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Measuring Air-borne Particles in and from Poultry Production

Particles are mainly emitted from poultry production. In the following measurements from broiler and turkey houses, as well as in the waste air from forced-ventilation facilities are reported about. PM10 concentrations within and outside the building are compared as an example of a naturally ventilated poultry house.

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Airborne particles in stables must be seen under various aspects. Particles are a fact of air quality, which may affect health and well-being of man and animal. In the past this was the main task for measurements of dust concentration in animal houses. But looking to the interactions between animal production and environment particle emissions, the vicinity of the stables must be included. In Germany national particle (dust) emissions are limited by the TA-Luft 2002 (Technical Instruction of Air Pollution Control). International particle emissions are part of macro-scale strategies of air pollution for example the Geneva Convention of long range transboundary air pollution (LTRAP) [1]. National annual emissions will be calculated using animal numbers and specific species related emission factors. Here is a lack of reliable data, especially if it will be taken into account that not total dust but particular fractions are requested. At the present time PM10 is in the focus but other fine fractions like PM2.5 and PM1 will probably follow in the frame of the CAFE (clean air for Europe) programme.

Definitions

Depending on effects or targets CEN, ISO or US EPA defined different particle size distributions from total dust down to the ultrafines PM0.1.

The effects of particles on individuals depend mainly on their size given by the aerodynamic diameter, which reflects to the likelihood of deposition in the breathing system. Corresponding to this conventions commit different health related fractions. They describe mass related separation functions and are to understand as specifications for measuring airborne concentrations [2].

With respect to the environment US EPA created the definitions of PM10 and PM2.5 [3]. The numbers represent the particle diameter for a separation efficiency of 50 %.

A comparison of fractions of different conventions show the same values of 50 % separation for example PM10 and the thoracic fraction, but the shape of the curves differ. The thoracic fraction includes particles up to 40 µm, but PM10 ends with 15 µm. Therefore the separation characteristic must be given or a comparison of measurements is impossible.

Method

Dust concentration was determined using gravimetric methods. In the stable one central measuring location was used to get knowledge about long termed influences. There was no personal worn measuring equipment, which is normally used to detect strength of sources at different working places.

Sampling velocity was always 1.25 m/s in a height over the stable ground of 1m ± 0.2m. The use of a quasi online working dust monitor type R&P TEOM 1400a enabled the

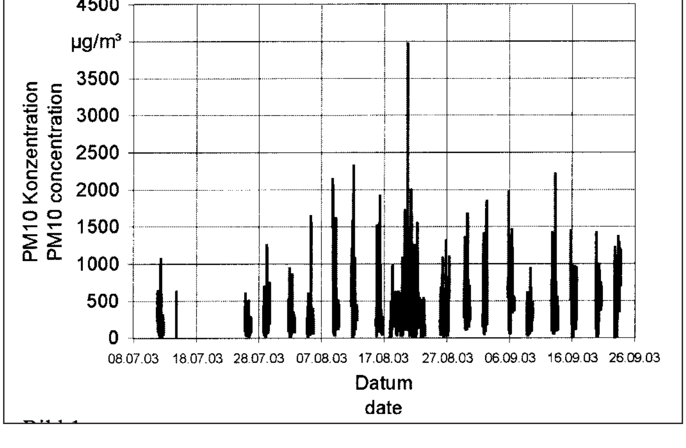

Bild 1: PM10-Konzentration im Verlauf eines Mastdurchganges bei Puten

Fig. 1: PM10 concentration during a fattening period for turkey

detection of daily or other courses of PM concentration. Equipped with pre-separators directly the fractions PM10 or PM2.5 could be measured.

This instrument was also available for the measurements in ambient air nearby the turkey house.

The emissions concentration and exhaust air flow rate were measured simultaneously. Selection of measuring positions and the condition of isokinetic sampling were done according to standards [4]. Local air velocity was taken by hot wire or blade anemometer. Through the selection of the probe duct diameter and adjustment of the sampling air flow, the isokinetic condition was kept.

Particles have been separated by glass fibre filters for weighing and membrane filters for an additionally required particle size analysis [5].

The measurements have been carried out in all exhaust ducts of a particular animal house. All fans are working in stable conditions to ensure constant air flow. With the assumption of stationary status, the different exhaust ducts were measured step by step and not parallel as required in principle.

