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INVESTIGATION OF CLEANING EFFICIENCY OF BIOLOGICAL AIR-TREATMENT DEVICE WITH ACTIVATED CHARGE OF DIFFERENT ORIGIN

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Abstract. In order to carry out an experimental investigation a biological air-treatment device was used, namely, a biofilter with a charge of a different origin composed of zeolite, foam and wood chips. When mixing foam and zeolite together with wood chips for air treatment from volatile organic compounds, not only a biological but also adsorptive air-treatment method is used. Using complex treatment technologies the device efficiency and the charge service period are improved. The investigation has shown that microorganisms, being predominant in the bio-treatment process, can breed in charges of on inorganic origin made of natural zeolite and foam. While cultivating spontaneous microorganism associations in the charge, biofilter treatment efficiency was determined to be dependent on the sort of the supplied pollutant, concentration and filtration period. The charge filtration function was most efficient at a velocity of 0,1 m/s when the device was supplied with acetone-polluted air. Cleaning air from acetone, when the original concentration of the pollutant was 103 mg/m^3, the filter treatment efficiency reached 95%. When the concentration of pollutants supplied into the biofilter is reduced and the filtration period is increased, the device treatment efficiency increases as well.

Keywords: biofilter, volatile organic compounds, biodegradation, zeolite, adsorption, microorganisms.

1. Introduction

In many countries of the world one of the most important questions is a rational usage of natural resources and environmental protection from different-origin pollutants, damaging not only to the environment, but to humans as well (Baltrėnas *et al*. 2004).

In industries, such as chemical, lacquer and paints, oil reprocessing and food, there are many organic compounds which in different ways get into the atmosphere. Together with the most permeated organic compounds goes acetone, butanol, toluene, xylem, etc. Emitting volatile organic compounds cause formation of photochemical oxidants a big concentration of which has an adverse effect on human health, flora and the environment in general (Baltrėnas *et al.* 2004; Jeong *et al.* 2006; Laškova *et al.* 2007).

One of the most perspective air-treatment methods today is the biological method which is performed using certain microorganism cultures. It is perspective to use this treatment method while cultivating spontaneous microorganism cultures in the charge. Then the biological air treatment is characterized by its cost effectiveness, efficiency, and no secondary pollutants are formed (Baltrėnas *et al.* 2004).

Life exists where carbon metabolism takes place because all chemical compounds existing in the cell are the compounds of carbon. The ability to use organic compounds is not a feature only of narrow-specialization forms, but also the quality of the majority of the representatives of microorganism groups. Microorganisms oxidizing carbohydrates are an important group of organisms, involved in the cycle of carbon metabolism. Microorganisms are able to use all organic and inorganic carbon compounds in its plastic metabolism. The most significant in this group are bacteria and micromicets. Among them the biggest part consists of bacteria. They are able to take various carbohydrates from the medium, and a short-life cycle is common among them. In commonly detected genera *Arthrobacter, Acinetobacter, Pseudimonas, Bacillus, Flavobacterium, Mycobacterium, Micrococcus, Rhodococcus* there are bacteria which are able to oxidize carbohydrates. Carbohydrates can be disintegrated by microorganisms of more than 70 of genera (Jankevičius and Liužinas 2003; Malhautier *et al.* 2005; Liu *et al.* 2005).

There are quite a few genera able to disintegrate carbohydrates identified between micromicets. Often *Penicillium, Aspergillus, Cladosporium, Alternaria, Botrytis, Fusarium, Mucor* species of micromicets genera are detected (Lugauskas *et al.* 1997).

The efficiency of the biological air-treatment process is dependent on the microorganism cultures breeding in the bio-medium. Microorganism growth can be reached by food abundance using primary air-treatment method by supplying pollutants to the biofilter and activating the microorganisms.

The velocity of ferment reaction of the microorganisms is dependant on substratum – concentration of carbohydrate. This dependency can by expressed by the formula:

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$$v_o = \frac{v_{\max} \cdot C_1}{K_M + C_1}, \tag{1}$$

where: v_o – ferment effect velocity, $mg/m^3 \cdot s$; $v_{\max}$ – maximal ferment effect velocity, $mg/m^3 \cdot s$; c_1 – substratum concentration, $mg/m^3 \cdot s$; K_M – Michaelis – Menten constant.

