

Episode Title: Manure Gas Safety

Summary: Two of the most dangerous hazards with manure gas are hydrogen sulfide and methane. When inhaled, hydrogen sulfide can paralyze the respiratory system leading to asphyxiation and death. Methane in the presence of an ignition source can cause explosions. Today, we hear from a first responder describing some of the calls they've responded to for manure gas hazards, and then Renee Anthony, industrial hygienist and professor at the University of Iowa shares recommendations for safety including tips for ventilation, and using gas monitors.

Expert: Renee Anthony

Episode Quote:

"It's the worst thing to see a loved one become overcome by this, but it happens on the farm. And so, the reason I wanted to have the conversation is so people are aware of this, and pre-plan before they ever think of going into a manure pit."

– Renee Anthony, Professor, College of Public Health, University of Iowa

Transcript

00:04 K. Crawford

Welcome to the FarmSafe Podcast brought to you by the Great Plains Center for Agricultural Health. In the blink of an eye, an injury can change your life and your farm forever. During each episode, we share first-hand stories and real-life tips for making safer and healthier decisions while on the farm.

In this episode we are going to talk about manure gas hazards. Two of the most dangerous hazards with manure gas are hydrogen sulfide and methane. When inhaled, hydrogen sulfide can paralyze the respiratory system leading to asphyxiation and death. Methane in the presence of an ignition source can cause explosions. We hear first from a first responder in Iowa who talked to us about some of the calls they respond to for manure gas hazards.

Speaker 1:

One of the big things that we've ran into is the different gases that are produced. We get into methane where we might have a structure fire due to methane exploding— because it's a gas that hits a spark and then makes an explosion. A lot of what we've ran into is hydrogen sulfide. We get into manure pits and it's usually a multi-fatality incident. There's been quite a few different documented cases, one was— they're not sure if it was the farmhand or the dad that went in first, but one of them went in, the other one went to get him, they both collapsed. The wife came out, saw the husband, went in after him, collapsed, daughter number one came out, went in after mom and dad, collapsed, daughter number two came out, went in after mom and dad, so we lost a family of four plus the hired hand so five fatalities in that incident just because you think you can hold your breath, you think you can get there. A lot of these people don't have a 4-gas monitor so they can't see what they're walking into and especially if they're cleaning the pit or doing something with the ventilation fans, you have to know what you're walking into. With us, if we're walking into that situation, we have our 4-gas turned on and ready to go so we don't walk into something that we can't get ourselves back out of.

K. Crawford

My guest today is Renee Anthony, a Professor at the College of Public Health at the University of Iowa. Renee is an industrial hygienist with expertise in measuring and evaluating chemical exposures in the workplace. Thanks again for being here Renee. We always appreciate having you come on and talk about some of these agricultural health hazards. Today we wanted to talk about manure gas safety, so can you start by telling us what kind of hazards are involved with that?

R. Anthony

Yeah, if you look at the newspapers, a lot of stories where there has been an exposure to manure gas don't really go into detail on what components in the gas are hazardous, and there could be a lot of chemical components in the manure. So, we're talking about hog manure-so, pits underneath a building floor in hog production, but also in cattle and dairy areas where there's a big lagoon. Those would be counted also as manure storage that we would be interested in.

As animals do their biological functions and it enters the pit, or they're pumped into a lagoon, and we know that we've got ammonia that's generated from the urine, but we also have decay products from what we call anaerobic digestion. So, there's not a lot of air in these storage bins, but there are still bacteria under there, and it is working on our solid waste and generating things like methane and hydrogen sulfide. So those tend to stay pretty close to the liquid level in that manure pit, but once we start moving things around, then we start to release both methane and hydrogen sulfide.

Hydrogen sulfide is an extremely hazardous chemical that has been known in many industries, including municipal, solid waste management, pulp and paper, going into confined spaces for telecommunications. Hydrogen sulfide has killed a lot of workers globally, because something that is decaying is going to generate hydrogen sulfide. And we can smell it at very low concentrations, but as the concentration rises into the range of being dangerous, we no longer can smell or detect its presence, and hydrogen sulfide is a problem because what it does is it paralyzes the respiratory system. So, one big inhalation of, say, 1,000 parts per million, will stop a person from respirating. They pass out, become unconscious. If we can pull them out of the area safely and give them CPR very quickly, then we can stop that fatal outcome. But there are some issues as far as rescue that we do want to have a discussion on today.

