

Methods of Mass Depopulation for Poultry Flocks with Highly Infectious Disease

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ABSTRACT

Mass depopulation of floor-reared poultry flocks is a very difficult task! Until recently, the options were limited to various methods using carbon dioxide gas with no ideal or best method for all farm situations. During the past two years a team of University of Delaware researchers have developed and validated an alternative mass depopulation method using water-base foam. This emerging technology offers great potential, particularly for flocks with a zoonotic disease and those in structurally damaged houses. The advantages include: less time to depopulate farms, a significant reduction in the number of workers and their potential exposure to a zoonotic disease, less physical activity, suppression of airborne particulates, potential enhancement of the in-house carcass composting process, and greater flexibility of use in various style houses. This method does require a significant quantity of water, a supply of foam concentrate, and an investment in foaming equipment. There are two major types of foaming equipment being marketed; 1) a nozzle system, and 2) a generator system. The United States Department of Agriculture, Animal Plant Health Inspection Service (USDA, APHIS) has conditionally approved foam and the American Veterinary Medical Association (AVMA) has endorsed the use of water-base foam for **emergency mass depopulation**. This technology is being rapidly adopted in the U.S.A. for mass depopulation of flocks with highly infectious disease.

INTRODUCTION

In the event of a highly infectious disease outbreak such as avian influenza (AI) the decision may be made to depopulate the flock in an effort to contain and eradicate the disease outbreak. Being prepared to respond swiftly and effectively to such an event is essential. Preparedness involves having knowledge, training and equipment for depopulation options that address animal and human welfare, and environmentally sound disposal procedures that can be implemented in a biosecure manner. The University of Delaware and authors do not endorse the procedures listed below, but merely report some of the techniques used for large-scale emergency mass depopulation of broiler flocks with AI.

During recent AI events, some workers have experienced illness and even death when exposed to the H5 and H7 virus when depopulating infected flocks. These concerns mandate proper precautions be taken to protect human health. The U.S.A. Centers for Disease Control recommends the following guidelines for responders involved in an AI event; protective clothing, footwear, gloves, eye and respiratory protection; hand sanitation, a seasonal flu vaccination prior to the event and antiviral drugs during the event. Compliance with additional guidelines such as a medical survey of workers prior to and after the event may be imposed by local and state health departments.

Mass Depopulation Considerations

First, there is a distinction between euthanasia and depopulation! The USDA, APHIS recently defined euthanasia as; “involves transitioning of an animal to death as painlessly and stress-free as possible” while mass depopulation: “is a method by which large number of animals must be destroyed quickly and efficiently with as much consideration given to welfare of the animals as practical, but where circumstances and the task facing those doing the depopulation are understood to be extenuating.” In the event of an AI outbreak or natural disaster, the options for mass depopulation have been limited. Mass depopulation of broiler flocks in the U.S.A. has been limited to cervical dislocation (not a real option for large numbers of poultry) and the use of carbon dioxide gas (CO₂). There are four basic methods of using CO₂ gas for mass depopulation of floor-reared poultry flocks. They include whole or partial house gassing, containerized gassing systems, gassing birds under polyethylene sheeting and other mobile gassing (or electrocution) systems. Each method may be best suited for certain bird and house types, and all have many limitations. The recent conditional approval of water-base foam by the USDA and endorsement by AVMA gives the poultry industry another option for **mass depopulation** of flocks. All methods used for mass depopulation, particularly for zoonotic diseases, must take into consideration, and balance, poultry welfare and human health; and must minimize biosecurity risk and logistical challenges.

Mass Depopulation Methods Using Carbon Dioxide Gas

The following four CO₂ methods have been used in previous AI events; whole house, containerized, poly tent and mobile gassing systems. To achieve a desired goal of 70% CO₂ concentration with these methods, the kilograms of CO₂ required can be calculated by multiplying the cubic meters of space in the enclosure by the factor 1.283 kg. The supply of CO₂ can be in various size cylinders or tanker trucks. Equipment freezing can be a significant challenge with some forms of gas systems. Liquid forms of CO₂ may need to be converted into a gas phase using a specialized vaporizer. Regardless of CO₂ form, appropriate safety precautions must be followed to protect human health.

Whole house gassing with CO₂ has been used in recent years with varying degrees of success. This procedure works best in totally enclosed environmental houses and requires sealing off all openings to minimize gas leakage. Since CO₂ is heavier than air, it tends to concentrate at bird level first. This method does not have a

large manpower requirement and minimizes potential virus exposure to workers. However, it may require significant amounts of gas and support equipment, and can be costly. In some situations, the desired gas concentration and time to death may be less than ideal with this method. To address these concerns, manifold systems are being developed to allow for faster and more even distribution of gas into the house.

