DRAMM

Effective Disinfection with Thermal Fogging

White Paper

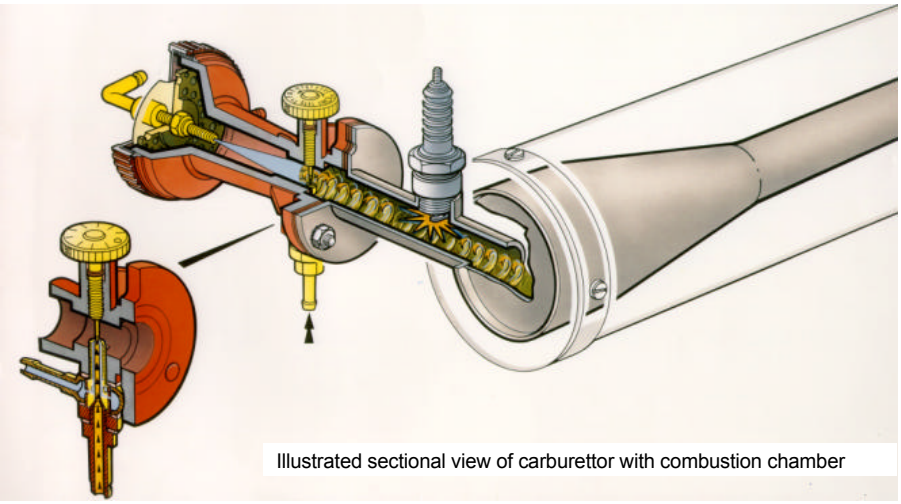
Thermal Fogging for disinfection in livestock facilities is a safe and effective method for final decontamination. This article explores the thermal fogging process, explains the mechanics and the physics of thermal fogging and addresses the efficacy of thermo-kinetically atomized droplets in the disinfection process.

Thermal Fogging Explained.

Since the late 1960s, disinfectants have been applied via thermo-kinetic nebulization, or thermal fogging, with great success. Thermal foggers rapidly atomize spray solutions via a combination of heat and kinetic energy release, creating a fog that can fill a barn, contact pathogens in the air, decontaminate equipment, and disinfest surfaces.

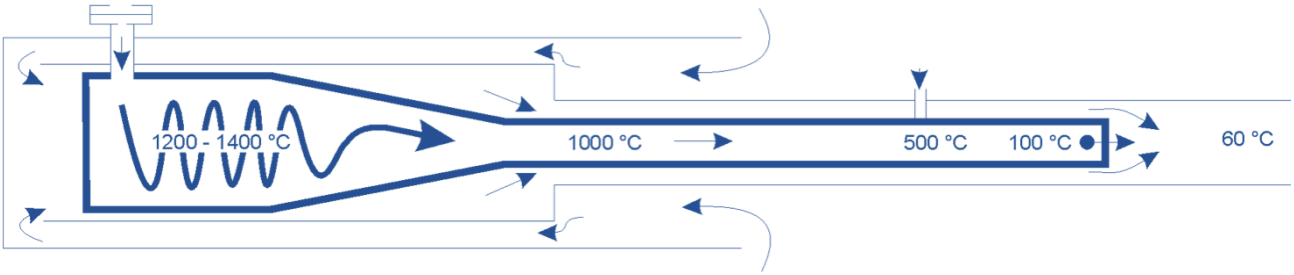
The PulsFOG Thermal Fogger operates like most similar devices but with some improvements. Gasoline is combined with air and ignited via electrical spark in a bottle shaped combustion chamber. Once running, the spark is no longer required and automatically shuts off.

The exhaust gases from the combustion chamber escape at very high velocity through a long exhaust pipe which has a diameter smaller than the combustion chamber. This accelerates the exhaust. When operating correctly, there are approximately 80-100 pulse-jet explosions per second.



Illustrated sectional view of carburettor with combustion chamber

Air is pulled into the outer cooling jacket as a result of the exhaust and serves to cool the outer barrel and provide cooler air to re-condense the fog as it exits the barrel.



Chemical solutions are pumped from a tank that has been slightly pressurized by the intake of air from the carburetor to nozzles on the barrel of the PulsFOG. These nozzles are interchangeable to allow for different flows of solution depending on their composition and viscosity.

