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Characteristics of aerial dust in finishing buildings

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Abstract

Eleven finishing units were surveyed to study the characteristics of aerial dust and factors that influence dust concentrations. Feed dust was the major portion of the total dust mass and can be minimized with feed additives, less feed wastage, enclosed feed delivery, and periodic cleaning. Ventilation was the primary method for dust removal. Naturally ventilated buildings had higher dust concentrations than mechanically ventilated buildings because of lower average airflow rates, especially during cold weather. Swine workers can minimize respiratory symptoms by wearing face masks.; Swine Day, Manhattan, KS, November 19, 1987

Keywords

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CHARACTERISTICS OF AERIAL DUST IN FINISHING BUILDINGS[1]

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Summary

Eleven finishing units were surveyed to study the characteristics of aerial dust and factors that influence dust concentrations. Feed dust was the major portion of the total dust mass and can be minimized with feed additives, less feed wastage, enclosed feed delivery, and periodic cleaning. Ventilation was the primary method for dust removal. Naturally ventilated buildings had higher dust concentrations than mechanically ventilated buildings because of lower average airflow rates, especially during cold weather. Swine workers can minimize respiratory symptoms by wearing face masks.

Introduction

The control of solid airborne particles or dust is an important aspect of environmental management in swine housing. The quantity, size, and composition of the particles help to determine their detrimental effects and the potential for possible dust control measures. The objectives of this research were to study the characteristics of airborne dust inside finishing houses.

Procedures

Dust samples and environmental data were collected from 11 commercial finishing buildings located within 40 miles from Manhattan (Table 1). Each unit was surveyed eight times between July, 1985 and March, 1986. An outside sample and several inside samples of aerial dust were collected on filters during 1-hr visits made between 9:00 a.m. and 5:00 p.m. Air samplers were placed in the service alley toward the center of the room.

Dust concentration by mass was determined from inside and outside filtered samples. The number of particles per unit volume of air was counted with an electronic particle analyzer after the dust was washed from a filter into a liquid solution. Another filtered sample was prepared from observations with a light microscope and an electron scanning microscope.

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Results and Discussion

A particle is respirable if it is small enough to be inhaled into the lung. We identified starch, grain meal, and skin particles in the nonrespirable size range with the light microscope. The occurrence of large, nonrespirable particles is responsible for 1) more settled dust, 2) higher odor levels, 3) higher mass concentrations of aerial dust, and 4) irritation of the upper respiratory tract where large particles are filtered out before reaching the lung tissue. Seventy-eight percent of the nonrespirable particles were identified as starch and grain meal, which arise from the feed. Skin particles comprised only 1 percent (Table 2). Both respirable and nonrespirable particles were identified with the scanning electron microscope. About 65% of the 1,518 particles we observed with this method were identified as grain meal, 13.5% were starch and 1% were skin. The inorganic portion of aerial dust averaged 13.1%. Potential sources of inorganic particles include soil and feed supplements. Since a major portion of the dust originates from feed, effective dust control measures may include: 1) adding tallow, soybean oil, or water to the feed 2) totally enclosing the feed delivery system, 3) reducing feed wastage, and 4) cleaning the floors.

Dust concentrations were based on the mass (mg) of dust per cubic meter (MCM). Inside the units, the concentrations ranged from 0.4 to 38.2 MCM and averaged 8.1 MCM. The average outdoor concentration was only 0.3 MCM. For comparison, we will mention that OSHA has a threshold of 10 MCM over an 8-hr work period for nontoxic industrial dusts. This concentration was exceeded during 25 of the 88 farm visits.

We found higher dust levels in the winter than in the summer. Also, the modified-open-front (MOF) buildings were generally dustier than the mechanically ventilated buildings, but mostly during cold oustide temperatures (Figure 1). Higher dust levels in MOF units corresponded to less ventilation as the buildings were closed up during cold wether. It was also found that, at equal temperature differences indicating approximately equal airflows, MOF's were consistently dustier than mechanically ventilated buildings. This was probably due to less uniform air circulation patterns in MOF buildings. Lower dust concentrations were also seen with higher inside relative humidity. As partilces take on water in moist air, they tend to settle out. The buildings were also visually observed for cleanliness. Two exceptionally clean units had average dust levels of 3.3 and 7.7 MCM. Two units that were consistently below typical cleanliness had average dust levels of 10.3 and 14.5 MCM.

A written survey of 12 workers among the 11 farms showed that eight persons experienced coughing. The survey also reported four each for sneezing, eye irritation, and coughing up of phlegm and two each for chills/fever, chest tightness, and shortness of breath. One worker reported no symptoms, whereas another indicated that his coughing never subsided, even after work. All workers were non-smokers. Dust masks can significantly reduce the amount of dust entering the respiratory tract.

