Effects of Electrostatic Particle Ionization on Air Quality, Emissions, and Growth Performance of Pigs Housed in a Thermo-Regulated Facility

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Summary

Two identical 200-head nurseries at the Kansas State University Segregated Early Weaning Facility were used for 5 consecutive all-in, all-out groups to determine the effect of electrostatic particle ionization (EPI) on air quality, emissions, and growth performance of pigs housed in a thermo-regulated facility. During five 6-wk periods (13 to 51 lb BW), the EPI system was used in one barn for a complete group and then used in the other barn for the next group. At the beginning of each 6-wk trial period, pigs were randomly allotted to pens based on average pig weight. Air measurements and pig growth were measured every week throughout the studies.

Overall, when active, the EPI system reduced ($P < 0.05$) 0.3, 0.5, 1.0, 2.5, 5.0, and 10.0 µ dust particles in the barn and dust particles/ft^3 at the exhaust fan. There were no differences ($P > 0.10$) for in-barn air ammonia and hydrogen sulfide concentrations and no significant differences ($P > 0.10$) in ammonia concentrations in the dust between the control and EPI barn. The EPI system tended to improve ($P = 0.09$) ADG, which led to a tendency for improved ($P = 0.06$) final BW. No differences were detected ($P > 0.10$) for ADFI or F/G.

The EPI system improved barn and exhaust air by removing particulate matter from suspension, which tended to improve growth rate in 13- to 51-lb pigs.

Key words: dust, electrostatic particle ionization, emissions, growth, nursery pig

Introduction

Dust particles in hog barns have been problematic for swine producers since the inception of raising pigs in confinement. Ventilation for thermo-controlled barns has been uniquely created to ensure barn temperatures remain within a set range according to the pig's thermo-neutral zone. Feces, dried skin, feed, and other particles make up the majority of the airborne particles in swine facilities in thermo-regulated barns. These irritants have been shown to cause health problems in both humans and swine (Collins et al., 1986[3]; Iverson et al., 2000[4]). Particulate matter in confined spaces also can trap odorous compounds such as ammonia (NH_3) and hydrogen sulfide (H_2S), which creates an incentive for many producers to reduce emissions from hog barns. Technolo-

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[3] Collins, M., and B. Algers. 1986. Effects of stable dust on farm animals: A review. Vet. Res. Comm. 10(6):415–428.

[4] Iverson, M., S. Kirychuk, I.L. Drost, and L. Jacobson. 2000. Human health effects of dust exposure in animal confinement buildings. Journal of Agric. Safety and Health 6(4):283–286.

gies have been implemented to control barn particulate matter, including filtration systems, fat addition to diets, and spraying barns with oil. Each has had limited success in providing sustainable and cost-effective results.

Electrostatic particle ionization (EPI) is an emerging technology that emits up to a thousand trillion negative ions into the air per second, which creates polarized air particles. When these polarized particles in the air collide with other floating particles, they cause the floating particles to become polarized, having both a positive and negative side. Due to the charge from the system, polarized particles stick to one another and any surfaces that they collide with. These polarized air particles attach to conductive or grounded surfaces in the barn, such as the ground, walls, and pens, clearing them from the pig's breathing zone (Figure 1). Extensive research has been conducted in poultry facilities and confirmed that this technology reduces barn air particulate matter. A large commercial swine operation conducted a similar trial that showed H_2S and NH_3 concentrations, along with particulate matter, could be reduced by more than 50% and result in improved growth performance (http://epiair.com/why-epi/epi-data-certifications/).

Thus, the objective of our experiment was to determine the effects of electrostatic particle ionization (EPI) on air quality, emissions, and growth performance of nursery pigs housed in a confinement facility.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol for this experiment.

Two identical 200-head totally enclosed, environmentally controlled nurseries at the Kansas State University Segregated Early Weaning Facility were used in a 12-month study. During five 6-wk periods (13 to 51 lb BW), the EPI system was used in one barn for a complete group and then used in the other barn for the next group.

Dust particles were collected weekly inside the barn and in fan exhaust air for determination of particle size and average quantity of dust for each group. These particles were collected using a handheld particle counter (Model 3016-IAQ, Lighthouse Worldwide Solutions, Fremont, CA). Particles were collected at four different spots in each barn and inside the exhaust fans. During exhaust measurements, all external fans were temporarily turned off except for the exhaust fan sampled. Air velocity was measured at 8 different cross-sections along the diameter of the fan shell using a digital air velocity meter (Model 575C1, Test Products International Beaverton, OR).

