Werner Frosch, Halle-Wittenberg, and Wolfgang Büscher, Bonn

Slurry additives for reducing ammonia and methane emissions

There remain a large number of gaps in the knowledge of ammonia emission behaviour and that of the climate-damaging gases nitrous oxide and methane. Reasons include the lack of international recording standards, insufficient databases and the ignoring of animal-related surrounding conditions [1, 2].

In long-term laboratory and practical trials it has been shown that the application of emission-reducing slurry additives has a role as a component within a sustainable, animal welfare acceptable and environment-protecting agriculture.

Prof. Dr. Wolfgang Büscher is professor in the Institute for Agricultural Engineering, Bonn University, 81 Nussallee 5, 53115 Bonn, e-mail: *buescher@uni-bonn.de*

Dr. Werner Frosch is scientific assistant at the Chair for Procedural Technology in Livestock Production and Agricultural Building at the University of Halle-Wittenberg, 06108 Halle, Martin-Luther-University Halle-Wittenberg, Institute for Agricultural Engineering and Rural Culture, Ludwig-Wucherer-Straße 81; e-mail: *frosch@landw.uni-halle.de*

Keywords

Liquid manure additives, ammonia emissions, methane emissions

Whereas a series of data covering ammonia emissions from pig production in general is available there is very much less information concerning production of the greenhouse gases nitrous oxide and methane with nothing currently available as far as nitrous oxide production in piglet rearing is concerned. Plenty of production-technical, nutritional-physiological, meteorological and ventilation-technological reasons are given for this lack of usable databases and for the fact that information actually available has a large error margin. Slurry additive trials so far have led to strongly opposing statements on the efficacy of such preparations with differentiating between positive, negative and absolutely no effect [3]. Thus one can assume that the efficacy mechanism involved in the release of damaging and climate-relevant gases has been insufficiently investigated so far and this leads to consequences in the methodology in investigations. The first consequence is the need to carry-out long-term investigations under laboratory and practical conditions which guarantee complementary results regarding emission reducing effects through additives. Important information on measurement methods for ammonia emissions is contained in the KTBL paper 401, 2001 [7].

The second consequence is a comprehensive chemical analytic informing on elementary changes within slurry.

Depending on composition, structure and texture of the slurry the different effects on slurry gas release can be mainly divided into biological, chemical and physical. *Table 1* contains a selection of slurry additives listed according to their primary effect and material characteristics.

Whereas bacterial and algae preparations which encourage microorganism activity (whereby odour and NH_3-release is meant to be reduced) with Cu-containing preparations, e.g., the bacterial activity is very strongly reduced. Through moving of the dissociation balance between NH_3 and NH_4^+ in direction of ammonia, chemical preparations have achieved a reduction in pH which brings a reduction in polluting gas emission. Using additives with a physical effect leads above all to convective, as well as molecular, diffusion being suppressed in the outer layers. Further classifications of slurry additive are known from the literature:

1. Preparations with inner and unknown effects as well as effects on the surface characteristics of slurry [4].

Table 1: Classification of liquid manure additives according to primary effects and material characteristics

biologically	chemically working additive	physically
micro organism-encouraging and impairing additive, changing composition of bacteria flora	Reducing pH, ˝Binding with ions (NH_4^+)	adsorption ⇐ convective diffusion } (outer layer effect)
e.g. through	e.g. through	e.g. through
• preparations containing bacteria and algae • preparations containing Cu	• inorganic and organic acids • superphosphate	• ground stone and chalk • puzzolanic material • plastics

⇐ Increasing absorption ↓ Limiting convective diffusion

Table 2: Climatic conditions for characterising measuring conditions

Parameter	Control compartment	Variant
Recording period 13.1 to 14.3, 2000 (animals 8•25 per compartment)		
Compartment temp (°C)	25,2	22,9
Slurry temp (°C)	18,8	17,9
Relative air moisture (%)	76,9	66,3
Recording period 30.3 to 30.5, 2000 (animals 8(25 per compartment)		
Compartment temp.(°C)	25,0	24,7
Slurry temp. (°C)	19,1	19,0
Relative air moisture (%)	60,1	57,1