Table 1. Building Parameters and Averages of Environmental Data

Unit	Type	Size ft^2	Hyg[2]	T in F	T out F	RH_i %	NTMC[3] mg/m^3
A[1]	Mech	5917	Avg	53	74	64	7.0
B	Mech	10543	Avg	50	68	68	6.0
C[1c]	Nat	5906	Poor	58	68	64	14.5
D[1c]	Nat	3550	Avg	55	67	61	11.3
E[1]	Nat*	2808	Avg	63	72	63	3.1
F[c]	Nat*	4454	Good	48	67	69	7.7
G	Nat*	2905	Avg	52	68	65	6.6
H[c]	Nat*	4841	Avg	63	70	68	5.2
I	Mech	979	Poor	55	76	61	10.3
J	Nat*	6509	Avg	52	71	58	11.2
K	Mech	5917	Good	59	70	64	3.3

*Monoslope roof. Others were gable roofs.
[c] Automatic curtains. Other naturally ventilated units used manual panels.
[1] Automatic sprinklers for cooling.
[2] Visual rating of building cleanliness.
[3] Inside-outside dust concentration.

Table 2. Compiled Particle Counts from 86 Samples by Light Microscopy

Particle Type	Diameter at Upper Limit of Each Size Class, µm							
	<2.7	3.8	5.4	7.6	10.8	15.3	21.6	30.5
Total	8544	2432	1682	1286	1011	661	352	158
Starch				64	124	149	99	53
Grain meal				885	697	426	202	82
Skin				0	4	3	1	6

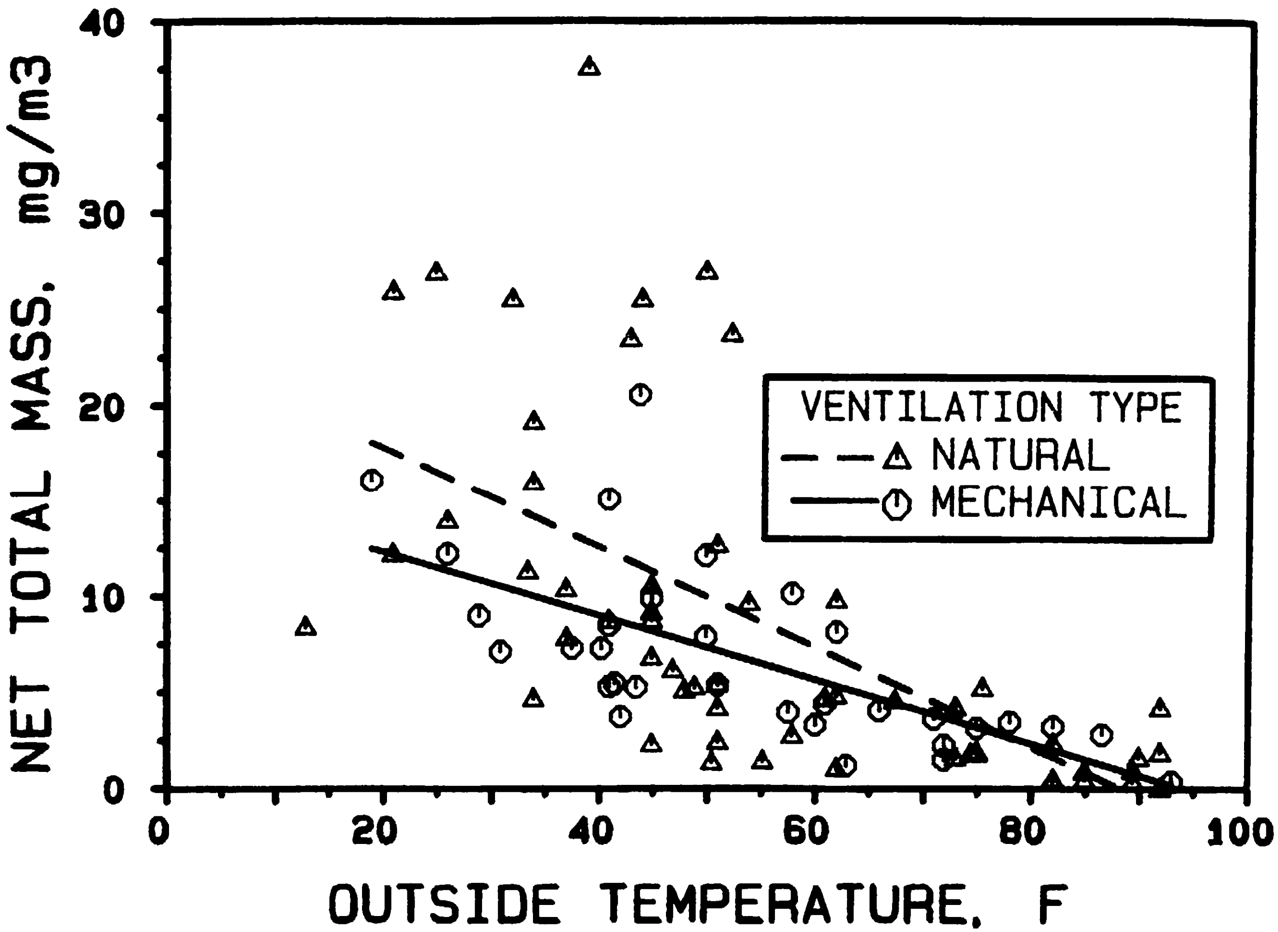

Figure 1. Net total mass concentration in naturally and mechanically ventilated swine finishing buildings as influenced by outside temperature. The lines show the regressions for each type of system.