Another procedure that greatly reduces the volume of space to gas birds is containerized gassing systems. One example is a steel cabinet specially designed and constructed to fit over livehaul cages. This system was used in Virginia during a low pathogenic AI event in 2002. Broilers are caught, placed in livehaul cages and moved to an outside work area where a cabinet is placed over the cage, the bottom sealed to minimize leakage and gas injected using a single CO₂ cylinder tank per cabinet. Six cabinets are needed per typical broiler farm. This method resulted in rapid death, but is labor intensive for catching birds, placing cabinets over cages and removing dead birds from the cages. It also creates a potential biosecurity risk since infectious carcasses are removed from the houses and preventing feathers from littering the landscape is a concern. A similar system was used in the UK and found to be somewhat slow and labor intensive. There is a potential for heat exhaustion for the workers implementing these procedures when using the required personal protection equipment.

Another procedure used for mass depopulation is the poly tent method. CO₂ cylinders are placed (spacing of tanks based on bird age) down the center of the house. Next, one edge of 12.2 meter wide polyethylene sheeting is anchored with litter on each side of the house while the opposite edge of the poly from each roll is temporarily fastened to the ceiling. Starting on one side of the house for the entire length, workers pull the edge of the poly that was temporarily fastened to the ceiling over the birds, then repeat the process for the opposite site of the house. The CO₂ gas is then turned on under the overlapping layers of poly. This method is also labor intensive, has the potential of exposing workers to the virus, requires trained personnel to execute properly, and requires disposal of the contaminated poly. One major advantage of this method is materials for this procedure are often readily available and thus, can be implemented in short notice.

There are a number of mobile euthanasia systems that have been used for broilers and caged layers. One U.S.A. company offers a mobile conveyor system that can gas birds with CO₂ or electrocute animals using an electrical contact pad mechanism. The procedure requires catching birds and placing them into the unit or driving birds onto a conveyor. They fall into a chute, are euthanized, and conveyed into a container for ultimate disposal. During and following a 2003 AI outbreak in Europe a Dutch company developed a number of different types of culling machines. They include various types of CO₂ gas and electrocution systems. These systems tend to be labor intensive and require handling individual birds.

Mass Depopulation Using Water-Base Foam

In the midst of responding to a low pathogenic AI outbreak on the Delmarva Peninsula in 2004, the author proposed using foam (like that used by fire companies) as

an alternative method for mass depopulation of broiler flocks. Over the past two years a team of researchers at the University of Delaware (E. Benson, B. Malone, B. Alphin, G. VanWicklen and C. Pope) have conducted numerous experiments to validate and develop this method for mass depopulation. Benson, et al., 2007 found that the time to death in small groups was similar for CO₂ and foam, yet foam was faster as group size increased; adding CO₂ gas to foam did not enhance efficacy; based on blood corticosterone concentrations the foam was no more stressful than CO₂ depopulation; and the necropsy and histological examination of birds subjected to both foam and CO₂ had lesions consistent with hypoxia as the cause of death. Similar to chemical-induced hypoxia with CO₂, when broilers are submerged in the **proper consistency** of foam, there is a rapid physically-induced hypoxia via airway obstruction. Additional equipment development and validation work has been done by North Carolina Department of Agriculture personnel. The **initial** starting conditions under which USDA, APHIS and AVMA (http://www.avma.org/issues/policy/poultry_depopulation.asp) has conditionally approved foam for **emergency mass depopulation** include; floor-reared poultry, poultry with a potentially zoonotic disease, poultry experiencing rapid spreading disease that state or federal officials feel can not be contained by other means, and poultry in damaged buildings that does not allow human entry. Furthermore, USDA, APHIS has drafted performance standards for the water-base foam technology that includes specifications for foam type, consistency, bubble size, fluidity, coverage, application procedure, residence time, time to achieve death, and reproducibility under various operating conditions.

To date, compressed air foam, aerated foam nozzles and modified high expansion foam generator systems have been used successfully. The foam technology has many potential advantages over current depopulation methods. They include: one-half to one-third less time to depopulate farms, significant reduction in the number of workers and their potential exposure to a zoonotic disease, less physical activity which can be a major issue when having to conform to the personal protection equipment required in a disease situation, suppression of airborne particulates when the house is blanketed with a layer of foam, potential enhancement of carcass disposal using in-house composting, and greater flexibility of use in various style houses and those structurally damaged. This method does require a significant quantity of water, a supply of foam concentrate, and an investment in foam equipment that is dedicated for this purpose.

