Simulating Ammonia Emissions from Slurry Pits

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Summary

By modelling the production and transmission of ammonia in a swine building, we will be better equipped to investigate methods to reduce ammonia concentration inside the buildings. Ammonia emission from slurry was measured and compared to two sets of model calculations to determine which model is more suitable for use in an overall room model. Both models simulated the fluctuation in emissions relatively well, but neither model sufficiently predicted the concentration levels. Slurry pH was deemed the most significant input parameter in the model calculations.

Introduction

The slurry pit and urine puddles on the slatted and solid floor have been identified as the main sources of ammonia in a pig-housing unit. Decreased protein in the diet will result in decreased nitrogen in the excreta. Increased fermentable carbohydrates, such as sugar-beet pulp, will increase the amount of nitrogen excreted in the feces compared to the urine. Nitrogen that is excreted in the feces is more stable and takes longer to decompose, whereas nitrogen in the urine is in the form of urea, which readily converts to nitrogen. The objective of this experiment was to measure the ammonia emission from slurry samples produced by pigs fed different diet compositions, and compare the measured results to model calculations. Two models will be compared and one will be chosen to represent the slurry emission in the future overall room emission model.

Experimental Procedures

Eight pigs in 58-kg and 94-kg weight ranges were housed individually in metabolism crates. Four different diet treatments were used: low protein, with and without sugar-beet pulp added, and high protein, with and without sugar-beet added. The urine and feces from individual pigs was collected, mixed and placed in emission boxes. The emission boxes were designed to simulate the slurry pit, with a low airspeed over the surface of the slurry and very little mixing. Air was pulled through the boxes and the ammonia in the outgoing air was continuously monitored over three to four days using an infrared ammonia analyser. Ammonia concentration in the boxes was simulated using two different models: a model developed by Aarnink and Elzing[1] (Model 1), and a new model developed by the authors (Model 2).

Results and Discussion

In this experiment, lowering the crude protein content and adding sugar beet pulp to the diets did not result in lower ammonia emissions. Both models showed the fluctuation in ammonia levels over the sampling period (Fig. 1). However, neither model simulated the level of concentration very well (Fig. 2). Model 2 calculations were chosen to represent the slurry pit emission process in the overall room model because Model 2 considers the pit concentration and previous concentration levels. Additional work is required to adjust the level of ammonia concentration predicted by Model 2.

Figure 1. Measured and simulated ammonia concentration in an emission box containing slurry from a finisher pig fed a high protein, sugar-beet pulp added diet

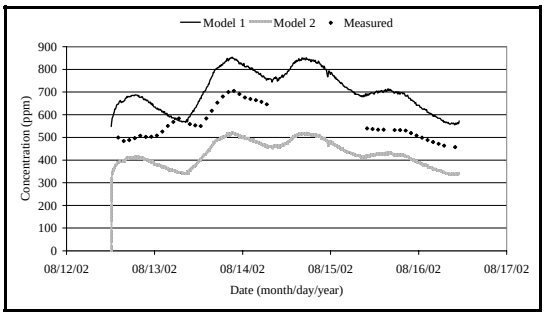
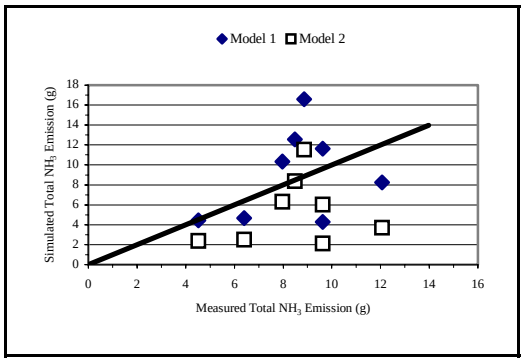


Figure 2. Comparison of the total simulated ammonia emission by both models to the total measured emission for all slurry samples in the second trial.



Based on a sensitivity analysis, slurry pH is the most influential factor in model calculations. A 1.0 unit decrease in pH will decrease ammonia emissions by 90%, but a 1.0 unit increase in pH will increase emissions by 833%.

Implications

The ammonia emission from the slurry pit is a major contributor to the ammonia concentration in a pig-housing unit and the ammonia emission to the environment. By validating model equations to simulate ammonia emission