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Combined Exhaust Cleaning Systems in Pig Houses

In recent years guidelines (TA-Luft - technical regulations on air pollution control; GIRL - odour immission guidelines) were established, which designate the threshold values for non-air foreign substance emissions and immissions. For the agricultural sector, ammonia, dust and odour concentration from animal house exhausts is significant. Expansion and new constructions are subject to these guidelines. The demands on exhaust cleaning systems have risen nowadays. In Cloppenburg, exhaust cleaning system certification is a prerequisite to a building permit. In a 3-stage exhaust cleaning system, the cleaning capacities for dust, ammonia and odour, as well as energy consumption, were ascertained.

In the context of a research project, a suitability test of a three-stage exhaust air cleaning system was carried out with regard to its capacity to remove dust, ammonia and odour. The emission source, a fattening house for 650 pigs, is equipped with a MagixX exhaust air cleaning system available from Big Dutchman International GmbH. The air cleaning efficiency of the system was tested in accordance with the specifications of the "Guidelines of the Cloppenburg district for determining the suitability of exhaust air cleaning systems in livestock management, for use in building permit procedures and in monitoring" (http://www.lkclp.de/formulare/kv_ba_biofilter_1.pdf)

The MagixX Exhaust Air Cleaning System combines three successive stages. The first stage primarily serves the purpose of dust removal. The system operates with a cardboard cooling-pad which is sprinkled with water from above. Having passed through the pad wall, the water is collected in a tank and subsequently recirculated. A sprayer, removing bigger dust particles from the wall, was installed upstream of the first cleaning stage to protect the pad wall from blockages.

The second stage is set up like the first, but it operates with an acidic additive in the circulated water. Sulphuric acid is added to the water for chemical cleaning, with the dosage depending on the pH value of the water.

The third stage operates with a bio-fill of root wood chips in stacked plastic boxes. The plastic boxes prevent undesirable sagging of the fill.

Measurement Technology

In the framework of the research project, measurings were taken in the summer and winter over a stretch of eight weeks each. The dust removal capacity of the filter was determined in weekly measurements of the dust concentrations upstream and downstream of the exhaust air cleaning system. The measuring system employed was an aerosol spectrometer available from Grimm Aerosol Technik GmbH & Co. KG in Ainring, Germany. Operating on the scattered light principle, it establishes the mass and number of particles in a size range starting at 0.3 µm.

The ammonia concentrations in the raw and clean gas were determined photo-acoustically with a Brüel & Kjær multigas monitor. The raw and clean gas samples were analysed in turn, with measurements being performed continuously.

The weekly odour measurements were performed with an olfactometer. The samples of raw and clean gas were analysed with a TO8 (or TO7) available from Ecoma Emissionstechnik und Consult Mannebeck GmbH. The raw gas samples were taken in the cen-

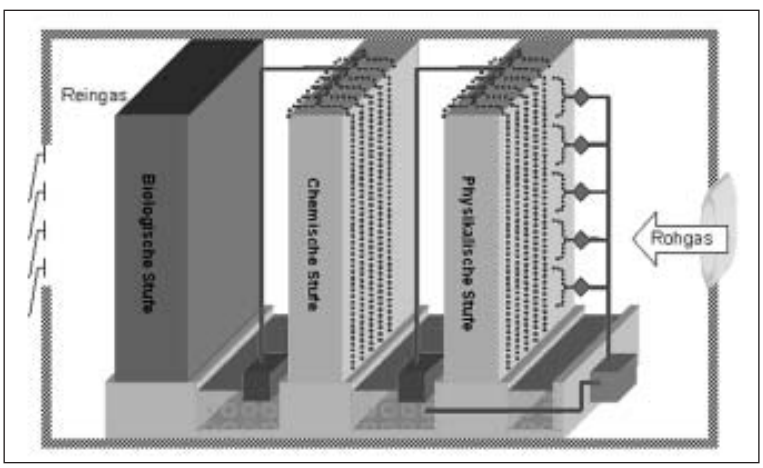

Fig. 1: Set-up of a 3-level exhaust cleaning system

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Keywords

Exhaust cleaning, reduction of emissions, reduction of odour-, ammonia- and dust- concentration