The number of microorganisms depend on the being sorbated pollutant type. In this case substratum is carbon and energy source of the microorganisms. Biomass increase reliance on the substratum concentration can be expressed by the formula:

$$\mu = \frac{\mu_{\max} \cdot c}{K_s + c}, \tag{2}$$

where: μ – biomass increase velocity, h^{-1}; $\mu_{\max}$ – maximal biomass growth velocity, h^{-1}; c – substratum concentration, mg/m^3; K_s – Monod constant, mg/m^3.

Biodegradation intensity of aromatic compounds depends on the number of the structure rings and condensation degree. The more condensed multi-ringed compound, the slower its mineralization. It is maintained that the ability of microorganisms to disintegrate aromatic compounds is almost inversely proportional to the number of their structure rings. Single carbohydrates of a condensed structure with four or more rings are disintegrated slowly.

The most important factor is temperature determining germ breeding velocity and the intensity of biochemical reactions. Various microorganism groups are acclimatized to live at a different temperature. Microorganisms as well as other organisms can have their temperature minimal, optimal and maximal. When the temperature falls below the minimal or jumps above the maximal temperature, vital processes are interrupted. The best temperature for the breeding of microorganisms is optimal. E.g., genera of psychrophilic and mesophilic microbes, such as *Pseudomonas* and *Achromobacter*, can breed at a temperature varying from 10 to 30 °C.

The *pseudomonas* culture, taking an active part in organic compound destruction processes, is widespread in nature. Some bacteria of the *Pseudomonas fluorescens* species can be found in water and on the surface of plants. When educing bacteria of *Pseudomonas* genera from the substratum of water and wood, the *Pseudomonas fluorescens* constituted accordingly 55 and 67% (Tekorienė and Lugauskas 2001).

The main element of a biological air-treatment device is the filtrating medium which is necessary both as a substratum of the microorganisms and as a way to supply the needed nutrients. In practice as filtrating mediums charges of a natural origin, such as compost, peat, wood chips, barks and active sludge, are used (Zigmontienė and Baltrėnas 2004).

Artificial charges, composed of polyurethane, propylene, polyethylene, glass, ceramic balls and other materials, are frequently used. However, all these materials, under the sway of microorganisms decompose after some time (Baltrėnas *et al.* 2004; Yun and Ohta 1998; Torkian *et al.* 2003).

Aiming to prolong the period of charge service and to increase the device treatment efficiency, there are a few treating methods possible to be combined, i.e. biological methods together with adsorptive ones. As zeolite has a regular even-sized pore structure, it is characterized by a large internal individual surface area and thermal stability, therefore it is widely used in air treatment as an adsorbent. Wood chips mixed with zeolite can prolong the charge service period as well, as it can improve sorptive characteristics of the filtrating medium (Baltrėnas and Paliulis 2002). Microorganisms of spontaneous cultures will develop not only in wood chips, but also in zeolite of an inorganic origin (Luo and Lindsey 2006). Microorganisms, accumulated in the bio-membrane which is formed on the surface of zeolite, will disintegrate in zeolite pores accumulated organic compounds. To maintain better sorptive characteristics of the charge, wood chips can be mixed with charges having a larger sorptive surface, such as foam. Then the charge will be given improved features of humidity sorption, little density, its cost effectiveness and a large treatable surface area.

The aim of the investigation is to determine the biofilter treatment efficiency dependencies on the pollutant type supplied to the device, concentration and filtration period, using activated charges composed of natural zeolite, foam and wood chips.

2. Methods

Experimental investigation is carried out using a biological air-treatment device – biofilter (Fig. 1). The main element of the filter is an activated charge composed of zeolite, foam and wood chips. Aiming to maintain an even air flow and humidity distribution over the whole layer of the charge and to reduce aerodynamic resistance of the charge in the filter, five cartridges were installed, separated by metal screens from each other. The lower cartridge of the biofilter is filled with wood chips mixed with natural zeolite granules sized 10–15 mm. The wood chip and granule mixture proportion according to the volume reaches 50: 50%, and the height of the layer is 100 mm. The biofilter cartridge above the latter is filled with wood chips of 20 mm, mixed with foam cubes sized 30×30×20 mm. The proportion of wood chip and cubes mixture according to volume reaches 50:50%, and the height of the layer is 150 mm. The third, fourth and fifth biofilter cartridges are filled with a charge of wood chips sized 20–30 mm (Fig. 2).

