UTILISATION OF BIO-TECHNOLOGICAL AGENTS IN THE PROCESS OF COMPOSTING

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Abstract

In the contribution are presented results of two experiments with utilisation of bio-technological agents Bacteriocomposter Plus and Bio-Algeen G40. The effect of these agents on the course of the composting process and emissions production from the composting was investigated. The experiment was also carried – out with utilisation of biofilter. The emissions measuring was carried – out by the continual method utilising the measuring apparatus INNOVA MULTIGAS (monitor 1312) Multipoint Sampler 1309 INNOVA. The results of the experiments have confirmed that the bio-technological agents have effect on the reduction of the emissions production from the composting activity.

Key words: controlled microbial composting, biofilter, gas emissions; compost, bio-technological agents

INTRODUCTION

According to the Annex No. 2 of the Governmental Decree No. 353/2002 determined the emission limits and other conditions for operation of other air pollution stationary resources also such activities belong to the stable livestock breeding which are connected with the animal excrements handling including areas for crop production. Therefore even the composting plant can be included into the devices serving for the animal excrements processing.

For all agricultural resources of pollution is valid the specific emission limit for ammonia on level of general emission limit (= 50 mg/m^3) and specific emissions limit for volatile substance = 50 OUER/m^3. The general emission limit for volatile substances for the composting plants is 50–100 OUER/m^3 on the filter output or 5–20 OUER/m^3 on the composting plant boundary.

In some cases the many gases release during the composting process what is caused by the composted raw materials decomposition. In consequence of this process generates odour in the fillings surrounding. On the market is available a lot of bio – technological reducing or even removing the odour after their application as recommended by the producers. Besides this ability some of them are acting as the composting process stimulator and thus the number of compost turning is reduced.

MATERIALS AND METHODS I.

The measuring was carried-out at the RIAE Prague experimental composting plant located in the RIAE Prague premises consisting of area 60 x 10 m. In June 2004 has started an experiment at the composting plant with a scope to verify effect of the bio-technological agents on the gaseous emissions production, composting process course and final product quality. For this purpose was utilised technology of the controlled microbial composting in the belt heaps – aerobic controlled composting.

After the experiment implementation was established one filling containing three heaps of identical raw material composition. The heap 1 was treated by the bio-technological agent Bio-Algeen G 40, the heap 2 served as controlling and the heap 3 was treated by the bio-technological agent Bacteriocomposter Plus. Each the heap was divided into two halves of which one always was covered by the fabrics Top Tex. Each heap was measured for gaseous emissions, temperature and oxygen content.

The emissions measuring was carried-out by the measuring device INNOVA MULTIGAS (monitor 1312) Multipoint Sampler 1309 INNOVA (Jelínek, Pecen, 2002). Measured was the NH_3, CO_2, CH_4, H_2S content. The measuring was performed from 6. 24. 2004 to 7. 1. 2004. The measuring sensors were removed from the heap during the compost turning and inserted again after the turning finishing (about 1.5 hour).

The compost temperature was measured by the digital thermometer with the necking-down probe of firm Sandberger, the oxygen content was found-out by the apparatus of firm ASEKO. The raw material composition of the compost heaps is presented in Table 1. The scheme of heaps distribution and size is shown in Figure 1, scheme of emissions measuring points, temperature and oxygen in Figure 2.

DESCRIPTION OF USED AGENTS

Bacteriocomposter Plus – determined for acceleration of crop waste composting by aerobic way. It consists of the selective adapted microbial cultures mixed with enzymes, emulgators, yeast containing mainly vitamins of group B and growth factors, inorganic resources of N and P, zoeletium acting as sorbent and material for living micro-organism, physiological factor Nall and

Tab. 1: Compost heaps raw material composition

Heap No.	Raw material composition 21. 6. 2004	Volume (m^3)	Percentage share (%)	Volume weight of sample (kg/m^3) 21.6.04	Volume weight of sample 1.7.04
1 1/2 covered 1/2 uncovered	Application of agent Bio-Algeen G40 3l G40 + 150 l H_2O			1,581.67	638.33
6.24	*Application 3 l G40 + 150 l H_2O*				
6.25	*Application 3 l G40 + 150 l H_2O*				
6.28	*Application 3 l G40 + 150 l H_2O*				
	Farmyard manure	4	50		
	Grass	4	50		
	Σ	8	100		
2 1/2 covered 1/2 uncovered	Control heap			482.22	628.33
	Farmyard manure	4	50		
	Grass	4	50		
	Σ	8	100		
3 1/2 2 covered 1/2 uncovered	Application of agent Bacteriocomposter Plus *1 kg of agent +50 l H_2O*			591.67	632.67
	Farmyard manure	4	50		
	Grass	4	50		
	Σ	8	100		

