February 2021

Four Tips to Increase the Value of Manure
By Kris Kohl, Ph.D., P.E.

Manure is a valuable fertilizer for crop production. However, it gets expensive to move very far from the barn because of its high water content. Here are four tips to get the most out of your manure.

1. **Test it:** The manure's value is mostly in Nitrogen, Phosphorus, and Potassium. Knowing what you have is the first part of determining where to put it. Nitrogen and Potassium are water-soluble and predominately dissolved in the liquid fraction. Phosphorus is enriched in the solids fraction. Look closely at the solids content of the manure sample. The solids content as excreted from a pig is approximately 13%. Most swine deep-pit manure samples are between 5 and 10% solids. If your sample has low solids content, look for water waste. Particularly, assess if you can modify the cleaning and the power washing methods to reduce wastewater production. While it is important to thoroughly clean for biosecurity, extra water use increases manure water and costs more to haul.
2. **Test the Soil:** Figure out where the soils are low in Phosphorus and where high and very high phosphorus levels exist. On many livestock farms, Phosphorus levels are higher closer to the farmstead and much lower farther away. Newly acquired farms are often lower in soil Phosphorus. They are prime candidates to apply manure with high solids content to build Phosphorus levels. Mapping and planning where fields need Phosphorus will ensure you get the nutrients to the areas that need them most.
3. **Manage the agitation:** Because the liquids have a lower concentration of Phosphorus, apply the first loads out of the pit without agitation. These loads will have higher N:P ratios and should be applied to the crop's Nitrogen needs. When the manure pit is about 1/2-2/3 full, start agitation. Make sure to start agitation soon enough that sufficient liquid is present to suspend the remaining solids. These later loads will often have 2-to-3-fold higher concentrations of Phosphorus, and the higher nutrient content makes it more cost-efficient to haul to distant fields or build fertility in low testing parts of a field. Care must be taken when this agitation starts to prevent pit gas problems, and the ventilation needs to be increased.
4. **Measure your success:** Take samples of the un-agitated early loads to see the manure nutrient content and compare it to the later agitated loads. Comparing samples will let you see how nutrients are being concentrated. Take soil samples to see the changes made in soil fertility. Twenty pounds of Phosphorus per acre should raise the soil test by one ppm. Measure the yield and watch crop response.

Adjusting pit agitation strategies can help move nutrients to where they are needed most.

Manure Foam Safety

This winter, we've seen manure foam and the dangers it can present. Common questions are why now, why again? In this article, I'll review what we know about foam, why it forms, and how to manage it.

Safety

Spontaneous foaming in swine manure pits is an ongoing challenge and has serious potential danger. Methane gas is trapped in the bubbles and creates the potential for fires and explosions, especially when the foam bubbles or during low/minimum ventilation. Hazardous conditions are during agitation, pumping, pressure washing or activities like welding and hot work where slag might fall into the foam. If you are dealing with foam, make sure you take the appropriate precautions to ensure safety for you, your employees, your pigs, and the building. Below are a few best tips for working with foam or check out this video for a refresher on dealing with foam.

- Provide continuous ventilation to prevent gas build-up. Increase ventilation during agitation to quickly dissipate released gases.
- Turn off heater pilot light and other non-ventilation electrical systems, such as the feeding system, that might produce an ignition spark.

Treatment

What does this mean for mitigation? Finding ways to get lower methane production leads to less foam. Items that reduce carbon in the manure lower the chance of foam by lowering the microbial food supply. This could be dietary changes towards more digestible feed ingredients (typically those lower in fiber content) or finding ways to make currently utilized components more digestible (including finer grinding or feed treatments to improve digestion).

Treatment with ionophores impacts the methane production pathways and has been effective. Skysis (Narasin) is a swine-safe additive, and our research, suggests rates in the manure of approximately 5 lb/100,000 gallons. Similar compounds include Rumensin and Coban. Results indicated reduced methane production from treated manures for around 90-120 days.

