Episode Title: Gas Monitors

Summary: In this episode, we continue our conversation about manure gas hazards. The focus today is on gas monitors that can be used to detect the presence of hydrogen sulfide and methane. Because we cannot sense the presence of hydrogen sulfide or methane at high concentrations, we need to rely on a gas monitor to detect and alert us when we are in danger. Renee Anthony, an industrial hygienist, talks about how to use, store, and bump test these monitors.

"Having a monitor that is giving you those numbers, gives you that additional amount of decision-making ability– it's like this is really dangerous, I'm going to go out, absolutely nobody's going to go in, we've got to ventilate for a little bit longer, figure out what's going on and then we'll recheck the area."

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

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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 continue speaking with Renee Anthony, industrial hygienist, and professor in the Department of Occupational and Environmental Health at the University of Iowa.

In our last episode we talked about hydrogen sulfide and methane, two hazardous manure gases. 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 talked about steps to take to prevent manure gas fatalities including posting signs to make sure everyone recognizes hazardous areas, restricting access, creating an emergency plan, and how to prepare a space for work either through ventilation or shutting off equipment to eliminate spark sources. Renee also mentioned using gas monitors, which is what we are going to focus on today. Because we cannot sense the presence of hydrogen sulfide or methane at high concentrations, we need to rely on a gas monitor to detect and alert us when we are in danger.

Renee, we mentioned these monitors last time but let's get some details about how they work and how they should be used. Let's start with the hydrogen sulfide monitors. First, how do they work?

R. Anthony

Yeah, that's a great question. These monitors use a chemical reaction. So, if it detects hydrogen sulfide, it does that because a molecule of hydrogen sulfide has gotten into the sensor and has a chemical reaction with the material that's in that sensor. That chemical reaction generates a change in voltage and then the signal of voltage is processed into this measurement that gives us a concentration. So, we want to make sure that there's enough–basically–juice in that sensor in order to still read the hydrogen sulfide, and we want to make sure that the voltage that's generated is translated properly into a concentration, so when we know we're safe versus it's a hazardous concentration.

So, what we recommend is just a simple thing called a bump test. You want to buy a container of hydrogen sulfide. So, there's a calibration gas– there's a little aerosol gas. We've got a bunch of tips online that that we'll send your listeners to if they want to get more information. But you basically will put a known concentration of hydrogen sulfide directly onto that sensor. And when you buy a monitor it will have a little cap– don't throw the cap away, because that's what we use to put this little gas puff onto the sensor, and

if we buy a bottle that's 25 parts per million of hydrogen sulfide, we're going to put that– there's a little tube that will come with your kit– you're going to put that tube onto the sensor and you're going to wait till that sensor reads hopefully 25. It may read 26, it may read 24. It may be somewhere close in there and it starts to alarm. So, we're going to check the alarms but we're also checking that sensor.

If you put 25 parts per million gas on and you're only getting 10 parts per million, that means your sensor is starting to fail, and there's not much you can do about it with the more inexpensive, disposable monitors. A more expensive monitor– there's some additional things you can do. But it's basically telling you that your sensor is going to respond a little bit lower than it should. And it may take a while for it to respond, so if it doesn't respond to immediately but if it takes a minute to get to that 25, know that when you're walking into a space, you've been in a concentration for a minute before that reading comes out on the monitor. So, it's really good to do that bump check. If your life depends on this monitor you want to make sure it can still see hydrogen sulfide, and that it responds quickly enough for you to make a decision that it's not safe and I've got to get out of the area.

K. Crawford

How often do you need to bump test?

R. Anthony

You want to bump test it before you put your life on the line with it. So, every time you're going to use it for the day, you do want to put some gas on it, and make sure it's still working today. We do recommend that if you're doing a big pump-out that you go ahead and dig out the monitor and do a bump test about two weeks before your scheduled manure pumping is scheduled. And we say two weeks, because that gives you enough time to assess A) Can you find it? B) Is it working? and C) Do I have to get a new one? And so right now it may be taking a little bit longer to get your hands on these devices. So, you know, maybe two weeks might not be long enough, but give yourself time that if it's not working that you can get your hands on it. So, there may be some folks at extension offices that you could borrow some from. There may be a neighbor that you can rely on it for a pump-out as long as you're not all doing pump-out on the same day.