Hydrogen sulfide concentrations were measured weekly at 10 locations in the barn using a H_2S analyzer (Jerome 631-X, Arizona Instruments, Chandler, AZ). These measurements were then averaged for each barn within week. A pump (Dräger Accuro pump, Lübeck, Germany) was used to measure NH_4 concentrations at two locations in each barn on the first, third, and fifth weeks of the group, which were then averaged within treatment group for analysis. Dust samples were taken from four 12-in. plastic circles mounted above the pens in each quadrant of the barn, then analyzed for NH_4 on the first day of the first, third, and fifth weeks of the group. Air samples were also taken during the first, third, and fifth weeks of the group using 10-mL vials and analyzed for NH_3 and H_2S.

At the beginning of each 6-wk trial period, pigs were randomly allotted to pens based on average pig weight. Pigs were provided unlimited access to feed and water by way of a 4-hole dry self-feeder and a cup waterer in each pen (5 ft × 5 ft). Pig weight and feed disappearance were measured approximately every week to determine ADG, ADFI, and F/G. In tandem with the current study, other nutritional trials were also conducted during each group. Nutritional treatments were balanced across each barn to eliminate the confounding effects of dietary treatment.

Data from all groups were combined and analyzed as a randomized complete block design using PROC MIXED in SAS (SAS Institute, Inc., Cary, NC) with barn as the experimental unit. Air filtering (EPI or control without filtering) treatment was considered a fixed effect, and group was considered a random block effect in the statistical model. Pairwise comparisons were used to determine differences between the EPI and control barns. Results were considered significant at $P \leq 0.05$ and a trend at $P \leq 0.10$.

Results and Discussion

Overall, the EPI system reduced ($P < 0.05$) 0.3, 0.5, 1.0, 2.5, 5.0, and 10.0 µ dust particles in the barns and dust particles/ft^3 of emissions at the exhaust fan (Table 1). There were no differences ($P > 0.10$) for in-barn air NH_3 or H_2S concentrations and no significant differences ($P > 0.10$) in NH_3 concentrations in the dust between the control and EPI barns. The EPI system tended to improve ($P = 0.09$) ADG, which led to a tendency for improved ($P = 0.06$) final BW. No differences were detected ($P > 0.10$) for ADFI or F/G.

Results from this study show that the EPI system significantly reduced levels of airborne particulate matter in the barn by up to 50%. This reduction inside the barn led to significantly reduced airborne particulate matter emitted outside of the barn. Even though dust particles were removed from suspension inside the barn, there was no effect of EPI on barn H_2S and NH_3 concentrations, which disagrees with previous work. This may be a result of overall improved air quality baseline in our research facility compared with commercial barns or our sampling method. By removing airborne particulate matter from inside the barn, the EPI system tended to improve both ADG and final BW with no effect on ADFI and F/G. In conclusion, the use of the EPI improved air quality and emissions by reducing airborne particulate matter that tended to improve pig growth rate.

Table 1. The effects of electrostatic particle ionization (EPI) on hog barn air quality, emissions, and pig growth performance[1]

Item Treatment:	Control	EPI	SEM	Probability, *P* <
Inside dust[3], particles/min				
0.3 µ	687,345	417,797	98,698	0.02
0.5 µ	94,019	46,602	11,098	0.009
1.0 µ	94,470	41,361	18,088	0.02
2.5 µ	173,363	77,759	27,236	0.01
5.0 µ	28,956	13,512	3,708	0.002
10.0 µ	166,980	72,998	30,189	0.01
Exhaust dust[4], particles/ft^3				
0.3 µ	306.2	160.5	49.4	0.03
0.5 µ	37.9	18.6	6.6	0.02
1.0 µ	32.1	14.4	8.2	0.03
2.5 µ	54.3	22.1	12.8	0.02
5.0 µ	7.6	2.9	1.7	0.03
10.0 µ	20.6	7.4	4.6	0.04
Air quality[5]				
NH_3, ppm	4.02	4.21	1.39	0.86
H_2S, ppm	0.81	0.82	0.31	0.89
Dust quality[6]				
NH_4, ppm	939.48	961.35	99.11	0.75
Growth performance[2]				
ADG, lb	0.91	0.98	0.23	0.09
ADFI, lb	1.57	1.62	0.19	0.45
F/G	1.61	1.61	0.59	0.99
Final BW, lb	49.7	51.2	4.96	0.06

[1] Two identical 200-head nurseries at the Kansas State University Segregated Early Weaning Facility were used in a 12-month study to determine the effect of EPI on air quality, emissions, and growth performance of pigs housed in a thermo-regulated facility.