Research has shown treatments that destabilize the proteins, such as proteases, can significantly reduce foaming capacity and foaming stability. Other treatments that seed microbes, especially microbes known to produce proteases, into the manure may be a viable treatment. The second component could be targeted as a mitigation approach, is the microbially produced poly-liposaccharide. Efforts to extract and better characterize this substance are underway; however, at this time, not enough is known about the material, or the microbe that produces it, to target this specific aspect of foaming.

In non-foaming manures, the microbial community tended to be focused on lactobacillus and Volatile Fatty Acid (VFA)processing. Within these barns, the manures showed an accumulation of VFA, which lead to slightly lower surface tension in the manure and lower methane production rates. Inoculating with lactobacillus may be a viable treatment alternative.

Ventilation

If a treatment is performed to mitigate the foam, especially a treatment that breaks the foam and releases substantial methane quantities, ventilation rates should be increased to purge methane from the facility. Figure 1., estimates the time required to purge the methane as a function of the ventilation rate. We recommend doubling or tripling this time to account for non-uniform mixing of air within the facility.

When this is occurring, potential sparking equipment should be turned off, including heaters.

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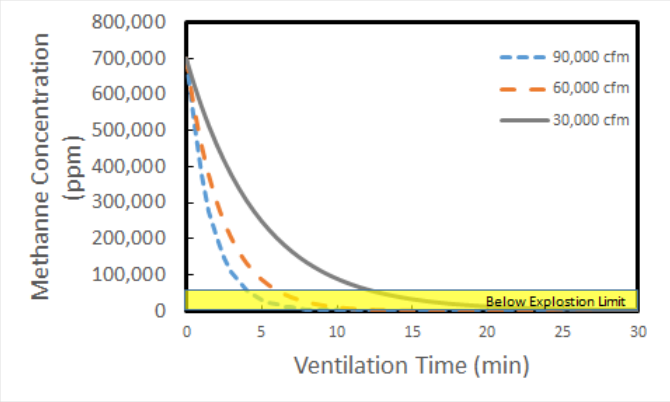

Figure 1. Ventilation recommendations when foam is treated or disturbed.

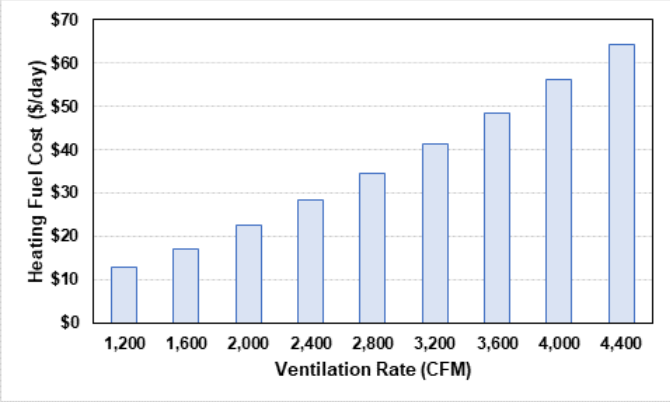

Figure 2. Estimated heating costs for various ventilation rates (empty barn, LP assumed $1/gal)

Another dangerous period is when the facility is empty between turns, especially during cold weather when ventilation systems are turned down. Minimum ventilation of 1.8 cubic feet per minute could result in a methane concentration of approximately half the explosive limit. A ventilation rate of 1.8 cubic feet per minute in a 2,500-head barn is approximately 2-pit fans running at 50% and could result in poor air mixing within the facility and potential hot spots with high methane concentration.

Time and care should be given to the swine finishing facility's ventilation system to ensure both adequate minimum ventilation and air mixing to avoid hot spots where explosions could occur. Assuming a 2,500 head wean to finish barn, a single pit fan running at 50% would result in a methane concentration in the barn around the explosive limit. Two pit fans would reduce the concentration to approximately half that but would have extremely poor mixing where certain areas of the barn exceed the explosive limit. In a room less than 50 feet wide, one pit fan should be operating every 100 feet of room length (can alternate or be on one side of the barn). If room is greater than 50 feet wide, pit fans on both sides should be operating every 100 feet of room length. The estimated heating cost of various ventilation rates (empty barn, LP assumed $1/gal) are provided in Figure 2.

