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Microscopic Test of Dust Particles in Pig Fattening Houses

Differences between Dry and Liquid Feeding

There are dry and wet feeding plants for pigs. Tests till now have shown significant differences in dust composition and dust concentration. High feed dust concentration can be found in the house air of dry feeding systems. In houses with wet feeding, feed dust can often not be detected. This research demonstrates to which extent the differences can be found in current state of the art. Only fractional differences in particle size distribution and particle form could be determined in modern facilities.

Some studies of the last years show that houses with wet-feeding-systems release less than 50 % particles (mg/m^3) than houses with dry feeding-systems [1, 2]. In those wet feeding systems "feed" is barely detectable as a source for dust particles. Dawson measured a high concentration of particles in barns with ad libitum dry-feeding-systems [1].

In consideration of recent technological solutions the differences should be checked in both feeding systems. A comparison of the technological constructions of both feeding systems shows just a few differences that have an influence on the composition of particles.

Tested pig fattening houses

The particle size distribution and the particle shapes in the air were analysed in two fattening pig barns with 100 pigs each and with two different feeding systems (dry - wet). Both barns were configured with complete slatted floors and occupied by fattening pigs, each with a weight of 85 kg. The principle of ventilation was forced ventilation through the doors.

The dry feeding system consists of pipe wet feeders that were filled by a feed hopper five times a day. The wet feeders were closed on the top. A pipe leads from the feed valve at the feed chain to the wet feeder, whereas the feed has no contact with the air. The dry feed can be watered in the feeding bowl by the pigs.

The wet feeding system conveyed the wet feed with a dry matter content of 22-24 % to the feed bowls six times a day. The mixing tank was only filled with ground components. It took only a few minutes till the feed bowl was emptied by the pigs at each feeding time.

Methods of measurement

The dust particles were collected with an eight stage impactor (Andersen-Sampler from Schäfer-Technology, Langen) in both feeding systems. The sampler divides the particles into eight stages according to their aerodynamic diameter. The sampler was located 1 m over ground. The sampling time was 20 minutes. To carry out a microscopical analysis the particles were collected with glass impactor plates. In addition to the studies in the barns, feed dust was analysed with the same method.

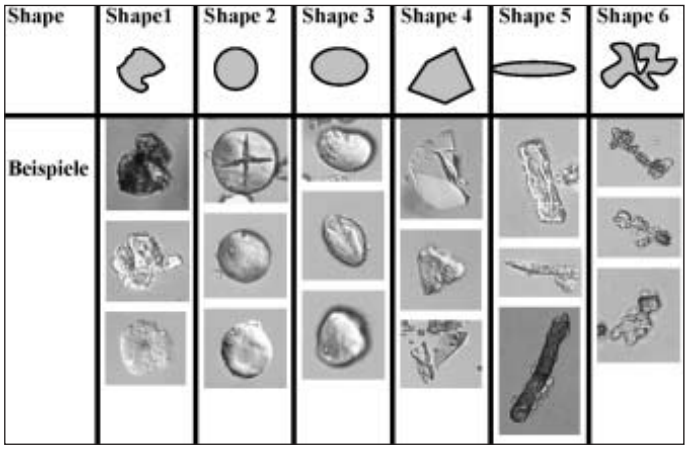

Table 1: Classification of particle structure after shapes

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Keywords

Dust, dust origin, particle size, particle form, fattening pigs, liquid feeding, dry feeding

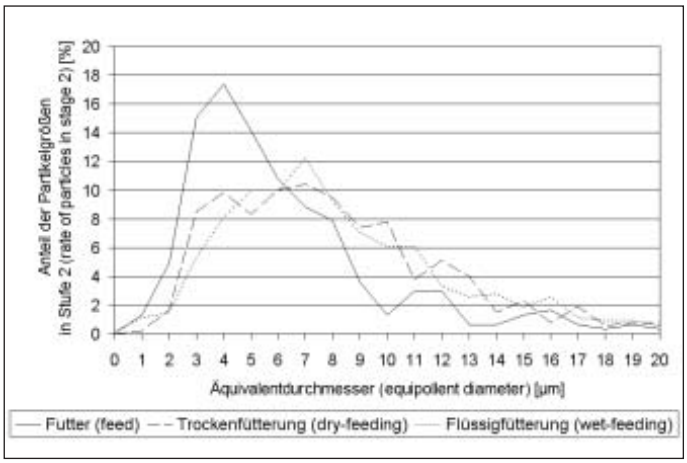

Fig. 1: Percentage of particle sizes at the respective equivalent diameter in µm in stage 2 of the Andersen-collector