The solution is injected via these nozzles into the hot, high-velocity exhaust. The spray is atomized into droplets sized from 1-50µ (micron) Volume Mean Diameter (VMD, depending on the nozzle and solution used. Atomization occurs due to both thermal and kinetic energy at the point of injection. The heat gasifies a portion of the solution, which is condensed as it exits the barrel of the machine when combined with cooler entrained air and the air outside the barrel. The majority of the solution is shattered by the kinetic energy of the exhaust velocity. Finally this energy propels the fog, with the largest machines, up to 300 feet from the operator.

The result is that chemical solutions can be easily and rapidly applied to large areas. Not only are surfaces contacted, but the fog remains in the air for long periods of time, contacting airborne insects and pathogens.

PulsFOG does not damage active ingredients.

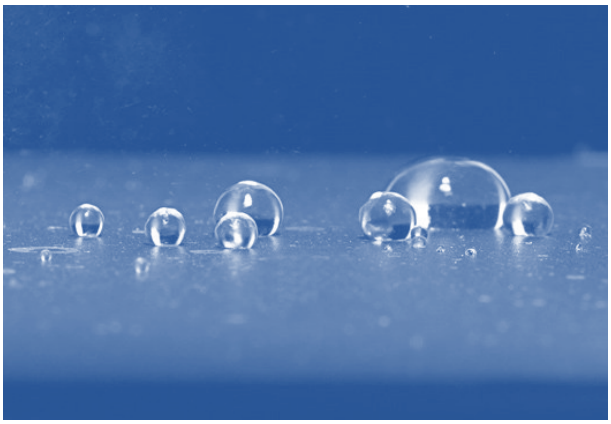
A common misconception is that thermal foggers burn or volatilize the chemicals they are atomizing. **This is not the case**. Thermal foggers do not create a smoke or gas[1]. There is a class of backyard foggers that do "burn" or volatilize the chemical. These work by spilling oil based chemicals onto a hot surface. These are commonly used for mosquito control. However, this is not how the PulsFOG works.

PulsFOG creates a fog or a mist. The droplets are small, but they are measurable. Typically, droplets range from 1 to 50µ in diameter, depending on the machine and the solution being atomized. For reference, human hair is approximately 100µ in diameter

In 1972, the Technical University of Berlin published a research report[2] discussing this issue. The authors of this report discovered that the period during which the chemical solution remains in the hot exhaust is ***only 0.05 - 0.1 seconds***. The fog is then rapidly expelled into the air where the temperature is greatly reduced.

When a drop of water falls on a hot surface it dances for a long time before evaporating quickly. This is a result of the creation of a fine vapor layer that surrounds the droplet upon encountering such heat. This vapor layer acts to insulate the droplet from further evaporation.

Chemical solutions applied by the PulsFOG do not remain heated for a long enough time for the heat to affect the solution.



[1] When using chemicals with a low vapor temperature, some gasification may occur. However, in disinfection, this is often a good thing. For example, formaldehyde is very effective as a gas and, consequently, very effective in the PulsFOG.

[2] Professor Mathes, Dr. Bau, Technische Universität Berlin. www.tu-berlin.de

In effect, it is similar to passing your finger through a candle flame. Move quickly and you don't feel the heat. Hold your hand over the flame and you will burn yourself.

What makes PulsFOG different?

The PulsFOG differs from other thermal foggers in several ways.

First, the PulsFOG uses a patented, direct fuel injection carburetor and a vibrating diaphragm for air intake. These allow for a very controlled pulsating combustion. This quick-start feature eliminates the need for a compressor or pump to operate the PulsFOG and does not require a fuel pump to supply gasoline to the engine.

Secondly, the placement of the nozzle in the various PulsFOG models aides in proper atomization promoting re-condensation of the fog exiting the barrel. Often, different equipment will spit solution directly in front of the machine, wasting solution and creating a hazard.

Nozzle placement will also have an effect on the amount of chemical that remains on the barrel of the fogger. This can become messy to clean up and corrosive to the equipment.

PulsFOG pioneered and patented the **BIO thermal fogging** concept that allows for the application of heat sensitive biological and chemical solutions while cleaning the inside of the barrel of sticky or caustic solutions. The BIO PulsFOGs can also be used to eliminate the flame danger from highly combustible fogging solutions.

Patented BIO Technology

1. The water is injected into the resonator at a point of higher temperature and cools down the hot exhaust gases to the water steam temperature of an open system = 100°C (212˚F). The pesticide with a sensitive active ingredient is injected at a cooler point, where it is subject to a temperature of 100°C for 0,05 - 0,1 second. This leads to an even lower temperature of between 30 - 40°C into the mixing area of "Venturi effect".

