

Partitioning of Ammonia and Hydrogen Sulfide Emissions Into Pit and Wall Exhaust Fractions for a Deep-Pit Pig Finishing Barn

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Many pig-finishing buildings in the Midwest store manure in concrete pits (8 ft. deep) directly beneath the buildings. These so-called deep-pit barns are often mechanically ventilated and have from as low as 1/10 up to 1/2 of the barn's total ventilation air exhausted from the pit area. To manage and/or control gas and odor emitted from these barns, producers need to not only know the total emissions (if in compliance with new federal and state regulations) but also the distribution of these pollutants between the pit and the wall air streams. The distribution is important since control technologies such as biofilters that are very effective at reducing gas and odor emissions, have generally been applied to the pit portion of the ventilation exhaust stream rather than the wall exhaust stream.

Ammonia (NH₃), hydrogen sulfide (H₂S), and odor emissions were measured from a 2000-head tunnel-ventilated deep-pit finishing barn in southern Minnesota for 45 days during August and September 2004. Gas and odor concentrations were measured at pit and wall exhaust fan locations along with indoor and background locations. Additional pit exhaust fans were added to one side (south 1000 head room) of the double-wide building to test whether more pit ventilation would result in the reduction of NH₃, H₂S, and odor wall emissions, along with an improvement in the indoor air quality.

The data collected in this study showed that for a deep-pit finishing barn, the gas emissions are much higher from the pit ventilation fans than for the wall ventilation fans. The north barn in this study was operated with a relatively constant pit ventilation rate of 27,500 cfm or 27 cfm/pig that is typical for a majority of U.S. Midwestern finishing barns. The daily average emissions of NH₃ and H₂S for the north barn are given in figures 1 and 2 plus the overall emissions means are listed in Table 1 for these two gases plus odor. The north barn's results show that approximately 70% of the NH₃, 75% of the H₂S, and 62% of the odor were emitted through the pit ventilation fans. The south barn's pit ventilation system was modified with the addition of two supplemental pit fans to boost the pit ventilation rate by roughly 40 % up to 43,700 cfm or 44 cfm/pig during the daytime. It was assumed that by increasing the pit ventilation rate, the pit fan emissions for NH₃, H₂S, and odor would be proportionally increased and subsequently reduced what the wall fans emitted plus improve the indoor air quality, as is often the stated reason for pit ventilation. However, the results given in Table 1 for the south barn show only a slight increase in the percentage of NH₃, H₂S, and odor (77%, 81%, and 67% respectively) that was emitted through the south barn's pit fans compared to the north barn. Wall fan emissions of NH₃, H₂S, and odor were not greatly affected by increasing the pit ventilation rate.

Ammonia concentration is often used as an indicator of indoor air quality and many extension engineers suggest a concentration of 10 ppm (NH₃) as the upper threshold for acceptable conditions in a pig barn. Figure 3 shows the diurnal average NH₃ concentrations for a central pen location in both the north and south rooms during the study. Concentrations in both barns vary between 3 and 5 ppm (mean of 4 ppm) and remarkably were very comparable, showing a similar pattern over an average 24 hour period, with the highest concentrations at night /early morning and lowest levels midday when ventilation rates are lower and then higher, respectively. This is the case even though the south barn had roughly ½ of its ventilation running through the pit, compared to the north barn where only ¼ of the air was removed by the pit fans.

The results of this short-term study indicates that additional pit ventilation has little impact on pit fan emissions of NH₃, H₂S, and odor and did not improve indoor air quality. Further research has just begun at another deep pit finishing barn this fall (2005) to determine the minimum amount of pit ventilation required to maintain a majority of the NH₃, H₂S, and odor emissions in the pit exhaust stream. This would allow producers to minimize the size of “catch and treat” control technologies like biofilters, their installation and operating costs. These results will assist pork producers in selecting appropriate control technologies for deep-pit buildings that will be effective but also affordable.

Table 1. Mean ammonia (NH₃), hydrogen sulfide (H₂S), and odor (geometric mean) emissions from north and south rooms via the pit and wall fans from a 2000 head tunnel ventilated deep-pit finishing barn for the 45 day sampling period.