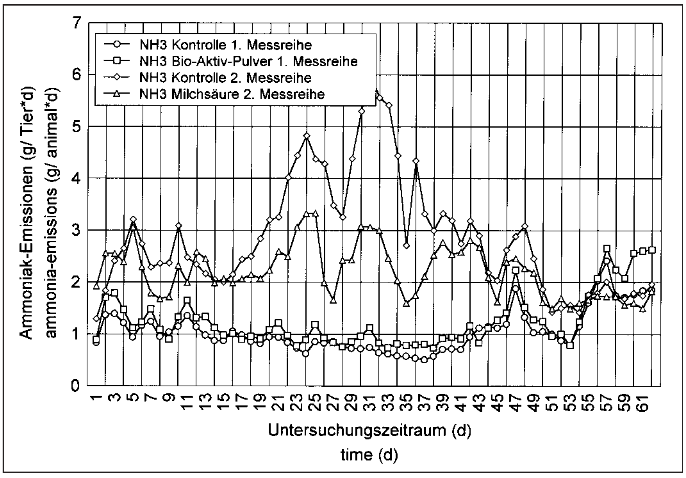

Fig. 1: Influence of liquid manure additives on ammonia emissions

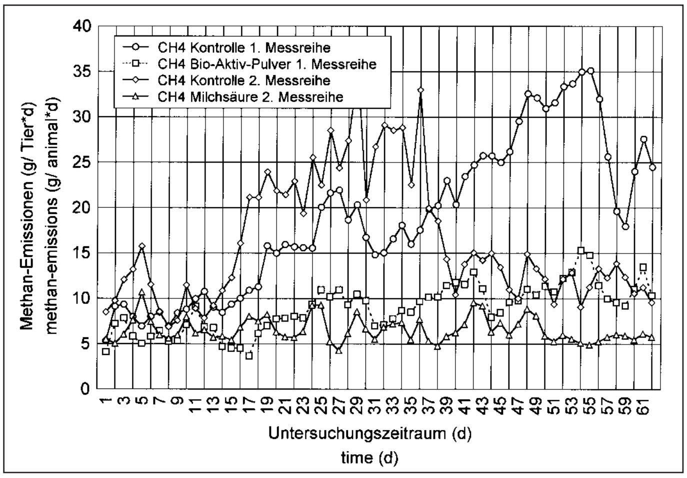

Fig. 2: Influence of liquid manure additives on methane emissions

2. Mineral or mineral-organic based additives [5].
3. Additives on the basis of nitrification-limiting or microbial conversion [6].

Method measurement conditions

The measurement methods have already been comprehensively described by the authors in LANDTECHNIK 2/1999 for the laboratory and in LANDTECHNIK 3/2001 for practical trials. Here, the applied additives and their dosages as well as the equipment involved are described.

The following results come from a series of measurements carried out in a piglet rearing house from January to May 2000 under practical conditions.

Whereas no slurry additive was used in the control compartment, in another (variant) a preparation based on ground quartz was tested as was an 80% lactic acid liquid.

Gathered in *table 2* are selected climate data from the investigated compartments over the trial period.

Results

The course of ammonia and methane emissions given in *figure 1 and 2* cover in each case two recording series (rearing periods) in the above trial period.

Firstly it is noticeable that there are large differences in the emission rates between both series. These can be caused by, among other things, seasonal differences in air volume.

Further, the lactic acid variant showed *(fig. 1)* a substantial reduction of emission rates compared with control, whilst the NH_3 emissions of the bioactive variant showed almost the same progress as the control compartment. In total, ammonia emissions could be reduced by around 23% by the lactic acid application which could be attributed to a pH reduction of 2.0.

A similarly differentiated picture was shown for methane emissions from both trial series *(fig. 2)*. Whilst the additive variants demonstrated uniformly low emission values there was in the control compartments a substantial variability in measured values. The achieved reduction rates lay here between 50 and 60%.

While methane emissions were also strongly reduced by the organic acids through their reduction in pH, the additives based on chalk or ground quartz caused enlargement of the inner surface of the slurry and this in turn meant emissions of odours and pollutant gases could be reduced through the absorption conditions thus created.

An aim of future investigations should be the development of suitable technology for continuous addition and dosing of slurry additives.

Conclusions

Through applying pH-reducing slurry additives it was possible to reduce emissions, especially of ammonia and odours. These offered the advantage of sustainable application in conventional production systems.

According to the literature, slurry additives can result in singular or multiple positive, negative or absolutely no effects. The reasons can be attributed to the complexity and variability in the composition of the slurry as well as to exogenous influences influencing biochemical conversion procedure. In trial series carried out in the laboratory and in practical conditions different slurry additives were tested for their emission reducing effect on pollutant and climate-relevant gases. It was shown that temperature and pH had a decisive influence on reducing emissions of ammonia and methane. Whilst lactic acid additive caused substantial ammonia and methane reductions through moving the pH into the acid area, the use of bioactive powder giving a notable enlargement of the slurry inner surface only reduced methane emissions.

For use of additives in practice it is important which slurry characteristic is to be addressed in the first place. Here, the application of objectively tested preparations is required.

In order to be able to achieve reliable information regarding amount of emissions values in livestock production further long-term trials in the laboratory and in practice will have to be carried out.

Literature

[1] *Van Den Weghe, H.*: Emissionen der Schweinehaltung und Minderungsmaßnahmen. KTBL-Symposium „Emissionen der Tierhaltung und Beste Verfügbare Techniken zur Emissionsminderung", Bildungszentrum Kloster Banz, 3.12. – 5.12.2001

[2] *Hartung, E. und G. J. Monteny:* Emission von Methan (CH4) und Lachgas (N2O) aus der Tierhaltung. Agrartechnische Forschung 6, (2000), H. 4, S. 62 – 69

[3] *Kunz, H. G.*: Güllezusatzstoffe – mehr als fauler Zauber? Top agrar 25 (1996), H. 5, S. 64 – 66

[4] *Ammler, A., E. Hartung und W. Büscher*: Flüssigmist-Additive im Test – Prüfstandards für Zusatzstoffe für Flüssigmist. Landtechnik 52 (1997), H. 1, S. 42 – 43

[5] Arbeitsgemeinschaft Güllebehandlung e.V. München: Versuchsergebnisse der ArGe Güllebehandlung zum Thema „Güllebehandlungsmittel". Schweinewelt (1994), S. 25 – 26

[6] *Huether, J. A.*: Zusatzstoffe für Schweinegülle: Produktionsfaktoren oder Wundermittel?, Deutsche Geflügelwirtschaft und Schweineproduktion, (1990), S. 228 – 230

[7] -: Messmethoden für Ammoniak-Emissionen. KTBL-Schrift 401, Hrsg. Kuratorium für Technik und Bauwesen in der Landwirtschaft e.V. (KTBL), Darmstadt, 2001