Leon's Safety Message:
Leon Sheets shared the story, his story, of a fire/explosion at his swine barn. His important message reminds us all of the importance of safety. "Farmers need to be careful whether they are pumping, power washing, or doing maintenance. When it comes to these accidents, we want no more, nobody else." Take the time to hear Leon's message.
https://youtu.be/W9XCQq4RDCo

Foam Formation

Swine Diet
What we feed pigs impacts manure's characteristics—the carbon content, the chemical composition, and the microbial community that develops. Our research showed higher fiber diets, such as feeding DDGS, increased the chance of foaming and led to more methane production potential in the manure. Excreted carbon alone doesn't cause foaming, but it provides the possibility for foaming to develop. This led researchers to start asking why this might be happening. Through several dietary feeding trials, it was discovered that diets higher in fiber tend to be less digested by the pig, which results in more carbon entering the manure storage.

This past summer, some swine diets were formulated to slow growth. These diets often had less digestible fiber ingredients, such as those that may have been fed too slow.

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Methane Production

Methane is always produced during the anaerobic breakdown of manure. When we store manure in a deep-pit, methane is generated. Foaming barns consistently produce methane at faster rates than their non-foaming counterparts, often making three times as much methane per day. Methane is the explosive gas of concern, so higher production rates mean more ventilation is required for the removal of this gas.

Additionally, the higher flux of methane through the manure works to separate some chemical compounds by adsorbing them on the bubble and floating them to the manure's surface.

Foam Stabilization

Research has found the stabilizing agent are fine-sized particles (2-25 µm) that are enriched in proteins. These particles need something to bind proteins together. Data suggests the binder is a microbially produced poly-liposaccharide, aka microbial goo. This microbial goo causes the foam to be very viscous, keeping the bubbles wet and making them last longer. One way of thinking about this stabilization chemistry is like comparing it to making meringue for your lemon meringue pie.

Microbial Community

Research showed substantial differences in the microbial community between foaming and non-foaming manures. Notably, the methanogens present as well as potential carbon degradation pathway changes. Dietary ingredients influence the microbial community, but other factors seem to make as much of a difference. This was true both in the field and with the feeding trials conducted; however, based on the feeding trials, it was clear that specific properties did influence the microbial community that developed. In particular, our study showed that manure carbon contents (microbial food) led to differences in microbial community. Our evidence suggests that higher fiber diets, especially from DDGS, tended to lead to foaming communities in the field.

Manure Applicator Training Continues

The March 1 is deadline for renewing certification without a late fee. New applicators can contact your local county extension office to watch the reshows for these programs. There is no charge for viewing the video on the scheduled reshow date and time. However, applicators requesting to view the training materials at non-scheduled times will be charged a fee. Additionally, the DNR also offers E-Learning for Commercial, Confinement Site, and Dry Applicators.

Events

March 4, 12-1
Minnkota Lunch and Learn Series
The second Minnkota Lunch and Learn Series will start with a brief update on projects from Iowa State (Brett Ramirez), research and cage-free housing transition from the Egg Industry Center (Rich Gates), then, presentations on updates to swine euthanasia/depopulation (Chris Rademacher) and commodity economics (Lee Schultz; recorded). There will also be time for questions and discussion. Brett Ramirez will moderate the session. Here is the Zoom Meeting link.

February – April 2021
Manure Mondays: A Virtual Conversation About Manure
March 1: Manure Application Timing and Sidedressing Options
Glen Arnold (Ohio State) and Brian Dougherty (Iowa State) will share their experiences and research results.

March 2021
Multiple dates and locations
Managing your Unseen Employee: The Ventilation System

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