EVALUATION OF DUST AND ODOR MITIGATION TECHNOLOGIES AT A POULTRY FACILITY

Saqib Mukhtar, Ken Casey, and Brock Faulkner
Texas A&M University Department of Biological and Agricultural Engineering

Sheryll Jerez
Stephen F. Austin University College of Forestry and Agriculture

In cooperation with

Tony Provin
Texas Agrilife Extension Service
Soil, Water, and Forage Testing Laboratory

Eddie Caraway
West Texas A&M University
Olfactory Laboratory

Edited by
Aaron Hoff, Texas Water Resources Institute

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Background

As concern for particulate matter (PM) emissions continues to grow as a result of expanded regulation, greater emphasis has been placed on identifying feasible solutions for reducing PM emissions from key sources (Cambra-Lopez et al. 2009). Poultry houses are one such source, where PM concentrations inside the facility can be 10 to 100 times higher than those normally found in residential buildings (Lee and Zhang, 2006). Though conventional means of air cleaning can be effective, the use of air ionization is beginning to see expanded use due to lower energy consumption and propensity to produce less hazardous by-products (Daniels 2001). Previous research shows that electrostatic particle ionization (EPI) systems are less effective in ventilated facilities (Grabarczyk 2001), so in buildings such as poultry houses, a second mitigation technique may need to be implemented in order to impound any remaining PM that has passed through the poultry house's exhaust fans. This can be achieved through the use of permeable geotextile enclosures placed over the exhaust fan array and placing a miniature EPI unit inside the enclosure to ionize any remaining PM in the air before it exits. This project tests the effectiveness of both technologies under different scenarios using a multi-phase approach on a pair of poultry houses in East Texas where residential growth is beginning to encroach on areas populated with poultry operations and air quality complaints are becoming common.

Economic Analysis

Fixed and variable costs of operating the automated electrostatic particle ionization system (The EPI system is automated for self-adjustment of corona lines for optimal ion flow through the system as seen in Figure 1) and the BioCurtain™ system (two systems, one per battery of mechanical ventilation fans as seen in Figure 2. Each BioCurtain™ includes a mini EPI system inside the BioCurtain™) for one 46' wide and 500' long broiler barn, housing an average of 23,000 birds, are provided in table 1. It is estimated that each barn houses five flocks of broiler chicken per year at a grow out rate of 63 days per flock. Useful working life of EPI and BioCurtain™ systems and repair and maintenance costs are assumed to be 10 years and 2% of the fixed cost, respectively. Two hours per week of labor cost for inspection of both systems per barn is also included in the cost estimates.

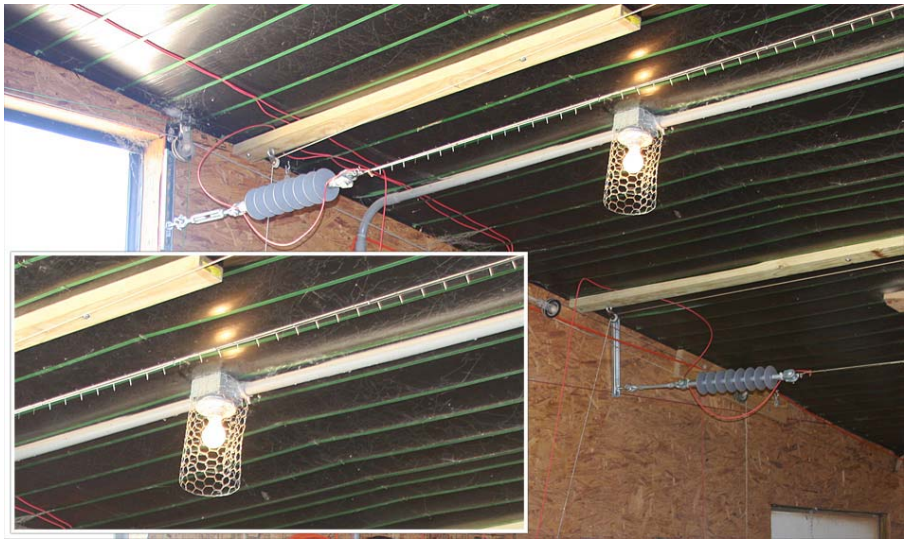

Figure 1. Corona lines running from power source.

