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INVESTIGATION INTO EMISSIONS OF GASEOUS POLLUTANTS DURING SEWAGE SLUDGE COMPOSTING WITH WOOD WASTE

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Abstract. The main environmental problem of sewage sludge treatment and storing processes is unpleasant smell caused by emitted gases, such as NH_3, H_2S etc.; which are released during organic matter decomposition process. The second environmental problem is that during sewage sludge composting process global warming gases, such as CO_2, CH_4, and N_2O are emitted, the emissions of these gases can be reduced by creating optimal composting conditions (C:N, aeration, pH and humidity) and by adding some additives (wood cuttings, shavings, zeolites, peat *etc.*) into sewage sludge. In our study we analyse the experimental results on CH_4, NH_3, H_2S and VOC emissions during sewage sludge composting process. For this experiment, centrifuge-dried sewage sludge from Vilnius City Municipal Sewage Treatment Plant were used. Used Ashen bark, oaken cuttings, aspen shavings, shredded deciduous tree branches. The composting process was performed in a compost site-simulating facilities.

Keywords: Sewage sludge, composting, gaseous pollutants, odors, wood waste.

1. Introduction

Biological, biochemical and physical processes take place during composting biodegradable waste in the course of which, with the participation of microorganisms and zoocoenoses as well as enzymes evolved by them, the complex processes of organic waste mineralisation, biogenic element release and humus formation take place. Degradation is performed by bacteria, micromycetes (mold fungi), different kinds of protozoa, invertebrates and minor animals that feed on or degrade organic matter. The aim of sewage sludge composting is to stabilise sludge and reduce its amount, and improve the structural and microbiological-parasitological parameters of the sludge. Composting means an aerobic process of sludge stabilisation during which pathogenic microorganisms are destroyed when temperature rises (Spellman 1996; Baltrėnas *et al.* 2004, 2005).

The process of composting might be employed as the final stage of sludge treatment. The key composting factors having an influence on the process and finished product include aeration, humidity, temperature, pH and duration of compost maturation. The quality of compost also depends on the structure and size of particles as well as the content of nitrogen, carbon, and heavy metal phosphorus and potassium. Carbon, nitrogen, phosphorus and potassium are the main substances necessary for the optimum activities of microorganisms during composting. These substances are also necessary for plants to grow and develop. Therefore, the value of compost depends on their content in it (Ashbolt, Line 1982; Turovskiy, Westbrook 2002; Baltrėnas *et al.* 2005; Lazdiņa *et al*. 2007).

By its appearance and properties, the product of composting is similar to dark humus soil. It improves the structure of the soil and enhances its ability to absorb air and water, reduces erosion and allows avoiding additional synthetic nutrients (Zuokaitė, Ščupakas 2007; Kvasauskas, Baltrėnas 2009).

Sewage sludge treatment and storage causes the problem of gas emissions and unpleasant odour. Decaying of organic materials (both of animal and plant origin) results not only in the evolvement of gas having an unpleasant odour (sulphuric and nitric compounds of organic and inorganic origin, acids, aldehydes and ketone) but also in greenhouse gas emissions (CO_2, CH_4, N_2O). The emissions of gaseous pollutants can be reduced by providing the optimum conditions of composting and using additives. Composting and compost use reduce greenhouse gas emissions directly, by isolating carbon dioxide, and indirectly, by improving the properties and composition of soil. However, the greatest benefit of composting is reduction of released methane gases, which causes global warming effect (Brown 2008; Composting Council 2008; Hellebrand 1998; Jackel *et al.* 2005; Kazragis 2005).

Recently, sewage sludge has been mainly stored on sewage storage sites fitted up in the territories of wastewater treatment plants. Products from sludge degradation pollute air, soil and water. Lithuania annually generates around 6.5 million m^3 of sludge with a dry matter content of 65 700 t. The wastewater treatment plants of industrial enterprises and residential areas generate another 1.6 million m^3 of sludge.

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Upon having stabilised waste through the employment of the biological treatment method, the short-cycle carbon dioxide remains in the obtained material for a limited period of time: it is assumed that around 8% of organic material present in compost will remain in soil in the form of humus in the period of 100 years (Commission… 2008).

The impact on the environment of composting is for the most part related only with the emission of some greenhouse gases and volatile organic compounds. The impact on climate change of carbon dioxide sequestration (sequestration means the control CO_2 in the form of inorganic carbonates) is limited and mainly temporary (Commission…2008).

Composting is one of the best sources of a stable organic material from which humus can form in the barren soil.

The aim of this research is to evaluate the regularities of the formation of gaseous pollutants (CH_4, NH_3, H_2S, VOC) emitted to the environment during sewage sludge composting as well as the possibilities of reducing these emissions by employing natural additives.

The research was done within the framework of COST ES0805 programme "The Terrestrial Biosphere in the Earth System".

2. Research Methods

The surplus sewage sludge dewatered with centrifuges, ash-tree bark, oak sawdust, aspen chips and minor branches were used for researching the emissions of gaseous pollutants (CH_4, NH_3, H_2S, VOC) from sewage sludge composting. Composting was carried out in the facilities imitating a composting site (Fig. 1). The sludge composting facility consists of: PVC box, hood with an opening for gas sampling and temperature measurement, and sealing tape (PVC).