Each layer of the charge is 0,85 m in length, 0,65 m in width and 0,15 m in height. Having filled the cartridges, the charge is activated by keeping a proper temperature in the biofilter, bio-medium acidity, and the amount of biogenic elements. For spontaneous microorganism adaptation in the bio-medium, polluted air is supplied into the device via volatile organic compounds. This is the way for microorganisms to get required oxygen and carbon.

Before starting up the biofilter, the charge is humidified using water spray, installed above each layer. Water, saturated with biogenic elements, is supplied to the spray by a pump, which is fitted in the excess-water reservoir.

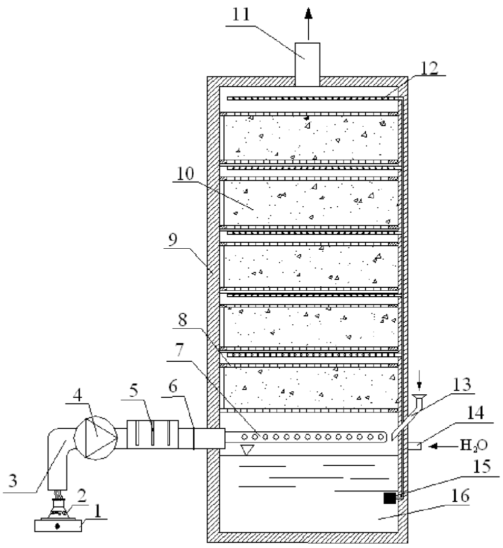


Fig. 1. Stand of biofilter: 1 – electrical stove, 2 – bulb with a pollutant, 3 – air-feeding pipe, 4 – fan, 5 – air-supply channel heater, 6 – air-flow control valve, 7 – collector, 8 – screen, 9 – biofilter wall, 10 – cartridge, 11 – air-elimination pipe, 12 – water spays, 13 – biogenic element-feeding pipe, 14 – water-feeding pipe, 15 – water pump, 16 – water reservoir

The water pump operation is controlled by a time relay, installed in the biofilter control panel, which turns on the water pump for 8 seconds every hour. During the ivestigation the pump operational period was adjusted so that 75% of charge humidity was maintained. To this purpose 7 l of water were sprayed on the charges every day in order to maintain the humidity of the entire charge volume (0.387 m^3).

In order to keep an even air flow and for excess water to drain into the water reservoir, equipped in the lower part of the filter, the layers of bio-medium are separated from each other by metal screens. Humidity in the charge is controlled via the weighting method. Before the samples are taken, dishes are exsiccated together with lids in the oven for about 1 hour at a temperature of 105 °C and then are cooled in the desiccator. Exsiccated dishes with lids are weighted on analytical balance.

Fig. 2. Biofilter charges: a – wood chips; b – mixture of natural zeolite and wood chips; c –mixture of foam cubes and wood chips

Taken by pincers samples weighing 1–2 g are placed into the dishes and corked up. The operation sample is evenly distributed on the bottom of the dish (0.2 g/cm^2). The weighted dish with the sample is put back into the oven and exsiccated for 3 hours at a temperature of 105±2 °C. The exsiccated sample is weighted and then its humidity is calculated (Baltrėnas and Zagorskis 2007).

For charge mechanical stability maintenance and even humidity distribution over the whole charge area, there is a screen with meshes of 3×3 mm equipped above each layer.

To improve the growth and energy of the microorganisms, a solution of mineral salts, providing microorganisms with vitally important biogenic elements, is essential. The solution of salts consists of: K_2HPO_4 – 1g, KCl – 0.5g, $MgSO_4 \cdot 7H_2O$ – 0.5g, $FeSO_4 \cdot 7H_2O$ – 0.1g, $NaNO_3$ – 0.90g, water – 1000g. This solution is poured into the water reservoir and sprayed on each layer of the charge. To provide microorganisms metabolism the acidity in the bio-medium of pH = 7.0 is maintained. To maintain the acidity buffered solutions are used, composed of sodium and potassium hydrophosphates. The acidity of the bio-medium is measured by the pH-meter (Baltrėnas and Vaiškūnaitė 2003).

