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Pighouse odour emission dynamics – part 2

Results from parallel measurements with olfactometry and „electronic nose“

In the first part of this report [1] the problems and targets of the completed trials, the equipment used, both methods applied and instruments used for odour recording – olfactometry and „electronic nose“ – as well as the trial programme were all comprehensively presented and described. This second and final part offers an overview of the measurements carried out in the investigation and presents examples of results for individual part-aspects.

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Keywords

Odour, olfactometry, chemo-sensor array, pig keeping

The strongly varying operational conditions in pig production through climatic and biological changes have a substantial influence of the level of actual odour emission. The project trial programme here presented covers the odour release dynamics reflected by seasonal (feeding period), daily and short-term (feeding time) recording. Parallel to classic „olfactometry“ an „electronic nose“ with a chemosensory-array of 10 metal oxide sensors was applied. The highest odour emissions recorded were on hot summer days, the lowest on cold winter days. The „electronic nose's“ sensor signal showed clear differences on days with large volume flow changes and clearly indicated alterations in gas and odour composition during feeding time. Recommendations for odour sampling were taken from the recording results, also for consideration of seasonal variations of odour emissions in odour-spread calculations and for application of the „electronic nose“ for evaluation of odour emissions.

Results

Measurements with the olfactometer and the „electronic nose“ were carried out in three consecutive feeding periods in a forced ventilation trial pig house as described in the first part of this report [1]:

- Feeding period 1: 8/2000 – 12/2000 (autumn/winter)
- Feeding period 2: 1/2001 – 5/2001 (winter/spring)
- Feeding period 3: 6/2001 – 10/2001 (summer)

In all three feeding periods the odour concentrations were olfactometrically analysed from at least two weekly odour samples. Additionally, on six mornings a large number of odour samples (6 – 8) were taken for olfactometrical analysis of the odour concentrations and odour samples were also analysed per olfactometer from a number of samples taken during up to 16 feeding times.

As a rule odour samples for olfactometric analysis were taken in parallel to those recorded by the „electronic nose“ which were either distributed over the day to determine the pattern over this period, or during a feeding time to determine the influence then. In the following report selected recording results are presented showing the different influences on odour emissions from which the important dynamic effects of the odour emissions and their influence on the recording results can be explained.

Seasonal influence

In *figure 1* the changing amounts of the olfactometrically determined odour data over the three feeding periods are presented. Each of these lasted around four months and occurred over different seasons which had an effect of the amount of the temperature-re-

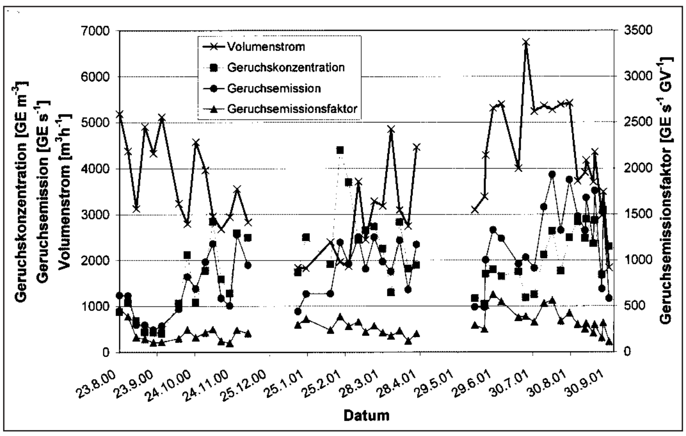

Fig. 1: Course of olfactometrically determined odour concentrations (mean of two odour samples), odour emission, odour emission factor and volume flow over three fattening batches investigated.

gulated exhaust air volume flow. According to the seasonally-related outer temperature the first feeding period in autumn showed a tendentially decreasing volume flow, the second period in spring an increasing one and the third in summer a generally higher volume flow. For the weekly measurement days the average from two different odour samples are presented from different times of the day. The odour concentrations lay mainly between 1000 and 3000 GE$\,m^{-3}$ but could, however, assume values under 500 GE$\,m^{-3}$ in summer as well as over 4000 GE$\,m^{-3}$ in winter. The odour emissions varied between 500 and 4000 GE$\,s^{-1}$ and tendentially were larger in summer with high volume flows. The odour emission factor in all three feeding periods showed a reduction of around the factor 2 because of the increasing liveweight of the pigs and was between 100 and 550 GE s^{-1} GV $^{-1}$.

