Hans-Joachim Müller and Kristina von Bobrutzki, Potsdam-Bornim, and Dieter Scherer, Berlin

Ammonia Emissions and Immissions in Broiler Fattening

For species adapted animal husbandry specified house climate parameters must be met. Therefore, animal houses must be permanently ventilated. For broiler housing additional air conditioning equipment is necessary. To keep the negative effects of the emissions in the surroundings at a minimal level, the emission stream must be as low as possible. Besides the emission stream, the dispersion process in the surrounding area plays an important role. The Leibnitz for Agricultural Engineering (ATB) carries out basic research in real livestock buildings to provide the necessary basic data for immission predictions and for clarification of the dispersion processes.

Dr.-Ing. Hans-Joachim Müller und Dipl.-Ing. Kristina von Bobrutzki sind wissenschaftliche Mitarbeiter in der Abteilung Technik in der Tierhaltung am Leibniz-Institut für Agrartechnik Bornim e.V. (ATB), Max-Eyth-Allee 100, 14469 Potsdam; e-mail: *hmueller@atb-potsdam.de*
Prof. Dr. Dieter Scherer leitet das Fachgebiet Klimatologie am Institut für Ökologie der TU Berlin.

Schlüsselwörter

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Keywords

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Literature

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For species adapted animal husbandry specified house climate parameters must be met. Therefore, animal houses must be permanently ventilated. Through ventilation waste heat, waste vapour and waste gases will be transferred from the animal zone and reach the surrounding. In broiler housing additional air conditioning equipment like heating systems and humidifiers are necessary. To keep the negative effects of the emissions in the surrounding at a low level, the emission stream must be minimized. Beside the emission stream, the dispersion process in the surrounding plays an important role, e.g. in licensing procedures. In Germany the VDI guidelines (VDI 3471 [1]; VDI 3471 [1]; VDI 3472 [2]; VDI 3473 [3]; VDI 3474 [4]) are used to minimize the conflicts, resulting from odour by minimum distances between animal houses and residential areas. Also the guideline "Technical Instructions on Air Pollution Control" (TA Luft) [5] contains distance rules, regarding odour. Furthermore in this guideline a distance rule regarding to ammonia is to be found. In this case the distance between animal houses and nitrogen sensitive plants and ecosystems must be met. As guidepost for application of the guideline "TA Luft" in the field of agricultural practice the KTBL script 447was published [6].

To provide the necessary raw data for pollution predictions and to resolve the dispersion behaviour, the Leibniz-Institute for Agricultural Engineering (ATB) carries out basic research in real livestock buildings and in a wind tunnel. This paper reports about real site measurements which are focused on ammonia. The results about the investigated odour emissions will be published at a later date.

Besides the emission stream, the dispersion process in the surrounding area plays an important role. The Leibniz for Agricultural Engineering (ATB) carries out basic research in real livestock buildings to provide the necessary basic data for immission predictions and for clarification of the dispersion processes.

Ammonia emissions from broiler fattening

The share of total ammonia emission of the poultry industry within animal husbandry in Germany was about 9 % in 1999 [7]. 57 %

Table 1: Examples for the ammonia emission from broiler houses

Source	Ammonia-Emission (kg/a per Tierplatz)
TA Luft (2002) [5]	0,0486
Brunsch et al. (2005) [7]	
Messungen Stall 1 / ATB / Einstreu: Sägemehl	0,0500
Brunsch et al. (2005) [7]	
Messungen Stall 2 / ATB / Einstreu: Stroh-Häcksel [7]	0,0320
Najati et al. (2000) [9]	
Referenzstall / Einstreu: Stroh-Häcksel	
(auf ein Jahr umgerechnet mit den Annahmen:	
36 Masttage und 7 Servicetage)	0,1250
Najati et al. (2000) [9]	
Trampolinestall / Einstreu: Stroh-Häcksel [9]	
(auf ein Jahr umgerechnet mit den Annahmen:	
36 Masttage und 7 Servicetage)	0,0641
Casey et al. (2003) [10]	
Masttag: 11 – 21	0,0304
Masttag: 47 – 56	0,2979
(auf ein Jahr umgerechnet mit den Annahmen:	
56 Masttage und 7 Servicetage)	
Wheeler et al. (2003) [11]	
a.) neue Einstreu nach 5 Mastdurchgängen	0,1885
b.) vor jedem Mastdurchgang neu eingestreut	0,1130
(auf ein Jahr umgerechnet mit den Annahmen: 43 [a.)]	
und 39 [b.)]Masttage und jeweils 7 Servicetage)	

