The Effects of Acidifier Application In Reducing Emissions from Dairy Corrals

K. Stackhouse[1], J. McGarvey[2], Y. Pan[1], Y. Zhao[1], and F. Mitloehner[1]
[1]University of California, Davis, [2]USDA-ARS, Albany, CA

Species: Dairy
Use Area: Animal Housing
Technology Category: Chemical amendment
Air Mitigated Pollutants: Methanol, Ethanol

Description:

Methanol and ethanol are produced during anaerobic fermentation in the cow's rumen by microbial strains like *Streptococcus bovis* and *Ruminococcus albus.* Fresh slurry contains both of these alcohols and many volatile organic compounds (VOC) forming bacteria. Environmental drivers such as pH, temperature, and oxygenation of the slurry affect both microbial and physical processes that determine which alcohols are produced, metabolized by bacteria, and transferred from liquid to gas phase. Therefore, mitigation must address at least one of the main environmental drivers (e.g., pH) to effectively disrupt microbial and enzymatic activity and reduce gas release into the atmosphere (Jongebreur and Monteny, 2001).

Sodium bisulfate (NaHSO4, SBS) is a dry, granular acid salt that has been extensively used for many years as a pH reducer in a variety of agricultural applications (Sweeney et al., 1996; Sweeney et al., 2000). It is also used in the dairy industry to reduce ammonia emissions and bacterial counts in bedding, prevent environmental mastitis, and calf respiratory stress.

Streptococcus bovis bacteria does not grow in the presence of elevated sodium concentrations (5-6%) and there is a cessation of *Rumenococcus albus* growth at a pH of 6.0 or below, so the application of acidifying SBS could conceivably reduce the growth and survival of these alcohol-producing organisms (Schlegel et al., 2003; Thurston et al., 1993). Alcohol, amine, and ammonia losses from freshly excreted manures to the atmosphere occur very rapidly and effective mitigation needs to be implemented shortly after excretion (Meisinger et al., 2001). Acidification of manure slurry has also been suggested in the literature (Meisinger et al., 2001; Clemens et al., 2002).

ParlorPal (SBS, Jones-Hamilton Co.) is used for controlling ammonia and VOC emissions in animal stalls and animal production facilities and can be applied to dairy drylot corrals with tractor driven fertilizer spreaders or by hand application
In addition to reducing VOC emissions from the facility, it can be used to reduce flies population on dairies.

Mitigation Mechanism:

Sodium Bisulfate is a hygroscopic mineral acid salt and as ambient moisture is adsorbed into the SBS bead. The component dissociates into its sodium (Na^+), hydrogen (H^+), and sulfate ($SO4^-$) ions upon application to the manure, bedding or drylot surface. The hydrogen ion reduces the pH to a level that is not consistent with propagation of bacteria associated with VOCs production.

The reduction in pH reduces bacterial populations by 3-5 logs including reductions in coliforms, salmonella, clostridium, and campylobacter Sodium bisulfate is approved by the FDA for animal and human food use and by the EPA as a surface amendment for ammonia reduction and general bacterial reduction.

Applicability:

Emission studies conducted in our lab have identified alcohols (methanol and ethanol) as the major VOC group originating from fresh waste and fermented feedstuffs (Shaw et al., 2007; Sun et al., 2008).. Effective control of alcohol emissions could help meeting regulatory standards, satisfy public concerns, and improve local and regional air quality.

The present study was conducted at the University of California, Davis. In earlier study, SBS has been shown to be effective in the mitigation of ammonia and alcohols emissions from fresh dairy slurry (Sun et al., 2008). Therefore, SBS effectiveness was investigated under drylot corral conditions in a large scale study. A total 128 dry Holstein non-lactating cows were sorted into groups of eight cows and were housed in totally enclosed dirt-floored corral pen enclosures. This study focused on application rates under production-like conditions.

SBS application was effective at mitigating methanol (MeOH) and ethanol (EtOH) from dairy drylot corrals (Figures 1 and 2). The mitigation also offers a potential solution to MeOH and EtOH emission reduction in dairy exercise pens.