2. The produced water vapor cleans the resonator exhaust pipe and avoids residues of the fogging solution at the end of the pipe. This is useful when using thick powder solutions.

3. The injection of water avoids ignition of oil-based pesticide fog and also eliminates the danger of fire.

Summary: The pulsFOG BIO technology allows for the fogging of highly sensitive active ingredients, the ability to self- clean when suspensions are fogged and an increased flow-rate for thermal fogging solutions if the water nozzles are also used for injecting the chemical solution.

Thermal Fogging for Effective Disinfection

Understanding the principles behind thermal fogging, it is easy to see why this method is a safe and effective approach to better disinfection. Thermal fogging fills the entire barn, including the cracks and crevices that are difficult to reach via standard surface decontamination. Once application is complete, the disinfectant fog remains in the air, settling on surfaces for several hours. Quite often, fogging can be done from a stationary location at the entrance to the barn, resulting in a safer application for the employee. Finally, thermal fogging is a very fast way to apply disinfectants.

Research Results

Studies show that thermal fogging, when combined with proper cleaning and surface disinfection yields better results than with surface decontamination alone. Various trials have been completed around the globe. Each shows that the application of a disinfectant after cleaning is superior and recommended for a large variety of chemistries.

In a 2007 collection of works entitled Environmental Microbiology Research Trends[3] edited by George Kurladze, Dr. Kim Oren Gradel, a Veterinarian in Aalborg, Denmark sums up the body of work on the elimination of *Salmonella Enteritidis* in livestock facilities. Throughout her paper she reports that "Salmonella was generally detected in houses in which only surface disinfection was applied whilst surface disinfection followed by thermal fogging yielded *Salmonella* free post-disinfection samples."[4]


NEWSLETTER
Equipment Disinfection - The Holes Matter

In a 2008 trial, a group of scientists at the University of Delaware researched thermal fogging versus surface decontamination of portable equipment used on farms[5]. In their trial, they inoculated a gasoline engine with Newcastle Disease Virus (NDV). Several different products were used to test for control via surface, direct fogging and indirect fogging of tented equipment. The report stated: "Based on our current results, to effectively inactivate the virus in the difficult to access parts of

[3] Dr. Kim Oren Gradel, DVM, Ph.D. "Disinfection of Empty Animal Houses - Scientific Evidence for Applied Procedures, " Kurladze, George V. Environmental Microbiology Research Trends, Nova Science Publishers, 2007

[4] Gradel, Kurladze, pg. 81.

[5] Benson, Eric, Ph.D.; Alphin, Robert; Johnson, Keith; Dawson, Michael; Hougentogler, Daniel; "Equipment Disinfection - The Holes Matter," University of Delaware.

a skid steer loader, a combination of directly applied and indirectly applied thermal fog is the preferred method."[6]

In a 1985 study of different disinfection methods, Dr. P. Dorn and Dr. H Speiß from the Tiergesundheitsdienst Bayern EV[7] trialed various chemicals for efficacy as both surface and thermally fogged disinfection. In their trial they used formaldehyde as the base level of control and measured all other disinfectants against this control. In most instances, surface disinfection with the various products did not yield results similar to surface disinfection with formaldehyde. However, in all instances, thermal fogging with the various solutions "furnished comparable results to the wet disinfection with Formalin."[8]

In fact, the livestock industry itself is the best judge. Countless manufacturers of disinfectants for the livestock industry recommend and even label their products for thermal fogging. Many showcase results of their own trials. Each shows an increase in efficacy when thermal fogging is added to a disinfection program.

While most livestock chemistries work well in thermal foggers, some may require the addition of a carrier solution to help retard evaporation and promote even atomization. However, there are some disinfectants that are not manufactured for use in thermal foggers. These products are not labeled for this type of application for a number of reasons. **When applying disinfectants as a fog, it is important to consult the chemical manufacturer for their recommendations and experience.**

When used correctly, thermal fogging is an important step in good livestock hygiene. Thermal fogging after proper cleaning reaches areas not easily accessible through conventional means and does so very quickly. At the same time, the droplet sizes utilized allow the fog to remain airborne for several hours, slowly depositing on surfaces inside the barn.

For more information on the use of thermal fogging for disinfection or other applications, please contact the Dramm Corporation.

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[6] Benson, et. al., pg 2.

[7] Dr. P. Dorn, Dr. H Spieß TGD-Bayern, www.tgd-bayern.de

[8] Section 8.5, "Report about the disinfection in a broiler production farm." 26/05/1986, Dorn, Speiß