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CO_2 Measurements in a Fattening Pig House

Exposure to noxious gases in pig fattening houses presents an increased risk to respiratory health for both humans and animals. To improve house air quality carbon dioxide contents can be monitored with sensors in the stable and be linked as a controlling parameter to the ventilation control system. The range of CO_2 content in the house air within a compartment and the importance of the measuring location are demonstrated in this paper. The results from two different CO_2 measuring techniques are compared here.

Carcass findings show that up to 50% of the lungs of fattening pigs show clinical symptoms [1], which can be linked to high concentrations of noxious gases in the animal areas. From an economic perspective, the total losses are of less interest than the greater economic damages due to the longer fattening period for sick animals due to their delayed course of growth. Depending on the extent of the lung damage, this can be converted into a loss of 17 Euros per slaughtered pig. For humans, work in animal house also presents an increased risk for the development of work-related bronchial symptoms and the development of respiratory system obstructions [2]. Furthermore, worldwide emissions should be reduced. Climate protection programs demand the reduction of climate-relevant green house gases, of which about 10% are released by agriculture [3]. In order to improve the air quality in barns and to reduce the noxious gas emissions at the same time, a CO_2-based exhaust control seems to make sense.

Within the framework of the project "Reduction of Exhaust Volume Flows of current Animal Husbandry Processes through Automatic Air Control Based on Noxious Gas Concentrations with Consideration of Animal-Appropriate Stable Air Quality," CO_2 measurements were undertaken with fattening pigs in the Institute of Process Engineering at the FAL Braunschweig. In order to make a statement on the air quality differences within the animal bays, a so-called carbon dioxide profile was created. For this purpose, CO_2 and other concentrations were measured at different locations in the testing bays. The data was compared with the results of independent exhaust quality measurements in the neighbouring Institute for Technology and Biosystems Engineering.

Material Methods

The tests took place in the experiments pig fattening stall of the FAL Braunschweig. To create the carbon dioxide profiles, measurements were carried out in four almost identical sections, two with 16 animals each, and two with 18 animals each. The CO_2 levels in the air were documented with sensors from the Dräger Co. The sensors used were Polytron IR CO_2 NDH sensors with a measurement level of up to 5000 ppm. Data was stored with a FSU8-climate computer from the Fancom Co. One sensor was available for each section. Over a period of 42 days, the sensors were regularly relocated. The measurement sites were selected according to the functional activity, lying and manure areas. The sensors were installed at two different heights, one at 30 cm under the ceiling, and the other at the height of the animals. The sensors at the animal level were at a safe distance directly above the animals and were regularly raised as the animals grew in height. The exhaust air was analyzed with a Multor 610 from the Maihak Co. This analyzer measures oxygen and carbon dioxide concentrations. Both measurement components were measured simultaneously [4]. The air samples were taken from the exhaust canal and transported to an NDIR measurement process (non dispersive infrared spectroscopy)

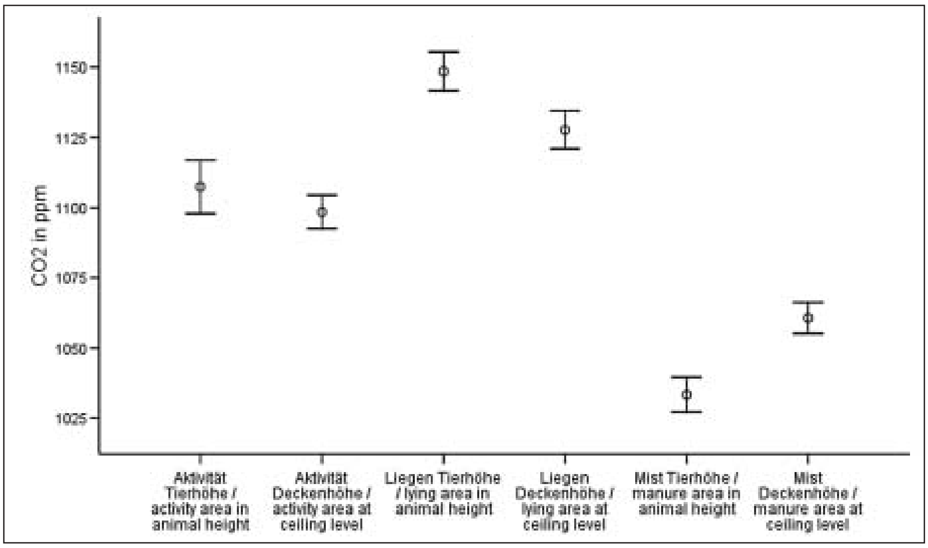

Fig. 1: Carbon dioxide profile versus different measuring sites

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Keywords

Carbon dioxide, pig fattening husbandry, profile development, measuring techniques

