Katja Schöpf and Andreas Gronauer, Freising

Plume Measurements of Odour Immissions from Outdoor Pig Climate Houses

Odour Plume Inspection Results

In order to measure the odour immissions caused by pigs in outdoor climate houses, odour plume inspections were made over a six month period on various housing types, in accordance with VDI 3940 [1]. It could be shown that the minimum distances to residential and commercial buildings required by TA Luft are not justified for normal operations in Bavaria (up to 80 livestock units). The transferability to larger housing units still needs to be examined.

Dipl.-Ing. agr. Katja Schöpf is scientific assistant at the Institute of Environmental Technology in Land Use at the Bavarian State Research Centre of Agriculture; Dr. agr. Andreas Gronauer is coordinator of this Institute. Address: Am Staudengarten 3, 85354 Freising, e-mail: *katja.schoepf@lfl f.bayern.de*.
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Keywords

Immissions, odour, plume measurement, outdoor climate houses, pigs

Literature

Literature references can be called up under LT 03416 via internet http://www.landwirtschaftsverlag.com/landtech/local/literatur.htm.

Despite comparatively small stables in Bavaria (Ø 12,3 livestock units of fattening pigs), outdoor pig housings get more and more common there for reasons of animal and environmental protection, animal health and economy. Numerous obscurities about the immission effects of these stables bring difficulties about for the authorising agencies in the rating of distances to residential and industrial buildings. The consisting legal and administration basis (TA Luft [2]; VDI-Richtlinie 3471 [3]) does not specify on marginal immissions nor takes for outdoor climate housings into account. For these stables empirical data to size minimum distances do hardly exist.

Purpose

On the base of plume measurements, distance rules for outdoor housings were compiled. Also the influence of factors concerning meteorology and management at the dispersed odour immissions were tested.

Methods of investigation

The plume measurements at eleven naturally ventilated and one forced ventilated stables in Bavaria were made in accordance to the VDI-Richtlinie 3940 [1]. Different to this guideline a scoring system from 0 to 3 was developed (grade 1: crossing the detection threshold; grade 2: crossing the recognition threshold). From April to October 7 to 8 measurements per farm have been accomplished each with 4 to 5 participants. As additional peripheral parameters the air temperature and humidity outside (≈ 50 cm above ground), the stable climate (grade of dirtying of animal bodies and ground), the air temperature and humidity inside (≈ 50 cm above ground) and the number of livestock units were registered .

Data evaluation

The determination of maximum thresholds at the farms was made by scatter diagrams (x: average distance between cross section and edge of the farm building; y: arithmetic mean of the percentage odour time per cross section). The detection threshold was defined by the frequency of occurrence of grade 1, the recognition threshold by the total of grade 1 to 3.

The minimum, maximum and average thresholds within (as far as possible) homogeneous subgroups were acquired on the same way [e.g. grouping in type of ventilation, dispersion class (VDI 3782, sheet 1, appendix A, [4]) and number of livestock units]. These groups were compared. By using univariate analysis of variance, the in-

Table 1: Compilation of the most important operating data

Farm	Design	Ventilation	Kind of Husbandry	Animal Places	Treatment
0	warm stable	positive flow, exhaust ventilator	fattening house	700	no straw
1	cave	ridge open, front with windscreen	fattening house	560	no straw
2	foil	ridge open, sides with windscreen, jalousie	fattening house	600	with straw
3	bed	windscreen, jalousie, 4 exhaust ventilators	suckling pigs	2000	no straw
4	deep litter	ventilation damper at the sides	breeding sows	50	with straw
5	boxes	ridge open, spaceboard with jalousie	fattening house	456	no straw
6	boxes	spaceboard	fattening house	650	no straw
7	boxes	ventilation damper at the sides	fattening house	680	with straw
8	deep litter	windows and damper	fattening house	400	with straw
9	boxes	ventilation damper	fattening house	700	with straw
10	boxes	windscreen, jalousie, exhaust ventilators	suckling pigs	1200	no straw
11	bed	ridge open, spaceboard with jalousie	breeding sows	120	with straw

fluence of the peripheral parameters on the percentage of odour times within each group was statistically examined (probability of error 5%).

Results

The highest detection thresholds were found at fattening houses, such as farm Nr. 7 (225 m; 88.4 l. u.), Nr. 1 (150 m; 78), Nr. 5 (121 m; 59.3) and Nr. 2 (117 m; 78), the lowest ones at the farms Nr. 4 (24 m; 17.5), Nr. 8 (55 m; 49.4) and Nr: 9 (60 m; 91).