Figure 1: Heap dislocation and size

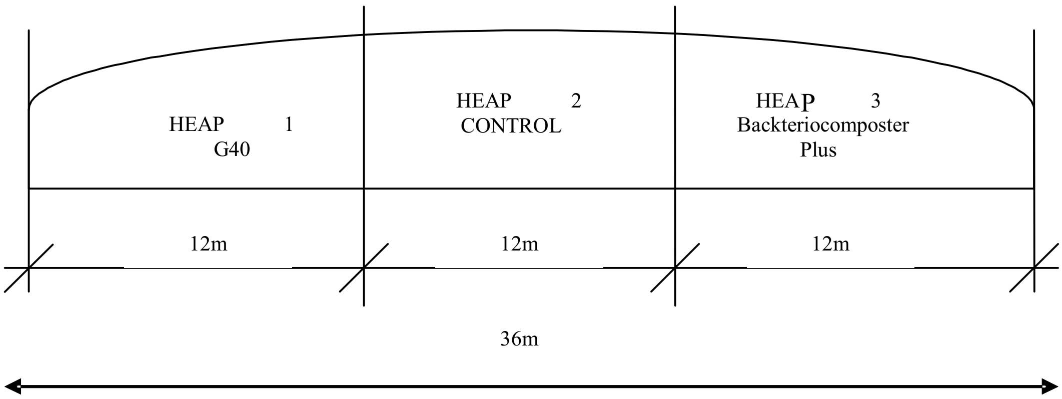
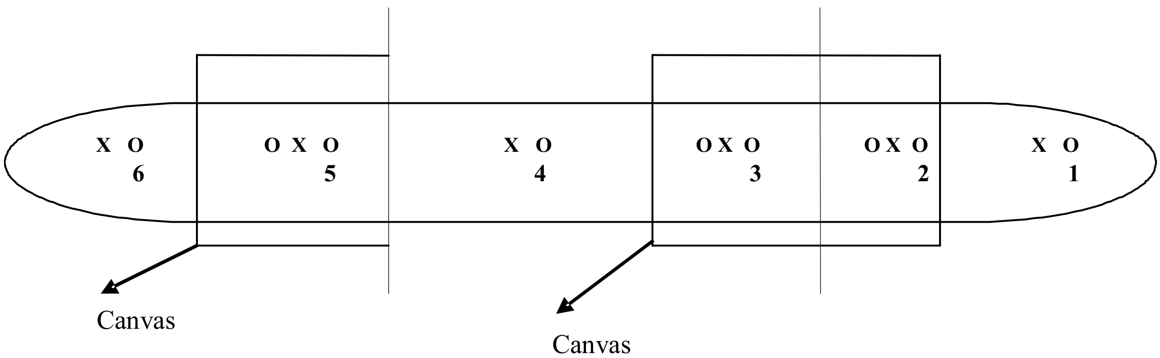


Figure 2: Scheme of emissions, temperature and oxygen measuring points



Notice: X – measuring point of temperature and oxygen O – emissions measuring point micro-nutrients, immobilisation in the preparation. The agent is acting as "starter" and "accelerator" of the composting process:

Bio-Algeen G40 – hydrolysis plant of the brown sea algae contains amino acids, peptides, organic acids, minerals, and vitamins. The agent support development of micro-organisms accelerates bio-degradable processes and reduces H_2S and NH_3 emissions.

RESULTS I.

In the course of the composting process was provided also visual and sensuous evaluation of the filling heaps. In the heap 1 and 2 was found increased occurrence of small flies, in the heap 3 their occurrence was slightly lower.

The temperature has reached in all heaps relative low values, only the heap 1 has shown higher temperature at the beginning of the composting process. This was probably caused by the fact that the composted raw materials were matured (degraded) and the composting process has passed with a lower intensity.

The oxygen content was almost identical in all the heaps and the values were constant in the course of the composting process.

The compost samples were taken – off during the experiment establishing and its finishing. The sample analysis is carried – out in the Agrarian laboratory in Research Institute of Agricultural Engineering Prague (RIAE Prague).