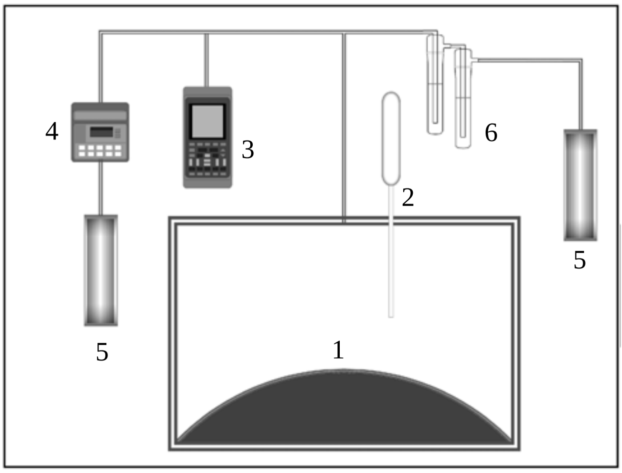

Fig. 1. Scheme of the sludge composting facility: 1 – sludge composting equipment with materials being composted; 2 – thermometer; 3 – gas meter; 4 – gas meter GD/MG7; 5 – air pump; 6 – Zaitsev absorbers

Composted materials are placed into boxes with a capacity of 45 l (dimensions: 590×390×290 mm) each, which are covered with hermetic hoods. The boxes are filled with 5±0.001 kg of sewage sludge and additives:

- sewage sludge without additives (control);
- sewage sludge mulched (covered) with ash-tree bark 1.5±0.001 kg;
- sewage sludge mixed up with ash-tree bark 1.5±0.001 kg;
- sewage sludge mulched (covered) with fine oak sawdust 1±0.001 kg;
- sewage sludge mixed up with fine oak sawdust 1±0,001 kg;
- sewage sludge mulched (covered) with aspen chips 0.5±0.001 kg;
- sewage sludge mixed up with aspen chips 0.5± 0.001 kg;
- sewage sludge mulched (covered) with fine deciduous tree branches 1±0.001 kg.

Each hood of the facility imitating composting is fitted up openings (Fig. 1) for gaseous substances sampling:

- For determining the ammonia (NH_3)concentration an air mixture is passed through the Zaitsev absorbers;
- For determining the concentrations of methane and hydrogen sulphide a gas meter GD/MG7 is used;
- The concentrations of volatile organic compounds (VOC) are identified with a portable gas meter MiniRae.

The temperature of the ambient air and of the formed gas is recorded on a regular basis.

Sampling is done every 3–4 days. The composting equipment is sealed 24 h before the sampling. Upon sampling completion, all boxes are opened and compost is mixed up (in the samples which are not covered but subject to mixing).

This method helps us to identify: methane (CH_4), ammonia (NH_3), hydrogen sulphide (H_2S), volatile organic compounds (VOC), humidity of the waste, pH, and total carbon.

The electrochemical method is used to identify methane (CH_4) and hydrogen sulphide (H_2S). The gas meter GD/MG7 measures methane with an accuracy of ±1%, and hydrogen sulphide – ±0.1 ppm.

The concentration of ammonia (NH_3) is determined by the photometric method.

The concentration of VOCs is determined with a device MiniRae 2000 with a PID (photoionisation detector) sensor. The measurement accuracy at a pollutant concentration of 0–2000 ppm is ±2 ppm.

Waste humidity is determined by drying the sludge at a temperature of 105±3 °C up to its constant mass and is calculated on the basis of its weight before drying.

Measurement of pH is done with a pH-meter Multi-Cal 538 WTW with a glass electrode.

3. Analysis of experimental investigation of the emissions of gaseous pollutants during sewage sludge composting

The surplus sewage sludge dewatered in centrifuges from Vilnius City Municipal sewage Treatment Plant was used for the experiment. Wood chips, sawdust, crushed bark and minor twigs (Fig. 2) were used as additional materials. The wood chips, sawdust, crushed twigs and bark increase the porosity of compost, reduce its compression and improve oxygen circulation within a compost pile. Natural materials with different levels of porosity and of different fractions (sizes) were selected. For instance, if livestock slurry is covered with a 140 mm layer of wood sawdust, the efficiency of reducing gas emissions is achieved as follows: ammonia – 90.9%, methane – 31.7% (Guarino *et al.* 2006).

Fig. 2. Additional materials used for composting: a) oak sawdust; b) aspen chips; c) crushed ash-tree bark, d) minor twigs of deciduous trees

The intention is to find out which fraction of wood waste (as a natural additive) would serve best for the reduction of concentrations of pollutant emissions into the ambient air during composting.

Bacteria which are thriving in the oxygen-saturated medium auto-decompose and compost sewage sludge. During this process of oxidation pollutants are decomposed into carbon dioxide (CO_2), water (H_2O), nitrates, sulphates and biomass (microorganisms). Normally, the C/N of sewage sludge is low, 5–16, whereas the C/N of wood reaches even 600. Where the C/N is below 20/1, carbon is rapidly consumed by microorganisms and nitrogen remains free, and ammonia and nitrogen oxides are released into the atmosphere. Therefore, the inclusion of wood chips and/or sawdust into the sewage sludge being composted optimises the C/N ratio of the compost and at the same time reduces the emissions of gaseous pollutants.

Characteristics of the sewage sludge used for the investigation: pH – 6.5–6.9 weakly acid-neutral; the content of the total organic carbon – 56.3%; humidity (the percentage of water in the material) – 81.6.

Humidity of the additional materials used for investigation: oak sawdust 1.05%; aspen chips 2.25%; ash-tree bark 1.44%; branches 2.24%.

