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Dynamics of odour release

Application methods for olfactometry and the „electronic nose“

Odour emissions from pig housing vary greatly. More exact information on their dynamics is necessary for a suitable choice of representative sampling times and for realistic calculation and evaluation of emissions. The project presented here deals with olfactometric and „electric nose“ measuring of annual (feeding cycles), daily, and short-term (feeding), dynamic effects of odour releases.

For prognostic calculation of odour pollution, exact knowledge of odour emissions is necessary. For this, odour concentration in exhaust air and exhaust volume flow have to be measured with odour emission calculated from the product [1, 2]. Olfactometry is applied as standard method for determining odour concentration. However, despite all standardisation, this has shown to have a few important disadvantages. Through the non-continuous sampling involved in individual sampling, only momentary samples are possible in odour situations where output is mainly variable. The subjectivity of human testers plus the relatively high costs per odour sample are further disadvantages of olfactometry. In comparison, the new „electronic noses“ featuring chemosensory-array as functional core with several different sensors [3], function continually with simultaneous objectivity of the sensors and relatively low running costs. They therefore offer the possibility of recording odour emission alterations on a time basis. But there are also a few principle problems in odour concentration investigation via „electronic noses“ [4]. One, differentiating between odour-active and odourless gas components is not directly possible. Also, calibration of „electronic noses“ for olfactometrically-determined odour concentrations is suitable only for an odour with constant gas composition. First investigations of their use are summarised in [5].

Object

The aim of this investigation is the determination of the time-based dynamics of feeding pig house odour emissions. An „electronic nose“ was used and, through its continuous functioning, this allowed a higher time-based analysis of the data than allowed by olfactometry. Additionally, a large number of regular odour samples were also analysed via „classical olfactometry“ for determining the absolute strength of odour concentrations. The parallel application of both methods offered the possibility of compensating for the weak points of each system by the other's advantages.

Investigation programme

The trials were conduced over three feeding periods from August 2000 to October 2001 with the following dynamic influences on odour emissions from pig housing investigated:

1. Pattern of odour emissions and factors over the feeding period
2. Daily pattern of odour emissions
3. Short-term influences on odour emissions (e.g. feeding)
4. Investigation of potential factors affecting emission amount through time-parallel determination of the surrounding conditions and possible influence factors.

Trial equipment

The trials were conducted in experimental housing for feeding pigs at Hohenheim University [6]. The compartment was fully slatted and force-ventilated with underfloor air

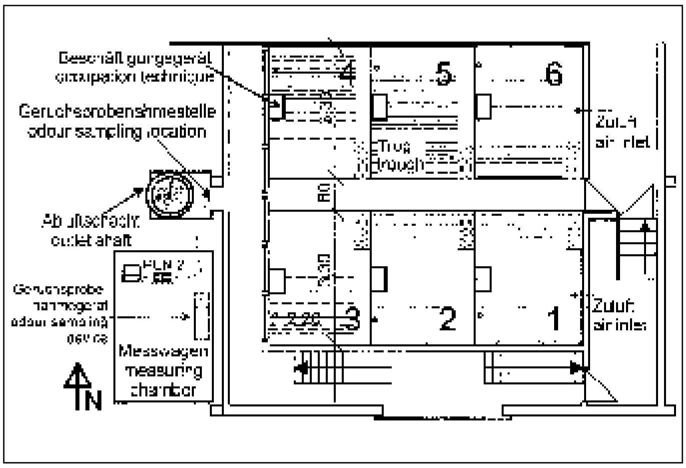

Fig. 1: Layout of the investigated pig house

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Odour, olfactometry, electronic nose, pig housing

withdrawal via a single exhaust air shaft. *(fig. 1)*. Feeding was at intervals of 1.5 hours between 6 am and 10 pm.

Sampling
The olfactometry and „electric nose" sampling points and the odour samples were taken immediately before the exhaust air shaft. The ~ 4 m Teflon sampling tube led to an adjacent measurement wagon containing the „electric nose" with equipment for the conditioning of reference air and the vacuum sample-taker which filled the 10 l capacity Nalophan(r) bags with smell samples for the olfactometer.