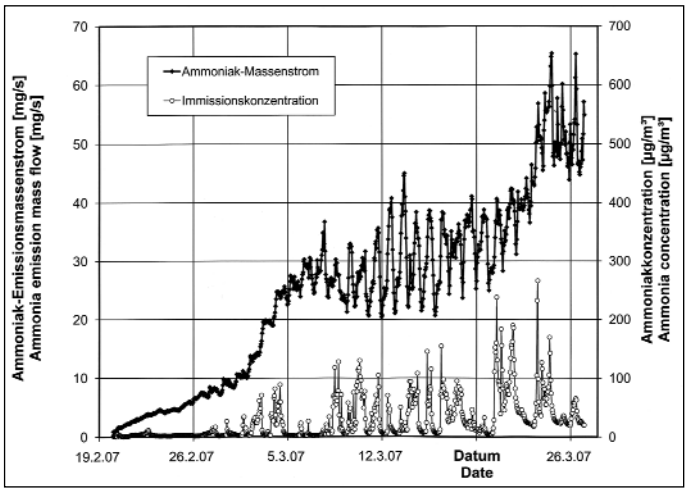

Fig. 1: Ammonia emission mass flow from the investigated house with 30000 animals and the immission concentration in 10 m height (February/March 2007)

of the total emissions from poultry come from housing, 5 % from manure storage and 38 % from manure spreading. In this regard, ammonia from poultry is mainly a problem of locations (farm sites). Between 1970 and 1990 a lot of East German poultry farms were established in forests. The idea was to reduce the risk of epidemics. Such farms, among these also broiler houses, have now difficulties. The vicinity to the forest means tightened locational problems. The questions regarding to the rate of ammonia emission and the dispersion in the surrounding have special importance. Regarding ammonia emissions, there are numerous specifications in the literature. Selected results are presented in *Table 1*. From the referred bibliography, the following conclusions can be drawn for ammonia emission from broiler houses:

- Floor management with littering is the standard keeping method
- Keeping with a higher area per animal results into higher emissions
- The ammonia emission stream increases dramatically with the animal live weight
- The range of variation of annual emissions is very high – even within one farm or for one building for different keeping periods
- The extension of the fattening period produces more emissions
- Fresh litter before every keeping period reduce the emissions
- Additives to the drinking water may reduce the emissions

Investigation methods

Emission
A detailed description of concentration measurement and determination of the air exchange rate can be found in [7].

Outside climate
On the one hand the outside climate has an impact on the emissions (e.g. outside climate dependent variation of the air volume stream) and on the other hand the outside climate influenced essentially the mass transfer in the atmosphere. At several and different places inside the farm terrain the meteorological data were recorded. The ammonia concentration was measured in 10 m height inside the farm terrain by NO_x-converter and at 5 different places by passive samplers.

Wind
The wind is also an outside climate parameter but it plays an important role in connection with the dispersion process. The wind velocity was measured with 10 Hz at 5 different places in different heights (up to 10 m high above ground) by ultrasonic anemometer (all 3 components of the wind velocity).

Investigated farm

The investigated broiler farm consists of 15 houses altogether. 22,000 animals per building are kept in 9 buildings and in 3 new buildings (divided in two separated parts a 30,000 animals) 60,000 animals per building. The different number of animals is caused by different animal houses. The result is 378,000 animal places for one fattening period. The whole area of the farm covers 6 hectare and is surrounded by forest. Measurements of emission streams were done in a building with 60,000 animals and the measurements outside were done at the same time during two keeping periods. The measurements were carried out by the ATB Potsdam in collaboration with the faculty of climatology of the University of Technology Berlin. The following results are from the first campaign in February/March 2007.

Results

Figure 1 shows the course of the ammonia emission mass flow which is emitted from the investigated animal house and has an effect on the environment. At the beginning of the fattening period the ammonia emission mass flow is nearly "zero". This flow increases fast during the first two weeks. Between March 18th and 20th the ammonia emission mass flow reaches a certain level and the diurnal fluctuation is well visible. After that time the ammonia emission mass flow increases again up to the end of the keeping period.

The course of immission concentration is also to see in the *Figure 1*. The heavy fluctuations point out to the complex processes, which are influencing the ammonia immissions and which must be investigated more accurately. The coefficient of determination of the hourly values between emission and immission a R^2 is 0.23. For the daily average, R^2 is 0.39. That means that only 23 % or 39 % of the immission concentration can be explained by the values of the emission mass flow. It can be assumed that the atmospheric transmission conditions have decisive impact on the immission flow. Beside the horizontal transport process by the air flow, the vertical dilution of ammonia plays an important role for the dispersion process. These processes will be more detailed considered in more detail in the further evaluation of the results and be investigated. The main wind direction measured in 10 m height was from southwest. The other local stations on the farm area show a big influence of the geometry of the livestock buildings. Parallel to the further evaluation of the measuring results, dispersion calculations will be carried out with different dispersion models. Compared to the measuring results, evidence about the accuracy of the different dispersion models can be expected.

Conclusion

The results from literature and of own measurements show the wide variation of the ammonia emission values in broiler housing. The single value given in the instruction "TA Luft" can only be looked at such a single value. Compared with this single value, big deviations are possible in reality.

Possibilities of reducing of emissions seem to be only restrictedly available for broiler keeping. Shortening of the fattening period, fresh litter before every fattening period, additives for drinking water and manure drying by special ventilation systems are such possibilities.

The first results regarding the immission behaviour show that for this problem considerable research requirements are necessary. More research results on this field will contribute to qualification of the dispersion models. Analysis of wind and its effect on immission processes will be of utmost importance.

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