During the experiment the average (daily) temperature of the ambient air varied between 2 and 17 °C (Fig. 3). As the quantities of the composted materials were not large the temperature of the formed gas was the same as that of the ambient air.

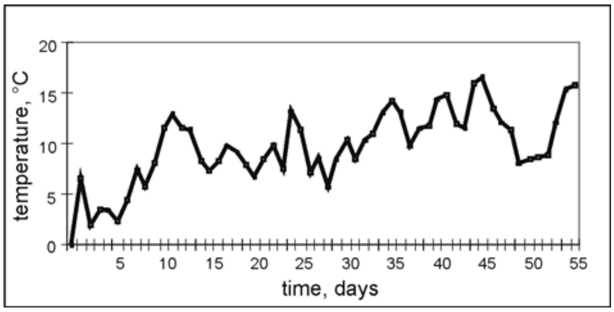

Fig. 3. Average temperature of the ambient air (produced gas)

The experiments were mainly focused on the fact that the selected natural additives for composting were of different fractions (sizes of the particles were different).

One of the main and primary gaseous pollutants causing an unpleasant odour during sewage sludge treatment is ammonia (NH_3). Analysis of anaerobic digestion schemes allows a conclusion that ammonia is evolved in the phase of acetogenesis when, with the help of chemical reactions and through the participation of microorganisms, organic compounds of nitrogen emit organic acids and ammonia. As the data obtained from the performed experiment of composting sewage sludge with ash-tree bark show, the crushed ash-tree bark reduces ammonia emissions threefold (Fig. 4).

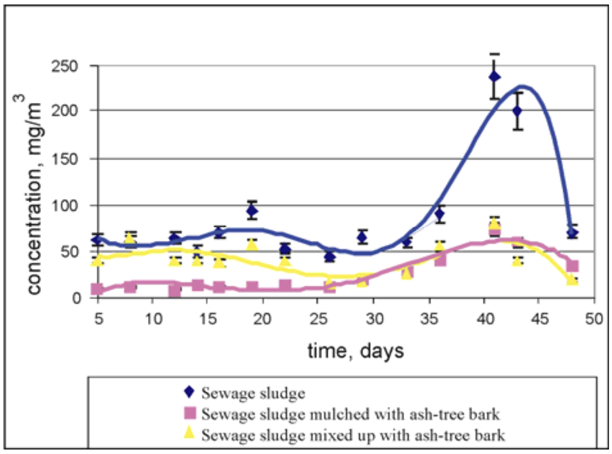

Fig. 4. Ammonia gas emissions during composting sewage sludge with ash-tree bark

Comparison of the obtained data on the compost mulched with wood bark and on the mixed compost shows that smaller amounts of ammonia (during the first 25 days) evolve from the mulched compost, but on around the 30th day of the experiment the emissions of ammonia became equal. This can also be confirmed by the fact that throughout the experiment the highest concentration, 240 mg/m^3, was identified in the sewage sludge that was composted without any additives. In this process wood bark serves as a natural adsorbent and therefore the amounts of ammonia released to the atmosphere decreased.

Wood bark has a porous structure which enables the adsorption of gaseous pollutants.

The greatest emission of ammonia from the sewage sludge without any additives was recorded on the 35th–40th days of the experiment. Like in the case of composting with a bark additive, when composting with a sawdust additive, the amounts of ammonia increased in the samples mulched with bark and sawdust on the 30th–35th days of composting.

When sewage sludge was composted with chips (Fig. 6), similar tendencies of ammonia emissions were recorded like in the case of composting it with bark and sawdust. An especially big difference in pollutant emissions was recorded during the first days (1st–10th days) of composting when the average concentration of ammonia emissions from the sewage sludge mulched with chips stood at 12 mg/m^3, whereas that from sewage sludge without any additives was fivefold higher and reached

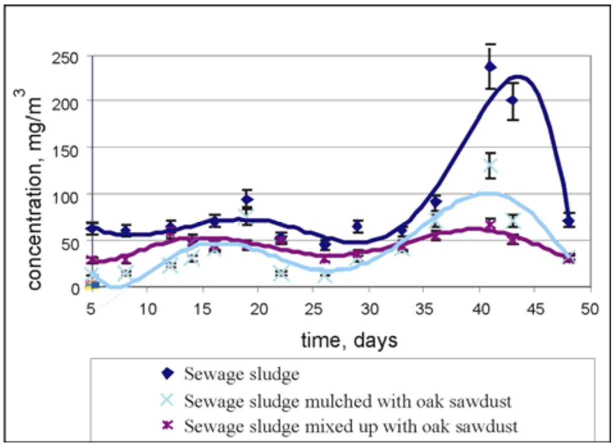

Fig. 5. Ammonia emissions during composting of sewage sludge with oak sawdust

60 mg/m^3. When the experiment continued, the emissions of ammonia from the sewage sludge mulched with chips were continuously increasing and reached 96 mg/m^3 on the 40th day compared to 240 mg/m^3 of the sewage sludge (without any additives) on the respective day. When sewage sludge was composted by mixing it with chips, a more stable concentration of ammonia emissions was recorded, on average by 50 mg/m^3 per day.

The average recorded amount of ammonia before the 10th day of the experiment was 10 mg/m^3. When the experiment proceeded, the concentration of ammonia released from the sewage sludge mulched with branches increased and averagely amounted to 50 mg/m^3.

