun nozzle and the contact surface. Respective temperature is based on when using an Optima Steamer XD unit (boiler operating temperature rated at 350°F/178°C) in 65°F/18°C ambient temperature.† The consistency of steam volume and temperature affect the residual heat capacity as well. Comparing two steamers with the identical steam temperature rating, a steamer with more volume will transfer higher temperature on contact surfaces due to its higher residual heat capacity.



Sanivap, a European dry vapor steamer manufacturer that focuses on disinfecting application markets, published dry vapor steam's validation reports against viruses including one in the coronavirus family in 2015.†† In this study, a mop attachment was used to contain the steam, increasing the residual heat capacity as much as possible.

Distance to contact surface, ambient temperature, residual heat capacity of steamer equipment must be considered and planned accordingly to achieve successful thermal disinfection.

† [Optima Steamer Steamer Temperature from Gun Nozzle](#) by SJE Corporation

†† [Efficacy on Viruses on Multi-resistant Microorganisms](#) by SaniVap

Cases for and against dry vapor steam in disinfecting efforts

Concerns surrounding using dry vapor steam for disinfecting purposes can be summarized as following:

- Ensuring contact surface temperature (keeping very close distance, which makes a longer process)
 - Ensuring contact surface time - depending on the pathogen and temperature it takes <1 sec to >30 minutes of exposure time
 - There are no known 6 log reduction data on viruses in the coronavirus family currently
- On the other hand, dry vapor steam has many practical benefits as well.

- Flexible usage thanks to no waste-water runoff (i.e. deployment during business hours)
- No residual chemical cost as it requires only (soft or softened) water which is much more economical and accessible
- Better penetration on porous surfaces
- Appropriate for chemical-sensitive environments
- Safe for human inhalation
- No hazmat storage or training required

Examples

As practical examples, South Korea has been using dry vapor steam in conjunction with sodium hypochlorite based chemical treatment in disinfecting “phone booth-style” COVID-19 testing stations inside hospitals.† Seoul Metro has been disinfecting subway trains with hydrogen peroxide based electrostatic misting systems and dry vapor steam for upholstery and human contact surfaces.††

† [South Korea's Phone Booth Coronavirus Testing Stations disinfected with dry vapor steam](#)

Steamericas YouTube channel

†† [Seoul Subway Trains Receive Deep Clean As South Korea Reports A Jump In COVID-19 Cases](#) by NBC News

Recommended steps

As demonstrated above, dry vapor steam has many benefits and shortcomings in deployment. Due to environmental constraints in deployment of dry vapor steam and incomplete knowledge of the new virus, it is advised that dry vapor steam is used in conjunction with EPA approved disinfectants† for combating COVID-19 at this present time. However, it should be noted that disinfectants should never be added directly to steamer’s water tank or boiler as doing so will not only damage the equipment and is harmful and unsafe to the user, but also may compromise the chemical bond and integrity of the disinfectant’s active ingredient from being exposed to high temperature above its boiling point.

The following steps are recommended.

- (1) Wear proper personal protective equipment (PPE): N95 or better mask, goggles, gloves, and a full suit are recommended to protect sanitation professionals against inhaling chemicals and exposure to the virus
- (2) Clean first: Remove visible particles first before disinfecting (Steam can be used for cleaning in certain cases)
- (3) Use proven disinfectant chemical recommended by respective government†
- (4) Use steam to remove chemical residue and/or to utilize heat to inactivate remaining viruses
 - Keep distance of 4” or less between nozzle and surface.
 - For upholstery, use steam on contact for better heat transfer.

† [List N:Disinfectants for Use Against SARS-CoV-2](#) by EPA

Conclusion and Disclaimer

The COVID-19 causing virus known as the novel coronavirus is so new that at this present time, there is no validation available for steam specifically for SARS-CoV-2. Above information and recommendations based on existing scientific data on known pathogens and what is known about viruses in general. Currently using dry vapor steam is recommended as an additional tool to enhance sanitation, not as a sole “disinfectant” to combat COVID-19.