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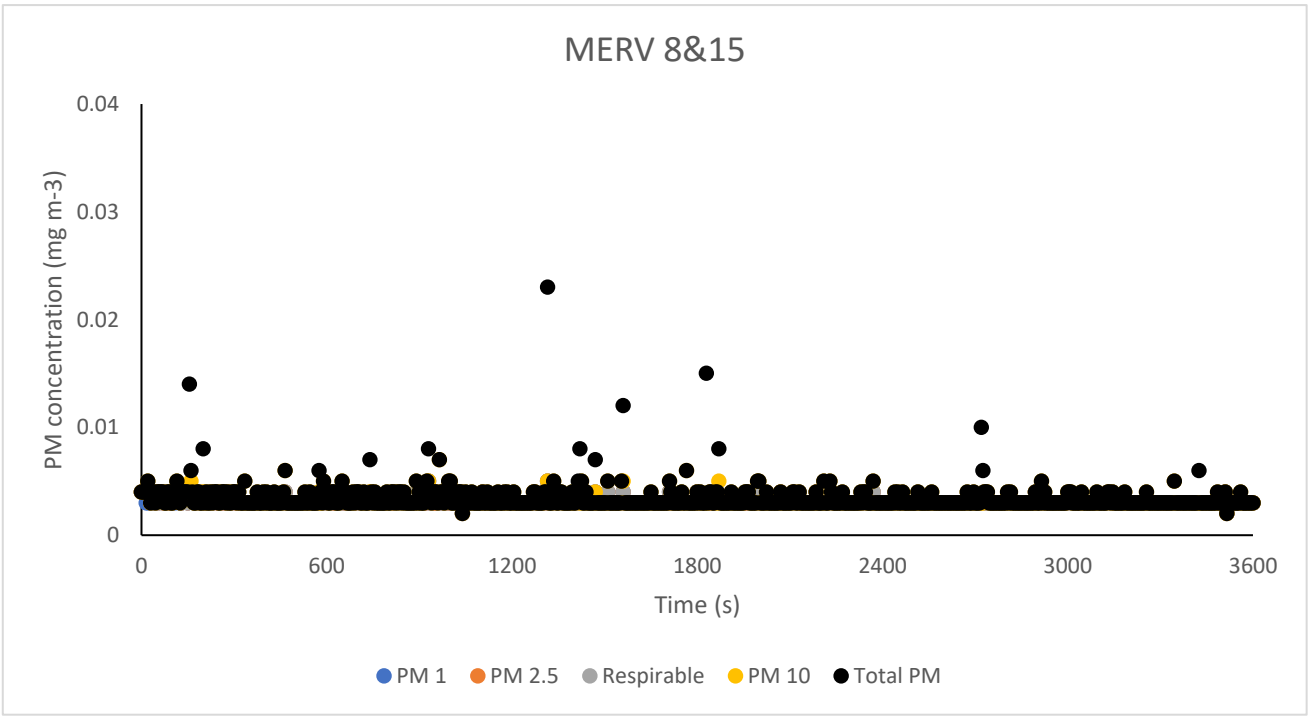
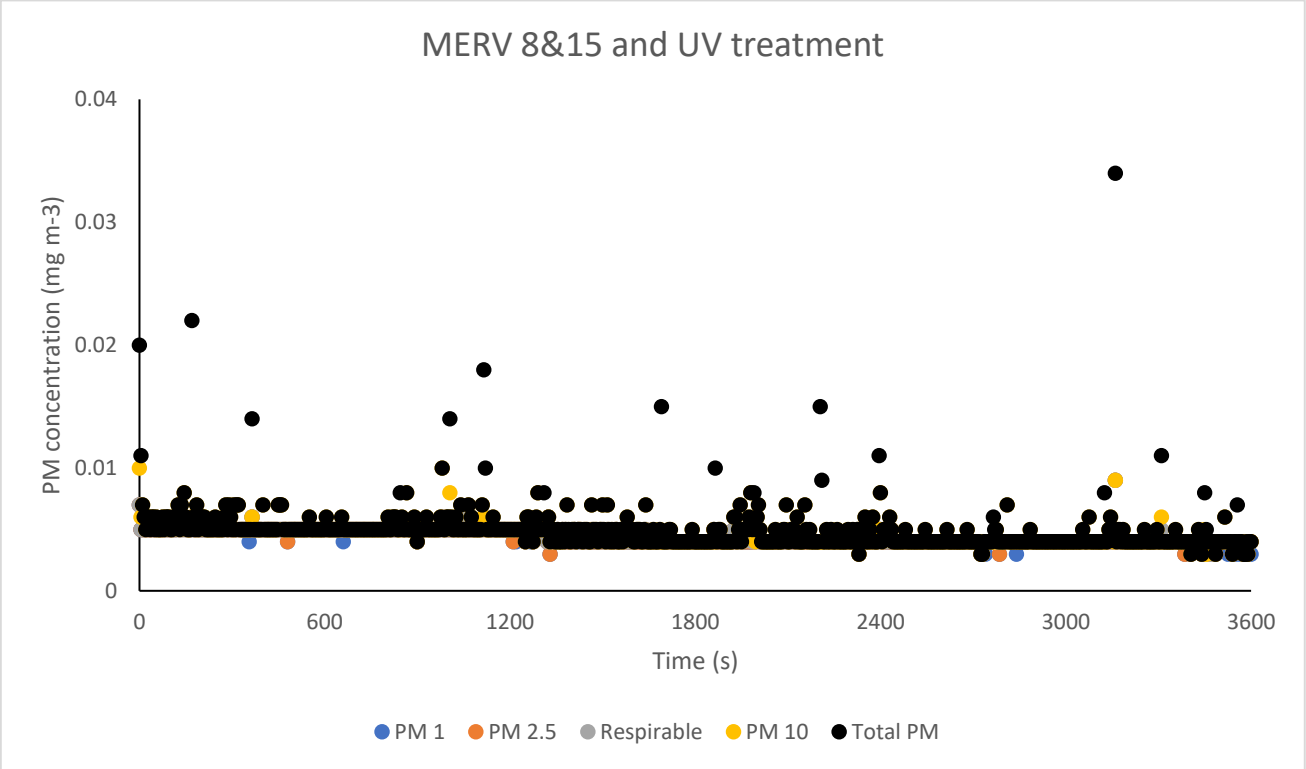
Supplementary Material