Analysis of ammonia emission tendencies in all the samples shows that the concentrations of ammonia in both categories of samples, mixed and mulched (with the same material), become the same on around the 30th day of the experiment. Before the 30th day of the experiment, mixing is a more efficient method, but after the 30th day it is mulching that is more efficient.

Comparison of average ammonia emissions in all the samples (Figs. 4–7) shows that it is the bark that is the most efficient in reducing ammonia emissions into the atmosphere averagely threefold, and it can be stated that this happens due to porosity of the bark. In the other samples containing additives the content of ammonia fell averagely twofold. After analysing the obtained data it can be stated that all the additives that were used are suitable for the reduction of ammonia emissions.

Under anaerobic conditions (oxygen-free medium) methane evolves from composted sewage sludge under the influence of bacteria. A process during which organic acids are decomposed to CO_2 and CH_4 is known as the process of methanogenesis. During the entire process volatile organic compounds serve as an intermediary product of ongoing biochemical reactions.

After investigating methane emissions during sewage sludge composting, different tendencies were recoded in the samples mulched and mixed with bark (Fig. 8). The highest emissions of methane are recorded in non-mulched sewage sludge with concentration reaching 38%.

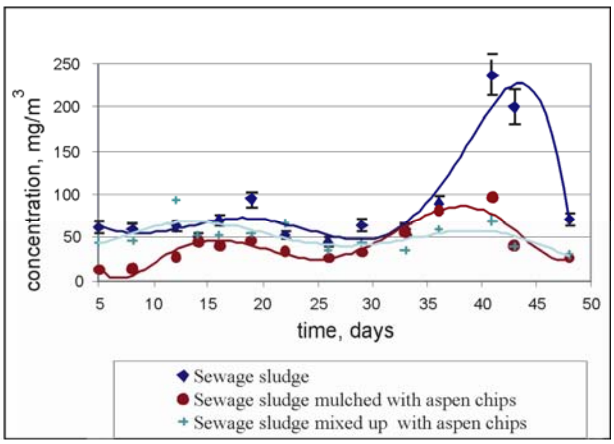

Fig. 6. Ammonia emissions during composting sewage sludge with aspen chips

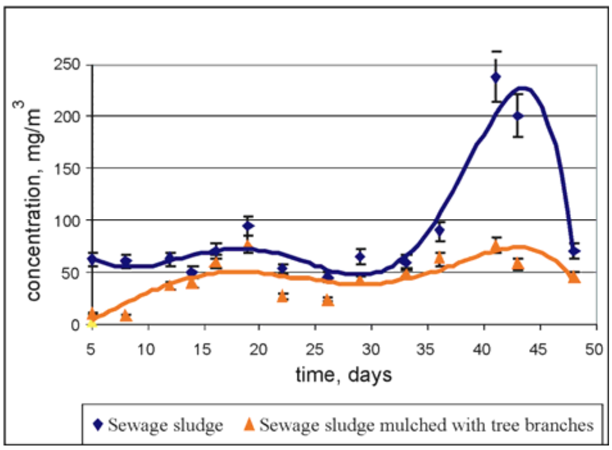

Fig. 7. Ammonia emissions during composting sewage sludge with minor branches

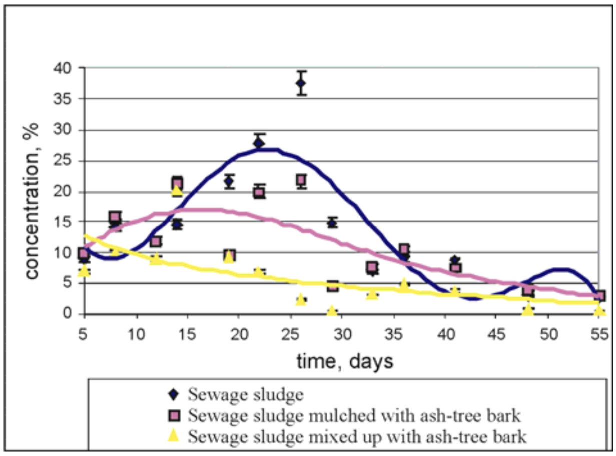

Fig. 8. Methane gas emissions during composting sewage sludge with ash-tree bark

Crushed bark (Fig. 8) reduces methane gas emissions from compost (both mixed and mulched); however, the recorded concentration of methane emissions when mixing bark with sewage sludge was lower. Contrary to ammonia, a lower content of methane evolved in the samples which were mixed with additives. This tendency is predetermined by the fact that when mixing materials being composted with additives, oxygen is assimilated better and the conditions of composting become aerobic.

Throughout the experiment the highest recorded concentration of methane was 38% in the sewage sludge that was composted without any additives. The experiment revealed that, when composting sewage sludge without any additives and mulching it with bark (Fig. 8), methane gas started evolving on the 5th day of the experiment with concentration growing and reaching the peak (22%) on around the 25th day. Meanwhile, the samples made of sewage sludge mixed with bark evolved regularly decreasing amounts of methane approaching zero on around the 30th day of the experiment with its average concentration of 2% on the 30th–35th days of the experiment. Comparison of the two methods of composting, mulching sewage sludge with bark and mixing it with bark, shows that lower methane concentrations build up and evolve using the second method (mixing). This can be explained by the fact that at the time of mixing sludge with additional natural materials (bark, sawdust) air spaces form due to which an anaerobic process takes place. Under ideal aerobic conditions organic matter is degraded to CO_2 and H_2O. When composting takes place in the aerobic medium, 50% of organic carbon withdraws from compost in the form of CO_2, whereas when composting takes place under anaerobic conditions up to 95% of carbon is lost together with the evolved methane.

