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Manure - What Makes it Stink?

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The problem of odors from manure on farms has been around for a long time. But in recent years there have been an increasing number of complaints about odors emanating from animal producing farms. There are a number of reasons for this; one is that as livestock operations become larger the odor problems have also increased. Another reason in populous states like Michigan is urban sprawl. As people move into rural areas there have been an increasing number of complaints.

Many things have been tried to reduce odor problems on farms including injecting manure, altering the diet feed to the animals and various attempts to treat the odors. It is difficult to assess the effectiveness of these measures because the measurement of odor is subjective. It is also quite expensive to make good odor measurements, as trained panelists are needed to do this work. Another way that we can measure the effectiveness of measures to control odors is to measure the concentration of odorous compounds in the air in and around the farm. By doing this we can determine if we have been able to reduce concentration of the odorous compounds present.

Past research has established the types of odorous compounds that are present in manure. These compounds include: sulfur containing compounds, such as hydrogen sulfide and methyl mercaptan; nitrogen containing compounds, such as ammonia, organic amines and indoles, phenols and fatty acids. Not all these compounds may contribute to livestock odors. For example, ammonia is emitted from manure, but the concentration of ammonia in the air around livestock facilities rarely exceeds its odor threshold (the concentration at which it the odor can be detected by an average person).

Gas-chromatograph used to analyze the samples

At the Department of Agricultural Engineering we have been developing the methods to measure the concentration of odorous compounds in swine housing facilities. While measuring the concentration of some of the odorous compounds, such as hydrogen sulfide or ammonia is relatively easy, it is very difficult to measure the concentration of some odorous compounds. The reasons for this are two fold: firstly, the odor threshold of some compounds is very low, for example, indole can be detected at concentrations of less than 1 part per billion. If a granule of indole about the size of a grain of fine sand was dispersed into a large barn it would create an odor. The other reason it is difficult to measure the concentration of odorants is that there are hundreds of compounds present in the air only a handful of these compounds contribute to the odor. Looking for the odorous compounds is like looking for the "needle in the haystack".

To do this we use a sophisticated analytical instrument called a gas chromatograph-mass spectrometer, GC-MS. The gas chromatograph separates the compounds. The mass spectrometer identifies the compounds present in the air. Even though this GC-MS is very sensitive we need to concentrate the compounds present in the air. To do this we use two techniques. One uses a sorbent tube, which is a tube that contains a powder that sorbs (soaks up) the compounds present in the air. These compounds can then be removed from the sorbent by heating it. The second technique, solid phase micro-extraction, or SPME for short, is also based on sorption. However, in this case the sorbent is coated on a glass fiber. Because there is very little sorbent on the fiber it only removes those compounds that are strongly sorbed. We found that we cannot use the sorbent tube for these compounds, as they are strongly sorbed onto the powder in the tube that we cannot get them off.

Examining the mass spectra of a compound found in livestock air

Using the analytical techniques developed we can gain insight into processes occurring during treatment. For example, in other studiesconducted at MSU it has been found that comparatively low doses of ozone can reduce intensity and offensiveness of odors from swine manure. After ozone treatment, the manure still smells, but the odor was not as strong or offensive. By analyzing the manure it was found that the ozone destroyed most of hydrogen sulfide and phenolic and indolic compounds present. Very little of the ammonia or fatty acids present were destroyed. This makes sense, as the hydrogen sulfide and phenolic and indolic compounds are extremely reactive with ozone, whereas ammonia and the fatty acids are not. By doing the chemical analyses we able to confirm this and to come up with a way to monitor the reduction in the concentration of odorous compounds, so we optimize the ozone dose needed.