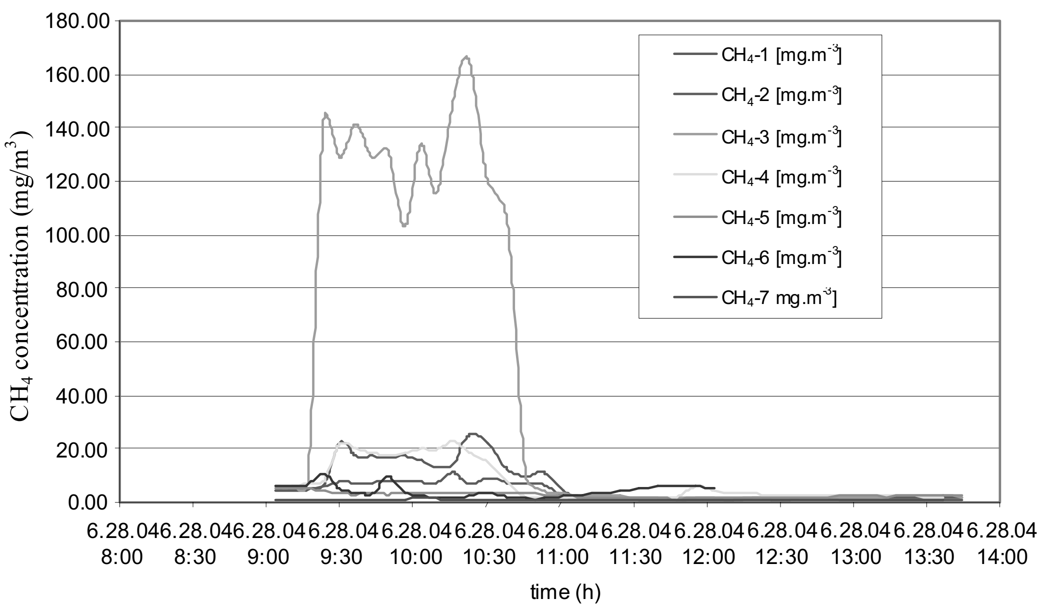
The analysis results are presented in Table 2 and 3.

On the basis of the finished compost agrarian chemical analysis can be stated that the heap 3 treated by the agent Bacteriocomposter Plus and the control heap 2 have varied from the requirements of the standard ČSN 46 5735 "Industrial composts in the qualitative sign-moisture". The control heap 2 does not meet also demand for the combustible substances content. The heap 3 treated by the agent G40 complies with the all qualitative signs as specified by the standard ČSN 46 5735 "Industrial compost", except pH – value.

On the basis of the emission measuring results was found – out that the agent Bio – Algeen G40 has reduced the NH_3 emissions production by 72%, CO_2 emissions by 40%, CH_4 by 72.28% and H_2S emissions by 35.24% compared with a value measured in the control heap (without agent application).

The agent Bacteriocomposter Plus has reduced the NH_3 emissions production by 66.53 %, CH_4 emissions by 73.89 %, H_2S emissions by 16.96 %, CO_2 emissions have increased by 57 % in comparison with a value measured in the control heap. The CO_2 emissions increasing can be caused by the agent incorrect application. The CH_4 emissions measured values from 6. 28. 2004 are presented in Figure 3.

Figure 3: Graph of CH_4 concentration measured values course from 6. 28. 2004



Tab. 2: Compost agrarian – chemical analysis (6. 24. 2004, Agrarian laboratory RIAE Prague)

	Moisture (%)	Combustible substances (% d. m.)	N_2 (%)	pH
Heap 1 (agent G40)	48.83	45.25	1.97	8.47
Heap 2 (control)	45.77	42.38	1.97	8.29
Heap 3 (agent Bacteriocomposter Plus)	53.92	42.63	1.85	8.38
Qualitative signs according to ČSN 46 5735	40.0–65.0	min. 25	min. 0.60	6.0–8.5

Tab. 3: Compost agrarian – chemical analysis (1. 7. 2004, Agrarian laboratory RIAE Prague)

	Moisture (%)	Combustible substances (% d.m.)	N_2 (%)	pH
Heap 1 (agent G40)	42.10	36.15	1.75	8.66
Heap 2 (control)	33.47	20.72	1.61	9.,02
Heap 3 (agent Bacteriocomposter Plus)	34.45	27.3	1.58	8.71
Qualitative signs according to ČSN 46 5735	40.0–65.0	min. 25	min. 0.60	6.0–8.5

MATERIAL AND METHODS II.