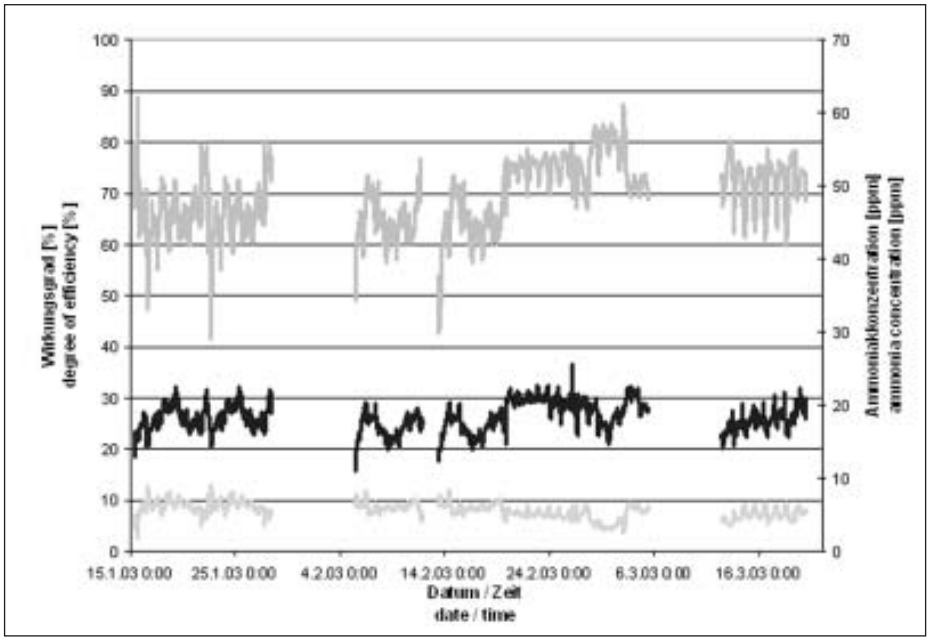

Fig. 2: Ammonia concentration during the winter period

tral exhaust air shaft upstream of the exhaust air cleaning system. The clean gas samples were taken downstream of the third (biological) stage. There was no need to use a sampling hood of the kind used with conventional biofilters, because the biological stage was situated within the filter room of the pig house.

As the measurements were taken in the framework of a long-term study, the measuring equipment was required to operate with high degrees of continuity and failure immunity.

Measurement Results

Measurements were performed over two periods of time. The average removal of respirable dust particles determined during the winter measurements, between 30 Oct and 2 Dec 2002, was 95.3 %. The removal efficiency measured during the summer, between 26 June and 22 Sep 2003, was 95.1 %.

The continuous measuring of ammonia produced a large amount of data. As the following diagrams show, the ammonia concentration is very constant both in the raw gas and in the clean gas. The collected data reveal winter means of 24.1 ppm NH_3 in the raw gas and 7.2 ppm NH_3 in the clean gas. Accordingly, the cleaning efficiency was 70.1 %. In the summer period, concentrations dropped to 13.7 ppm NH_3 in the raw gas and 3.7 ppm NH_3 in the clean gas. The corresponding degree of ammonia removal efficiency is 72.9 %.

According to the olfactometric analysis of the odour particle concentrations in the raw and clean gas, there was no smell of raw gas to be detected in the clean gas. The mean of the winter measurements was 1858.5 OU/m^3 in the raw gas and 256.5 OU/m^3 in the clean gas. During the summer measurements, mean odour particle concentrations of 1330.9 OU/m^3 in the raw gas and 248.8 OU/m^3 in the clean gas were determined.

An average daily energy consumption of 30 kWh/h was determined for the pumps (one impeller pump and two submersion pumps) and the control equipment. This figure does not take into account the additional energy consumed by the fans, as a result of higher flow resistance.

Conclusions

The long-term measurements have proven the exhaust air cleaning system to be suitable for reducing air pollutants. Proof of the combined removal of dust, ammonia and odour by means of the system in question has been furnished. The system offers an opportunity to reduce emissions in regions with dense livestock populations or in adjacent residential areas and thereby to avoid conflicts.

The exhaust air cleaning system in question is a complex system that requires regular specialist checking and maintenance. Only on this condition, a cleaning performance at a consistently high level can be guaranteed.

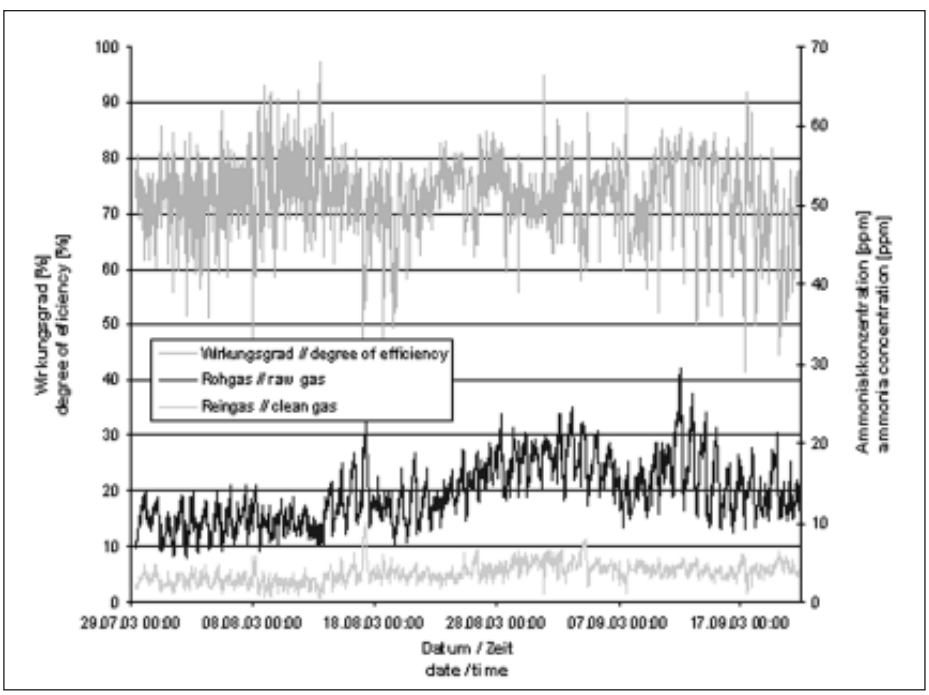

Fig. 3: Ammonia concentration during the summer period