

Post Outbreak Disinfection of Mobile Equipment



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Abstract

Current control strategies for avian influenza virus (AIV), exotic Newcastle disease (END) and other highly contagious poultry diseases include surveillance, quarantine, depopulation, disposal, and decontamination. Skid steer loaders and other mobile equipment are extensively used during depopulation and disposal. Movement of contaminated equipment has been implicated in the spread of disease in previous outbreaks. One approach to equipment disinfection is to power wash the equipment, treat with a liquid disinfectant, change any removable filters and let it sit idle for several days. In this project, multiple disinfectant strategies were individually evaluated for their effectiveness at inactivating Newcastle disease virus (NDV) on mechanical equipment seeded with the virus. A small gasoline engine was used to simulate typical mechanical equipment. A high titer of LaSota strain NDV was applied and dried onto a series of metal coupons. The coupons were then placed on both interior and exterior surfaces of the engine. Liquid disinfectants that had been effective in the laboratory were not as effective at disinfecting the engine under field conditions. Indirect thermal fog showed a decrease in overall virus titer or strength. Direct thermal fog was more effective than liquid spray application or indirect thermal fog application.

Objective

The purpose of this research was to evaluate the efficacy of liquid, indirect thermal fog, & direct thermal fog applied disinfectants on complex mechanical equipment. The EPA approval testing for disinfecting agents for AIV & NDV is done under laboratory conditions & does not require field testing. Therefore, many disinfectants have not been tested under field conditions on equipment that has covers, hard to reach areas or blind holes. NDV was used as a surrogate virus for AIV in these studies.