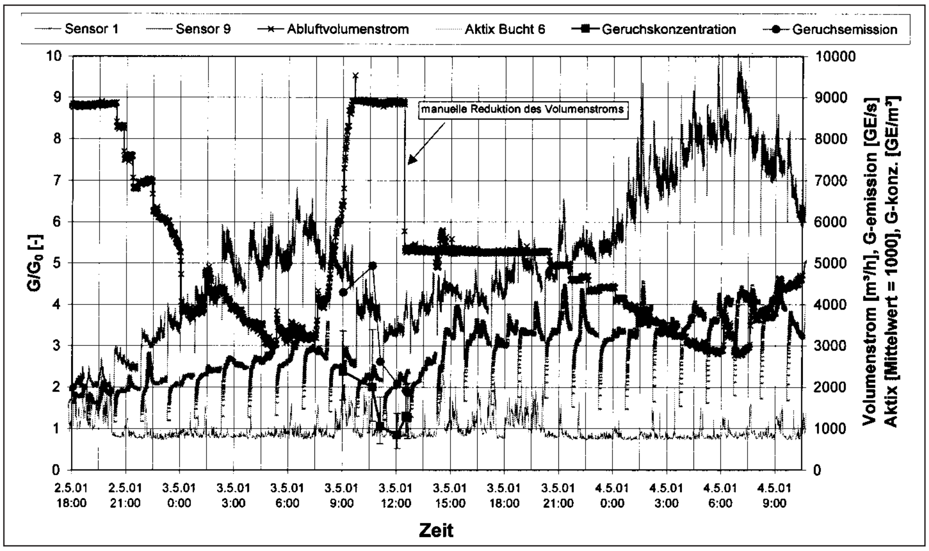

Fig. 2: Daily course of selected parameters at two days with big change of volume flow between day and night

Influence of daily progression

For determining the progression over the day of emissions and other parameters, measurements were taken with the „electronic nose“ on days with as different as possible local and surrounding conditions. The sensors 7 and 9 reacted with the highest signals to the gases and odours in the exhaust air of the pig-feeding house. The sensors 1 and 3 also reacted clearly and indicated partly spontaneous signal alterations from short-term variations of the gas and odour composition in the exhaust air. The remaining sensors clearly showed less reaction and for this reason in the following text the sensors 1 and 9 were selected for describing the „electronic nose“ sensor signals. Because of the large variability of the weather-influenced and house interior conditions, these showed very heterogeneous results. Using the following example, the important influences and relationships resulting from influences over the day are presented.

Because of the large number of measurement parameters for clarity only a selection of the most important parameters are highlighted.

In *figure 2* are presented the emission changes during two days with large temperature differences between day and night and with that appropriately large volume flow change. It is shown that the sensor signals on these days also showed strong variations whereby these run against the volume flow. This can be explained in the main by the increased dilution in the exhaust air with increasing volume flow whereby gas and odour concentrations in the exhaust in principle sink and the sensor signals also decrease. Short-term changes in the sensor signals appear most importantly during feeding times and this will be more closely described below. However, in days with large day/night differences the short-term signal changes are definitely smaller as the differences between day and night. The olfactometrical odour concentration showed a decreasing trend during the investigated mornings and then once again lightly increased after the manual volume flow reduction which in priciple also followed the progress of the sensor signal. However the insecurity of the odour concentrations according to the olfactometer measurement is so large that no secure statement about the progression of odour concentration can be made.

Influence of feeding

Even during the presented daily progression feeding time could be identified as an especially odour-relevant event because of the clear changes in sensor signals from the „electronic nose“. For feeding the feed plant meters a freshly-mixed liquid blend into the troughs of every pen. The pigs which are mostly quiet beforehand suddenly spring up and seek a place at the trough, an action which is associated with shoving and pushing between the animals. Often increased urinating and excreting around the time of feeding can be observed.

During the feeding some of the „electronic nose“ sensors show an increase in the sensor signal and this can be clearly seen in *figure 3*. The animal activity increases the emission potential of gases and odours from excrement through creating new emission surfaces, or even fresh urine and excrement is added. The altered composition of the gas and odours in the exhaust air is reflected in a change and increase of the „electronic nose“ sensor signals. The sensor signal increase starts within a few minutes and continues up to a maximum value. The sensor signal reduction then takes place slowly until odour emissions are once again back at the starting level.

The olfactometrically determined odour concentration showed slightly higher values before feeding began but these can, however, not be differentiated clearly from other odour samples because of the large range of variances in olfactometry (in fig. 3 presented from a 95% secure area from every single odour sample). The olfactometrically determined odour concentrations partly increase during feeding but often also decreases – which can also be seen from other recordings. The reduction of odour concentration during feeding contradicts, however, the expectations as well as the „electronic nose“ sensor signals.

Practical application of the results

The following recommendations can be taken from the results given here concerning the evaluation of odour emissions from odour samples, consideration of seasonal variations of odour emissions in odour spread calculations and application of the „electronic nose“.

