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Reducing emissions by applying pH-lowering slurry covering material

Gas emissions from slurry stores can be reduced by covering the material. Another possibility for reducing emissions is by lowering slurry pH, either by adding acids or by adding substrates that themselves encourage the production of more acid in the slurry. The aim here was effective reduction of emissions through a combination of slurry store cover and pH reduction. Small amounts of covering material and acids or substrate should lead to an effective reduction of ammonia, methane and dinitrogen monoxide emissions as well as of odours.

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Keywords

Emission reduction, slurry cover, slurry acidification, lactic acid

Floating covers of straw, granulates or plastic sheeting or else solid covers of plastic, concrete or timber are used for reducing emissions from slurry stores. Above all, these applications reduce odour and the emission of ammonia. According to current knowledge such covers can, however, lead to an increase in methane and/or dinitrogen monoxide emissions [1, 2].

Investigations into reducing the pH of cattle and pig slurry with lactic acid have shown that this approach largely stops emissions of all three mentioned gases, although no reduction in odour production could be achieved [3].

The combination of covering the slurry and reducing its pH was aimed at decreasing ammonia, methane and dinitrogen monoxide emissions as well as odour production. In addition to increasing efficacy this approach was expected to reduce material input through the covering material acting also as carrier for the acid or the substrate promoting acid production. This approach also ensured that the pH reduction be limited to the surface of the slurry, the location of the emissions.

There are two ways to reduce the pH: one, through adding lactic acid to the slurry or, two: by including substrates such as sugar or starch which then serve as basic nutrition for the lactic acid producing bacteria in the slurry and thus encourage lactic acid fermentation in the material [4]. Recorded in the following are first results from investigations into the first-mentioned possibility.

Materials and methods

The investigations took place on a laboratory scale with storage containers each holding 75 l of pig slurry. The dry matter (dm) content of the slurry lay between 6 and 9%. Used as covering material in the trials was Pegülit® perlit, either in its standard commercially available form, i.e. without any supplementation, or with lactic acid added. The applied lactic acid amount was measured to represent 2 vol. % of the amount of slurry, i.e. 1.5 litres of 50% acid. Other containers with slurry had 4 vol. % (3 l) of 50% lactic acid added. Untreated slurry in containers served as controls.

The slurry storage was in open containers over a period of 31 days. During gas measurements the containers were closed and aerated in a defined way (open chamber). The following parameters were determined:

- dry matter, ammonia and total nitrogen contents of the slurry at the beginning, and end as well as in-part during the mixing operation during storage
- concentration of the gases ammonia, dinitrogen monoxide and methane in the exhaust air from the storage containers
- slurry temperature
- slurry pH
- odour threshold of exhaust air from the slurry containers
- sedimentation behaviour of the slurry.

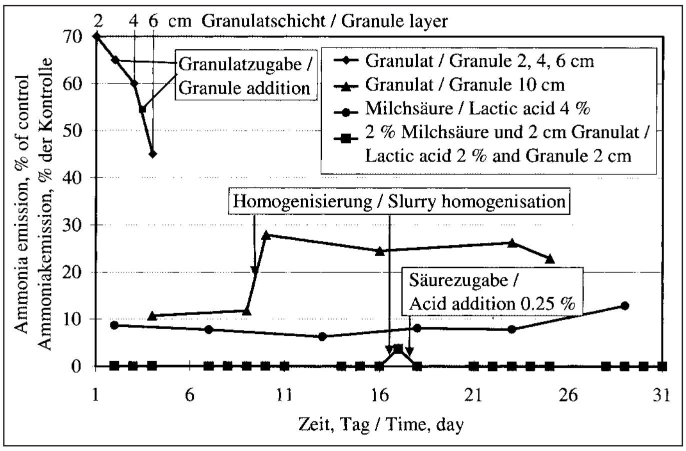

Fig. 1: The effects of different reduction measures on ammonia emissions.

