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Composting pre-dried manure from poultry

A laboratory-scale composting plant was used for the description of composting processes using pre-dried poultry manure. This comprised a total of six heat-insulated batch reactors with forced ventilation. The very uneven quality substrate indicated an extremely low C/N ratio. This led to very high and almost constant ammonia emission over the whole three week trial period. A ventilation rate of around 7 to 8 l/kg dry matter and hour should not be exceeded for a good composting process and, where possible, an additional C-source should be mixed with the substrate.

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Keywords

Composting, batch reactors, poultry droppings, ammonia release, ventilation rates

The aim of the presented research work emerged from an EU research programme on the application of catalytic exhaust air cleaning reactors in agriculture [1]. The paper can be divided into four parts: description of the composting process using pre-dried poultry manure; calculation of ammonia emissions in association with different ventilation rates; C/N ratios and dry matter contents; calculation of the minimum ventilation rate.

Material and methods

A tested batch composting plant was used for conducting trials under constant and reproducible conditions [2]. The computer-controlled compost plant enabled different treatments to be tested in trial series at a laboratory scale.The plant comprised six heat-insulated and force-ventilated batch reactors (*fig. 1*). The air intake temperature was determined in the common supply pipeline for the six reactors before it was distributed between the reactors. A floating-body flowmeter was incorporated with each reactor for controlling the ventilation rate. The reactors had a total volume of around 60 l. The substrate was piled to a height of around 0.3 m onto the stainless steel sieve flooring, representing a usable volume of around 36 l. The compost substance was ventilated through the air inlets in the underside of the reactor. The air space below the sieve floor represented a pressure chamber which ensured a consistent airflow through the rotting material (fig. 1). In the centre of every reactor was an air exhaust opening where the exhaust temperature was also measured. A PVC pipe running through the lid also had a sensor built into its end to determine substrate temperature. The exhaust air from the reactors was channelled via a measurement point switch through two consecutive gas analysers: one for determination of the ammonia concentration, the other for determination of oxygen and carbon dioxide concentration (fig. 1). The successive determinations of the three different gas concentrations requires 30 minutes per reactor. Thus, the gas concentrations of all six gas reactors were determined every three hours. So that ammonia concentrations were also able to be measured when above measuring instrument range (5,000 ppm), a dilution of the exhaust air flow with a defined amount of pure air was possible.

Results

The following report covers the results from three consecutive trials B, C and D. The ventilation rate was held constant within the individual trials for two or three of the reactors in each case. Because minimum ventilation rates of from 7 to 10 l/kg dry matter content and hour are given in the literature for pig and cattle manure [1, 2, 3], these were varied within a range of from around 2 to around 12 l/kg dry matter and hour. This was done

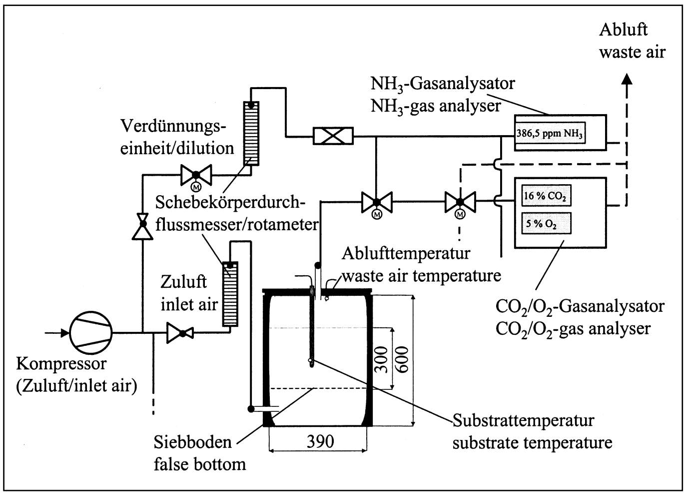

Fig. 1: Sketch of one section of laboratory composting unit

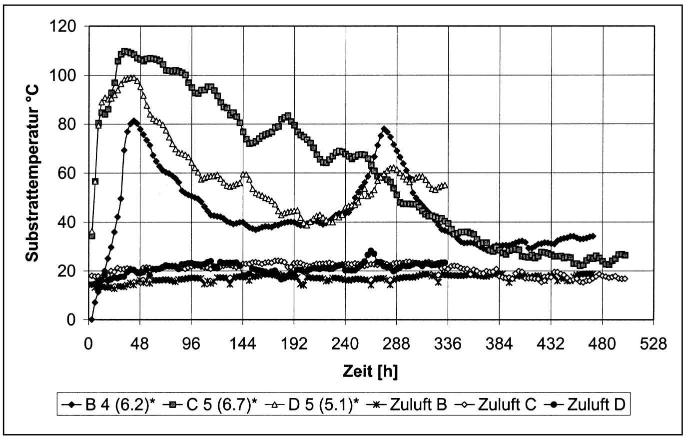

Fig. 2: Course of temperature of inlet air and substrate during composting of pre-dried layer hen droppings, compared with similar aeration rates (in [L kg^{-1}dry matter^{-1} h^{-1}]) during composting*

