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Ammonia Emission from Different Stall Floor Types in Pig Fattening

Systematic emission reduction in the stall requires knowledge about the sources and their importance for total emission. Depending on its design, the stall floor can be regarded as the main emitter in the stall. Therefore, one must differentiate between slatted floor and closed resting areas.

Past publications almost exclusively referred to the total emissions from stall systems.

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Keywords

Emission sources, greenhouse and eco-relevant gases, animal house floor

Literature

[1] *Büscher, W.*: Ammoniakfreisetzung aus zwangsbelüfteten Stallanlagen mit Flüssigmist. Ansätze zu deren Reduzierung, Agrartechnische Berichte 27, Hohenheim, 1995
[2] *Martinec, M., E. Hartung und Th. Jungbluth*: Daten zu Geruchsemissionen aus der Tierhaltung. KTBL-Arbeitspapier 260, Darmstadt, 1998

For the quantification of trace gas- and odorant emissions from animal housing, numerous examinations were and are currently being carried out. According to reference [2], however, the data material remains insufficient. The emission factors which result from these studies are described in a very unspecific manner primarily as a function of the housing- and ventilation system.

Below, results of studies by the authors gained in stall compartments (VS) of a fattening pig house with regard to specific ammonia emission from slatted metal floors (VS I), slatted concrete floors (VS II), and spherical sloped floors in resting areas (VS I and VS II) will be described.

Method

The wind tunnel method described in LANDTECHNIK 6/02 was used to quantify the different sources of harmful gases. The wind tunnel was employed as an active hood for the quantification of NH_3 emission from different stall floors.

The measurement series carried out weekly in the different source areas in the stall were characterized almost exclusively by recurrent emission behaviour over the sampling time. The use of different materials and the surface design of the stall floors allow characteristic courses of the series of wind tunnel measurements to be determined.

For technical reasons, the measurement series over slatted metal floors were generally only able to be carried out during the winter months, while the measurements over slatted concrete floors took place under summer conditions. 17 of 19 measurement series carried out were included in the main examinations for the determination of NH_3 emission from spherical sloped floors in resting areas. Of these, 13 measurements in the experimental stall VS I and four measurement series from the experimental stall VS II were considered in the evaluation. In each of the two stalls, one measuring day was disregarded for technical reasons.

Results

In general, temperature, air volume flow, soiling, and liquid manure level under the slatted floor must be mentioned as factors influencing the ammonia emission of stall floors. The main factors which influence the individual stall floor types in particular will be described below. The typical seasonal course of emission as well as the emission level of the individual stall floors will be discussed.

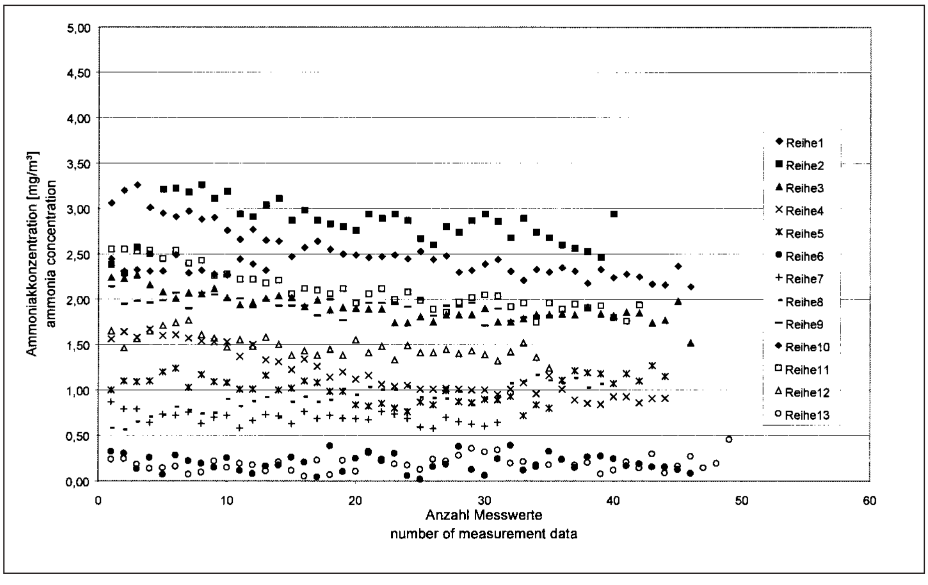

Fig. I: NH_3-concentration over spherically sloped floors in VS I, measured by wind tunnel method.

Slatted Floor
In VS I, the average concentrations in the wind tunnel fell from 2.06 mg/m^3 to 1.37 mg/m^3 over a measuring period of two hours. This corresponds to a 33.5% decrease in the concentration level over the period of a measuring phase. In VS II, the average concentrations dropped from 4.86 mg/m^3 NH_3 to 3.33 mg/m^3. At a 31.5% decrease in ammonia concentration, these measurement values are comparable with VS I. While in VS I measurements of harmful gases were carried out with a simulated summer- and winter air rate, air speed in VS II exclusively corresponded to the summer conditions. On the examined area, NH_3 emission from slatted metal floors in VS I amounted to an average of 1.02 g/h/m^2 during the trials. On the slatted concrete floor in VS II, a mean ammonia emission of 13.33 g/h/m^2 was determined. *Table 1* shows the statistical data of the entire measurement series over slatted floors.