The measuring was carried-out also at the experimental composting plant RIAE Prague. In September 2004 was established an experiment at the composting plant with objective to find-out effect of the bio-technological agents on the gaseous emissions production from composting with utilisation of the bio-filter. For this purpose was utilised technology of the controlled microbial composting in the belt heaps – aerobic controlled composting.
The compost filling has contained one heap covered by the air – tight canvas. The heap raw material composition is presented in Tab. 4.
The compost temperature and oxygen content were measured regularly. The compost temperature was measured by the digital thermometer with the necking – down probe of the firm Sandberger, oxygen content was found-out by the measuring apparatus of the firm ASEKO.
The gases emissions measuring passing through the bio-filter was implemented by the measuring apparatus INNOVA MULTIGAS (monitor 1312) Multipoint Sampler 1309 INNOVA. Measuring of NH_3, CO_2, CH_4, H_2S content was carried–out, too.
The bio-filter consists of the large-volume container, perforated bottom and inlet pipeline and partition walls. For the experiment purpose the whole space was divided into the three chambers. For the chambers charge was used the wooden bark moisturised to about 60 %. The two chambers charge were treated by the bio-technological agents Bio-Algeen G40 (Charge 2) and Bacteriocomposter Plus (Charge 1). The central chamber charge has not been treated – controlling.
The gases emissions were measured in the five measuring points, S1 – in the compost heap, S2 – in the compost inlet pipeline, S3 – in the bio-filter chamber without bio-technological agent application, S4 – in the bio-filter chamber with the bio-technological agent Bacteriocomposter Plus application and S5 – in the bio-filter chamber with the bio-technological agent Bio-Algeen G40 application. The charges composition of the bio-filter individual chambers is presented in Table 5. The bio-filter and gaseous emission measuring points scheme is presented in Fig. 4.

Tab. 4: Compost heaps raw material composition

Heap No.	Raw material composition	Volume (m^3)	Percentage share (%)	Volume weight of compost sample (kg/m^3)
1	Pig manure	6	30	267.62
	Grass	10	50	
	Chopped material	4	20	
∑		**20**	**100**	

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Tab. 5: Bio-filter charge

Chamber	Charge	Volume weight (kg/m^3)	Porosity (%)	Moisture (%)
Charge 1	wooden bark 0.33 kg Bacteriocomposter Plus10 l water	328.33	61.68	57.3
Charge 2	wooden bark 0.12 l Bio- Algeen G40 10 l of water	333.33	57.85	60.3
Control	Wooden bark without application - control	333.33	63.33	60.1