Mitigation of particulate matter and airborne pathogens in swine barn emissions with filtration and UV-A photocatalysis

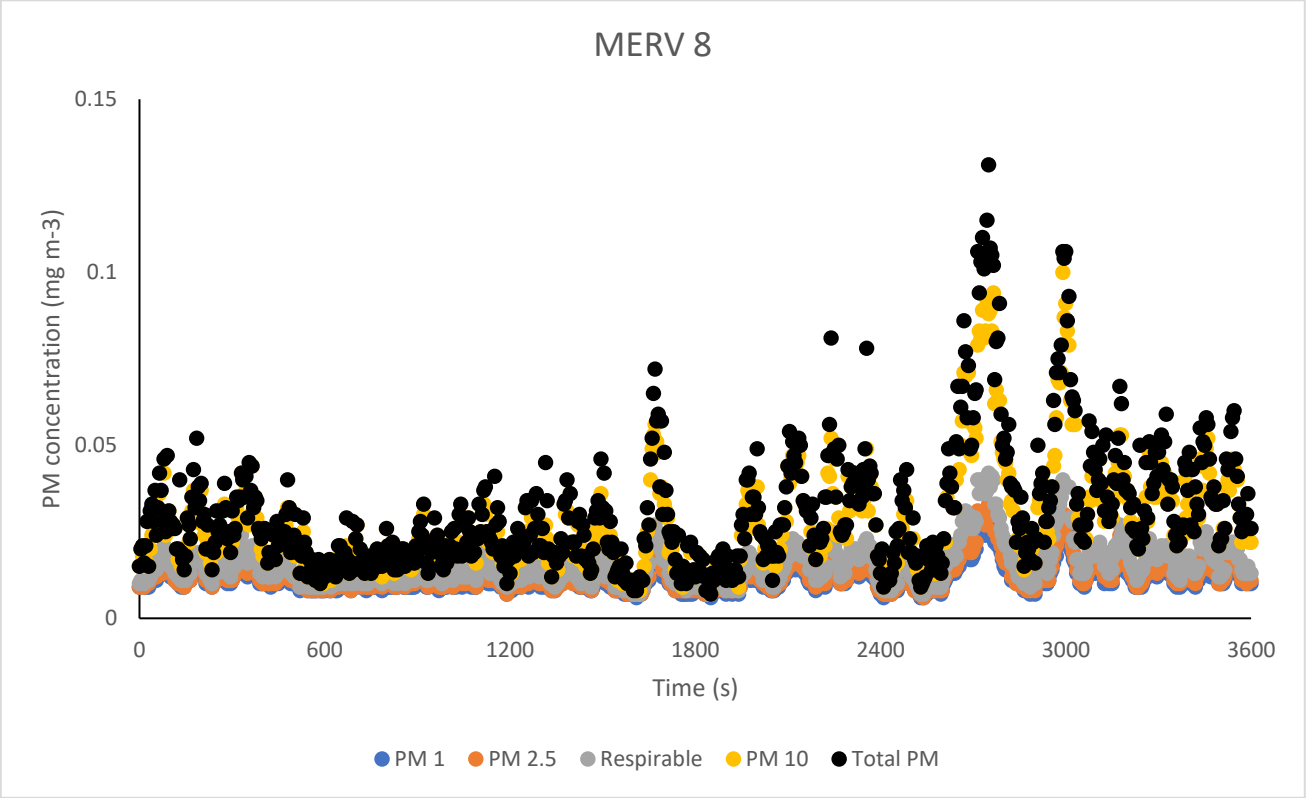
Myeongseong Lee [1], Jacek A. Koziel [1]*, Núbia Macedo [2], Peiyang Li [1], Baitong Chen [1], William S. Jenks [3], Jeffrey Zimmerman [2], R. Vincent Paris [4]