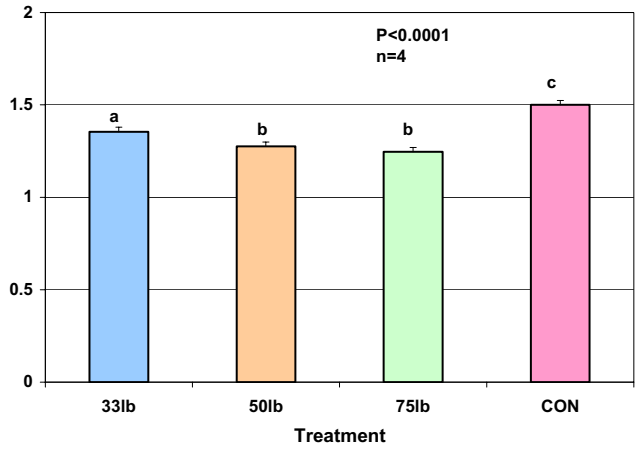

Figure 1. Effect of treatment on methanol emissions

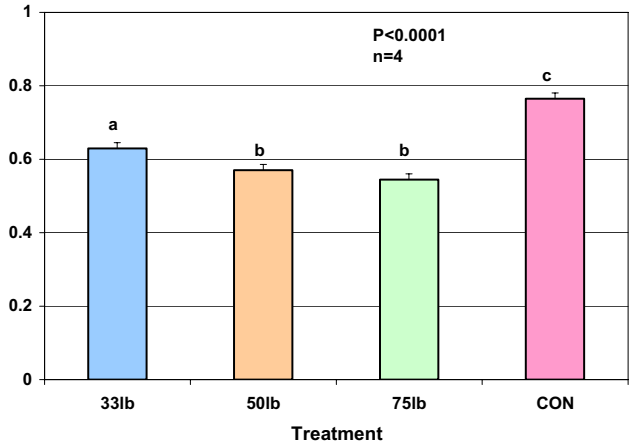

Figure 2. Effect of treatment on ethanol emissions

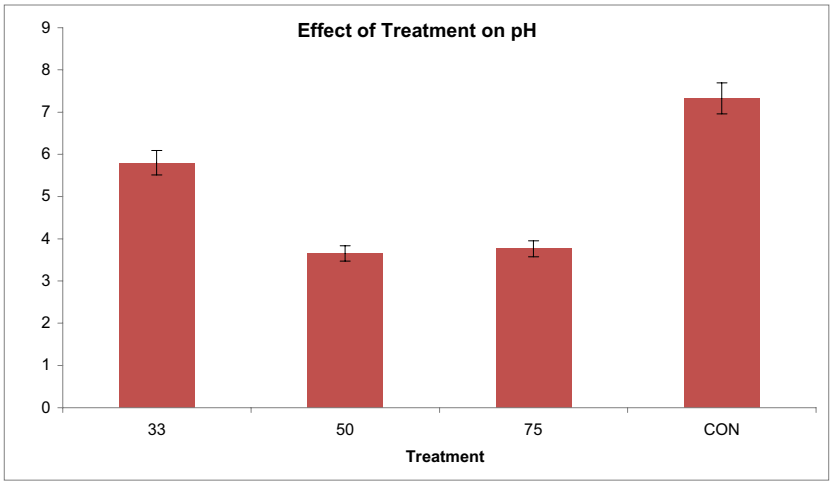

Figure 3. Effect of treatment on pH

We found that SBS is most effective at an application rate of 50 lbs over 1000 ft^2 at three times a week application or 75 lbs applied over 1000 ft^2 twice a week. At the application rate, SBS was only used around feed bunks and water troughs and at apparent manure accumulation spots. This application rate reduced emissions of methanol and ethanol most effectively (see figures 1 and 2) with out causing formation of other emissions. Sodium bisulfate can be applied while animals are present in the pen. This research has demonstrated reductions of methanol and ethanol of 27% and 17%, respectively.

SBS also offers a potential in reducing certain pathogens and fly larvae due to the acidic environment induced by the application. This reduction in pH (see figure 3) caused by SBS application could reduce pathogen loads in animal housing areas as well as reduce fly populations on the dairy. This could potentially reduce disease prevalence in the herd and improve animal welfare.

Limitations:

Sodium bisulfate is a mineral acid salt. Appropriate measures, as defined by the chemical supplier, should be used during the handling of SBS.

In locations that are sensitive to salt or areas with existing high salt loading in soils, applications of SBS should be considered with care because sodium is one of its components. Application at high rates could cause formation of nitrous oxide.

In addition, SBS must be applied consistently to manure to maintain constant emission reduction as the substance looses its effectiveness over time.

Cost:

Bulk cost of product delivered to the farm is $660.00/ ton. Application at 50 to 75 lb / 1000 ft^2 2X / week equates to costs of between $33.00 to $49.50 / 1000 ft^2 / week. Treatment of heavy use areas, approximately 30% of the total pen area, reduces total pen cost by 70%. Cost / cow assuming 4 cows / 1000 ft^2 of pen area would be $2.48 to $3.71 / week treating only the heavy use areas.

Implementation:

There are no special requirements to implement this program. A fertilizer type spreader is required.

Technology Summary:

Sodium bisulfate application is an acidifier method that can effectively mitigate alcohol (methanol and ethanol) emissions from dairy slurry.

Additional Resources:

http://www.jones-hamilton.com/products.html

Acknowledgments:

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Point of Contact:

Frank Mitloehner, PhD
University of California, Davis
Department of Animal Science
Meyer Hall, One shields Avenue
Davis, CA, 95616
USA
530-752-3936
fmmitloehner@ucdavis.edu

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