Odour sampling at livestock building

If it is possible to take a sample from the exhaust air of an existing livestock building the odour concentrations can be determined from the samples while taking account of the season, the part of the feeding period and also time of day. Regarding seasons, measurements should be taken at least once each in a typical cold winter day and hot summer day as well as on two days during spring and autumn. On sampling days at least two samples

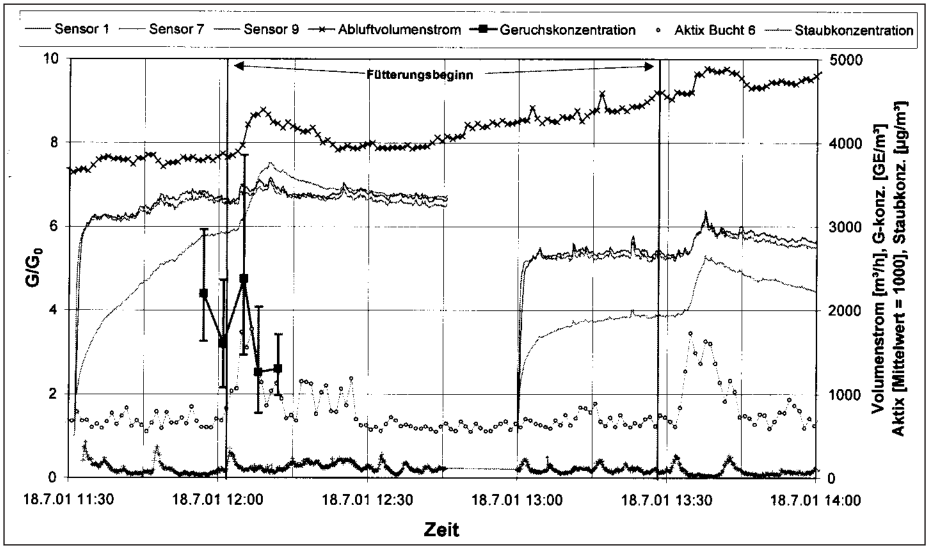

Fig. 3: Course of selected parameters during two feeding times with increase in volume flow

should be taken in early morning at constant minimum volume flow, at midday with constant maximum volume flow and samples equally distributed in mornings or afternoons during increase or decrease of exhaust volume flow. When possible the volume flow should be held constant during sampling. At all times attention must be paid that odour samples are not taken during, or within 30 minutes following, feeding. Suitable here is the parallel application of an „electronic nose“ during sampling days so that sampling during well-developed emission peaks because of feeding or other influences are recognised and avoided. All odour samples should be stored away from the light before analysis and olfactometrically analysed on the same day and if possible within eight hours. In total, there should be a minimum 24 odour samples per livestock building.

Consideration of odour emission variations in spread model calculations

With odour spread calculations the odour emission information required in planning permission cases is estimated from odour emission factors available in the literature and calculated from a comparable livestock system. If the livestock housing is already in operation when a complaint or other case is started odour samples for olfactometrical analysis should be taken according to the above recommendations. Odour emissions are calculated from analysed odour concentrations and the associated – recorded if possible – exhaust air volume flows. This involves the calculation at first of the individual daily average odour emissions from the sampling days. These are then summarized to an annual average odour emission figure for the livestock building in question. Independently from whether the annual average odour emission was estimated from odour emission factors or from analysed odour samples, the calculation of the odour spread on warm summer days is recommended – and in some cases to reckon with a double value of the assumed annual average emission and to consider the result in the total assessment of the pollution situation, especially in summer. One can also choose to apply the average odour emission from a summer sampling day. Adding to this, the winter situation can be represented as the half value of the assumed annual average odour emission or the daily average odour emission of the sampling days in winter taken account of.

Recommendations for application of „electronic noses“

While the sensor-arrays of the different commercially available „electronic noses“ are on the one hand equipped with different types and numbers of sensors and whilst, on the other hand, the sensor signals of the individual models are up until now not uniformly presented. This means harmonisation for better comparability of the different „electronic noses“ is necessary. Necessary here at the least would be a detailed statement regarding the applied „electronic nose“ and the required parameter adjustments. However, general information for the application of „electronic noses“ for measurement of odours from livestock housing is given. In that the surrounding air of livestock houses as a rule is heavily characterised by odours as well as other gases from the building itself and through nearby manure storage sites, a good recommendation is to use a synthetic and therefore uniform reference gas for the „electronic nose“ such as filtered compressed air at 50% relative moisture content and brought up to a constant temperature similar to the surrounding one. This reference gas helps to guarantee a relatively constant zero value of the sensor signal and also offers a good material for regular rinsing of the sensors. Because of sensor signal drift a maximum continuous measuring time of two hours is recommended. Feeding time and management rhythm in the livestock building should be taken account of in determination of sampling and rinsing times.

Literature

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