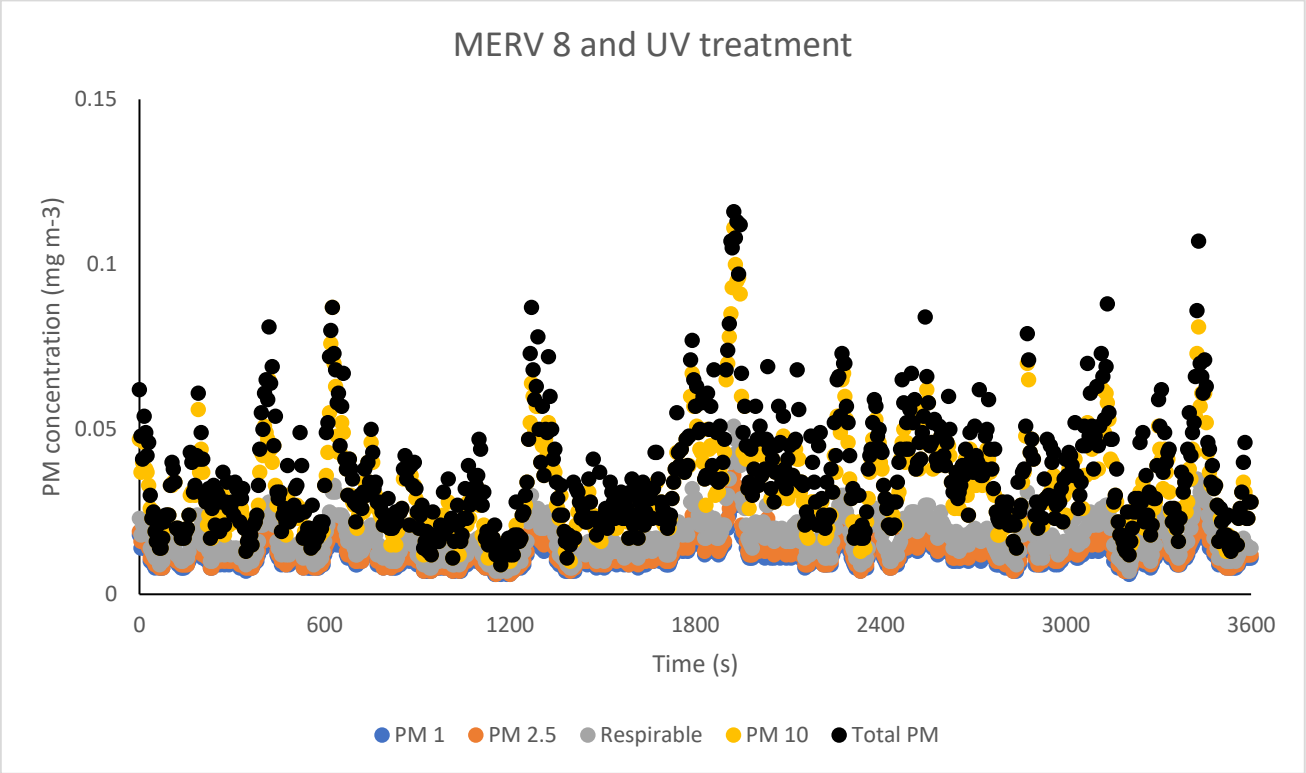
[1] Department of Agricultural and Biosystems Engineering, Iowa State University, Ames, IA 50011, USA; leefame@iastate.edu (M.L.), koziel@iastate.edu (J.K.), peiyangl@iastate.edu (P.L.), baitongc@iastate.edu (B.C.)
[2] Veterinary Diagnostic and Production Animal Medicine, Iowa State University, Ames, IA 50011, USA; nubia@iastate.edu (N.M.), jjzimm@iastate.edu (J.Z.)
[3] Department of Chemistry, Iowa State University, Ames, IA 50011, USA; wsjenks@iastate.edu (W.J.)
[4] Department of Statistics, Iowa State University, Ames, IA 50011, USA; vinny@iastate.edu (V.P.)
* Correspondence: koziel@iastate.edu; Tel.: +1-515-294-4206