Average	Wall air stream		Pit air stream		Total Emissions	
	North	South	North	South	North	South
NH₃, lbs/d	6.42	6.31	14.5	21.0	20.9	27.3
H₂S, lbs/d	0.35	0.20	1.10	0.84	1.45	1.04
Odor, OU/s	5,500	4,400	8,800	9,200	14,300	13,700

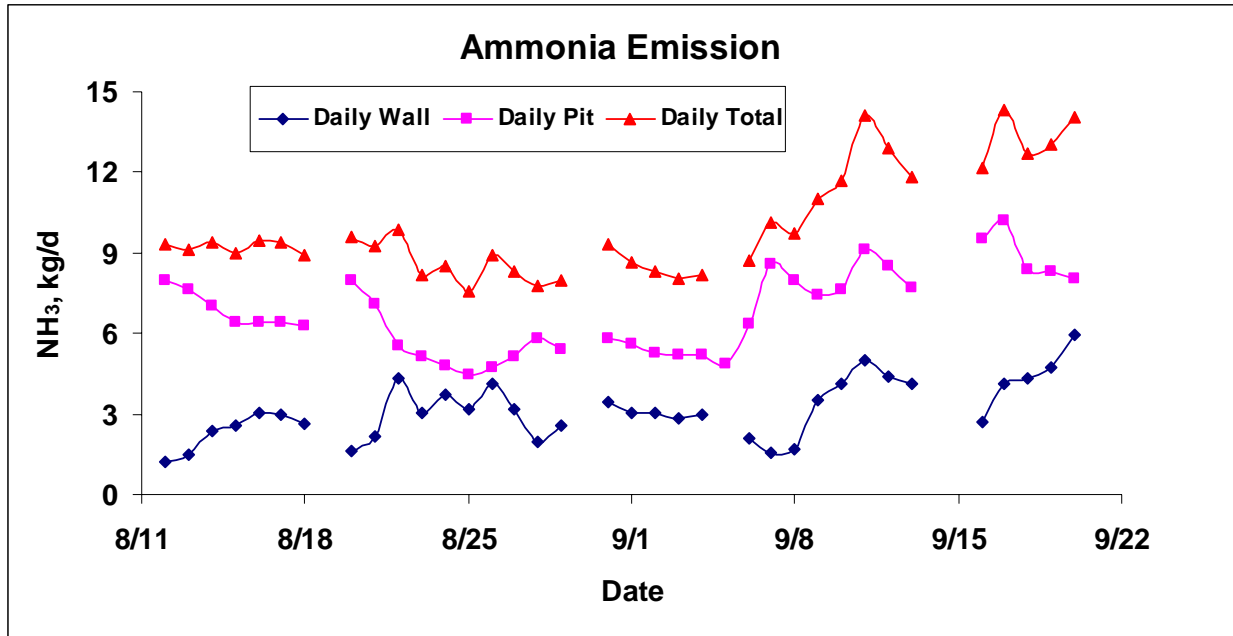


Figure 1. Daily average Ammonia (NH_3) emissions for the north barn.