K. Crawford

This is why hydrogen sulfide is so dangerous. It is rapidly absorbed by our bodies, paralyzing our respiratory systems, but at those levels we can't detect it by sight or smell. We just heard from a first responder talking about people collapsing quickly when exposed, and family members and co-workers are often killed because their first instinct is to go in after someone if they see them go down.

R. Anthony

Yeah, we've had a lot of cases in the upper Midwest over the past 5-10 years, where a father or a son drop something into a manure pit. They go in to just grab it and not even think about a manure gas paralyzing their respiratory system. They go in, retrieve something, and are overcome by hydrogen sulfide and a family member sees it, they go in and they're also overcome.

We've had cases where a wife is wanting to go in and rescue their husband in a high hydrogen sulfide situation, and in some cases, fortunately, they've been held back so they don't go and also have a fatal exposure. It's the worst, worst thing to see a loved one become overcome by this, but it happens in industry, and it happens on the farm. And so, the reason I wanted to have the conversation is so people are really aware of this, and pre-plan before they ever think of going into a manure pit.

K. Crawford

Yes, I want to talk about pre-planning today. First, when are people most likely to be exposed to hydrogen sulfide? What are some activities that people might be doing when they really need to be on alert?

R. Anthony

Great question, and there's a lot of different activities inside a building or outside working around manure where high hydrogen sulfide concentrations have been known to exist. So, in hog barns, we've known for a long time that if we're going to agitate the manure before we pump it, that when we do that agitation, we want to make sure all of our hogs and people are out of the barn. We know that's a high hazard activity. So, we're putting air in and mixing things up or even mechanically mixing manure to get the solids into the liquid. We are releasing some of that hydrogen sulfide that has been trapped in the liquid, and now has got enough energy that goes into the barn. And so, we've had people inside of a building when this goes on and animals have died, and farmers have died. So, we're pretty good in hog production about making sure people are out of the area during agitation of manure.

This has also happened in a big outside lagoon where agitation has happened, and the temperature was inverted, which means that contaminants don't rise in air like they normally would, but they stay close to the ground. And when you have a temperature inversion- so lots of low-lying fog- a cattle farmer doing agitation of the lagoon had experienced high hydrogen sulfide. So anytime

you're agitating manure that's the number one thing to think about is, do we have good airflow? Am I going to be protected? And we'll talk about a little bit later about monitors so you actually have real-time feedback as to whether you need to move. So, manure agitation is a really dangerous hydrogen sulfide situation.

After you drain a manure storage area, and you want to enter a manure pit that you think is clean, there still may be residual hydrogen sulfide in that. So, we want to treat that as a restricted area. You only go in if you ventilate it and again, have a monitor, or if it's an emergency situation, really, you would go in with a self-contained breathing apparatus, which I know most farmers don't have but emergency responders do have access to so if there's an emergency situation that's again where pre-planning happens.

There are also some other high exposure operations that haven't had lethal outcomes but doing things such as pressure washing does agitate the manure a bit, and in some cases, we have seen some dangerous but really short-term concentrations in the room of hydrogen sulfide. So, it's important to know that anytime we're agitating that manure down below a slotted floor, to really think, "am I walking into a situation where I'm going to release hydrogen sulfide from that manure?"

We've also had a situation in an outdoor above-ground tank, where kids were riding a bicycle around a big man-made structure holding manure and with the wind conditions were such that kids on the back side of the tank got a high dose of hydrogen sulfide, [and it] paralyzed their respiratory system. So working and being around manure without knowing if hydrogen sulfide is present, is pretty dangerous.

K. Crawford

What should folks do? What are your recommendations for people working around manure?

R. Anthony

During manure pumping operations it's always a good idea to have the building or the room, if you're just moving manure out of a room, you want to have ventilation on, so that you have air being pulled across the pit. So, if you've got pit ventilation, turn that on. That doesn't do a good job pulling all the way out of the room air, so open the sidewalls, or if you have long wall ventilation, just turn the ventilation on in order to get fresh air into the building and reduce any concentrations that are generated, while you're doing the at-risk tasks.