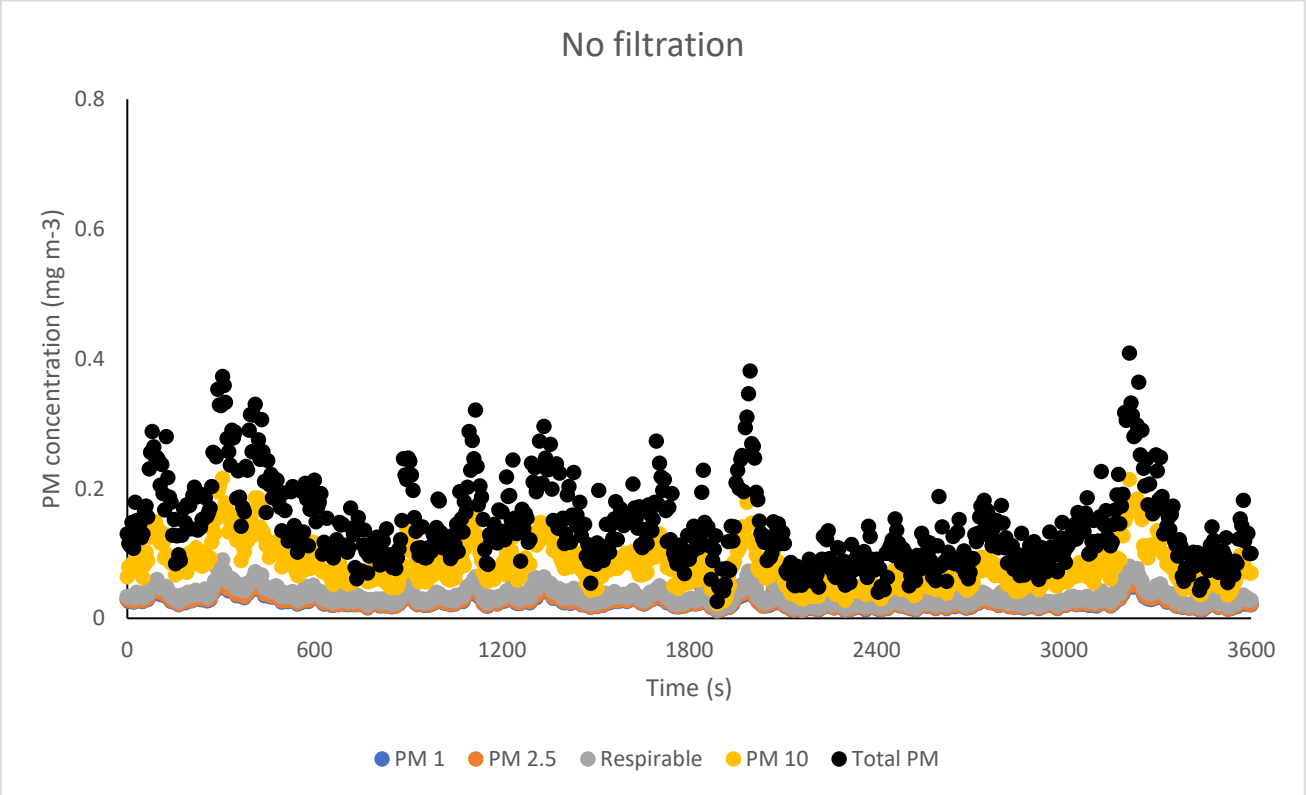


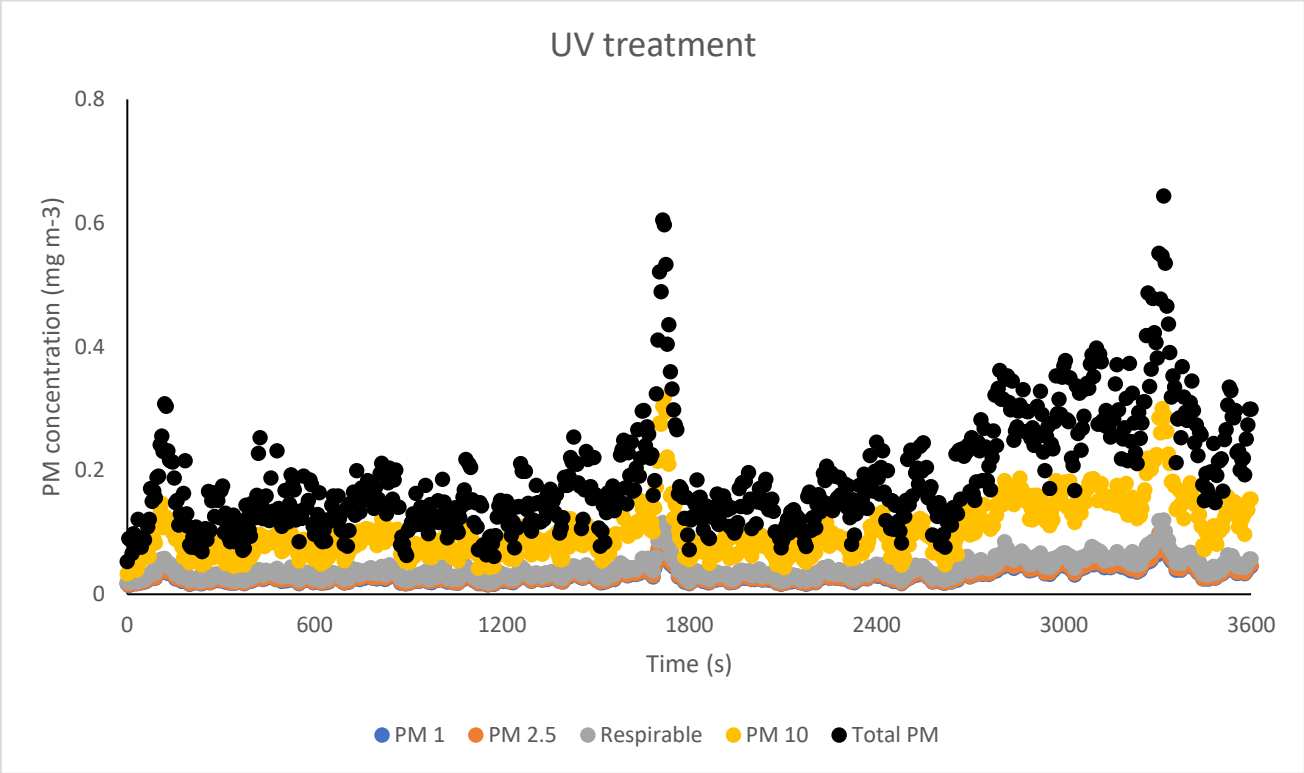
Supplementary Figure S1. Real-time measured PM concentration during 1 h air sampling (the '*best-case*' scenario, MERV 8 & 15 filtration and UV-A treatment).



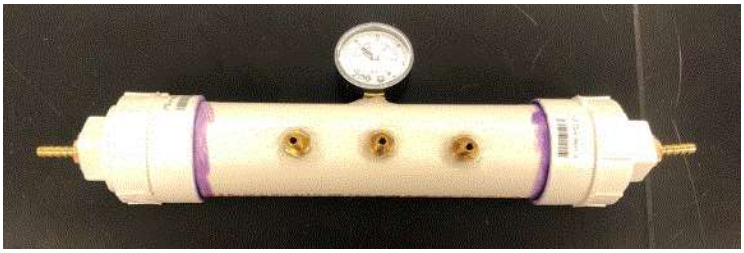