This equipment would be great to share, not only the equipment, but also the bump gas. Because it can get a little bit costly. It does expire, usually after about 18 months, and the cylinder is going to last you a long time. So, if there's a way to all come together and buy a cylinder and a regulator and then have it available for a bunch of people to share and you know, just do some calibration checks with it especially if you're land-applying manure, it's good to have it when you're doing that as well. So, I think, sharing the equipment, making sure everybody in the community understands that it's available, how to use it, how to interpret alarms would be really helpful for a community.

K. Crawford

You said last time these should be used during manure handling operations, pressure washing, and also for building re-entry after pumping. Can you give some more details on how they should be used in these situations?

R. Anthony

If you're working in the barn and just in the normal area of the barn, so the floor level where the hogs are normally located, or where the cattle may be, you would be wearing that monitor on your lapel. If you wanted to go into a space that had previously had manure, first thing you do want to ventilate it, and so there are some equations that are out there to get the right air exchanges and make sure that fresh air is being pumped into a confined space, so that any gases are drawn out.

But before entering any of those spaces, you can use the same monitor, you want to check the air that's kind of going to be in front of where you're going to walk, so you can clip it onto say, a yard stick or a tool and stick it out and wait for a couple minutes to make sure that the monitor responds– that it's safe to proceed. So, you would, instead of wearing the monitor on your lapel, you would want to either lower it down into a space, if it's below ground, or if you're going into, you know, a door into an area, you would put it on say the end of a stick and put it out in front of you, so you know as you walk into a space. Every 4 feet you want to do a little air check, and I do recommend each monitor takes a little bit of time to actually respond. If you buy a brand-new monitor; it's going to respond really quickly. If it's a little bit older monitor, it's going to be a little bit slower. And so, there are some tests to do before you

start using it to figure out how long it takes for your monitor today to respond to hydrogen sulfide. But you want to check the space out as you would enter into it. So, before your face gets to that level you want to make sure you've checked that.

But remember with hydrogen sulfide, it is what we call heavier than air. So, if you are in a situation where there is no air movement, hydrogen sulfide is going to pool onto the floor, and if you are in a space, you've checked out the air at your head level, but you want to think that down closer to your feet there may be higher concentrations of hydrogen sulfide. So do take that monitor and look down. If you drop something onto the floor, you want to make sure that if you put your face close to the floor that you're not going to breathe in a really high 1,000 parts per million of hydrogen sulfide so anywhere that your head may be in an area, you really want to check to make sure it's okay to breathe that air before you put your face in that zone.

And if you check out an area today, you know, you've pumped it, you ventilated it, you've walked in, you've taken care of everything– if you want to come back and go into that space two days from now, you're going to want to do this testing again, because conditions will change. Anything that may be residual in the bottom of that manure pit may have generated hydrogen sulfide again. So, you want to go through the same procedure that you did initially when you went in. So anytime you go in, you want to do this same monitoring.

K. Crawford

So, after checking out an area, when you're ready to go in, what do you do with the monitor?

R. Anthony

So, if you have one of the hydrogen sulfide monitors, you've checked out a space, you feel good about going in, you're going to put it back on yourself, or you're out in an area and you want to wear it. You want to have it up on your, kind of by your collar bone. Put it up high, as close to your face as possible on your chest. A lot of people will put it down at their belt; that's probably not the best idea to put it down low. I know how hydrogen sulfide, we said, is heavier than air, so it tends to settle down at the floor, but all bets are off when you're in an environment outside and air is moving. So, you really want it to be close to your face because that's where the hazard is. If you get a high puff close to your face that will paralyze your respiratory system, then you want to make sure you know that that is a high concentration right in that breathing zone. So, do wear it close to your collar or up kind of by your seam on your shirt, just to make sure that it's up where your where your breathing air is.