The experiment performed when using sawdust (Fig. 9) also testifies a (tendency that lower amounts of) methane form when sewage sludge is mixed with natural materials (wood sawdust, wood bark) and less amount of methane forms than in the case of mulching it with the same materials.

The investigation of methane emissions from sewage sludge composted with chips (using both methods of

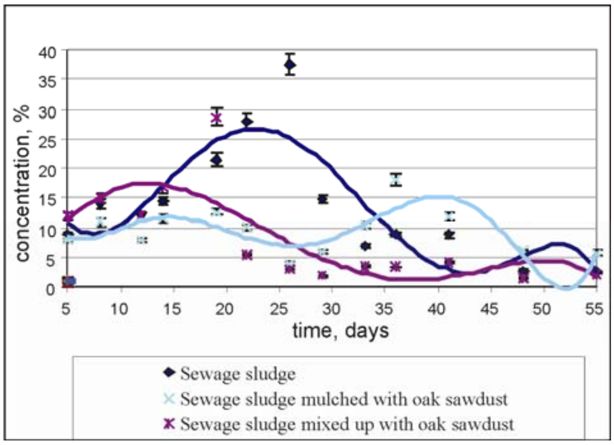

Fig. 9. Methane gas emissions during composting sewage sludge with oak sawdust

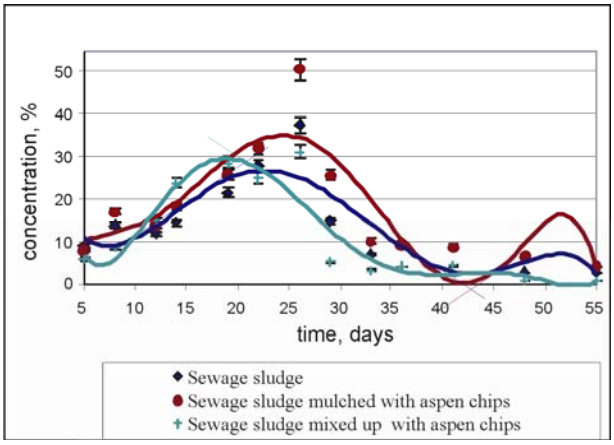

Fig. 10. Methane emissions during composting of sewage sludge with aspen chips

insertion, i.e. mulching and mixing) and comparison to the sludge composted without any additives (Fig. 10) show similar tendencies: the peak is approached on the 26th day of the experiment, afterward a decrease is recorded which is nearly fivefold in a week, i.e. it does not reach 10%.

Upon mulching the sewage sludge being composted with crushed branches, lower concentrations of methane emissions were recorded than in the case of non-mulched sludge averagely by 30% (Fig. 11). The peak of methane concentration in the sample containing branches was recorded on around the 14th day of the experiment reaching 18%, whereas in the case of composting without any additives – 38%.

Comparison of the average methane emissions in all the samples (Figs. 8–11) shows that it is the bark mixed with sewage sludge that is the most efficient in reducing methane emissions into the atmosphere. The reduction was more than double. In the other samples containing additives methane amounts dropped insignificantly. Analysis of the obtained data allows a conclusion that all the additives used reduce methane emissions except for the sample in which the composted sludge was mulched with chips (Fig. 10). Therefore, the use of chips as an additive for sewage sludge composting is inexpedient.

The emissions of hydrogen sulphide from sewage sludge composting produce unpleasant odours. The odour threshold of this compound is 0.012–0.03 mg/m^3. Upon completion of the experiment on composting the sewage sludge with crushed wood bark (Fig. 12), it was determined that the concentrations of hydrogen sulphide were the highest during the first days of the experiment which started falling from the 20th day. This fully complies with the mechanism of the anaerobic process of organic material degradation.

Crushed bark (when used for both mulching and mixing) reduces hydrogen sulphide emissions from compost (Fig. 12). The concentration recorded already during first days of the experiment is fivefold or sixfold lower than in the sample containing sludge without any additives. The peak of hydrogen sulphide in the sample composed of sludge without any additives is recorded on around the 14th day of the experiment reaching 31 ppm, which falls to around 5 ppm from the 30th day of the experiment. When using a natural additive, bark, the concentrations of hydrogen sulphide were reduced, averagely, threefold and fourfold. The experiment showed that the emissions of hydrogen sulphide concentration were lower in the case of mixing but not mulching compost with bark.

The use of both bark and sawdust is efficient for the reduction of hydrogen sulphide emissions (Fig. 13). The use of sawdust reduces hydrogen sulphide emissions fourfold or fivefold with it reaching zero concentration on around the 48th day of the experiment.

Throughout the experiment the highest recorded concentration of hydrogen sulphide was 42 ppm in the sewage sludge mulched with chips, in the sample containing sewage sludge without any additives the peak was 31 ppm (Fig. 14). The concentrations of hydrogen sulphide rise averagely by 20% when sewage sludge is mulched with chips. The use of chips for sludge covering is inexpedient due to the growing concentrations of hydrogen sulphide and at the same time increasing unpleasant odour. Comparison of the investigation data of hydrogen sulphide shows that its average concentration in sludge and sludge mixed with chips differs by mere 8%.