In the U.S.A. there are two major types of foaming equipment being marketed. A nozzle system (Figure 1) developed in North Carolina uses water and foam concentrate mixed in collapsible tanks on the farm. This mixture is pumped through two hoses into hand held Spumifer™ nozzles. The aspirated foam mixture has an expansion ratio of 35:1 (ratio of volume of foam produced from one unit of solution). The estimated water requirement when applying foam at 0.9 meter depth in a 15 x 152 meter house is 30,000 liters. This system may require up to 1 hour per house and a total of 8 workers; 2 operating the nozzles, 4 pulling hoses, 1 mixing foam concentrate and 1 operating the pumping systems. The University of Delaware has worked with Kifco, Inc. (<http://www.avi-foam.com/>) to develop a modified high expansion generator system

(Figure 2). This system has a mobile foam generator cart connected to a water supply (hose reel). The cart is pulled to the end of the house and foam dispensed as the hose pulls the cart back to the reel mounted on a trailer. The water pump, hose reel and foam injection system remains stationary on a trailer at the end of the house. Water is suctioned from a collapsible tank on the farm. This system produces foam at a higher expansion (120:1 to 135:1) and uses about one-half the water of the nozzle system. With a dual generator cart system it may require 30 minutes to foam a house at 0.9 meter foam depth with one person riding the cart, one coordinating water and foam use and another person operation the pump and adjusting the speed of foam cart retrieval.

With both systems the foam concentrate is added at 1% inclusion rate. The generator system uses both Class A and high expansion foam concentrates while the nozzle system has used only Class A foams to date. These foam concentrates are similar to soap or detergent in terms of composition and the foam quality is similar to shaving cream. There is additional research being conducted in the U.S.A. and Europe to fill the foam bubbles with either 100% carbon dioxide or nitrogen gas. If the techniques and technology can be developed without creating human health risk due to gas exposure, it will allow the use of high expansion foam. This would have the advantage of further reducing the water requirement and some welfare concerns.

Water-base foam depopulation systems are rapidly being secured in the U.S.A. for future mass depopulation response to AI. Who purchases and provides foam depopulation service varies. The options include; 1) train and work with regional fire companies, 2) contractual services with emergency management firms, 3) state agencies securing equipment, and 4) the poultry companies obtaining foam depopulation systems.

In April and July of 2007 antibodies to low pathogenic AI were detected in turkeys in the U.S.A. that required the depopulation of two separate farms. Foam was used for the first time for large-scale depopulation of poultry. This was somewhat a worse case situation in that these large 18 kg market-age turkeys required coverage with 1.2 to 1.5 meters of foam depth. This first time response using the foam technology provided many opportunities to learn from these events. Some of the important lessons learned included; need for qualified resource person to operate and maintain these mechanical systems, requires planning and coordination of quality water and an adequate supply of the proper type of foam concentrate delivered to the farms, and there is a need to train personnel on the proper implementation procedures for foam depopulation. These two foam depopulation events provided a great learning experience and the opportunity to build on our knowledge base when using this technology in the future.

SUMMARY

In summary, mass depopulation of floor-reared poultry flocks is a very difficult task! Realizing there is no ideal or best depopulation method for all situations, it is important we have options. Various methods of mass depopulation using CO₂ gas have been used with distinct advantages and disadvantages with each method. With the recent conditional approval of water-base foam, this technology is rapidly being

adopted in the U.S.A. for mass depopulation of flocks with a zoonotic disease. Compared to most CO₂ gassing methods, It has the advantage of less labor, potential exposure to a zoonotic disease and time; less physical and mental distress for workers; reduces biosecurity risks; flexible for most housing types and situations; and is compatible with in-house composting, the preferred carcass disposal method in the U.S.A. Water-base foam was recently used to depopulate market age turkeys and provided a opportunity to evaluate and learn how to implement this technology under real-world conditions.

REFERENCE

Benson, E., G. Malone, R. Alphin, M. Dawson, C. Pope and G. Van Wicklen. Foam-based mass emergency depopulation of floor-reared meat-type poultry operations. *Poultry Science*. 2007; 86:219-224.



Figure 1. Nozzle system for mass depopulation using water-base foam.



Figure 2. Generator system for mass depopulation using water-base foam.