With these results it can be assumed that the number of livestock units would have an obvious impact on odour immissions. However, on the basis of scatter diagrams, it became evident that a high number of livestock units does not necessarily mean a high detection threshold - except numbers of livestock units < 20 (below 20m). Between 44.2 and 91 livestock units the detection thresholds were highly varying. The numbers of livestock units showed no obvious correlation to the detection thresholds, neither did the stable climate. The statistical examination extensively confirmed this conclusion - except in case of extremely high or low odour immissions. The recognition thresholds were not regarded within this examination.

The air flow inside and outside of outdoor housings are substantially determined by the system of ventilation, the direction and force of wind and the circumstances of dispersion. Both, exclusive lateral ventilation and additional eaves-ridge ventilation, had average detection thresholds of 57 m maximum thresholds 225 and 150 m), so that the groups couldn't be differed. The higher variation of measured values in the first group was namely caused by stable Nr. 7. A statistical analysis of the factor „system of ventilation" was not possible because there were only two variants.

Within nearly all groups the wind force had an significant influence - except in case of average wind forces below 2 m/s. The comparison of those groups with the most frequent dispersion classes (III/1, III/2, IV, V) showed that in case of class III/1 or III/2 the highest odour immissions were detected. This conclusion was statistically verified.

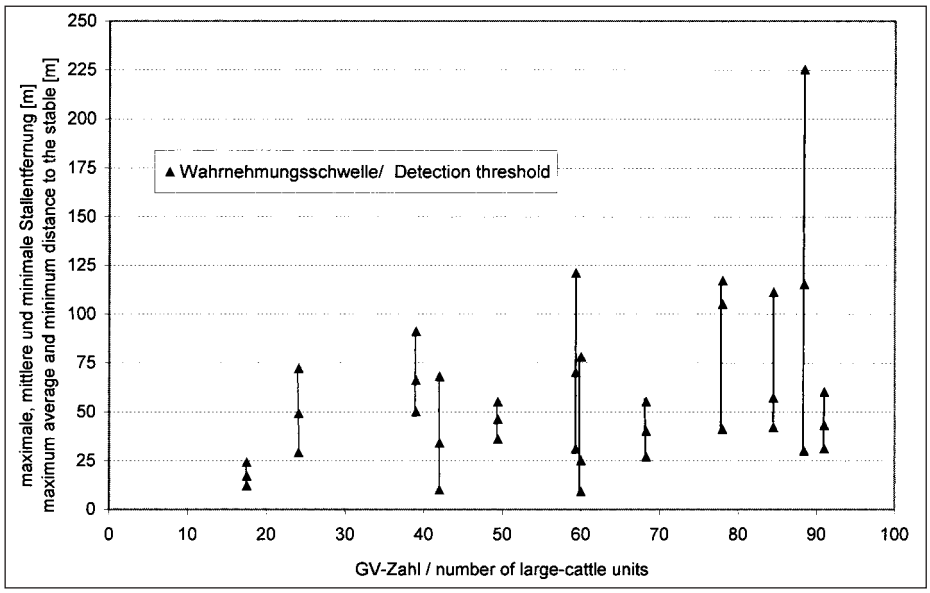

Fig. 1: Detection thresholds with different numbers of „large-animal" units

Outlook

The simultaneous impact of numerous peripheral parameters and their interaction means a special difficulty concerning the examination and interpretation of immission data. However this analysis brought up that the meteorological circumstances (especially direction and force of wind) at each location represent parameters of importannce. This fact might cause that other parameters such as the number of livestock units take a back seat so that the highest number of livestock units does not necessarily cause the highest olfactory nuisance .

According to this examination, the minimum distances postulated in TA Luft might cause an overestimation of odour immissions at outdoor housings in some cases. Because the transferability to bigger stables (> 80 livestock units) was not examined further investigations would be necessary in order to reach the aim of an odour prognosis system for naturally ventilated stables.

Farm	Max. Detection-threshold [m]*	Max. Recognition-threshold [m]*	l. u.	Kind of Husbandry
0	220	no dates	91	fattening house
1	150	85	78	fattening house
2	117	54	78	fattening house
3	78	9	60	suckling pigs
4	24	< 13	17,5	breeding sows
5	121	< 16	59,3	fattening house
6	111	< 30	84,5	fattening house
7	225	30	88,4	fattening house
8	55	< 28	49,4	fattening house
9	60	31	91	fattening house
10	72	< 17	24,1	suckling pigsl
11	68	46	42	breeding sows

*rounded up

Table 2: Detection and recognition thresholds of the animal houses examined

Literature

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