Experimental Procedure

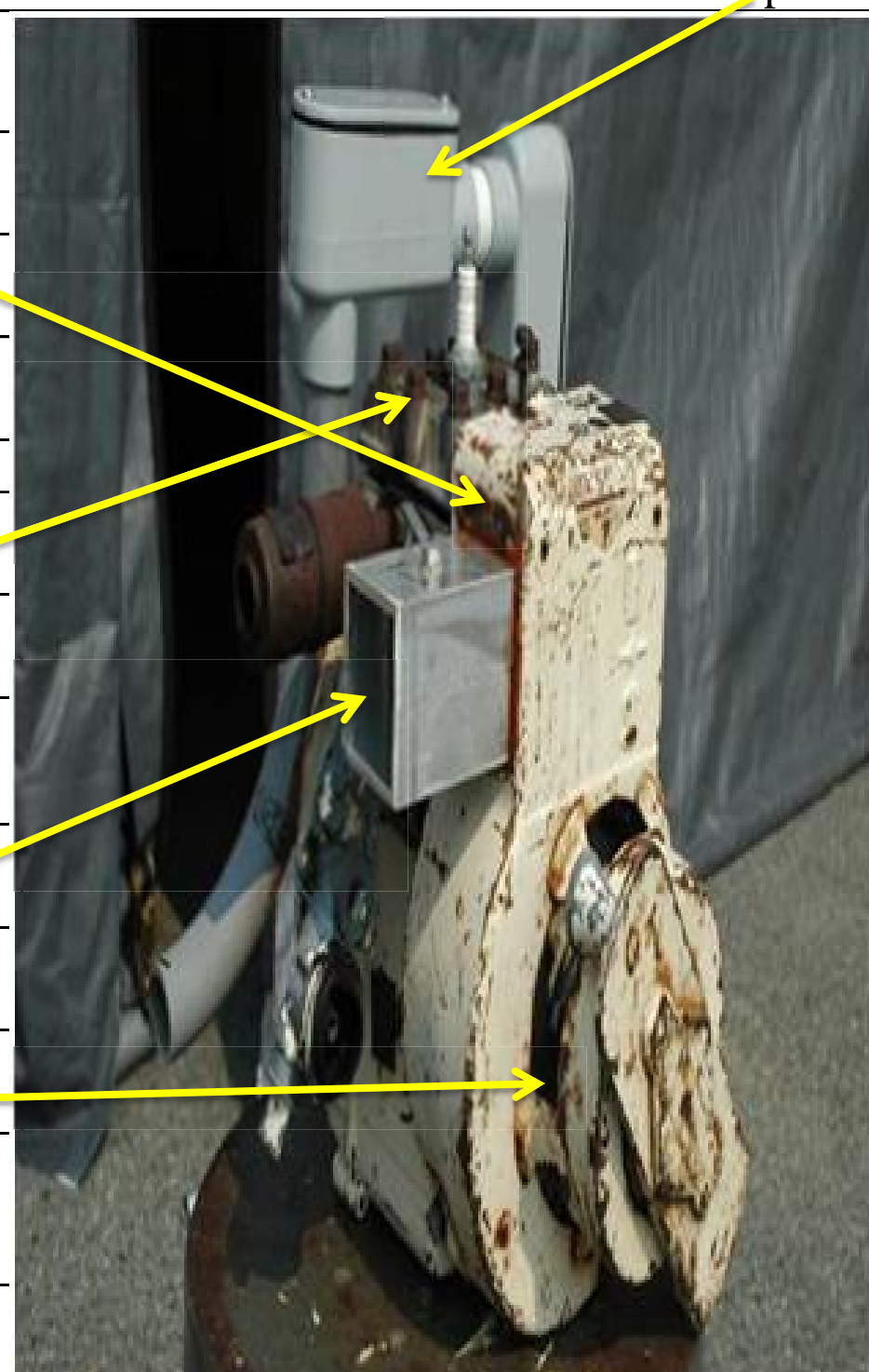


Direct Fogging

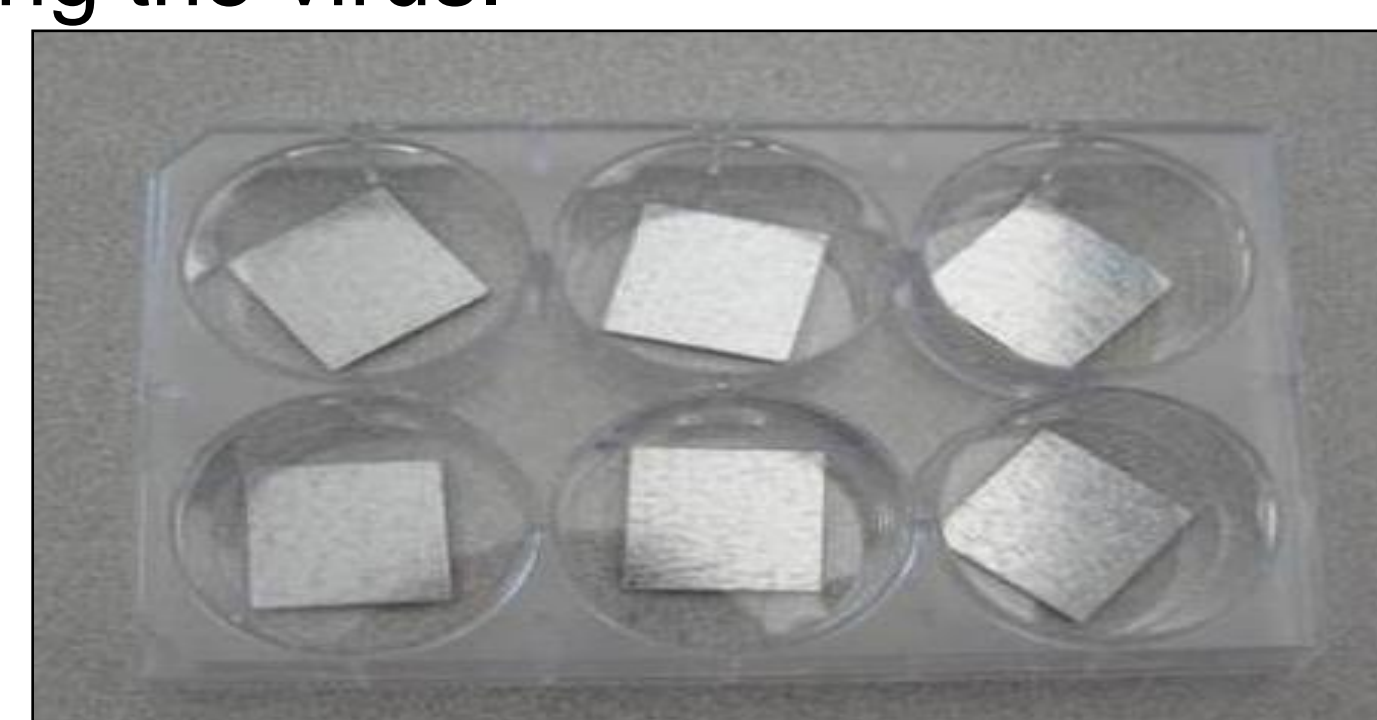
- A small gasoline engine was used to represent equipment typically found on a farm.
- NDV was deposited and dried on small metal coupons, and the coupons were secured on 12 magnetic strips attached to the engine.
- The magnetic strips were placed on 6 exterior and 6 interior locations.
- A backpack sprayer was used to apply the liquid disinfectants directly.

