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Effect of Animal Activity on Particle Composition in Various Pig Fattening Housing Systems

Especially in pig houses, animal activity measurements have disclosed a close interrelationship with particle dynamics. A series of investigations determined keeping specific and seasonal differences in preparatory and in finishing fattening houses. The investigations showed that, in addition to animal activity, indoor temperature, relative humidity and air volume flow had a strong influence on particle release.

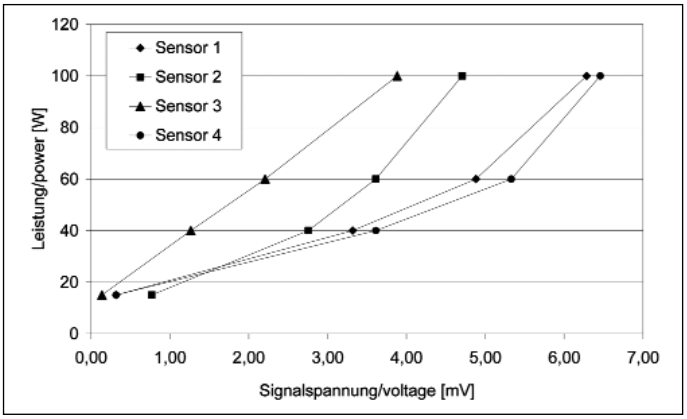

Fig. 1: Calibration data of infrared activity sensors

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Keywords

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Literature

References can be called up under LT 08319 via Internet www.landtechnik-net.de/literatur.htm

Pedersen [1] was the first to prove a close correlation between animal activity and the concentration of particles in the indoor air of livestock houses. His measurements – as well as those carried out for the present paper – used passive infrared sensors which can be used to record the temporal activity development of a group of several pigs. Bönsch and Hoy obtained comparable measurement results [2]. It is impossible, however, to detect the activity levels of individual animals. When analysing particle concentrations in the exhaust air from pig houses, it is important to bear in mind that particle size distributions vary depending on different climatic conditions, housing systems and production phases. Thus, the question arises whether animal activity contributes to these different particle distributions. In addition to providing an answer to this question, the present paper also touches upon the calibration results of the sensors used for the measurements.

Methods

The housing systems under study

The measurements for strawless housing systems were carried out in a fattening house for 112 pigs, which was equipped with a fully slatted floor, door ventilation and a floor-level exhaust system. The livestock house with straw beeding was equipped with door ventilation and a floor-level exhaust system as well. The pens with plane floor surfaces were arranged along the feeding passage. Their rear areas, which contained the straw bedding, could be accessed by the pigs via three steps. Fresh straw was added every day. The resulting manure mattress was removed from the pens at the end of the fattening period.

Additional parameters measured in the stables

Particle concentrations were measured continuously in accordance with measurement procedures standardised for occupational health purposes [3, 4]. One advantage of the scattered-light spectrometer used in the measurements was that it categorised particle numbers into 15 size ranges, according to their scattered-light diameters. The size-dependent particle densities were taken into account in the conversion of particle numbers into the corresponding particle masses [5].

Calibration of the passive infrared sensors

The operation principles and the specific modifications of the infrared sensors used are described in [6]. For each sensor, a calibration curve was drawn up, which transformed the output signal into comparable data. In the calibration process, the sensitivity of the individual sensors was tested using light bulbs with different power levels. The diurnal progression describes the relative deviation of the individual values from the daily mean. Accordingly, animal activity can be

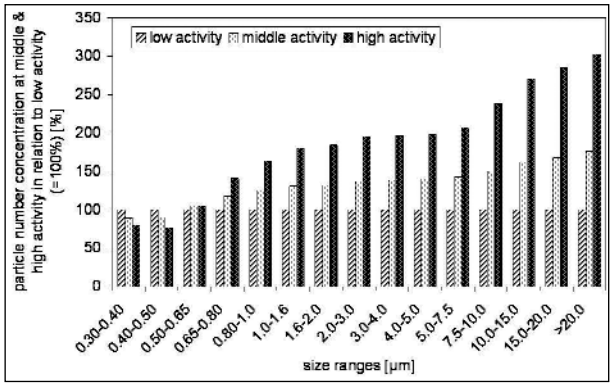

Fig. 2: Particle number concentration at middle and at high animal activity in relation to low activity (=100%)

