New tech removes air pollutants, may reduce energy use in animal ag facilities

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Researchers from North Carolina State University and West Virginia University have developed a new technology that can reduce air pollutant emissions from some chicken and swine barns, and also reduce their energy use by recovering and possibly generating heat.

Specifically, the research team designed, built, and evaluated a proof-of-concept unit that incorporates a biofilter and a heat exchanger to reduce ammonia emissions from livestock barns, while also tempering – or heating up – the fresh air that is pumped into the barns.

The pollution removal component utilizes a biofiltration mechanism, in which polluted air is passed through an organic medium, such as compost or wood chips, that contains bacteria. Those bacteria interact with the pollutants and break them down into harmless or less harmful constituents. Biofiltration also allows recycling of nitrogen because when the "spent" medium is applied on cropland, the nitrogen becomes available to the crops. However, biofiltration also introduces additional costs for animal agriculture operations. The researchers hope to defray those costs by reducing an operation's energy consumption.

Here's how their prototype works: warm, polluted air from the livestock facility enters the biofilter, and some of the heat is transferred to the heat exchanger. When fresh air from outside is pumped into the building, it passes over the heat exchanger, warming it up.

The prototype not only helps recover heat from the facility, it also

produces its own heat. This heat is generated within the biofilter when heat-producing biochemical reactions occur – for example, when the ammonia is converted into nitrate by bacteria. The heat from the biofilter is also routed to the heat exchanger.

Maintaining the appropriately high temperature is important for chicken and swine operations, because it is essential for rearing chicks and piglets to maturity.

"The technology is best suited for use when an operation wants to vent a facility that has high ammonia concentrations, and pump in cleaner air in preparation for a fresh batch of chicks or piglets – particularly in cold weather. It is also suitable for use when supplemental heat is required for raising the young animals," says Dr. Sanjay Shah, an associate professor of biological and agricultural engineering at NC State and lead author of a paper describing the research. For this to be feasible, it would be necessary to replace a couple of the conventional cold weather ventilation fans with higher-pressure fans. Shah explains that the technology is not compatible with summer ventilation using tunnel-fans, because of the high cost and choking effect on the fans.

Shah says the researchers focused on ammonia removal because: it is released from chicken and swine houses in large quantities; it contributes to nutrient loading problems such as hypoxia; it is an indirect contributor to greenhouse gases (GHGs) because it can break down in to the potent GHG nitrous oxide in the ground; and because it is a precursor to very fine particulate matter, which contributes to haze and public health problems, such as asthma.

Researchers showed that their design is effective under real-world conditions, operating their prototype in a 5,000-bird chicken house. The prototype removed up to 79 percent of ammonia and reduced the energy needed to maintain the necessary temperature in the facility – recovering

as much as 8.3 kilowatts of heat.

"We plan to continue working to improve the system design in order to make it even more efficient," Shah says.

More information: The paper, "Coupled Biofilter – Heat Exchanger Prototype for a Broiler House," is published in the December issue of *Applied Engineering in Agriculture.*

Provided by North Carolina State University