

Atomization Treatment to Improve Air Quality in a Swine Concentrated Animal Feeding Operation (CAFO)

P. Juergens and G. Rapp
Juergens Environmental Control

Species: Swine
Use Area: Animal Housing
Technology Category: Chemical Amendment
Air Mitigated Pollutants: Particulate Matter, Viable Bacteria, and Ammonia.

Description:

Poor air quality within swine concentrated animal feeding operations (CAFOs) poses a threat to producers, social responsibility within local communities, and livestock production. Accordingly, a current study by Johns Hopkins Bloomberg School of Public Health was conducted to evaluate Juergens Environmental Control Systems for reducing air pollution including particulate matter (PM), viable bacteria, and ammonia within such a facility.

The technology consists of an acid-oil-alcohol aerosol applied daily. Its effectiveness was evaluated by comparing air quality from before to after treatment and between treated and untreated sides of a barn separated by an impervious partition. On the untreated side, air quality was typical for a swine CAFO, with mean PM_{2.5} of 0.28 mg/m³ and PM_{TOT} of 1.5 mg/m³. The treatment yielded a reduction in PM concentration of 75-90% from before to after treatment. Effectiveness increased with time, application, and particle size (40% reduction for 1 μ m and 90% for >10 μ m). Airborne bacteria levels (total bacteria, Enterobacteriaceae, and gram-positive cocci) decreased one logarithmic unit after treatment. In contrast, treatment had no effect on ammonia concentrations. These findings demonstrate the effectiveness of an intervention in yielding exposure and emission reductions (Rule et al., 2005).

In addition to reducing PM concentration from the facility, other benefits to using the atomization solution have been reported as follows:

- Reduced allergy symptoms for farm workers due to reduced PM levels in the facility,
- Improved herd health through reduced mortality and morbidity rates,
- Better feed efficiency and faster pig growth rates,
- Consistent and uniform insect control throughout facility.

Mitigation Mechanism:

First process is the blending of the corn oil into a water formulation that includes alcohol, citric acid, eucalyptus, and vanilla to help mix the atomized aerosol, neutralize gaseous ammonia, and provide a pleasant odor, respectively. Second, the oil formulation is applied under high pressure, yielding micron-sized charged particles that efficiently remove PM through electrostatic attraction and coagulation.

Alcohol is also used to keep nozzles sterilized and acts as an antibiotic that heal infectious cuts and abrasions that occur throughout a hog's life. Studies have indicated that citric acid makes antibiotics more readily available to the hogs. Eucalyptus is used for medicinal purposes, primarily focused on the respiratory systems. Eucalyptus helps make the air easier to breathe and helps clean the cilia in the producers and hogs nasal/lung passages. Vanilla is used as a deception to influence a positive smell not associated to the barn. Vanilla has also proven to be a pheromone for sows and in people helps to fight anxiety.

Applicability:

Atomization treatment is effective at mitigating PM, ammonia and odor emissions in swine housing systems, such as in swine finishing, breeding and gestation production systems. It has been determined through different field tests that applying the solution more frequently at a lower inclusion rate has suppressed the dust even more than initially recorded by Johns Hopkins Bloomberg. The more frequent applications also have shown dramatic reduction in ammonia generated by the aerobic environment.

Additional benefits recorded by producers in the field using the atomization solutions, are reduced allergy symptoms due to reduced PM levels in the facility. Improved herd health through reduced mortality and morbidity records. Better feed efficiency and faster pig growth rates plus consistent and uniform insect control throughout the facility.

Before Atomization / Dust Particulates



After Atomization / No Dust Particulates



Premium Air Quality For The Producer And Their Pigs!

Limitations:

Juergens Environmental Control suggests that the equipment is serviced twice a year. Service Technicians inspect the unit or units, checking for plugged nozzles and clean the filters inside the bio-security unit or units optimizing the best potential solution flow. Dust is encapsulated with oil through electrostatic attraction and coagulation and may stick to gating and fan louvers. The extra dust observed on fixed objects is suspended from re-suspension and will require to be cleaned more frequently to the manager's prerogative. Future high quality field studies are needed to record quantitative data of the application method and to achieve maximum reduction with minimum costs.

Cost:

Field application of the atomization system and solutions are subject to change. The fixed cost of the system for 1000 - 8000-pig finishing operation averages \$1.96 - \$7.79 per pig per 3 year term (shipping and installation labor not included). The cost of atomization operating averages \$ 0.01 per pig per day over one year. The fixed cost of the system for 500-5000-sow operation averages \$9.00 – \$16.00 per sow per 3 year term (shipping and installation labor not included). The cost of atomization averages \$.01 per sow per day over one year.