Comparison was made of hydrogen sulphide emissions during composting sewage sludge with minor branches and during composting sludge without any additives (Fig. 15). The peak of the hydrogen sulphide concentration is reached on the 8th–14th days. Starting with the 29th day of the experiment, the concentration of hydrogen sulphide decreases reaching averagely 2.5–3.5 ppm. Since the

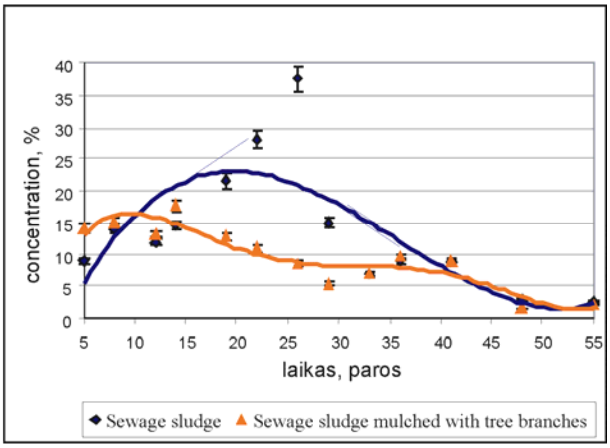

Fig. 11. Methane emissions during composting sewage sludge with minor branches

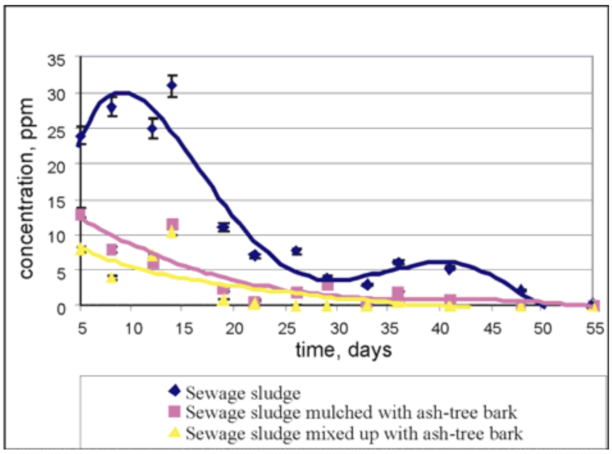

Fig. 12. Hydrogen sulphide emissions during composting sewage sludge with ash-tree bark

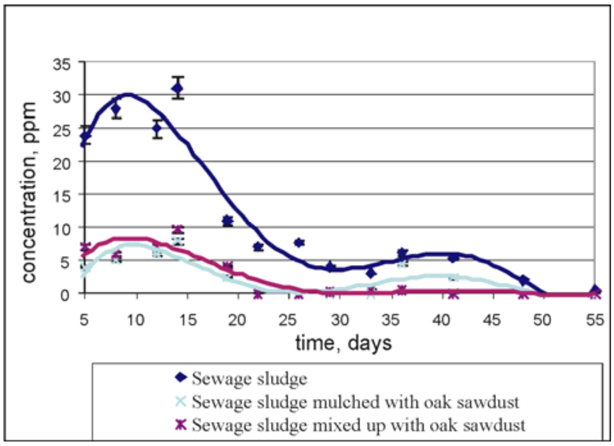

Fig. 13. Hydrogen sulphide emissions during composting sewage sludge with oak sawdust

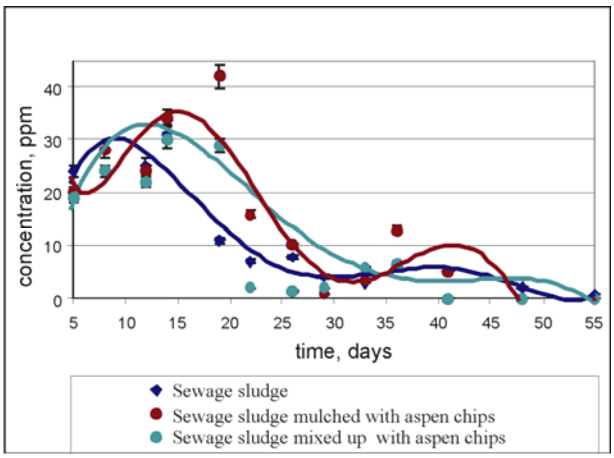

Fig. 14. Hydrogen sulphide emissions during composting sewage sludge with aspen chips

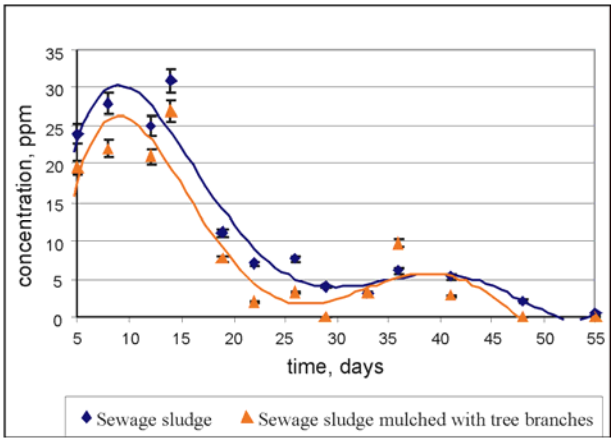

Fig. 15. Hydrogen sulphide emissions during composting of sewage sludge with minor branches