Supplementary Figure S2. Real-time measured PM concentration during 1 h air sampling (the '*midpoint*' scenario, MERV 8 only, and UV-A treatment).

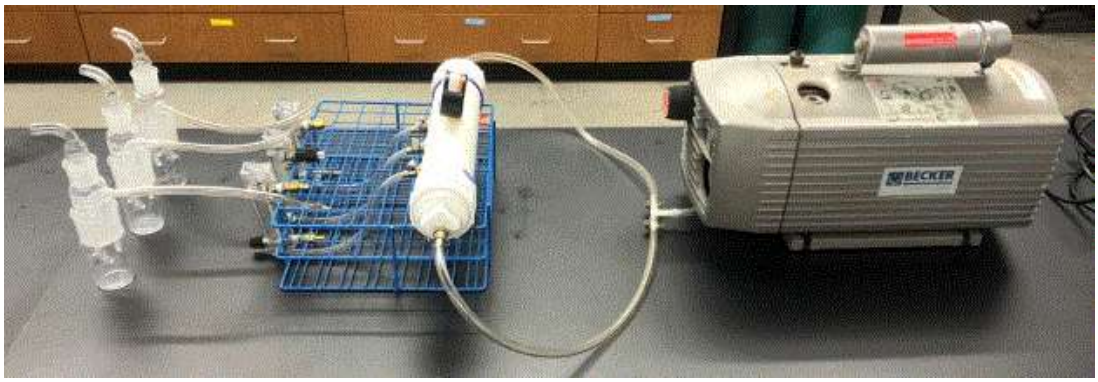




Supplementary Figure S3. Real-time measured PM concentration during 1 h air sampling (the '*worst-case*' scenario, no filtration and UV-A treatment).