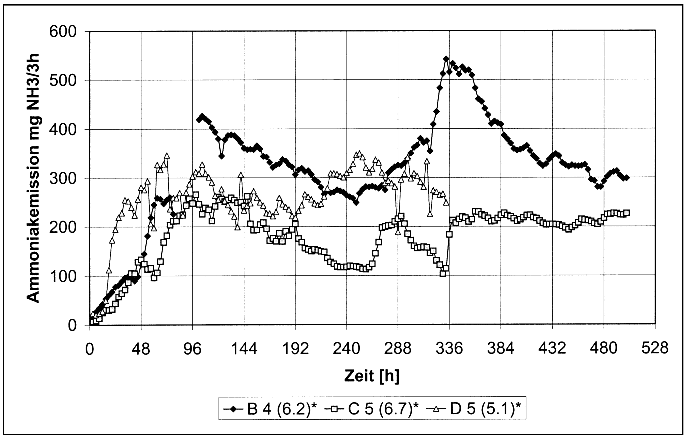

Fig. 3: Course of the ammonia emission released from pre-dried layer hen manure treated with similar aeration rates (in [L kg^{-1}dry matter^{-1} h^{-1}]) during composting*

especially to determine the minimum ventilation rate. In total, pre-dried poultry manure was characterised by a very marked non-homogeneity. Because of this, it proved very difficult to achieve an even as possible distribution on the reactors as well as obtain a representative sampling of the substrates for analysis of the contents. The dry matter content of the substrates varied between 35 and 75%, the C/N ratio ranged from 2:1 to 5:1 and was, therefore, at a very low level. In all trial series the inlet air temperature lay at a similar level and was able to be kept very constant over the total investigation period (two to three weeks) (*fig. 2*). Immediately after the start of the investigation the temperature of the substrate in all reactors rose quickly and reached a first maximum between 24 and 48 hours (fig. 2). As expected, the substrate temperature in all reactors of the trial series B up to at least 85 °C. In trial series C and D, on the other hand, the temperatures rose as high as 100 and 116 °C. In all reactors in trial series B and D, a second maximum of the substrate temperature was recorded after around 10 to 12 days (fig. 2, treatment B4 and D5). In order to reproduce tent of the influence of the substrate temperature on the amount of ammonia emission, the progress of ammonia emission from reactors with the same ventilation rate, but differing temperature levels (fig. 2), was observed. At the beginning of the composting process the progress of the ammonia emissions followed that of the substrate temperature and reached a maximum after around 48 to 72 trial hours (*fig. 3*). Substrate temperature which were over the average (≥100 °C) led to a slowing down of ammonia emission to a comparatively low level (fig. 3, treatment C5). A second maximum of the substrate temperature led to a similar ammonia emission maximum (fig. 3, treatment B4). The extent of the ammonia emission depended very strongly upon the respective ventilation rate, the ammonia emissions rising, i.e., when higher ventilation rates were applied (*fig. 4*), or lay at a similar level when the same ventilation rates were applied (fig. 3). Only through higher ventilation rates (around 11 to 12 l/kg dry matter and hour) was it possible to determine a clear maximum of ammonia emissions (fig. 4, treatments C3 and C4). In total, even after three weeks of composting, no decrease in the ammonia emissions was able to be observed, and instead the ammonia emissions continued as constantly as before.

Conclusions

The very low C/N ratio of the investigated substrate resulted in very high and almost constant ammonia emissions which continued over the total three week trial period. For a good progress of the composting process the ventilation rate should not fall below around 7 to 8 l/kg dry matter and hour, and where possible a supplemental C-source should be mixed with the substrate. Through the results of the trials, the effect of individual factors influencing the composting process could be described. Further investigations are necessary for a more detailed description of the interactions between the different influencing factors.

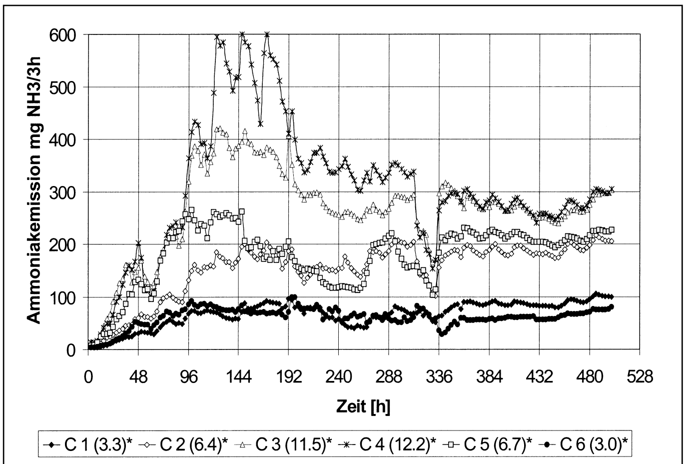

*Fig. 4: Course of the ammonia emission released from pre-dried layer hen manure treated with different aeration rates (*in [L kg^{-1}dry matter^{-1} h^{-1}]) during composting*

Literature

Books are identified by •

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