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Emission Factors in Poultry Production and their Dynamics

Performance level, feeding strategy and management are changing rapidly in poultry production. Hence, the nutrient composition in excreta is changing, too, as well as the subsequent emissions. Investigations on measures to control emissions in new housing for laying hens determined emission factors which are presented comprehensively here. Through long-term monitoring the dynamics of emission flows become visible and approaches for further developments in experimental design can be deduced.

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Keywords

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Germany was submitted to international obligations (UN/ECE protocol, NEC guideline) to decrease ammonia emission and to publish guidelines and recommendations for good agricultural practise ammonia emission control. Within the EU, the documents „Best available techniques for intensive livestock farming“ (BAT-notes) were passing the Commission in summer 2003 [1]. In Germany, peaceful neighbourhood between residential areas and animal production facilities is organised based on VDI guidelines since many years. These guidelines are mainly related to odour emissions. Ammonia emissions, however, are not strongly correlated to odour emissions, as has been shown by numerous experiments. In 2002, the „TA Luft“ [2] (technical instructions to avoid air pollution) was passed in Germany. Since then, the distances between animal production facilities and sensible ecosystems because of ammonia emissions are regulated by a legal framework. These regulations are important for the operation and planning processes for animal housing systems.

Production systems for farm animals are continuously under development. Additionally to the implementation of measures to reduce emissions, a better adaptation of feeding strategies to the demands of the animals is important for reducing the environmental impact of animal production. New demands posed by animal welfare acts often lead to an increased environmental pollution requiring new ideas in farm management. In line with this development an analysis of the impact of animal facilities on the environment under changing conditions on farm level is necessary.

The Leibniz-Institute of Agricultural Engineering Potsdam-Bornim (ATB) has carried out numerous investigations in poultry housing systems in the recent past. Main results are summarised and compared in this article. Supplemented by emission factors worked out by other authors the extended publication under LANDTECHNIK-NET.com gives an overview of the emission behaviour from poultry housing.

The importance of emissions from poultry housing

Compared to the total ammonia emission of animal husbandry in Germany the share of poultry industry was about 9% (42 kt NH_3/a) in 1999. The relative share is increasing. The total emission from poultry divides in about 24 kt NH_3/a from houses, about 2 kt NH_3/a from manure storage and about 16 kt NH_3/a from manure spreading [3]. In this regard, ammonia from poultry is mainly a problem of locations (farm sites). This situation will be aggravated by the transformation into more animal friendly systems, especially in laying hen keeping. For these new (alternative) housing systems reliable emission data are necessary. At the same time, the importance of ammonia increases because of the „TA Luft“ [2]. A lot of East German poultry farms were established in forests between 1970 and 1990. The idea behind this was to reduce the risk of epidemics. After 1990 the former keeping systems were changed into battery systems with high indoor air quality and low emissions. The nowadays demand to keep hens in aviary or floor systems results in higher ammonia emission per animal place (with reference to BAT-notes). Taking environmental protection into account a reduction of animal places in existing farms would be the result.

The data base for ammonia emission factors listed in appendix 1 of „TA Luft“ is unreliable in some cases [3] and produces the

Table 1: Ammonia emission from poultry places (kg/a per animal place)

Keeping conditions	Data by ATB*	TA-Luft
Turkey fattening	0.6 - 2.0	0.7286
Duck fattening	0.02 - 0.74	0.1457
Broiler fattening	0.032 - 0.05	0.0486
Broiler parent keeping		
Floor management	0.123 - 0.89	(0.3157)
Layers		
Cage keeping	0.0166 - 0.063	0.0389
Aviary systems	0.0908 - 0.136	0.0911
Designed cages	0.0305 - 0.049	0.0389
Floor management	0.097 - 0.389	0.3157