Supplementary Figure S4. Manifold with a pressure gauge to facilitate the simultaneous collection of three samples of airborne pathogens.

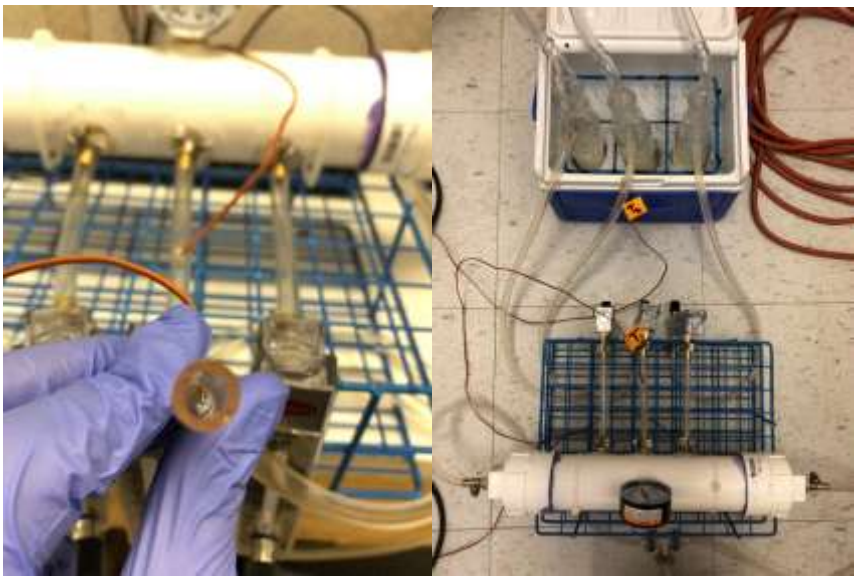


Supplementary Figure S5. Pathogen sampling system with three impingers, airflow meters, manifold with pressure gauge, and vacuum pump.

Supplementary Figure S6. Sampling tube inlets on the UV-A treatment side of sampling ports inside the mobile lab.

Supplementary Figure S7. Effects of the antifoaming agent addition into impinger solution. Foam formation during sampling (Left); No foam formed when Antifoam A added (Right). Impingers were held in an ice bath during air sampling.

Supplementary Figure S8. Airborne pathogen sampling system. (Left) Air inlet to the UV mobile lab (downstream from the MERV filtration unit); (Right) air outlet after UV treatment.



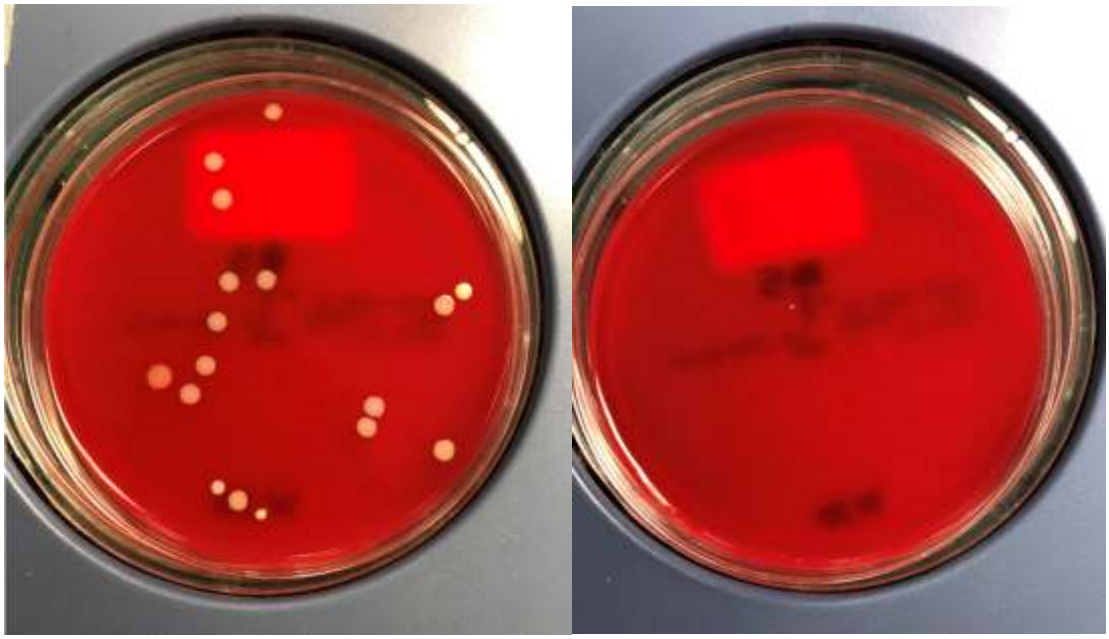
Supplementary Figure S9. Air sample temperature monitoring. (Left) thermocouple tip and seal; (Right) thermocouples installed immediately downstream from the impinger and after airflow monitor (rotameter).