Figure 4: Bio-filter scheme

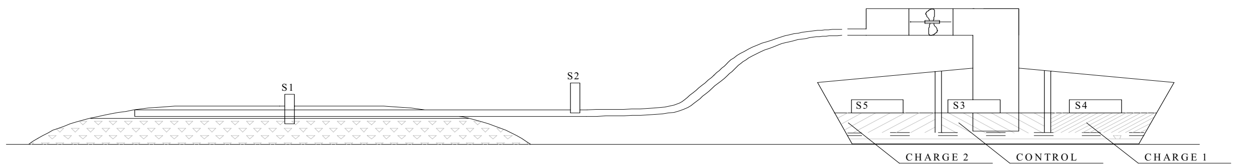
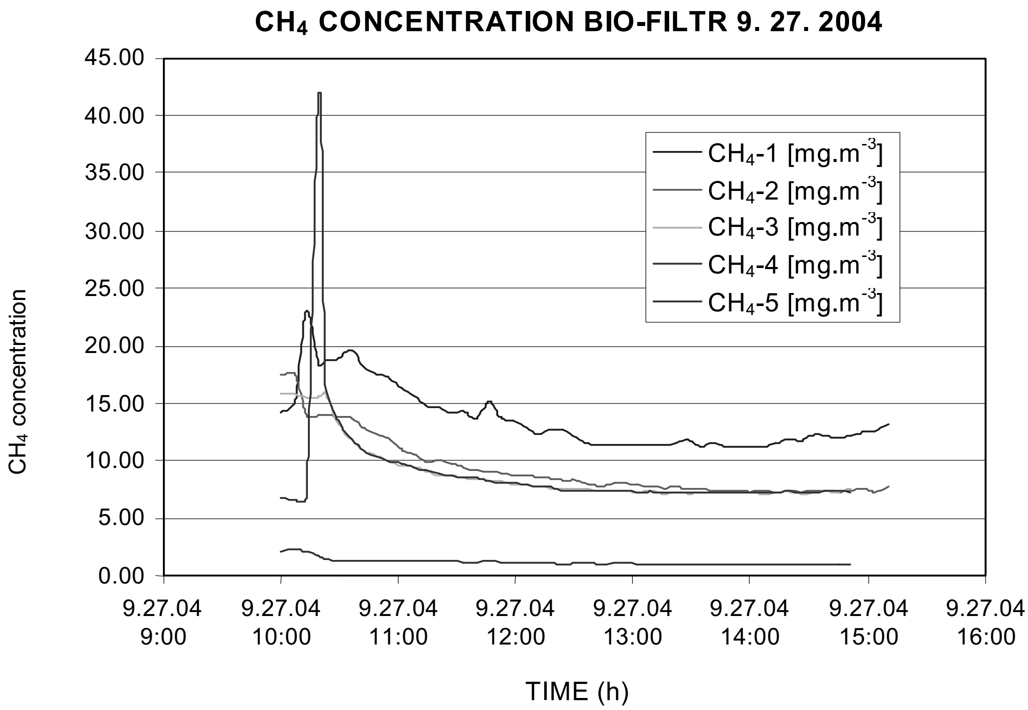


Figure 5: Graph of CH_4 measured concentration values course on bio-filter on 9. 27. 2004



Tab. 6: Qualitative signs of finished compost (Agrarian laboratory RIAE Prague)

Sample	Moisture (%)	Combustible substance (%)	N_2 (%)	C : N
Finished compost	35.98	61.12	1.71	17.87
Qualitative signs according to ČSN 46 5735	40.0–65.0	min. 25	min. 0.60	max. 30

RESULTS II.

The results of measuring have proved that the bio-filter reduced in comparison with the production of gaseous emissions from the compost heap the CH_4 emissions by 86.6 %, CO_2 emissions by 80.83 %, H_2S emissions by 68.46 % and NH_3 emissions by 83.20 %.

In the bio-filter part with application of the agent Bacteriocomposter Plus the CH_4 emissions were reduced by 42.3 %, CO_2 emissions by 48.79 %, H_2S emissions by 23.1 % and NH_3 emissions by 75.15 %. The graph of the CH_4 concentration values course from 9. 27. 2004 is presented in Fig. 5.

On the basis of agrarian-chemical analysis of the finished compost samples can be stated that the produced compost meets the requirements of the standard ČSN 46 5735 (Tab. 6) in the all qualitative signs.

DISCUSSION

An important role in the environmental policy currently plays the Kyoto Protocol on climatic changes. The biomass is known for a long time as partial substitution of the fossil fuels. At present exists a new look on the climatic changes stoppage. More significant role plays the organic matter fixed in soil. A strong motivation for the organic fertiliser application is effort to fasten the organic carbon in the soil (sequestration) and thus reduce the CO_2 content in atmosphere.

Other potential advantage is a fact, that the organic fertilisers improve the soil fertility, increase water collection, reduce the croppathogen occurrence (it leads to the pesticides consumption reduction), soil erosion reduction. It is difficult to appreciate these externalities but they can lead to the considerable energy consumption reduction what could play on important role in a future.

These facts are still more and more accepted as a stimulus for environmental policy. The thematic strategy for soil protection published by the European Commission emphasises importance of the carbon sequestration in the soil. The controlled microbial composting on the belt heaps is a technology applicable particularly for small-size agricultural enterprises but also for community and municipal composting plants.

One of many problems preventing the more large extension of that technology into practice is odour from the compost fillings what is a problem especially in the cases when the composting plant in situated nearby the human settlements. The problem is serious also for a reason of odour subjective receptivity and evaluation.

CONCLUSIONS

The submitted results of the research have proved that the bio-technological agents can be utilised for reduction of NH_3, CO_2, CH_4, H_2S emissions. Their application is suitable mainly in the case when for various reasons is not possible to provide correct course of the composting process and thus also the odour reduction by regular heaps turning.

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