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Brown coal reduces slurry emissions

For reducing emissions from slurry fine-grained Lausitz brown coal was tested in the laboratory as an alternative to floating layers of slurry and straw. The brown coal absorbed odour and formed, along with floatable slurry particles, a dense floating layer giving a substantial reduction in odour emissions. Addition of brown coal reduced the NH_3 emission by up to 30%.

The treatment of pig slurry with fine-grained brown coal improved conditions for an effective solid-liquid separation into an easily propelled liquid and reasonably transportable solids with high nutrient content.

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A refereed paper for LANDTECHNIK, the full-length version of which can be accessed under LANDTECHNIK-NET.com

Keywords

Cattle and pig slurry, emissions, odour, brown coal, solid-liquid-separation

Literatur

Literature details are available from the publishers under LT 02203 or via Internet at http://www.landwirtschaftsverlag.com/landtech/local/fliteratur.htm

Different slurry container coverings have been introduced over the past years for reduction of odour and pollutant gas emissions [1, 2]. These coverings represent a compromise between their odour reduction properties, their durability and the costs involved. Solid coverings such as silo lids or tent-like material roofing are highly effective but expensive. Floating covers of plastic, e.g., reduce emissions by notable amounts, are cost-effective and can reasonable have a working life of up to ten years [3].

Floating covers of natural material formed on stored slurry through floating slurry particles or added litter are recognised by the environment authorities as emission-reducing measures [4, 5]. However, distribution machine blockage problems are caused by the straw particles when bringing-out the slurry, especially where trailing hose or injection systems are used. Thus a floating layer without straw particles would be a great advantage.

Preliminary trials at Lausitzer Braunkohle AG with fine-grained young tertiary brown coal (BC) showed that odour emissions from cattle slurry were greatly reduced immediately after admixing through immediate absorption of the odour substances into the brown coal. The floating cover created by the lighter slurry particles and those of the coal caused an additional long-lasting reduction of odour emissions. It can be said that, on the one hand, humus material contained in the brown coal could also serve as long-term soil improver and, on the other, that the nutrients contained in the slurry and bound to the brown coal would be made available over a longer term in the soil in an environmentally friendly manner.

The envisaged method is substantially different from the concept „Slurry preparation through brown coal“ developed and tested by the Rheinbraun company but not yet economically applicable [6].

Material and methods

With the same dry matter (DM) content cattle and pig slurry can display different physical behaviour. For this reason cattle slurry with DM = 7% and 5% but with the same BC admixture of 3% was tested in trial 1. In trial 2 the DM content was 8.9%, the BC admixture 3% and 5%. In trial 3 pig slurry was tested with a DM of 5.2% and 7.6% with BC admixture of 3% and 5%.

Fine-grained brown coal is very water-repellent. For this reason a lot of attention has to be given to assure complete admixture of the particles in the slurry. Special mixing equipment has to be used and uniform mixing and reaction times followed. The laboratory containers for storage of the slurry-coal mix were without lids and situated in a climate-controlled room. Chosen temperature was 20 °C to ensure high emission rates of odour material and gases. Measured trial parameters were pH, slurry temperature, emissions of odour substances and gases, sedimentation and chemical content.

During recording of gas concentration the containers were covered. Outside air was directed over the slurry surface. The exhaust air contaminated with odour substances and gases was directed into bags or was sucked into the Multigasmonitor (Brüel & Kjær, model 1302) for gas analysing. Odour material concentrations were determined by TO 7 olfactometer.

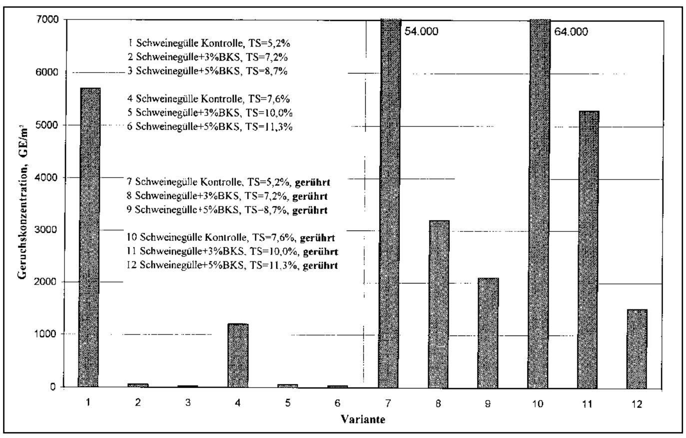

Fig. 1: Odour concentration above pig slurry after storage of 13 days

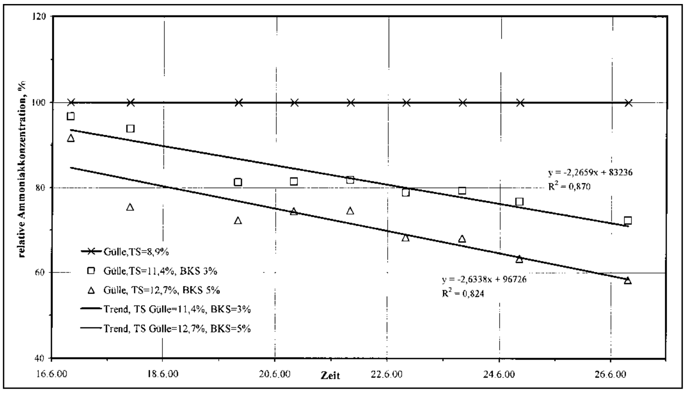

Fig. 2: Relative ammonia concentration abouve cattle slurry dependent on storage time