Supplementary Figure S10. Mobile laboratory for UV and filtration treatment deployed for testing mitigation of gaseous emissions at a swine farm.

Supplementary Figure S11. Arrangement of 55 UV-A LED lamps installed in one of the chambers inside the mobile laboratory to treat emissions from the swine barn.

Supplementary Figure S12. Pathogen sampling system before the MERV filtration unit samples raw exhaust from swine barn fan.

Supplementary Figure S13. Colony-forming in the culture medium after sampling for 60 min. (Left: before MERV filtration, Right: after MERV 8 and 15 filtration).



Supplementary Figure S14. Colony-forming in the culture medium after sampling for 60 min. (Left: after MERV 8 filtration, Right: after UV treatment).

Supplementary Figure S15. Sterilization of impingers, air sampling tubing, and the impinger-tube connectors prepared for autoclaving.

Supplementary Figure S16. Dust accumulated inside the inlet port to impinger after sample collection of raw swine barn exhaust and before MERV filtration unit. Dust is the potential carrier of airborne pathogens.

Supplementary Table S1. Summary of average PM concentration.

Sampling date (2020)		Control					Treatment				
		Total PM	PM 10	Respirable (PM 4 - PM 10)	PM 2.5	PM 1	Total PM	PM 10	Respirable (PM 4 - PM 10)	PM 2.5	PM 1
MERV 8&15	Aug. 13	0.00339 ±0.0014	0.0033 ±0.0008	0.00311 ±0.0004	0.00309 ±0.0003	0.00301 ±0.0003	0.00479 ±0.0022	0.0047 ±0.0007	0.0045 ±0.0006	0.0046 ±0.0006	0.00431 ±0.0006
	Sep. 8	0.00342 ±0.0012	0.0033 ±0.0006	0.00314 ±0.0004	0.00309 ±0.0003	0.00307 ±0.0003	0.00493 ±0.0019	0.00471 ±0.0009	0.00446 ±0.0006	0.0044 ±0.0006	0.00438 ±0.0006
MERV 8	Sep. 9	0.0306 ±0.0182	0.02695 ±0.0147	0.01502 ±0.0059	0.01236 ±0.0043	0.01154 ±0.0038	0.03596 ±0.0173	0.03138 ±0.0144	0.01651 ±0.0060	0.01303 ±0.0042	0.01197 ±0.037
No filtration	Sep. 10	0.1442 ±0.0592	0.0843 ±0.0411	0.03612 ±0.0318	0.02711 ±0.0091	0.02584 ±0.0247	0.191 ±0.0708	0.1012 ±0.05354	0.0404 ±0.0224	0.03488 ±0.0116	0.03119 ±0.0209
	Sep. 17	0.14227 ±0.0647	0.08022 ±0.0328	0.03359 ±0.0120	0.02832 ±0.0100	0.02688 ±0.0095	0.18724 ±0.0908	0.10061 ±0.0444	0.0403 ±0.0161	0.03383 ±0.0134	0.03209 ±0.0127

Supplementary Table S2. Mitigation of the airborne bacteria under the UV-A photocatalysis with MERV 8 & 15 filtration.

