impact

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Zeolite filter reduces ammonia and odor emissions from dairy manure flush pit

AT A GLANCE

Reducing ammonia and odor emissions are among the most beneficial steps dairy producers can take to minimize dairy operations' air quality impacts and improve community perceptions.

The Situation

Ammonia emissions and odors are two significant concerns related to dairy production and air quality in Idaho, where confined livestock production is highly developed. If not controlled, ammonia emissions can be a local and regional issue. Ammonia deposits in soils and water bodies generate an excess of nitrogen in natural environments. In most cases, the nitrogen stimulates the growth of invasive species in soils and eutrophication processes in water bodies. Ammonia can also contribute to soil acidification and greenhouse gas emissions through soil nitrification processes. The atmospheric reaction of ammonia with volatile organic compounds from vehicles and urban areas generate particulate matter (PM 2.5), an important low-level atmospheric contaminant that can affect the health of people and animals. Odors are usually the single most cited issue in conflicts between livestock facilities and neighbors or communities.

Our Response

The University of Idaho Extension educator in Gooding County teamed up with Extension specialists, a zeolite mining and processing company, and a dairy producer and obtained an Idaho USDA-NRCS Conservation Innovation Grant (CIG). A research and demonstration filter was designed and built by the author and installed at a dairy in the Magic Valley, Idaho. A cover structure was built to capture air from a pit receiving manure from a flush system. A fan extracted the air over the pit, and the fan speed was regulated according to pit wastewater level. The pit received flushed manure from two dairies totaling 4,800 cows. The pilot filter media consisted of clinoptilolite zeolite; a crystalline structure mineral mined in southern Idaho. The filter was designed to test different media if needed, be able to take diverse samples, and serve as a demonstration unit for people to understand its internal design and working principles.

Filter front view, connecting pipe and plenum. Front doors facilitate access, exhaust (bottom); capturing structure (left).

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Program Outcomes

At maximum capacity, the filter reduced 92 percent of ammonia emissions. As expected, emission reduction decreased over time, with a 43 percent reduction achieved after 60 days of operation of the small pilot filter. Odor concentration was reduced 45 percent in less than one second of residence time when the blower was at maximum speed. These values demonstrate a high capacity of ammonia and odor reduction from the clinoptilolite zeolite media. The capturing structure and pilot filter were able to withstand on-farm dairy operations and rigor. Filter design can be upscaled to increase media half-life or handle higher loads. Filters can be used on any covered or enclosed structure where air can be redirected through the filter, including manure collection pits, covered lagoons and enclosed barns, such as cross-ventilated dairy barns.

This technology adds an important new tool for the dairy producers' manure management toolbox. Incorporating zeolite filtration technology as developed in this study could help producers to achieve compliance on ammonia and odor emissions, reduce their environmental impact, avoid fines and improve community relationships.

Two field days were offered to demonstrate the technology and results to producers, state and federal agencies personnel, the press and the public. Research results are presented through refereed journals and a Ph.D. dissertation. The author is working on incorporating this technology as one of the recognized NRCS and Idaho Department of Environmental Quality tools for environmental livestock management.

The Future

The test-bed pilot filter and pit cover remain at the dairy. With new funding, different zeolite size or combination of clinoptilolite and other media can be tested. Other tests can be performed using the air capturing structure, including air scrubbing, biofiltration and other methods of air purification. Recovery of the nitrogen captured by clinoptilolite or other media can be assessed.

Cooperators and Co-Sponsors

This project was made possible thanks to a USDA Idaho NRCS Conservation Innovation Grant, award #68-0211-11-047. Additional funding for personnel was obtained through University of Idaho Extension internships. A key part of this study was the participation of the dairy farm. The support, participation, patience and trust, of the dairy producer and their employees, made this on-farm research project successful. IDA-ORE Zeolite company provided the clinoptilolite used in the study. Thanks to Kimberly USDA-ARS for the loan of the Ogawa samplers and ammonia lab analysis.

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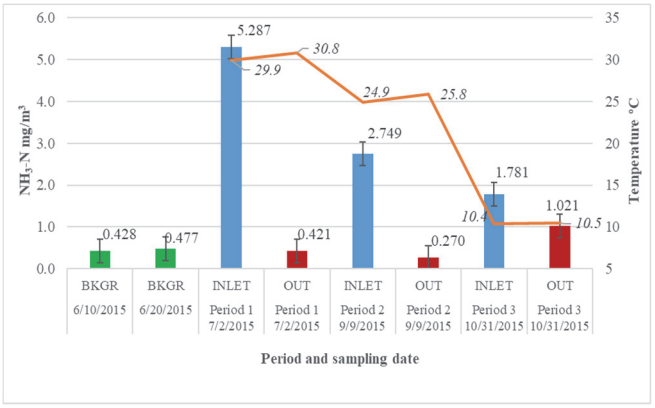
Cooperators: Swager Farms. Ida-Ore, Zeolite Company.



Ammonia concentration before and after treatment in the filter, the average temperature at the filter inlet and inside.

FOR MORE INFORMATION

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