Evaluation procedure

The microscopical analyses of the dust particles are carried out with a transmitting light microscope (Leitz, Wetzlar) with an attached digital camera. The observed microscopic pictures were photographed. It was possible to define the surface areas of the particles which were the main base for the sizing of the particles with image software. Beside the designation of the particle size, particle shapes classified. *Table 1* shows that there are not always exactly particles of equal form in the same shape category.

Every photographed particle could be described according to its equipollent diameter and its shape. Altogether the number of analysed particles from the feeding systems was n = 600 in each stage.

Results

The counted averaged equipollent diameters are equal to the aerodynamic diameters which are specified for the Andersen samplers. *Table 2* shows a comparison between the calculated averages and the theoretical defined aerodynamic diameters of the Andersen sampler.

In the following the particle size distribution and shape of the particles in each stage of the Andersen sampler will be used to describe the differences between the feeding systems.

Particle size distribution

The particle size distribution of the dust from dry and wet feeding systems is nearly identical in the stages 0 to 4. Therefore, stage 2 of the Andersen sampler is shown in *Figure 1*.

Stage 5 shows higher rates of smaller particles with equipollent diameters < 1 µm. In stage 6 the trend intensifies, whereas stage 7 rests on one level again in both feeding systems.

Shape of the particles

There are differences between the two feeding systems in all shapes. For example, in shape 1 the percentages for in both feeding systems differ only in stage 5 to 7 of the Andersen sampler. The smaller the particle size the higher is the rate of oval and round contents.

Discussion

In association with the results of the particle size distribution the conclusion can be drawn that dry feeding systems tend to result in higher dust releases than in wet feeding systems only in the stages 5 to 7 with diameters less than 1 µm.

But in the microscopic studies an increase of particles with equipollent diameters less than 1 µm can be detected. In stages 5 to 7 mainly these particles take a big sphere. So the difference between the feeding systems can be explained by testing feed dusts.

The dust reduction of 50 to 58 % can only be confirmed as a trend but not quantitativley, because a determination of the dust concentration has not been carried out. Both feeding systems are conforming. Furthermore, the differences between the feeding systems can only been found in the time from feeding to feed intake. However, the release of particles in the dry feeding system depends on the watering of the feed by the pigs. An observation in the dry feeding system shows that not all the feed is moistened by the pigs. Some parts stay dry. So the animal is an incalculable factor.

The particles in the wet-feeding-system are bonded by moisture. On the other hand the feed stays in the feeding bowl only for a short time. Only dry residues of the feed disperse into the air. They are not directly eaten by the pigs. As in dry feeding systems, the effect of the water on the feed can probably have an effect on the shape of the emitted particles. The influence of water absorption in the mixing tank on the shape of the particles could not be identified in this study.

Conclusion and outlook

Hitherto assumed differences in dust formation between dry and wet feeding-systems have to be put into perspective. With new technological solutions a nearly identical low formation of dust can be achieved in dry feeding systems and in wet feeding systems. Such new systems for dry feed, for example pipe wet feeders, are the current state of the art. Subsequent studies could be added to reduce dust concentrations in the air and to induce research about dust sources for the decrease of emissions.

	Feeding dust	Dry feeding	Wet feeding	Theory Andersen-Collector
Stage 0	6.40	13.62	12.80	> 11
Stage 1	5.34	8.31	8.34	7 to 11
Stage 2	4.69	6.92	6.89	4.7 to 7
Stage 3	2.79	5.03	4.71	3.3 to 4.7
Stage 4	1.29	3.13	3.37	2.1 to 3.3
Stage 5	0.81	0.61	1.87	1.1 to 2.1
Stage 6	0.48	0.59	1.37	0.65 to 1.1
Stage 7	0.33	0.40	0.41	0.43 to 0.65

Table 2: Comparing of computed means of equivalent diameters with the theoretically determined classification of aerodynamic diameters of the Anderson-collector [3], figures in µm

Literature

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