K. Crawford

I know that you take a lot of these monitors to farm shows and fairs, and I'm wondering what kind of questions you get and what kinds of conversations you have with folks about these.

R. Anthony

A lot of times once we explain this, people ask, "which one should I buy?" So, we've actually looked at a lot of different monitors. You got to love farmers. They want stuff to last forever, but it's really important to know that these monitors won't last forever. There's a chemical being used up when you're monitoring. And if you're storing it in your facility, and there's low levels of hydrogen sulfide around or any sulfur, you're going to eat up that sensor. So, we do recommend that you get a monitor that's going to last at least two years. The monitors that we recommend start at about $150. The hibernation case is $15, and it will allow you to expand it to an extra year, so it's well worth the $15 to get a hibernation case.

We do recommend that farmers select a device that reads the concentration. So, there are some devices that will just alarm and say hey, you're in a high concentration, but it's really important, I think, for farmers to say, "am I alarming at 10, or am I alarming at 60?" because the behaviors and the urgency of that behavior does differ when we're at 10 versus when we're at 60. So, it's a $50 increment more to get a number to be read on the device. We've got some examples online for some of the devices that farmers have adopted in the field.

Another question we have gotten from farmers is, what do these numbers mean on the monitor? Most of the time the monitors will max out at 100 parts per million, and different monitors will alarm at different levels. That's how you purchase the monitor. Some of them will alarm at 10 parts per million, some will alarm at 25 parts per million. As long as you know what the alarm is set at and how to behave, that's the key thing.

So, concentrations in the range of 2 to 20 parts per million, if you're working in that for eight hours a day you are going to probably feel a little dizziness, get a little headache, maybe feel a little nauseous. We all react a little bit differently. So, most of the monitors will alarm at the 10, 20, 25 parts per million range.

But a lot of farmers say, “well, I’m going to work through that, because I got work to get done.” That is your decision. We do recommend that you don't live in those concentrations long term. But when the concentration starts to get higher than 20 parts per million, it could be rising really fast, and at 1,000 parts per million, it is nearly instantaneous death. So, our monitors don't typically even go that high; they typically stop at 100 parts per million. But between 50 and 100 parts per million, somebody's going to start developing altered breathing.

So, we're going to have problems breathing and we really want to make sure that we're getting out of the wind. If it's a windy situation, and hydrogen sulfide is directed for us, and our alarm starts to monitor, we’re going to move out of the way when we get something over 20 parts per million, because what happens if we're pumping manure and/or agitating manure and we are directly downwind from a high puff, our alarm will go off, and we just need to move to the side to get out of that wind. That's how we use one of these monitors every day when we're doing these high-risk activities.

K. Crawford

This sounds really important, and I just want to make sure it’s clear. The importance of having actual numbers on your readout is because if your monitor is set to alarm at 10ppm and you walk into an atmosphere with 100ppm, the alarm will go off– but without the actual numbers, you won’t know if the atmosphere is 10ppm or 100ppm, right? You just know it’s at least 10ppm, but you would be in a lot of trouble if it was really high.

R. Anthony

Right. Yeah, I won’t know if it’s something that is going to knock me down or if it’s something that is going to give me a headache, so you really need to know what the alarm is set at and if it’s at 10 parts per million. We do recommend you look at where [the hydrogen sulfide is] and ventilate better and reduce that concentration. Because we don’t want workers in a concentration of 10 parts per million all day, because they will get headaches. But some transient exposures, most farmers are more comfortable with doing, and we’ve had these conversations, you know, in tents with folks.

And so, most of these monitors are going to alarm 10 up to a 100. Once it gets to 100 parts per million it’s still going to alarm, but it’s going to blink and say 100. We don’t know if we’re at a 100 or at 500 or 1,000 when we get to that 100 so 100 doesn’t just mean 100. It could be you’re really at an emergency situation when you’re getting there. And the reason we want people to respond and move out of an area and not proceed, not stay in there a long time because it could go from 10 to a 100, you know, pretty quickly. So, if you see it, go from 10 to 20 to 30, you need to get out. And so having a monitor that is giving you those numbers, gives you that additional amount of decision–making ability–it’s like “this is really dangerous, I’m going to go out, absolutely nobody’s going to go in, we’ve got to ventilate for a little bit longer, figure out what’s going on and then we’ll recheck out the area.” And if you’re doing pumping, it’s like, “Okay, the wind has changed and I’m now downwind. I need to move, and I got to get everybody to move.”