* Ranges from several measuring campaigns by ATB and its cooperation partners

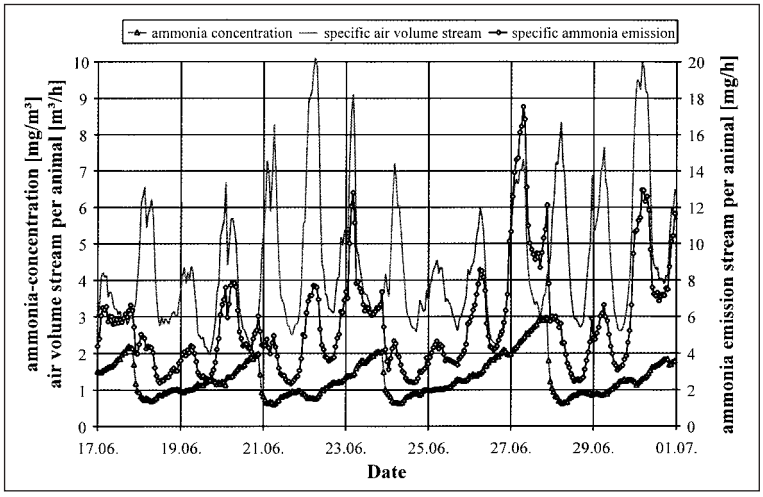

Fig. 1: Course of ammonia concentration, air volume flow and of ammonia emission in a laying hen house with furnished cages (June 2004)

impression of high accuracy because of four numbers right of the decimal point. It is, however, important to know that these factors are the result of calculation of a strongly estimated value for ammonia-nitrogen, published in [3], into ammonia. The emission data for forecasting scenarios of emission reduction on regional and national level are used for farm site specific planning process. In many cases this process results in a (unfounded?) very strict evaluation process before granting a production license compared to other EU-countries.

Data for granting a production license are mainly annual average values per animal place. Emission factors often derive from investigations with relatively short measuring periods. Such measurements of gas concentrations and volume flows are calculated together with data of the animal density in the stable. Experiences with own long time measurements [4, 5] confirm a big variation in emission data without any possibility to explain the reasons for it. Especially in poultry production the averages per annum are based on averages of some fattening periods broken by times without animals in the stables. The metabolism of the animals, the quantity of droppings, their nutrient content and the degree of accumulation of excreta are changing continuously over the fattening period, added by variations over the day, mainly coursed by the activity of animals and climate conditions. In stables for fattening poultry it is difficult to demonstrate a typical production situation in relation to the averaged emission factor.

Methods of measuring

The ATB uses the photo acoustic spectrometry (PAS) in a multi gas monitor by Brüel & Kjaer/Innova for measurements of gas concentrations. Tracer gas method (carbon dioxide, sulphur hexafluoride and krypton) are used for calculations of volume flows (air exchange). Detailed explanations can be found in the extended publication and in [6].

Results

Table 1 gives a summary of the span of ammonia emissions per animal place from various investigations of ATB and their cooperation partners. These data are supplemented with numbers from „TA Luft“.

The results from fattening of turkeys and ducks are based on measurements in the middle of the 1990s. On the one hand side the variation of emission depends on the age of animals (day of keeping, accumulation of excreta) but on the other hand side there was a big variation at the same age of animals. Such a variation is well known from long time monitoring in broiler houses. Duration of fattening period, feeding strategy, litter management, and house climate control for fattening poultry have an important influence on the annual averages of emissions.

The last twenty years developments in cage systems for laying hens result in high hygienic standards and low emissions. Systems with low ammonia emissions are wide spread in practice. With guideline 1999/74/EG a decision was made to end traditional cage keeping for laying hens. For furnished cages, however, only few information about emission behaviour is available. Own results show that on real farm conditions such animal friendly cages can have similar emission factors as traditional cages.

Other alternatives for traditional cages are aviary and floor systems. Caused by the difficulty to handle the droppings, these systems, compared to cages, have much higher ammonia emissions per animal place. Our results mainly confirm the ìTA Luftî data. But they moreover provide information about the potentials of a further reduction by using intelligent air flow management without problems with indoor air quality.

Figure 1 demonstrates the ammonia concentration, the air volume flow and the ammonia emission in a laying hen house with furnished cages over a period of 14 days. The saw tooth-like course of ammonia concentration is caused by the periodical interval of cleaning the manure belts. The large variations in volume flow are of only minor influence on the low ammonia concentration level. Resulting ammonia emissions vary in short time and over the measuring period considerably. It is to point out that for this investigation the air volume flow was calculated by the help of carbon dioxide mass balance. The guideline DIN 18910 contains only averages of a day for carbon dioxide production by the animals.

It is interesting to use this method especially for long time measurements but further research on the variation in carbon dioxide production by the animals over the day is needed. Differences between two measuring periods in the same hen house can be explained by differences of indoor temperatures and air exchanges.

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