On slatted floors, the depth of the emitting source is influenced by the liquid manure level in the channel. The soiling of the slatted floor, however, is only of minor importance for ammonia emission. The temperature exerts a significant influence on the emission behaviour of NH_3 over the slatted floors with outdoor temperature, wind tunnel temperature, and stall temperature having a significance of $p \leq 0.05$. Outdoor temperature has the greatest influence on the ammonia emission of slatted floors. One possible reason for these connections is the fact that the seasonal course of the outdoor temperature decisively influences the temperature level of liquid manure. The slurry temperature, however, was not documented.

Resting Area
Figure 1 shows that the measurement series of the NH_3 concentrations of VS I ran parallel and at different levels. In VS I, the arithmetic mean of ammonia concentration was 1.55 mg/m^3.

If one compares ammonia emission from VS I and VS II, the decisive influence of temperature can clearly be observed. NH_3 release over the resting areas of VS II was 15.48 g/h/m^2, whereas it was only 0.72 g/h/m^2 over the resting areas in VS I. The statistical values of ammonia emissions from spherical sloped floors in resting areas over the entire trial period are summarized in *table 2*. Ammonia emission ranged from 0.095 g/h NH_3 up to 29.79 g/h NH_3. The arithmetic mean of the emissions amounted to 4.57 g/h NH_3. The degree of soiling must be mentioned as the main factor which influences the process of ammonia emission over the spherical sloped floor in the resting area. The continuous inspection of the examined area as part of evaluation provides a direct connection between heavier soiling and growing NH_3 emission. *Figure 2* shows the relevant connections.

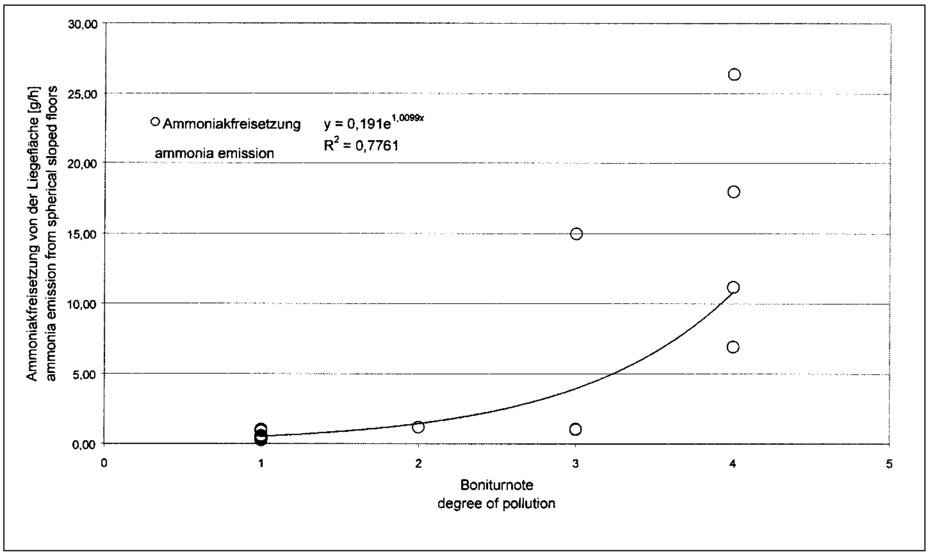

Fig. 2: Ammonia emission from spherically sloped floor and difference degrees of dirtying

Summary

After the completion of the trials, the described wind tunnel method is considered suitable. The verified active hood enables the emission process over different stall floors to be precisely documented. In the long-term trials carried out in order to quantify the emission of trace gases in fattening pig stalls, the differences between the NH_3 emission of slatted floors and spherical sloped floors in resting areas were determined.

As described in numerous other studies, temperature exerts the main influence on the entire emission process. In addition, a significant increase in ammonia release is recorded as a result of growing air volume flows.

The comparative studies did not show any significant difference between the slatted floors and the spherical sloped floors in resting areas. If one assesses the emission behaviour of the stall floor types, the stall aisle as a source can be neglected. 50% of the ammonia emission can be attributed to the slatted floors and 50% to the spherical sloped floors in resting areas. Seasonal influence on the emission behaviour of both stall floor types is extremely significant. While the spherical sloped floor in resting areas presents itself as the smaller NH_3 emitter under the conditions of the winter air rate, its emission rates in the summer months are slightly higher than those of the slatted floors. This is caused by the increase in heavily soiled areas, which is significant in some cases.

	n	Min.	Max.	Ø	s
Ammonia-emission [g/h]	776	0,14	34,50	4,2704	6,48157

Table 1: Statistical data on ammonia emission from slatted floors (wind tunnel method)

	n	Min.	Max.	Ø	s
Ammonia-emission [g/h]	698	0,095	29,79	4,5776	7,30602

Table. 2: Statistical data on ammonia emission from spherically sloped floors (wind tunnel method)