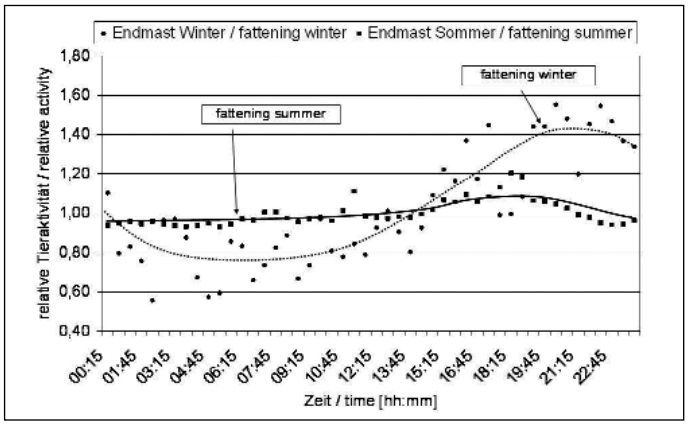

Fig. 3: Daily animal activity in fattening pig houses in summer and in winter

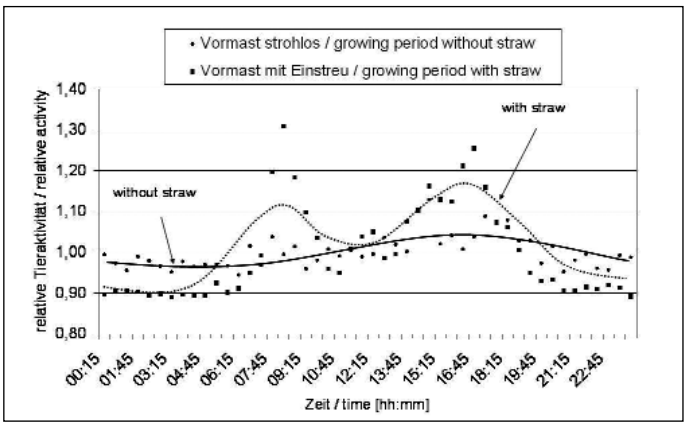

Fig. 4: Daily animal activity in preparatory pig fattening in littered and in non-littered houses

recorded in its relative progression, but not as an absolute value. The present paper shall examine in some detail the role of animal activity as an influencing factor on particle emissions. *Figure 1* presents the calibration curves of the four activity sensors used in the experiments.

Results and discussion

Influencing factors on particle emissions

In addition to animal activity, the other parameters monitored as possible influencing factors affecting particle concentrations in the course of individual days or in the seasonal progression of entire years were indoor temperature, air humidity and air volume flow. The results of the statistical analysis and assessment of the influencing factors show that animal activity is the main influencing factor not only during the preparatory feeding and finishing phases, but also in terms of variations between seasons. Air volume flow and air humidity alone also affect particle concentrations (*Table 1*), but this effect cannot be explained systematically.

Correlation between animal activity and particle distribution

Subsequent to the analysis of the influence of animal activity on particle mass concentration [6], the possible correlation between particle number concentration, animal activity and particle size had to be determined. The proportion of larger particles was higher in the immediate vicinity (2 m) of the exhaust point than at a distance of 9 m. The individual particle number concentrations in the exhaust air flow were categorised into three activity ranges for use in further investigations. The three ranges were defined in dependence on the maximum and minimum values of animal activity. Within each activity range, it was possible to calculate the average particle number concentrations for the different particle size ranges. *Figure 2* presents the calculated particle number concentrations at medium and high levels of animal activity in comparison to concentrations at low activity levels. From a particle size range between 0.65 and 0.80 µm upwards, particle number concentrations increase with increasing levels of animal activity. The larger the particles are, the greater are the differences. The figure shows how the concentration of large particles in particular increases with increasing animal activity.

The correlation between animal activity and climatic conditions

Seasonal influences of animal activity are evident during the finishing phase. In winter, the low heat tolerance of heavy animals leads to stronger deviations from the daily mean than in summer. In winter, moreover, the variation range is 21% larger than in summer. The diurnal patterns presented here were calculated by averaging n = 4 days of measurement in summer and n = 3 days of measurement in winter. In the summer measurements, changes in animal activity remained negligible even during daily animal checks. Only in the evening hours were changes more marked. Activity increases observed in winter conditions between 3 and 5 p.m. cannot be explained with reference to the recorded measurements.

Differences between housing systems with/without straw

Animal activity measurements were carried out during the transitional season in a stable with straw bedding and in a strawless stable. They coincided with the preparatory feeding period. The activity patterns depicted in *Figure 4* differ in terms of activity increases during the scattering of straw in the morning and during the animal checks carried out in the evening. Both effects are due to animal management activities. In the stable with straw bedding, the farm manager enters the animal area itself to carry out animal checks, whereas in the strawless stable the checks are carried out from the feeding passage. Apart from during the scattering of fresh straw and during animal checks, the differences between the daily animal activity patterns are small. Comparing absolute activity rates was impossible because the number of animals per sensor as well as the pen sizes of the two systems differed.

Conclusion and outlook

The experiments concerning particle concentrations in the indoor air of pig stables show animal activity to be the main influencing factor on the release of particles. Regardless of the time of year, it has a significant effect on the particle mass concentrations in the exhaust air during the preparatory feeding and finishing phases. Moreover, an increased number of large particles during increased animal activity imply higher particle emissions. Seasonal differences in the daily animal activity patterns have to be attributed to the pigs' natural behaviour. Their activity rate decreases in warm temperatures. In terms of the daily activity patterns of the pigs, there were no significant differences between stables with and without straw bedding. Future investigations into particle dynamics in livestock houses and research into particle emissions should take animal activity into account as a major influencing factor. This would significantly help explain causal relations in this field of study.

Table 1: Significances and Beta-coefficients of the influencing factors on dust in housing systems investigated

Predictor variable	Preparatory feeding summer		Preparatory feeding transitional season		t. s. straw		Finishing summer		Finishing winter	
	p	Beta	p	Beta	p	Beta	p	Beta	p	Beta
Animal activity	0.000	0.45	0.000	0.69	0.000	0.54	0.000	0.79	0.000	0.71
Luftvolumenstrom	0.005	0.20	0.636	0.09	0.003	0.19	0.743	0.02	0.068	0.37
Luftfeuchtigkeit	0.000	-0.52	0.106	-0.24	0.329	-0.06	0.001	-0.15	0.000	-0.67
Innentemperatur	0.015	-0.14	0.489	-0.13	0.028	0.13	0.000	-0.25	0.87	0.03

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