Galvanized steel coupons were placed at six interior and six exterior locations per test.

| ID Number | Location | Interior / Exterior | Orientation |
|-----------|-----------------------------|---------------------|----------------------|
| 1 | Outside of fan shroud | Exterior | Horizontal |
| 2 | Top of engine block | Exterior | Vertical |
| 3 | Bottom side of engine block | Exterior | Vertical |
| 4 | Outside block | Exterior | Vertical |
| 5 | Top of cooling fins | Exterior | Horizontal |
| 6 | Bottom of engine block | Exterior | Horizontal |
| 7 | Under fan shroud | Interior | Horizontal, inverted |
| 8 | Inside muffler assembly | Interior | Vertical, inverted |
| 9 | Inside fan shroud | Interior | Horizontal |
| 10 | Inside starting crank | Interior | Vertical |
| 11 | Inside custom pipe | Interior | Vertical |
| 12 | Inside custom pipe | Interior | Horizontal |



- The thermal fog was applied both directly & indirectly.
- During indirect fogging, the fogger was discharged into a large tent garage for 2 min.
- During direct fogging, the fogger was discharged for 2 min and was pointed directly at the engine for the initial 45 sec.
- After application, disinfectants were allowed a 10 min exposure period for viral inactivation.
- Coupons were removed, put in 6-well plates & covered with neutralizing broth to stop disinfectant activity. Each coupon was scraped with a pipette, the fluid was aspirated from the well & jetted back onto the coupon 3 times to dislodge the virus from the coupon. The pooled fluids from each plate were diluted & inoculated into embryonated chicken eggs. After 5 days of candling for viability, egg fluids were collected.
- Collected chorioallantoic egg fluids were tested for hemagglutination activity to determine whether or not the disinfectant was successful at killing the virus.