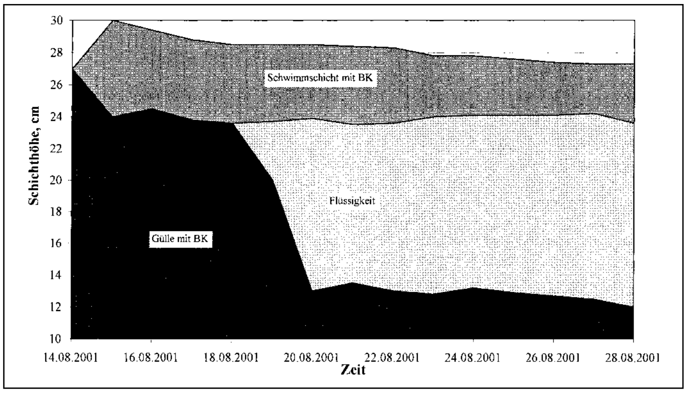

Fig. 4: Run of sedimentation of pig slurry with 3 % brown coal, DM = 10 %

Results and discussion

With each trial, air samples were uniformly collected 20 hours after each trial begin and at the end. Total trial periods differed in the individual series with 21 days (trial 1), 11 days (trial 2) and 13 days (trial 3).

However, the substantial differentiating characteristic was between samples before or after three-minute homogenising. In practice the aim was not to disturb the floating layer on the stored slurry in order to get the full effect from its emission reduction properties. Homogenising is, however, necessary now and again for avoiding sedimentation on the container bottom or for ensuring uniform distribution of the plant nutrients on the fields when the material has to be brought out.

An excellent effect in reducing odour emissions was obtained through treating the slurry with fine-grained brown coal. This was at least 70% effective before the mixing of 3% BC with cattle slurry and 90% to 98% afterwards.

With pig slurry, brown coal was even more effective in odour reduction as clearly shown in *figure 1*.

The minimising effect was 92% to 99% before and 92% to 98% after homogenisation.

The question as to whether the increasing of the brown coal admixture from 3% to 5% was effective is of economic interest. While the odour emissions were further reduced this was only by an additional 0.5% to 5% which were not significant within the context of a minimising rate of more than 90%.

Slurry pH was reduced through brown coal admixture, rather more in the case of cattle slurry than with pig slurry. The pH reduction was not serious however, representing 0.2 to 0.3 units.

Ammonia (NH_3) and methane (CH_4) were identifiable among the gases which were environmentally and climatically relevant. Nitrous oxide (N_2O) was not emitted. With cattle slurry, clear differences in NH_3 emission according to DM content and BC admixture could be seen. This trend was evident over the entire trial period (*fig. 3*).

Over the given storage period the average reduction in NH_3 emissions was 17% (3% BC) and 28% (5% BC).

The methane emissions were also reduced by coal admixture. On average the reduction was 17% (3% BC) and 29% (5% BC). These differences are statistically significant.

Where pig slurry was treated with fine-grained brown coal the reduction rates of NH_3 and CH_4 emissions were not so clear. While ammonia reduction was around 30% for the low DM samples there was no statistically significant effects with the samples of higher DM. The results with methane were similar.

Ammonia reduction rates given in the literature are from 70% with floating covers of natural material for cattle slurry and 30% for pig slurry. Using chopped straw increased these values to 80% (cattle and pig slurry) [8]. Artificially introduced floating covers through addition of fine-grained brown coal reduced emissions by up to 30% with cattle slurry. The results were not clear with pig slurry. This shows that the emissions of odours and gases only conditionally correlate with one another.

According to type of slurry and its dry matter content, the admixed brown coal influenced the sedimentation behaviour. Cattle slurry had more viscosity compared with pig slurry. When undisturbed, the suspended and colloidal particles behaved differently despite having the same dry matter content. In this way one could determine that the cattle slurry used in trial 2, with and without brown coal admixture, only separated into layers to a very slight extent.

On the other hand, the pig slurry with 3% brown coal admixture created a compact floating layer of light slurry and coal particles with a dark-coloured fluid containing rough sediment forming underneath after four days (*fig. 3*).

In undisturbed state, the floating layer prevented odour emissions to a large extent. This was also the case after homogenisation because the rising slurry and brown coal particles rapidly reformed on the surface.

Summary

Fine-grained brown coal amalgamates with light slurry particles in forming dense floating covers which, together with absorption processes, leads to a substantial reduction in odour emissions. With undisturbed cattle slurry in store, odour emission was reduced by 70% and by 90% to 98% reduced after homogenisation. With pig slurry, odour reduction before and after homogenisation was 92% to 98%.

This is an outstanding result which must be confirmed on a practical farm At the same time the application of the storage technology as well as economic aspects have to be investigated.

The treatment of pig slurry with fine-grained brown coal opens the technical possibilities of an effective solids-liquid separation to give an easily-handled liquid and a compostable and realistically transportable solid with high nutrient and humus content. Investigations into its long-term effect as humus builder in the soil remain to be carried out.