And there are some signs that are available to purchase, to put into your barn areas or out by your lagoons that really communicate this manure gas danger. We can give you some links to what those look like, but put them, I recommend, in any area where people would normally access the high-risk manure, storage areas. You could put it on the outside of a building just to remind people not to go into manure pits. But if you've got storage areas outside the main access point where people would walk up to a lagoon or to a storage area, put this "deadly manure gas danger" sign up so that people remember that hydrogen sulfide could be present, and we really don't want kids playing around these areas. And we want to make sure that if we've got people in this area that we've got either a monitor or we've got somebody able to call rescue, if need be.

K. Crawford

We are going to talk more in-depth about gas monitors in our next episode, but can you go ahead and introduce those here? Because I know that's a big recommendation too.

R. Anthony

Yeah, there are some direct reading monitors that are available these days. They used to be over a \$1,000 each. And now you can get a monitor that will clip onto your lapel, and, if properly maintained, will give you a response to let you know hydrogen sulfide is present and what the concentration is, and it'll give you some alarm feedback.

So, if you're doing any manure handling operations, we recommend you get one of these monitors, and you wear it when you're doing pressure washing, if you're inside of a building, getting ready for things that are manure related. And then, if you want to know when it's safe to go back into a building after doing some pumping, then you would also be able to use that monitor to kind of do the all-clear check.

K. Crawford

I want to circle back to the emergency planning we mentioned earlier. Can you talk about the importance of having a plan in place and how to go about doing that?

R. Anthony

So, before you do any of these high-risk activities you do want to put in some pre-planning. So, it's good to sit down and think about what is the work that we're going to do? Who's going to be doing what? And then review hydrogen sulfide hazards. Who's going to have the monitors? How are we going to check out a space? So, if we're pumping out of a building, how do we know it's safe to go back in if we are going into a space that used to have manure that we pumped out? How are we going to check out the space?

We also want to pre-plan emergency scenarios. So, what if somebody goes into a space and passes out? Our first thought has got to be, "there is a pocket of hydrogen sulfide that they have just breathed in." How am I going to rescue them? So, in pre-planning these scenarios, we want to make sure that we don't run in to rescue somebody. Some people will think "I can hold my breath long enough to pull somebody out of the building," and that is not going to happen.

So, if somebody's going into a storage area, we recommend again putting somebody in a harness, tying a lifeline to them, and having enough people or a winch to be able to pull them out to safe air where we can begin resuscitation. One of the things that we really don't want to do, and it's our first impulse to go in, and you know rescue somebody especially if they're a family member, but what you're doing is you're putting yourself in danger.

The only way to safely go into a space when you have seen this happen is to wear a self-contained breathing apparatus. So, if you're going to be doing some high-risk activities and your local volunteer fire department is interested and available to participate and watch and have SCBAs, or you've got somebody trained to wear an SCBA, then this is the time to have it available so that you've pre-planned if somebody goes into the space and there is a problem, this is how we're going to rescue them. But the last thing you want to do is send anybody in. We've had firefighters go into rescue, and they've been knocked down by hydrogen sulfide, so don't think that your body can tolerate these lethal concentrations because they can't.

K. Crawford

Can you explain what an SCBA is? This is a very different kind of respiratory protection than what most people might be using on the farm, right?

R. Anthony

Right. So, with hydrogen sulfide there is no air-purifying respirator that will protect the breather from hydrogen sulfide. So those N95 masks don't do any good. They're great for particles, but they don't prevent hydrogen sulfide from sneaking in with oxygen into the inside of the mask and getting into our respiratory system. There are no chemical cartridges that are allowed to be used for hydrogen sulfide. Those break through pretty quickly. There are some, if you see one, it's for emergency evacuation. For a cartridge for hydrogen sulfide, it truly is, put it in your mouth and run. So, it's not a situation where you can wear one of these things that is going to filter the air and remove hydrogen sulfide.