Figure 2. BioCurtain installations on poultry house

For the EPI system, there are four power supply units that use a maximum of 103 watts of power per unit. Therefore, total power usage for the system is estimated to be 412 watts for 23 hours a day. The system is shutoff for cooling of power supply units for one hour during every 24 hours of operation. It is assumed that the EPI system runs for 315 days (5 flocks x 63 days/flock) per year. At $0.08 per kWh, the total cost of electricity is $ 239 per year per barn. For the two BioCurtain™ Systems per barn, the mini EPI system runs on one power supply unit at 103 watts. Assuming the same operation time for the mini EPI power supply unit as the main EPI system inside the barn, at $0.08 per kWh, the total cost of electricity is $60 per year per barn.

Table 1. Breakdown of the cost items used to estimate dust and odor mitigation cost.

Cost Items		Materials ($)	Labor ($)	Total Cost ($)
Fixed cost (for 10 years)	Two BioCurtain™ Systems	18,997	3,000	21,997
	EPI System	23,025	1,800	24,825
				Total Fixed cost = 46,822
Fixed cost per year per barn spread over 10 years				4,682 yr^{-1}
Variable cost (based on 315 days per year of operation)	Electricity			
	Two BioCurtain™ Systems	0.103 kW × 23 h/d × 315 d × $0.08/kWh		60 yr^{-1}
	EPI System	0.103 kW × 4 units × 23 h/d ×315 d × $0.08/kWh		239 yr^{-1}
	Labor	1 labor × 2 h/wk × 45 wks × $10/h		900 yr^{-1}
	Repair and maintenance	2% of total fixed cost ($46,822) per year		936 yr^{-1}
				Variable cost = 2135 yr^{-1}

The estimated number of broiler birds finished per barn per year (23,000 birds × 5 flocks) is 115, 000. Therefore, the total cost (combined fixed and variable cost; $4,682 + $2135) of mitigation using the two technologies was estimated to be ($6817/115,000 birds) $0.059 per bird or about 6 cents per bird.

Maintenance of the Bio Curtain™ and EPI Systems

The Vendor estimates that producers should set aside two hours per week for routine inspection and maintenance of the two systems by one person per broiler house.

Routine inspection and maintenance of Bio Curtain™ include weekly inspection of curtain wear and tear and removal of excessive dust from the inside of the curtain surfaces using a power vacuum. Caution: To prevent electrical shock during cleaning of curtains The EPI System inside the curtains must be turned off so no electrical power is energizing the corona lines inside the curtain.

The Vendor has provided the following information on maintenance of various parts of the EPI system.

Regular Observational Maintenance and Recommendations

When walking through the barns on normal daily tasks, it is wise to observe the corona lines. Some basic observational maintenance can help keep the EPI System running smoothly.

- Look for broken ceiling insulators. The ceiling insulators keep the corona line from short-circuiting and do the lifting and lowering of the corona line. If they are broken, the chances of problems arising increase. Most ceiling insulators hold the corona line up, but some hold the corona line to the side or down, away from grounded objects. Replace broken insulators as soon as possible.
- Keep the corona points pointing toward the floor. Pressure washing between flocks occasionally causes the corona points to become tangled and point in odd directions. The EPI system works best when the corona points are pointing toward the floor as seen in Figure 3.

Figure 3. Corona lines for EPI system near roof of poultry house.

- Ground wires are connected to the ratchets, feeder lines, and water lines. All of these ground connections are important to the operation of the EPI system. The ground wire attached to the ratchets must be connected to the power supplies. The feeder lines and water lines are grounded via a connection from the center lifting cranks to the upper ground line of the EPI system. These grounds are important for keeping the feeder lines and water lines free of static charges.
- Never wash the power supplies with a pressure washer. The dust accumulation on the power supply needs to be kept clean, but do not use a pressure washer. There is a risk of damaging the power supplies. Use compressed air or a cloth to remove accumulated dust. (Dust accumulation on the power supply may cause it to become too hot, which can cause damage.)
- When washing the barns between flocks always unplug the power supplies to avoid the potential for electric shock.
- When walking past the power Supplies make sure the yellow light is on. If the yellow light is not on and the red light is on then, typically, a short-circuiting has occurred. The corresponding corona line should be walked to discover the short-circuiting.
- If no short-circuiting is evident; disconnect the HV wire from the power supply (unplug the power supply, loosen the black pressure fitting, and pull the HV wire out). Plug the power supply back in and if all three (green, yellow and red) lights turn on and stay on, then the power supply is functioning properly. Re-check the corona line for short-circuiting.
- If there are no lights on when looking at the power supply, make sure it is receiving power from the outlet. If the outlet has power, and the power supply is plugged in, but no light comes on, then the power supply is broken. If only the green light turns on, the power supply is broken. If only the green light and red light turn on (and no short-circuit is evident) the power supply is broken.
- If all three of the lights are on, and the voltage and amperage readings are “normal” the maintenance adjustment screw should be adjusted to a new setting.

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