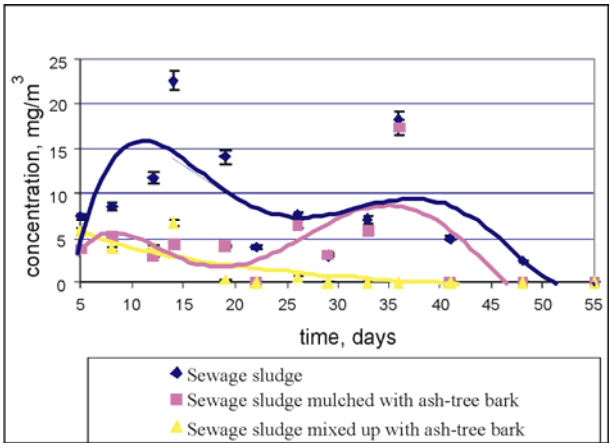

Fig. 16. VOC emissions during composting sewage sludge with ash-tree bark

48th day no hydrogen sulphide is identified in the samples composed of sewage sludge mulched with branches.

Comparison of the average hydrogen sulphide emissions in all the samples (Figs. 12–15) shows that the emissions of hydrogen sulphide are reduced most efficiently, even fivefold, upon mulching sewage sludge with sawdust and mixing it with bark. The sample in which composted sludge was mulched with chips (Fig. 14) produced higher emissions of hydrogen sulphide than the one composed of sludge without any additives. Therefore, the use of chips as an additive for sewage sludge composting is inexpedient.

During the anaerobic process volatile organic compounds serve as an intermediary product of ongoing biochemical reactions. VOC emissions during composting of sewage sludge in different ways are presented in Figs. 16–19. It is hard to control VOC emissions into the atmosphere according to the entire mechanism of composting as they, in fact, are evolving as an intermediate product during the entire process of composting. In addition, these compounds are of a different composition.

When sewage sludge was composted with bark (by mulching and mixing) (Fig. 16) the peak concentration of VOCs reached up to 7 mg/m^3. The highest recorded concentration of the sewage sludge that was composted without any additives was 23 mg/m^3. The use of bark reduced VOC concentration averagely fourfold.

When sewage sludge was composted with sawdust (by mulching and mixing) (Fig. 17), the peak concentration of VOCs reached up to 8–10 mg/m^3. The highest concentration of VOC emissions was reduced more than twofold when using sawdust compared to the composting of sewage sludge without any additives.

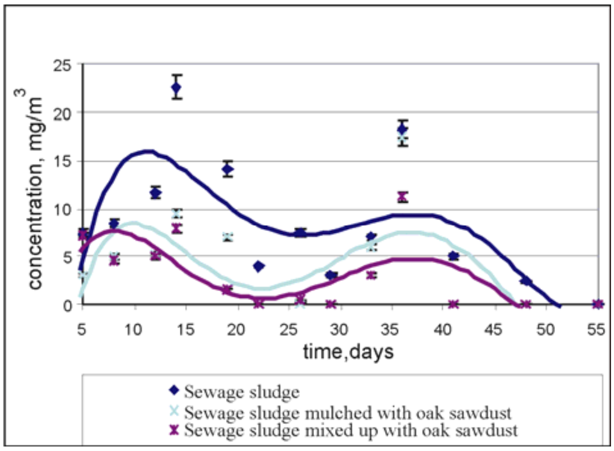

Fig. 17. VOC emissions during composting sewage sludge with oak sawdust

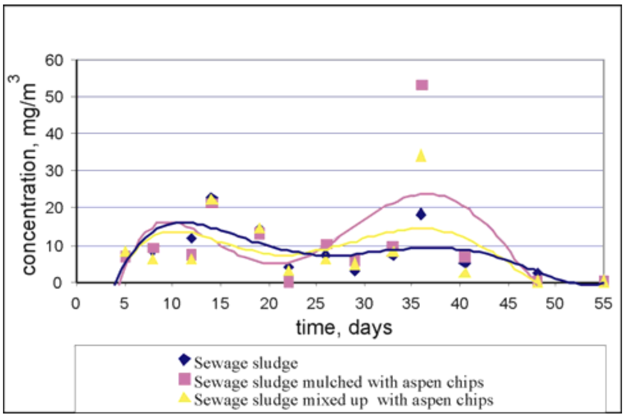

Fig. 18. VOC emissions during composting of sewage sludge with aspen chips

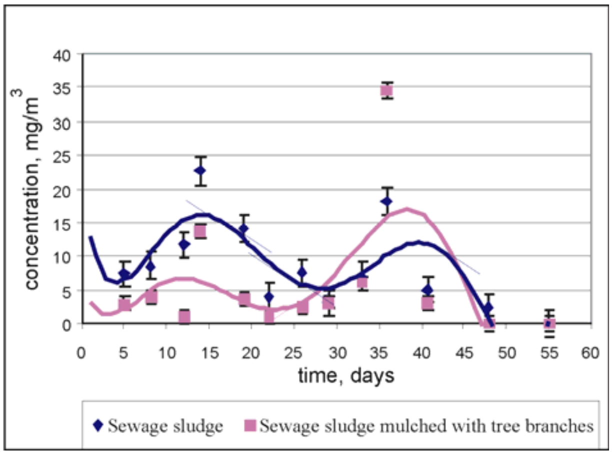

Fig. 19. VOC emissions during composting sewage sludge with minor branches

Throughout the experiment the highest concentrations of volatile organic compounds were identified on the 14th day of the experiment in sewage sludge without any additives and in sewage sludge with chips – 22–23 mg/m^3 (Fig. 18).