And remember it also lets you know when you can go back in. So, you wouldn’t want to bring people back in if it’s still alarming at 10 because if you ventilate it for another 15-20 minutes, it’ll drop down below that alarm level. So, you can use the monitor to actually manage your business as well as your safety.

K. Crawford

And once you start ventilating, the monitor is going to stop alarming once you get down below that level?

R. Anthony

Absolutely. Most monitors will stop alarming. Some of them have a feature and just have a look at the manual that you buy– there [are] a couple of buttons on it you can push, and it’ll say what your highest concentration was during any event. But it’ll stop alarming and then store a little bit of information in there that you can check out as soon as you get out of the alarming situation.

K. Crawford

What can you tell us about storage and maintenance for these monitors?

R. Anthony

When storing one of these gas monitors it's always good to store it in an area that doesn't have any of these contaminants in in the air. So, a lot of people will buy an H2S monitor and then store it in the barn. If you've got another place that's temperature controlled, that doesn't have a lot of, or potential background for, hydrogen sulfide, we do recommend storing it a cleaner environment. If you've got an office something like that. So, if it has a hibernation case, store it in a case, but also you could put it in a plastic bag or a plastic tote bin that will keep it protected out of moisture and contaminants. You just want to protect the lifespan of this device for as long as possible.

Also, these devices, some of them come with batteries. Some of them are just– you turn them on, and they die in 2 years. Farmers really want to have the batteries, because they think it will last for a long time. But what we have found when we tested them is once the unit starts to alarm, the batteries, get eaten up really quickly, and then the response to hydrogen sulfide later in the day changes. So, we do recommend these non-rechargeable types of devices that run at about a $150.

K. Crawford

Last time we also talked about methane, and you mentioned that for methane, you need to use an explosion meter, a gas monitoring device with an LEL, or lower explosive limit. They check for combustible gas with the LEL and also check for oxygen, carbon monoxide and hydrogen sulfide. Can you talk a little about those?

So, there are some now about $600 4-gas monitors that you turn them on, and they're good for 2 years. But you still need to test the sensors and make sure they're seeing things that they're supposed to be seeing. And it's really if you have an issue with methane, then you probably want to go ahead and get a 4-gas monitor, so you can check for oxygen content. If oxygen is good, then you can trust the explosive reading. If there's not enough oxygen, then we've got other problems in the room. And then once the LEL is okay, then you could go ahead and check your hydrogen sulfide, or you could use this also in a grain bin and look for carbon monoxide– make sure we don't have anything being generated from burnt out pumps, those sorts of things. So, we've got some additional information for folks to look at getting a 4-gas monitor if they have a little more extravagant things going on with their manure.

K. Crawford

As we wrap up, any other thoughts you want to share on this topic?

I recommend the farming community that is doing a lot of work with manure, either storage or pumping or land-applying, really figure out where in that community where equipment, shared equipment, including the calibration gas, could be available. It could be at a county extension office, but that may be too far for some folks. If there's a local emergency response or your volunteer fire department, you know they've got monitors where they'll come to your house to look for a gas leak. So, they kind of are familiar with these devices. It's a different gas for hydrogen sulfide but having equipment there where farmers can come and interact with one another and make sure that they're comfortable with these monitors and share the equipment, especially the calibration gas, would be good. But right now, there is no central repository. So, if you guys are out there and have set up something great, let us know. Share it. Give us some comments, what's working, what's not working. We've been trying to get people to adopt this technology, which has been used in oil and gas, and pulp and paper for a very long time, such that the prices have come down phenomenally low that it should just be part of a toolkit on a farm if you have any livestock with manure handling requirements.

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 and a link to a toolkit with train-the-trainer materials.

R. Anthony

Visit us at the FarmSafe podcast to join in on the conversation about keeping 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