Results

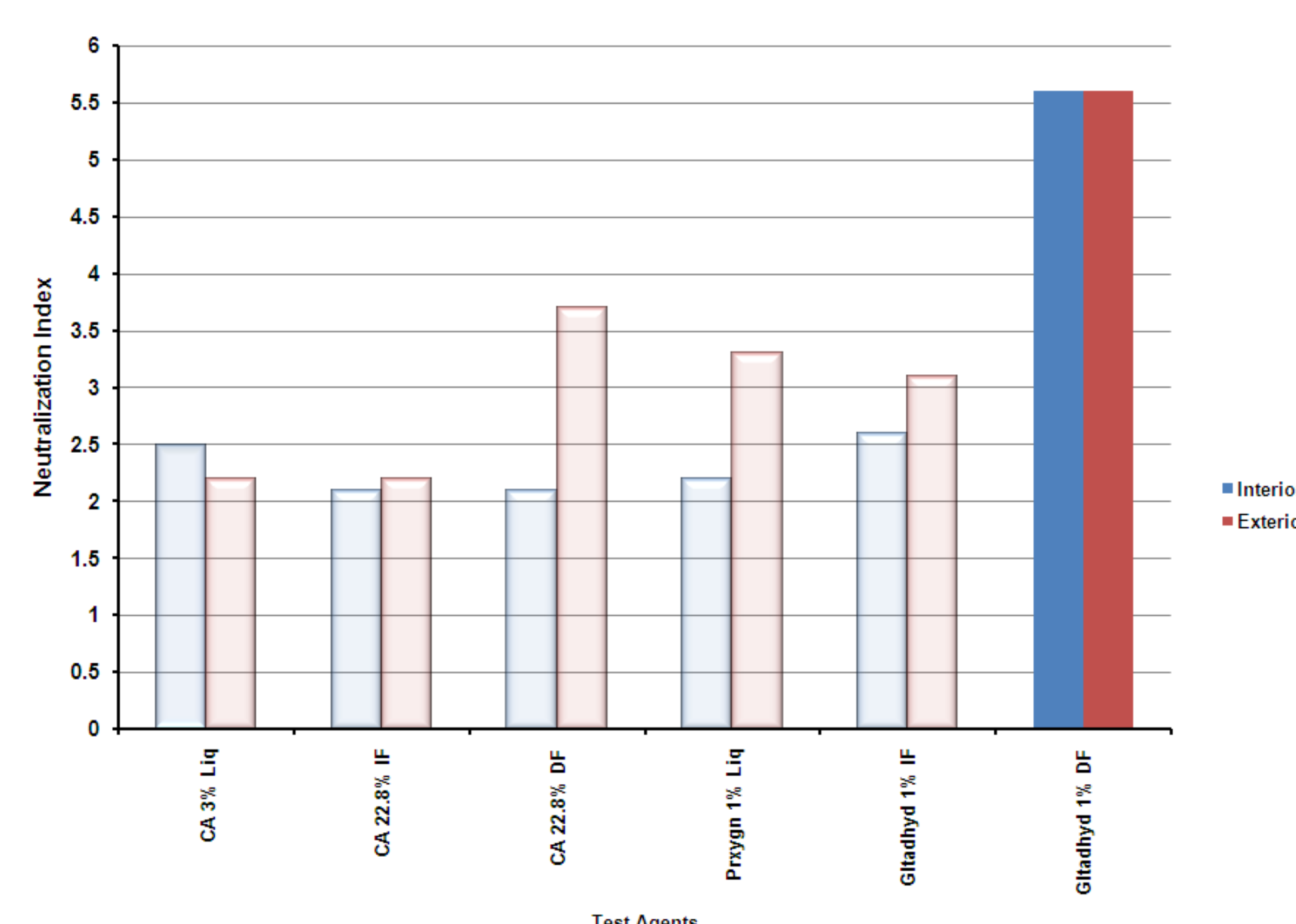


Figure 1. Comparison of test agents for equipment disinfection. Inactivation of NDV is considered effective by the EPA only when NI ≥ 2.8 , the positive control titer is $\geq 10^{4.0}$ EID₅₀/mL and there is no HA activity indicating no recoverable virus from any treated coupon.

Discussion

Liquid disinfectants were less effective in the field than in the laboratory. Citric acid liquid showed similar, but poor, performance at disinfecting interior and exterior surfaces. Peroxygen liquid showed variable differences between the interior and exterior surfaces. Since the peroxygen liquid did generate high exterior NI values during some tests, the disinfectant is capable of disinfecting the test agent; however, the liquid spray application method was not able to reliably ensure sufficient coverage.

Indirect thermal fog showed a decrease in overall virus titer. Indirect glutaraldehyde thermal fog was more effective than indirect citric acid thermal fog. Indirect glutaraldehyde thermal fog was not consistently effective. Citric acid was able to decrease virus titer, but a detectable amount of virus remained for both surfaces in all replications.

Directly applied glutaraldehyde thermal fog resulted in inactivation on both interior and exterior surfaces. Directly applied citric acid thermal fog was more effective than indirectly applied thermal fog; however, once again detectable virus remained. With directly applied citric acid, there were still differences in the level of detectable virus present on the exterior and interior surfaces.

Conclusion

One conclusion from the study is that liquid applied agents tested are not suitable as a single step equipment disinfection method. Indirect thermal fog application was not completely effective at inactivating the virus inside the engine or consistently on the outside of the engine. To effectively inactivate virus in difficult to access parts of a piece of equipment, a combination of directly and indirectly applied thermal fog is the best method of those tested.

The complication is most of the liquid applied agents require relatively standard personal protective equipment (PPE), gloves, eye protection, and coveralls. Thermal fog applied glutaraldehydes are toxic to humans and require the use of respiratory protection, resistant coveralls and more care while handling. SCBAs were worn, along with specially treated coveralls, during the direct thermal fog applications. EPA testing on surfaces is usually performed with a standard exposure time of 10 min and that parameter was used. More favorable test results may occur with the same disinfectants, especially with direct and indirect thermal fog, if the amount of exposure time and/or fogging time is increased. The ultimate goal of this research is to find effective, practical and safe ways to decontaminate equipment relatively quickly under field conditions.

Acknowledgements

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