Literature gives values of emissions derived from measurements inside the stables. To get a better guess of those investigations emissions measurements were accompanied by a reference inside the stable.

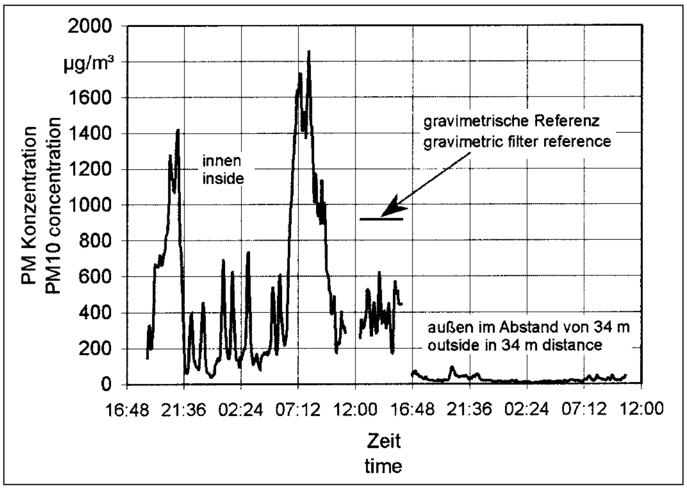

Fig. 2: PM10 concentration inside and around a naturally ventilated turkey house

Investigated stables

Emissions of turkeys were studied in a force ventilated experimental house with practice relevant stocking density, but with a little stock of birds only.

Inside measurements were extended to a naturally ventilated farm building with 3600 toms. At this farm the outside measurements took place.

The investigated Louisiana house housed 16000 birds. Samples were taken over several fattening periods.

Emissions result from measurements in 2 force ventilated broilers house with stocks of 5000 and 9000 birds respectively and from one house h with 8000 hens in cages.

Results

In the air of the Louisiana broiler house the concentration ranges were between 1 and 14 mg/m³. Concentration increases directly with the average weight of a single bird. Winter periods show higher values than in summer.

Also in the turkey houses concentration is higher in winter than in summer but on a lower level compared with the broiler. 6 mg/m³ were passed rarely and for short times only. There is no similar dependency between age or weight of the birds and dust concentration in the house. This can be shown also for the course of PM10, which is given in *Figure 1* for two 24 h measurements each week starting with the 9th week and ending with the 20th week of birds life time. For the whole measuring periods an average of 0.4 mg/m³ results.

In contrast to these data the results from emission measurements are to be seen as spots only to give an orientation of magnitude. In *Table 1* concentrations in the observed exhaust ducts and emission factors are given, which are number related for hens and weight (AU) related for fattened birds. Additional results at the reference location inside the building and the ratio between exhaust and stable air concentration are part of the table. These values confirm those from measurements which were carried out without the strong rules of the standards [6]. An estimation of possible deviations may be done using the ratio r which ranges between 0.7 and 2.1.

All the given values above are related to total dust. With particle size analysis the proportion of PM10 is found to be in the order of 25 % for turkeys and 40 % for broilers.

Main targets of air pollution and control are transport, dispersion and load of substances into the environment. Looking to this, PM10 is a quite coarse fraction with a rapid decrease of concentration with the distance from the source. To get an impression, PM10 concentration was measured in a distance of 34 m from the turkey house in the actual wind direction. The decrease function is shown in *Figure 2*.

Kind of Animal	Cab [mg/m³]	r	E_1 [mg/(h•Tier)]	E_2 [g/(h•GV)]
Broiler 1	4,8 - 7,2	0,71 - 1,06		3,3
Broiler 2	9 - 15	0,94 - 1,6		1,23
Hens	1,3	1,8 - 2,1	1,25	
Turkeys	0,5 - 4,7	~1		2 - 8

Cab Concentration in waste air   E Emission factor
r Ratio of concentration between Cab and indoor concentration

Table 1: PM emissions from poultry

Conclusion

PM measurements show higher concentration inside the buildings of broilers compared with turkeys. Emission factors of both are to be seen as relatively low.

Calculating emissions using inside concentration may cause more or less large errors, but with a right order of magnitude.

Nevertheless for measurements related to legal limits direct measurements in exhaust ducts are mandatory.

Literature

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