

Effects of Waste Management Techniques to Reduce Dairy Emissions from Freestall Housing

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Species: Dairy Cows
Use Area: Animal Housing
Technology Category: Management
Air Mitigated Pollutants: Volatile Organic Compounds, Methanol and Ethanol

Description:

Commercial dairies are a source of air pollutants and are increasingly regulated at the federal, state, and regional level. Current regulatory estimates state that dairies produce more smog-forming volatile organic compounds (VOCs) than passenger vehicles; however, there is little data on VOC emissions emitted from dairies. Initial research conducted by Rabaud et al. (2003) identified 35 VOCs from a small California dairy and suggested that alcohols were the main compound group, which was confirmed through our investigations. However, due to the complex sources of air emissions from dairies, additional research is needed to fully quantify VOC and GHG sources and to develop effective control strategies (ARB, 2006).

Dairies have multiple emission sources, including freestall barns, feeding surfaces, silage piles, fresh waste, and manure storage ponds (EPA, 2007). Recent dairy emission research in our lab has identified alcohols (methanol and ethanol) as the major VOC group originating from silage and fresh waste (Shaw et al., 2007; Sun et al., 2008). Enhancing industry typical freestall waste management techniques such as flushing and scraping, may provide an effective yet low cost VOC emissions mitigation technique. Large commercial California dairies typically house high producing lactating cows in freestall barns. Freestall barn waste is either removed by flushing with recycled lagoon water or by scraping using a waterless method and later left to dry, to be used as bedding material or land applied as fertilizer. Many VOCs (e.g., the alcohols methanol, MeOH, and ethanol, EtOH), are produced by microbes during anaerobic fermentation in the cow's rumen. Similar microbial strains are also present in fresh waste, where they continue to ferment carbohydrates. The objective of the present mitigation technique is to improve typical freestall waste removal mitigation strategies for VOC emissions from dairies.

Mitigation Mechanism:

The flushing system is typically found on modern dairies and requires a system that pumps recycled lagoon water through the freestall barn where it collects fresh waste that is then transported back into the lagoon (EPA, 2007). Lab bench studies in our laboratory have shown that alcohols (MeOH and EtOH), which are known to be water-soluble, are effectively trapped in flush water and further downstream (i.e. in the lagoon) they are decomposed to CO₂ and CH₄. Thus, the water solubility of the alcohols may explain the great reductions that we have seen in studies that compare flushing with scraping systems. Scraping requires the use of scraping equipment (such as tractors with scraping blades) to remove the manure into waste storage facilities (EPA, 2007). Since scraping can leave a thin slurry film behind, there is still the potential for alcohols to be transferred into the atmosphere from the residual slurry film.

Applicability:

Large commercial California dairies typically house high producing lactating cows in freestall barns. These barns have a concrete ground, which provide the best means for removing large amounts of waste, whether by scraping or flushing. Our research has shown that flushing is more effective than scraping in reducing MeOH and EtOH emissions from barns. Flushing three times daily versus scraping three times daily yields an emission reduction efficiency of 50% for both MeOH and EtOH. Furthermore, flushing frequency by itself significantly reduces emissions. A comparison of 3 times versus 6 times flushing daily showed decreased emissions by 79% for MeOH and 63% for EtOH.

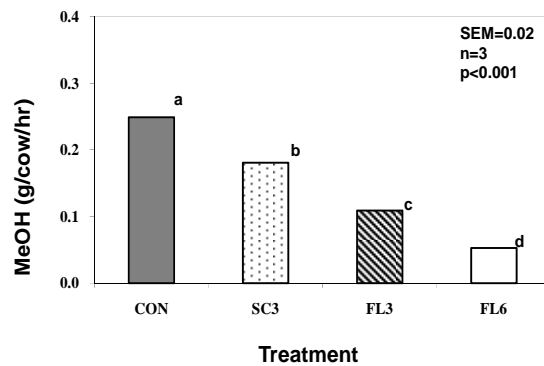


Figure 1. Effects of freestall waste management techniques on methanol emissions. (CON-Control; SC3-Scraping 3XDay; FL3-Flush 3XDay; FL6- Flush 6XDay)

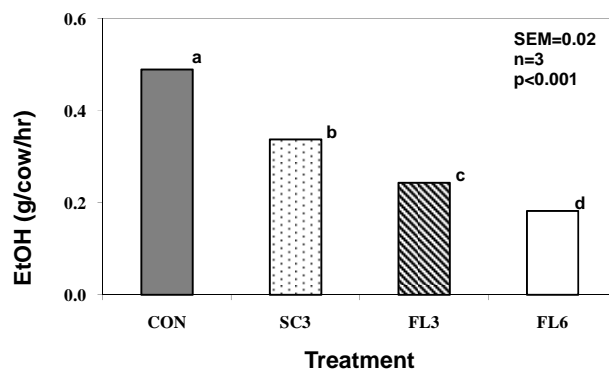


Figure 2. Effects of Freestall waste management techniques on ethanol emissions. (CON-Control; SC3-Scraping 3XDay; FL3-Flush 3XDay; FL6- Flush 6XDay)

Limitations:

Scraping leaves a thin film of residual waste on the concrete freestall floor. This film has the potential for alcohols to be transferred into the air.

Cost:

There is no cost associated with increasing the flushing frequency of a liquid manure handling system. Essentially, flushing frequency is increased, while the amount of water used for each flush is decreased. Since the water used to flush barns is recycled water from the lagoons, there is no cost to re-circulate lagoon water through the barn alleys.

Implementation:

Flush dairies can increase flushing intervals by adjusting the valves.

Technology Summary:

Typical dairy freestall waste management includes flushing and/or scraping. Enhancing waste management may provide a large impact on dairy VOC emissions (MeOH and EtOH) at a cost effective rate. Flushing versus scraping is approximately twice as effective in reducing VOC emissions under freestall conditions. More frequent flushing of dairy waste leads to further reduction of VOC emissions.

Additional Resources:

Air Resources Board Agriculture/District activities: <http://www.arb.ca.gov/ag/districtact.htm>.

Acknowledgments:

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