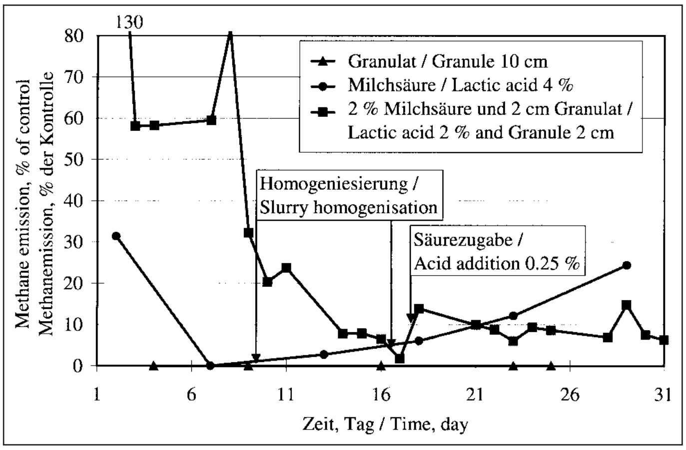

Fig. 2: Effects of different reduction measures on methane emissions

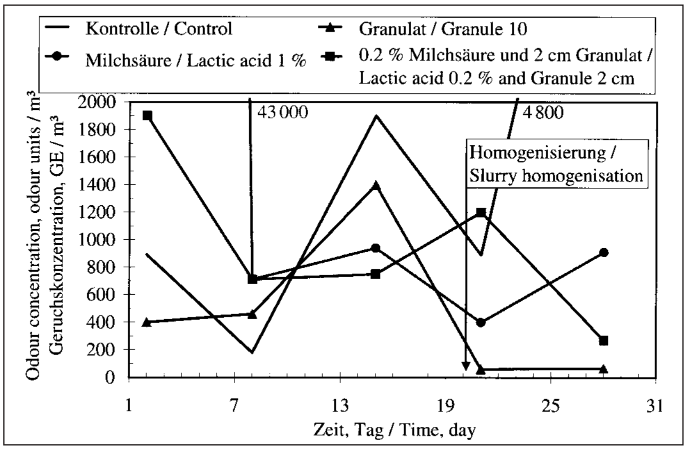

Fig. 3: Odour concentrations above differently covered or acidified pig slurry

Results

Ammonia emissions

Where Pegülit® was used for covering the slurry, a 10 cm thick layer is recommended. Layer thicknesses of 2, 4 or 6 cm proved to give insufficient emission reduction (*fig. 1*).

The 10 cm thick perlit cover initially resulted in a 90% reduction in ammonia emissions compared with control. Whilst homogenisation of the slurry led to a reduction in efficacy, it was expected that emissions would again be reduced if the storage period was prolonged.

Ammonia emission reductions through addition of 4% lactic acid depended on slurry pH and temperature. The pH was up to 23. day of trials around 5.2 rising to 5.4 at the end of the trials with temperature increasing at the same time from 13 to 17° C. Earlier investigations had shown that for effective reduction of ammonia emissions the pH value should not exceed 4.5 [3].

The combination of perlit with lactic acid at first completely stopped ammonia emissions. Only immediately following homogenisation were limited values recorded. A subsequent addition of 0.25% lactic acid was, however, not really necessary.

Methane emissions

The 10 cm thick perlit layer in these investigations completely stopped methane emissions (*fig. 2*). The pH reduction through applying 4% lactic acid reached full efficacy only after a few days. With the rise in pH there was also an increase in methane emissions recorded. From the earlier investigations already mentioned it is known that pH 5 represents the upper limit for effective emission control in this context. Completely stopping methane emissions required a pH of 4.5 and under [3].

With the combination of covering and application of lactic acid the methane emissions dropped to around 20% of the control slurry only after 10 days. Here it must be noted that methane emissions from the control slurry was very low for the first days. Subsequently, efficacy of the cover/acid combination increased and methane emissions reduced to under 10% of the control slurry. The addition of acid on day 17 of the trial led to a temporary increase in emissions.

No *dinitrogen monoxide* emissions occurred during the investigations.

Odour emissions

The 10 cm thick perlit cover also reduced odour emissions (fig. 3). However, the investigations did not allow exact quantification. In earlier practical trials odour reductions of ~ 90% were determined [5].

Adding lactic acid to the slurry altered the type of smell, although actual odour reduction through this has so far not been established. The extremely high value on day 2 of the trials could be attributed to the high amount of chemical activity immediately after acid addition.

There are also no absolute results in odour emissions available from the combined cover/acid investigations. If one accepts that the higher values at the beginning of the trials were through the increased initial chemical activity caused by the lactic acid application, then a reduction in odour emissions is to be expected.

After homogenisation of the slurry odour emissions were reduced, with the exception of the combined perlit/acid treatments. The combination also led to a very good control of emissions one week later, by which time a very high emission level had been reached by the controls.

Following homogenisation, the perlit resurfaced within a very short time. Within a few hours it was back on the surface in the combined treatment containers and the no-acid containers. Both coverings did not influence the sedimentation behaviour of the slurry.

Summary

The first trial results indicate very good suitability of the perlit/lactic acid combination for reducing emissions. According to the results it can be accepted that covering materials which also reduce slurry pH should be effective in reducing, or even stopping, odour emissions and emissions of the gases ammonia, methane and dinitrogen monoxide.

Aim of further investigations is the optimising of amounts and their application in livestock housing, testing the efficacy of other covering/carrying substances and also the application of substrates which encourage lactic acid fermentation in the slurry.

Literature

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