[2] Within replication, pigs were weighed every week. Data collection ranged from 3 to 6 wk in duration across groups.

[3] Dust samples were taken weekly at 4 locations within each barn.

[4] Dust samples were taken at a single exhaust fan from each barn weekly.

[5] Air quality measurements were taken approximately every 3 weeks in the 4 quadrants of the barn.

[6] Dust samples were taken from plastic mounts above the pens from the 4 quadrants of the barn.

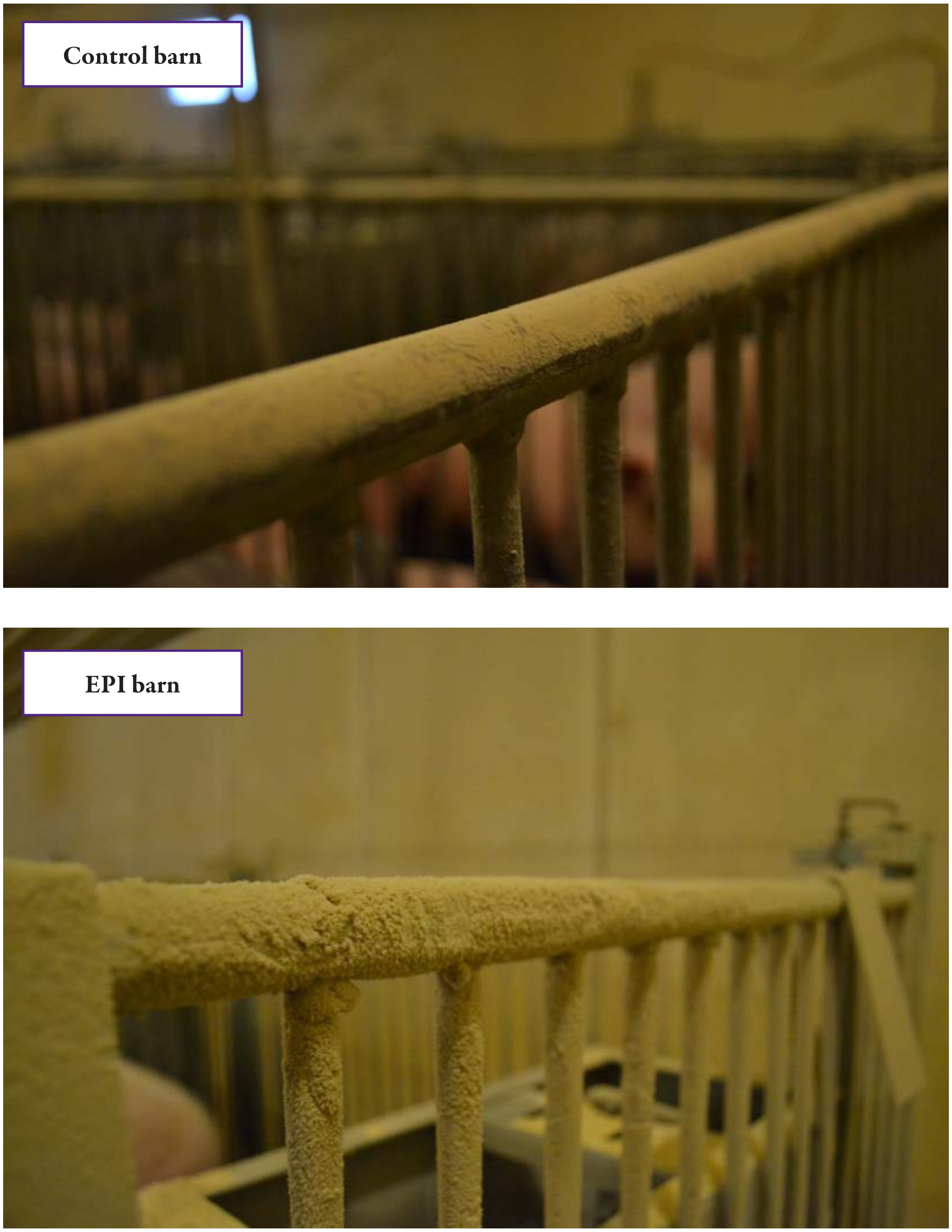

Figure 1. Dust accumulation on pen railing in experimental barns.