	Inlet air with filtered out particle matter			**Outlet air after UV-A treatment**		
Total CFU·mL^{-1} (as measured in the impinger media of 20 mL)	1.2×10^2	3.0×10^1	0	0	0	1.0×10^1
Total CFU	2.4×10^3	6.0×10^2	0	0	0	2.0×10^2
Sampling time (min)			60			
Air temperature (°C)		13.2			17.3	
RH (in front of impinger, %)		68.6			64.1	
Pressure (inside the manifold, psi)		450			450	
Airflow rate by rotameter (L·min^{-1})	20	20	20	20	20	20
Sampling rate of air by each impinger (Q_{st}, L·min^{-1}, NTP[a])	12.1	12.1	12.1	12.0	12.0	12.0
Total volume of air sampled (m^3, NTP[a])	0.73	0.73	0.73	0.72	0.72	0.72
Total CFU·m^{-3} in air (CFU_D, NTP[a])	3,300	825	0	0	0	279
Average total PM concentration during bioaerosol sampling (mg·m^{-3})		0.0034			0.0049	
Total CFU_D/average total PM (CFU_{PM}, CFU·μg^{-1})	964	241	0.0	0.0	0.0	56.6
Average total CFU_D/average PM in exhaust air (CFU·μg^{-1}, n=3, mean ± st.dev.)		402 ± 502			18.9 ± 32.6	
% reduction of CFU_{PM} (% *R*)			95.3			
p-Value			0.33			

Note: [a] Normal temperature and pressure is defined as air at 20 °C and 1 atm.

Supplementary Table S3. Mitigation of the airborne bacteria under the UV-A photocatalysis with MERV 8 filtration. **Bold** font signifies statistical significance.

	Inlet air with filtered out particle matter			**Outlet air after UV-A treatment**		
Total CFU·mL^{-1} (as measured in the impinger media of 20 mL)	3.4 ×10^2	3.6 ×10^2	4.9 ×10^2	2.5 ×10^2	2.5 ×10^2	2.9 ×10^2
Total CFU	6.8 ×10^3	7.2 ×10^3	9.8 ×10^3	5.0 ×10^3	5.0 ×10^3	5.8 ×10^3
Sampling time (min)	60					
Air temperature (°C)	9.8			13.4		
RH (in front of impinger, %)	93.8			80.2		
Pressure (inside the manifold, psi)	450			450		
Airflow rate by rotameter (L·min^{-1})	20	20	20	20	20	20
Sampling rate of air by each impinger (Q_{st}, L·min^{-1}, NTP[a])	12.3	12.3	12.3	12.1	12.1	12.1
Total volume of air sampled (m^3, NTP[a])	0.74	0.74	0.74	0.73	0.73	0.73
Total CFU·m^{-3} of exhaust air (CFU_D, NTP[a])	9,240	9,780	13,300	6,880	6,880	7,980
Average total PM of exhaust air during bioaerosol sampling (mg·m^{-3})	0.0306			0.0359		
Total CFU_D/average Total PM (CFU_{PM}, CFU·μg^{-1})	302	320	435	192	192	222
Mean Total CFU_D/average PM in exhaust air (CFU·μg^{-1}, n=3, mean ± st.dev.)	352±72.3			202±17.7		
% reduction of CFU_{PM} (% *R*)	**42.7**					
p-Value	**0.04**					

Note: [a] Normal temperature and pressure is defined as air at 20 °C and 1 atm.

Supplementary Table S4. Mitigation of the airborne bacteria under the UV-A photocatalysis without MERV filtration.

	Inlet air with particle matter			**Outlet air after UV-A treatment**		
Total CFU·mL^{-1} (as measured in the impinger media of 20 mL)	3.2 ×10^3	1.38 ×10^3	8.4 ×10^2	1.16 ×10^3	1.26 ×10^3	7.8 ×10^2
Total CFU	6.4 ×10^4	2.76 ×10^4	1.68 ×10^4	2.32 ×10^4	2.52 ×10^4	1.56 ×10^4
Sampling time (min)	60					
Air temperature (°C)	15.2			18.9		
RH (in front of impinger, %)	51.6			45.8		
Pressure (inside the manifold, psi)	450			450		
Airflow rate by rotameter (L·min^{-1})	20	20	20	20	20	20
Sampling rate of air by each impinger (Q_{st}, L·min^{-1}, NTP[a])	12.0	12.0	12.0	11.9	11.9	11.9
Total volume of air sampled (m^3, NTP[a])	0.72	0.72	0.72	0.71	0.71	0.71
Total CFU·m^{-3} of exhaust air (CFU_D, NTP[a])	88,600	38,210	23,260	32,530	35,330	21,870
Average total PM of exhaust air during bioaerosol sampling (mg·m^{-3})	0.142			0.187		
Total CFU_D/average Total PM (CFU_{PM}, CFU·μg^{-1})	623	269	163	174	189	117
Mean Total CFU_D/average PM in exhaust air (CFU·μg^{-1}, n=3, mean ± st.dev.)	352±241			160±38		
% reduction of CFU_{PM} (% *R*)	54.6					
p-Value	0.28					

Note: [a] Normal temperature and pressure is defined as air at 20 °C and 1 atm.