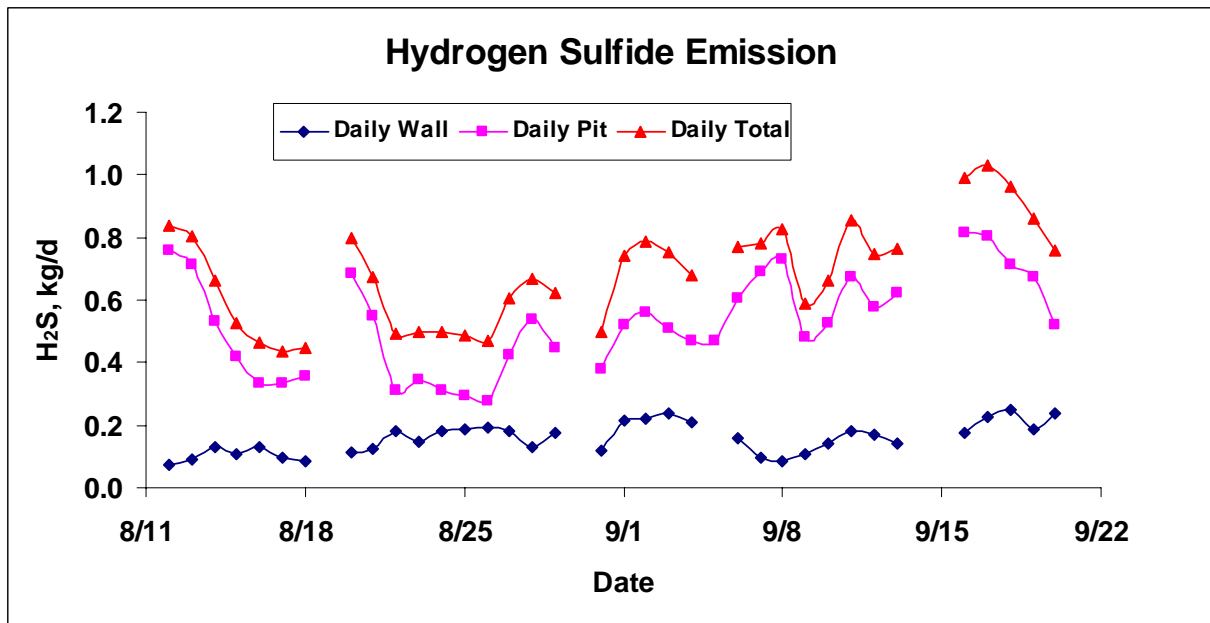


Figure 2. Daily average Hydrogen Sulfide (H_2S) emissions for the north barn.

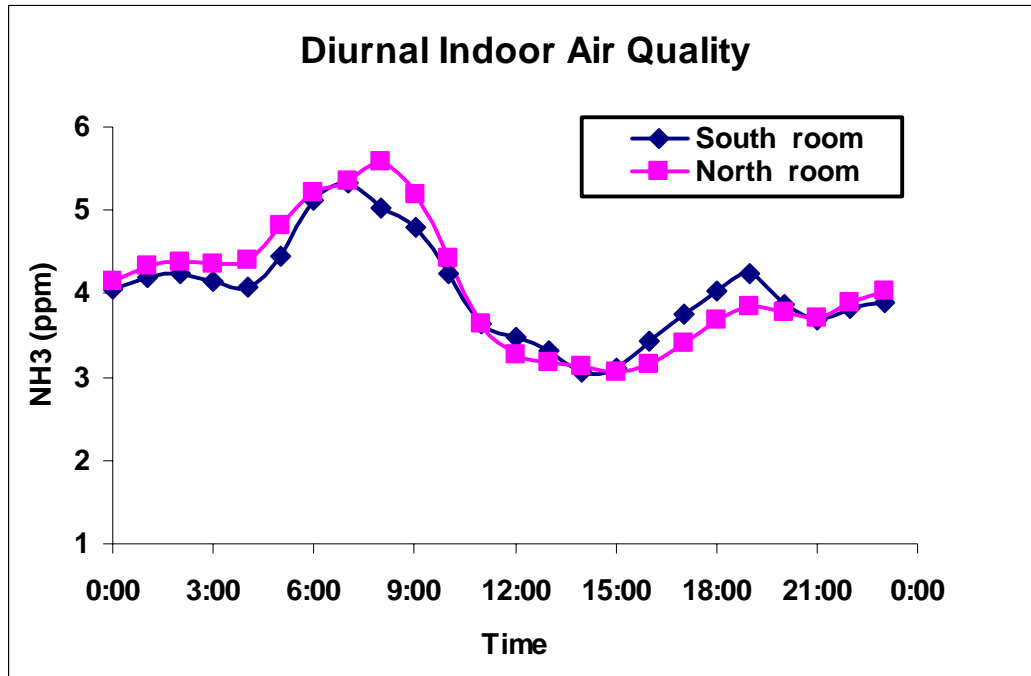


Figure 3. Diurnal NH₃ concentrations for center indoor location in north and south barns.