The only respiratory protection device that is acceptable for this gas is a self-contained breathing apparatus or an SCBA. So that's what the firefighters wear. You've got the mask on and you got the tanks, the bottles of air on your back. Or there's a long line, some of them have an airline respirator, but you have to have your own breathing air supplied in order to work in a highly hazardous hydrogen sulfide concentration.

K. Crawford

So, we've been talking a lot about hydrogen sulfide and the reason that we talk about that is because the effects are acute and lethal. But there's another manure gas compound that's very dangerous, and that's methane. So, we can shift gears a little bit and talk about methane?

R. Anthony

Most of the time methane in a manure pit- it's again part of the natural biological decay process. Methane is generated when bacteria are acting on manure, but in some cases, particularly in the upper Midwest, we have this problem that we lovingly call "foaming manure."

Feel free if you haven't seen it, to just Google that phrase and you'll get some pictures of basically manure pits that has a lot of foam on the top of it and the foam can be feet high. It can come back up through the slats. The problem is, in these foaming manure pits, that foam itself doesn't hold air, it's trapping methane. So, the foam can be 50-70% methane, which is not a problem in that high of a concentration, but if we knock down that foam, then we release that methane into the room, it dilutes and becomes explosive. So, if we knock down the foam on purpose by pressure washing it, that's a problem, putting water on it, even having feed drop onto it, it will break up that foam and release that high concentration of methane that then dilutes into the flammable range, and we're okay as long as we don't have an ignition source, but in an indoor building we do have a lot of ignition sources.

So, if heaters are cycling on and off, that switching may generate a spark that could ignite if that high pocket of methane reaches that device. If we are using a pressure washer and that system has a hot spot on it or sparks that could be an ignition source. If somebody just turns on a light switch and we don't have really good grounding that could generate an ignition.

So, we've had a lot of barns- hasn't happened in a while, but we still do have foaming, and we've had barns explode. We've had people severely injured. We've had a lot of animals perish because of this but we've also lost buildings, because we've had a barn explosion.

So, if the methane is released from the foam into the room, and there's an ignition source, we have a problem. So, we do recommend, and there's a lot of literature out there and guidance on how to pump manure when it's foaming, and you want to not agitate it while the foam is really high. You want it to drop down pretty low before doing this. You want to turn all the electricity off, shut off your LP tanks to the room so that you don't have an explosion source. If we do have an ignition, we want to ventilate that room. We want to keep the ventilation on, so we want it to not cycle on and off. We want to keep it on when we're doing any activities when we're breaking the foam and ventilate that area.

Similar to a hydrogen sulfide monitor, there are methane, or what we call explosion, meters. Those tend to cost a little bit more, because we want to make sure that the device isn't an ignition source if we reach high concentrations of methane. So those devices that have an LEL, which is lower explosive limit, or an explosion meter, you can either get a single monitor or get what we call a 4-gas monitor. So, we've got some information online about 4-gas monitors as well, and it's really if you have an issue with methane.

K. Crawford

Thanks for talking with us Renee. This is a lot of great information, and I will make sure that we provide links to these resources that you mentioned, and we will see you for the next episode when we talk more about these gas monitors. We'll talk about how to use them, how to store them, how to test them. Lots of good information there too.

K. Crawford

Check out the links provided in the episode resources section of our website which include a link to the Great Plains Center's resource page on manure gas hazards. Here you can find out more about these hazards, gas monitors, and tips for emergency pre-planning. And tune in next time when we continue our conversation with Renee and learn more about how to use gas monitors on the farm.

R. Anthony

Visit us at the FarmSafe podcast to learn more about keeping you and your family safe on the farm.

K. Crawford

We want to hear from you. Share your stories about health and safety issues on the farm, about injuries that made you change the way you work, or about the ways you keep yourself and others safe. Also let us know if there's questions you have or topics that you want to hear about on the air. You can visit our website at gpcah.org or email us. Original music for the FarmSafe podcast was written and performed by Ben Schmidt. This work was funded by the Centers for Disease Control and Prevention as part of the National Institute for Occupational Safety and Health's Great Plains Center for Agricultural Health.

Episode Resources

- [GPCAH Manure Gas Safety](#)
- [GPCAH Gas Monitor Training Kit](#)

Photo