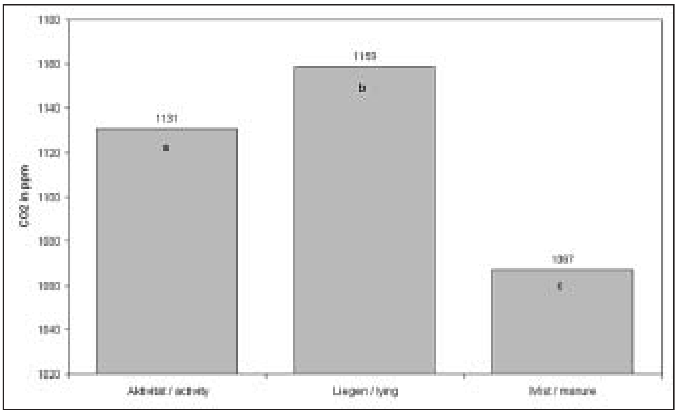

Fig. 2: CO_2 contents in different funtional areas

in a heated VA tube. The measurement value readings were carried out with OPTAS software. The measurement range was between 0 and 5 percent volume. Since other measurement sites were attached to this equipment, there was a longer measurement interval in comparison with the sensors in the sections. In order to make the two analysis processes comparable, the measured values were documented hourly.

Results and Discussion

The measured CO_2 concentrations showed visible differences (*Fig. 1*). The greatest difference of 120 ppm could be ascertained between "manure / animal height" and "lying / animal height." The least differences were found within the measurement heights of the individual functional areas, whereby the "manure area" played a special role here. Significantly lower values were obtained in "animal height" while in comparison in the other areas lower CO_2 levels were detected in the air at the ceiling level. This shows that a mixing of the air occurs. The mixture took place throughout the entire section and the values near the average the further they are taken from the largest source. This also means that the CO_2 levels at the ceiling level are more equal to each other than the CO_2 levels in the animal area.

Most decisive here is the difference between the housing areas. The highest values were calculated for the "lying area". The largest difference was found between the "lying" (1159 ppm) and the "manure" areas (1067 ppm) (*Fig. 2*). An explanation could be that carbon dioxide is mainly produced through breathing [5]. The animals spend the least time in the manure area, but the most time, about 80% of the whole day (older pigs more than younger pigs) resting [6, 7]. The effect that an active animal produces more CO_2 than a resting animal [8, 9], appears to be a consequence of the fact that this occurs less frequently and mostly for individual animals. In comparison, the more frequent lying in a group over the course of the day results in higher CO_2 values. Moreover the cause for lower carbon dioxide content in the manure area can be explained by the fact that under alkaline and damp conditions CO_2 will be absorbed [10]. The differences are consistent and thus significant.

In comparing the two CO_2 measurement processes over multiple runs, it becomes clear that the concentrations analyzed in the exhaust are continuously significantly higher. All in all, the two measurement processes show the same concentration courses, only at different levels (*Fig. 3*).

The differences can in part be explained through the different measurement systems and also through the different measurement sites. The air in the exhaust channel is sucked out of the entire animal bay and thus mixed, while with the sensors in the bay, hardly any or much less active mixing took place.

Summary

The carbon dioxide levels in the air of a fattening pig section differ significantly in dependence of the measurement site. The highest values are found in the lying area near to the animals (1149 ppm), while the lowest values (1033 ppm) were observed at the animal level in the manure areas, which can explained through the duration of pig visits to each area.

The comparison of both measurement processes shows that in the exhaust higher CO_2 levels were measured. This can be attributed to the different measurement processes and the different measurement sites. All in all show the two measurement processes equal concentration courses at different levels.

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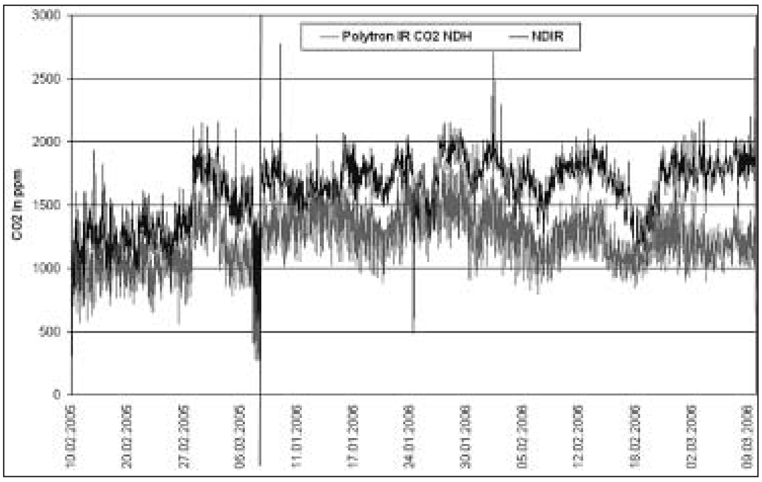

Fig. 3: Comparing CO_2 values from the measurement methods Polytron IR CO_2 NDH and NDIR