Olfactometer T07
After filling the sample in a bag the odour concentration was measured within eight hours by the T07 olfactometer [7] which worked in agreement with the CEN example prEN 13725 [8]. The selection of tester also took place according to CEN standardisation with n-butanol test gas which was also used for every olfactometry sitting for testing the actual condition of the testers.

PEN 2 „electronic nose"
A PEN 2 model from WMA Airsense with chemosensor-array of 10 metal oxide sensors was used [9]. The individual sensors are differently coated and thus reacted with differing sensibility to certain gas and odour constituents. Taken as measurement signals were the sensors' electrical resistance R or the electrical conductivity G which, through adsorption or catalytic reaction, altered the gas and odour material on the sensor. The sensor signal from the air sample was then compared with the signals R_0 or G_0 from odour-free reference air.

An internal pump sucked sample air from the same sample point as used for olfactometry *(fig. 1)*. The sample air was drawn through a Teflon filter to avoid damage to sensors. The „electronic nose" can be used in a continuous or semi-continuous mode where, through regular rinsing of the chemosensor-arrays with conditioned reference air, the sensor signal is repeatedly calibrated at a uniform zero value.

Further measurement parameters
For calculation of odour emission, the exhaust air volume flow is measured via calibrated recording fan fitted into the exhaust air shaft. Additionally, for determination of conditions in the housing and in the exhaust air, as well as identifying possible influence factors on odour emission, air temperature, relative air moisture content and dust content were all continually recorded. The latter was recorded by „Dust Track TM" aerosol monitors [10] and animal activity via passive infrared sensors [11]. Additionally, ammonia concentration in the exhaust air was recorded for checking a possible analogy between ammonia and odour release on the basis of similar release sources and mechanisms.

First results

Complete measurement results will be presented later. At this point, however, the first results should show that the sensor signals of the applied „electronic nose" were subject to substantial alterations on the basis of time which could be traced to variations in the odour substance and gas composition in the exhaust air.

In *figure 2*, the pattern from the 10 sensor signals of the „electronic nose" during a feeding time is shown. The strongly developed rise in the signals at the beginning of feeding time can be recognised. After the feeding period of a few minutes the values gradually fall again. During feeding, pig activity is substantially increased. Alongside feed consumption on its own, there's increased production of urine and dung and animal movement also increases which leads to renewal and opening of emission-active surfaces. This results in an increased release of odour substances and gases, reflected in higher sensor signals. Parallel olfactometric measurements must show whether this also becomes apparent through an increase of olfactometric odour substance concentration.

Summary and outlook

First results clearly indicate the potential of „electronic noses" for measuring dynamic changes of odour substances and gas composition. Parallel olfactometric measurements with „electronic nose" enabled the exploitation of each method's advantages and the balancing-out of each method's disadvantages. Evaluation methods adjusted to meet the problems should determine possible relationships between the sensor signals of the „electronic nose" and the olfactometrically analysed odour concentrations. Results will be presented in a second part.

Alongside the evaluation and presentation of the results the aim is to give recommendations for the number and choice of suitable representative sampling times and create a data basis for dynamic observation of outer expansion calculation. A chemosensor-array could, in future, represent a suitable instrument enabling long-term monitoring of odour patterns and which could be integrated as electronic sensor in the regulating system for odour reduction ventilation control.

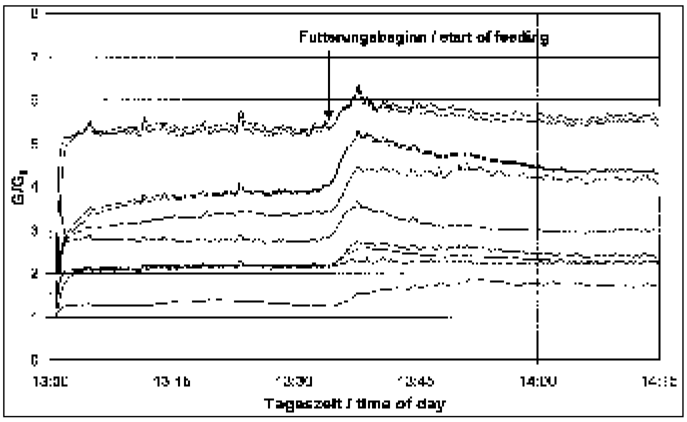

Fig. 2: Course of signals of the "electronic nose" during a feeding time

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