The use of minor branches for sludge mulching reduced VOC concentrations averagely 2–2.5 times (Fig. 19).

Analysis of the obtained findings shows that the concentration of VOC emissions remains constant when composting sewage sludge with chips compared to sewage sludge without any additives. The sharpest fall of VOC concentration, averagely fourfold, was recorded in the sewage sludge that was composted by mixing it with bark.

The concentrations of CH_4, H_2S, VOC emissions were most efficiently reduced when sewage sludge was mixed with additives (bark, sawdust, chips) and the best results were achieved upon mixing sewage sludge with bark. The concentrations of NH_3 were most efficiently reduced when sewage sludge was mulched with additives, and the best result was achieved when it was mulched with bark.

Analysis of all the results of the investigation shows that it is the crushed bark that most efficiently reduces the emissions of gaseous pollutants (CH_4, NH_3, H_2S, VOC) during composting sewage sludge. Due to its large surface area and porous structure bark can be used as a natural absorbent. In addition, this structure is suitable for microorganisms to develop and is used for biological air treatment.

4. Conclusions

1. Upon creating optimum composting conditions (C:N, aeration, pH, temperature and humidity) and using (by mixing or mulching) wood waste (bark, sawdust, chips, branches) of different fractions for this process, the emissions of gaseous pollutants during composting biodegradable waste can be controled.

2. It has been established experimentally that the concentrations of ammonia emissions from the sewage sludge composted without any additives were twofold or threefold larger than in the case of composting it with natural additives (bark, sawdust, chips, branches). It can be stated, therefore, that all the natural additives that were used are suitable for the reduction of ammonia concentrations in the process of composting.

3. As the data of the investigation show, crushed wood bark is the most efficient additive reducing the emissions of gaseous pollutants (CH_4, NH_3, H_2S, VOC) during composting sewage sludge (by mixing or mulching with it).

4. A large specific surface area and porous structure of natural materials used for odour absorption have a positive impact on the process of adsorption and at the same time these materials are suitable for the development of microorganisms of pollutants evolved into the ambient air during composting to; therefore, they can be used as a natural agent of biofiltration.

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DUJINIŲ TERŠALŲ, IŠSISKIRIANČIŲ KOMPOSTUOJANT NUOTEKŲ DUMBLĄ SU MIŠKO ATLIEKOMIS, TYRIMAI

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S a n t r a u k a

Nuotekų valymas, nuotekų dumblo apdorojimas ir saugojimas neišvengiamai kelia išsiskiriančių dujų, nemalonių kvapų problemą. Yrant organinėms medžiagoms išsiskiria nemalonaus kvapo dujos (NH_3, H_2S ir kt.) ir šiltnamio efektą sukeliančios dujos (CO_2, CH_4, N_2O). Biodegradacijos procesai vyksta gamtoje ir natūraliai, ir dirbtinai – kompostuojant. Sudarant optimalias kompostavimo sąlygas (C:N, aeravimas, pH ir drėgnis) bei naudojant priedus (medžio pjuvenas, drožles, ceolitą, durpes ir kt.) galima mažinti dujinių teršalų emisijas į aplinką. Nagrinėjami nuotekų dumblo kompostavimo eksperimentų rezultatai tiriant CH_4, NH_3, H_2S ir LOJ emisijas. Eksperimentui naudotas perteklinis Vilniaus komunalinių nuotekų valymo įrenginių nuotekų dumblas, nusausintas centrifugomis. Kaip papildomos medžiagos – uosio žievė, ąžuolo pjuvenos, drebulės drožlės, smulkios lapuočių medžių šakos. Kompostuota kompostavimo aikštelę imituojančiuose „įrenginiuose“.

Reikšminiai žodžiai: nuotekų dumblas, kompostavimas, dujiniai teršalai, nemalonūs kvapai, miško atliekos.

ИССЛЕДОВАНИЕ ГАЗООБРАЗНЫХ ПРОДУКТОВ, ОБРАЗУЮЩИХСЯ В ПРОЦЕССЕ КОМПОСТИРОВАНИЯ ОСАДКА СТОЧНЫХ ВОД С ДРЕВЕСНЫМИ ОТХОДАМИ

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Р е з ю м е

Очистка сточных вод, а также дальнейшая обработка накапливаемого осадка связаны с выбросами газов с неприятным запахом. Газы, образующиеся в процессе деградации органических веществ, не только обладают специфическим запахом (NH_3, H_2S и др.), но и вызывают парниковый эффект (CO_2, CH_4, NO_x). Известно, что процесс биодеградации может происходить как в естественных, так и в искусственных условиях, например, при компостировании. Используя примеси (опилки, щепки, цеолит, торф и др.), а также подбирая оптимальные условия для компостирования – C:N, аэрация, pH, влага, можно снизить выбросы газов в окружающую среду. В статье проанализированы результаты газовых выбросов – CH_4, NH_3, H_2S, ЛОС – при компостировании осадков сточных вод. В эксперименте был использован избыточный осадок из очистных сооружений города Вильнюса после обработки на центрифугах. В качестве дополнительного материала (примесей) в процессе компостирования были использованы кора, опилки дуба, стружка осины, небольшие измельченные веточки. Процесс компостирования был имитирован в лабораторных условиях.

Ключевые слова: осадок сточных вод, компостирование, газовые выбросы, неприятный запах, лесные отходы.

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