Implementation:

This solution is stored inside of an outdoor 8'X8'X8' utility shed called a bio-security unit. The bio-security unit is the brain of the system. It houses the computer that operates the system; The main pump for pressurizing the solution; Valves that operate each manifold; Filters for each manifold; Electrical panel for all switches and fuses that operate the

computer; And a 275 gallon tote to hold the solution. This unit is heated and centralized at each swine facility. The need for a bio-security unit is simply for operational purposes (i.e. Replenishing totes with solution and prevention of disease transmission).

The atomization manifolds are attached to the ceilings, which have nozzles spaced at either five or ten foot centers. In the breeding and gestation barns we require five foot centers due to the facility setup and uniform coverage that is recommended. In the finishing barns, they are required to be mounted on ten foot centers due to the facility setup and the uniform coverage that is necessary.

The computer is programmed to operate efficiently for different facilities. In the finishing facilities atomization occurs six times per day, once every four hours for only five seconds each cycle. In the breeding and gestation facilities the computers are programmed to atomize three times a day, once every eight hours for only three seconds each cycle. This is done simply to only cover the adequate amount of square footage recommended per animal space. Daily usage is subject to barn size.

In the beginning cycle the computer tells the system to start the atomization sequence. The system starts and agitates the solution in the tote for ten minutes to get the atomization solution into full suspension. Once the solution is in total suspension the pump pressurizes the solution throughout the manifold at 235 psi (1620 kPa) and a rate of 45 mL/m² and pushes the solution through the special manufactured nozzles to produce an aerosol mist for three to five seconds depending on the facility. The mist fills the barn collecting dust particulates magnetically and creating an acid base reaction that neutralizes the odors and gases present in the aerobic environment; providing a healthy atmosphere.

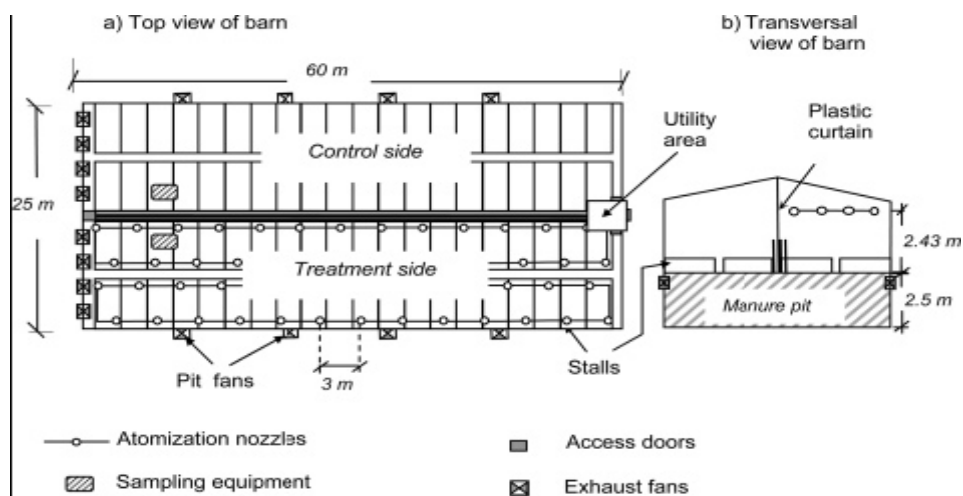


FIGURE 1. Schematic of the tunnel ventilated barn and location of access doors, atomization nozzles, sampling stations, and fans: (a) top view, (b) transversal cut. (Not to scale.)

Bio – Security Unit





Technology Summary:

Juergens Environmental Control Systems and the application of atomization solution demonstrate the effectiveness of oil atomization in reducing airborne PM levels within CAFO s. It logically follows that reductions indoors will yield proportional reductions in PM levels emitted into the surrounding community. The availability of Juergens Environmental Control Systems holds promise for reducing producer and community exposures to PM. Furthermore, because CAFO s can potentially fall within the definition of a stationary source under the Clean Air Act, the U.S. EPA and state governments have the authority to require that CAFO s measure and control their emissions. Juergens Environmental Control Systems and the application of atomization solution could help bring a CAFO in compliance for PM standards.

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Department of Environmental Health Sciences, Johns Hopkins Bloomberg School of Public Health, 615 N. Wolfe St. Baltimore, Maryland 21205

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Point of Contact:

Gary Rapp
 Juergens Environmental Control
 620 W. 3rd St. Box 1027
 Carroll, Iowa 51401
 USA
 (712) 210-3707
 garyrapp@westianet.net

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