To maintain a due temperature in the air-feeding pipe an air-supply channel heater is equipped, which heats the air supplied to the biofilter to an invariable temperature of 30 °C.

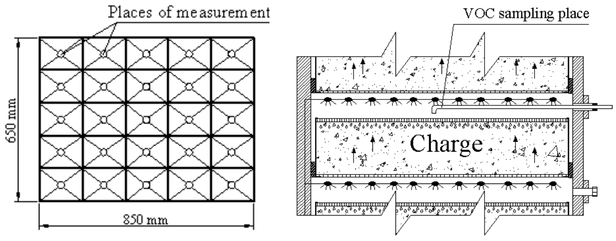
For microorganism energy maintenance, different acetone concentrations were passed through the charge. Acetone is used by microorganisms as food, emitting to the medium the products of metabolism – CO_2 and water. Different concentrations are produced by heating pollutants on the electrical stove. The temperatures of the fed vapour vary from 20–50 °C. The original concentration of the passed acetone reached 20 mg/m^3. The pollutant is supplied into the device 4 times a day, for 15 minutes each time. Later the concentration of organic compound is increased every two days, with the amount of 20 mg/m^3 each time thus prolonging the period of acetone supply to 1 hour the activation of the charge took 2 weeks. To ensure an even air flow and pollutant concentration distribution over the entire charge area, there is an air-flow distribution collector fitted in the lower part of the filter.

After the charge activation the polluted with acetone air is supplied to the device. The acetone concentration before five charge layers reaches 103 mg/m^3. To determine the concentration of the pollutant, air samples are taken when a constant velocity of 0.1 m/s of the supplied air-flow is maintained. When samples are already taken, the supplied air-flow velocity is increased by 0.2 m/s, adjusting it by the air-flow valve, installed in the filter. Testing is repeated gradually increasing the velocity of the supplied air flow by 0.3, 0.4 and 0.5 m/s.

For air-flow velocity sampling and temperature measurements, sampling branches with screw-caps were installed in front of and behind each cartridge in the biofilter.

In the rectangular air pipe, the branches are fixed on one wall. If measurements are not performed, the branches are to be sealed.

The cross-section of the rectangular air pipe is relatively parallel divided to its wall lines into the identical rectangles. Measuring points are located in the centre of each rectangle. The number of measuring points in the rectangular air pipe cross-section with an area of 0.55 m^2 has to reach 25 samples (Fig. 3 a).



a b

Fig. 3. Location of physical air settings and pollutant testing: a – places of air-flow velocity and temperature measurement; b – place of volatile organic compound sampling

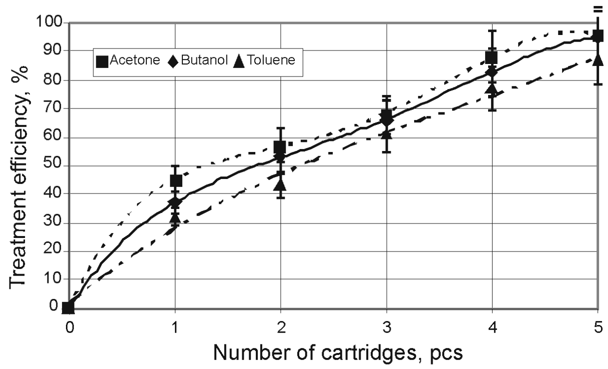


Fig. 4. Dependence of biofilter treatment efficiency on the number of cartridges when the velocity of supplied air flow is 0.1 m/s

The velocity and temperature of the air flow, let through the charge, are measured by the Testo 400 anemometer of the German firm TESTO.

In order to determine the dependency of the biological air-treatment device on the supplied pollutant concentration, the acetone concentration feeding is to be increased to 205 mg/m^3. Concentration of the pollutant is to be varied by heating it on the stove. Afterwards testing is repeated having increased the original acetone concentration to 301 mg/m^3.

When experimental investigation with acetone is performed, every 3 hours clean air is to be supplied to the device. In this way the velocities of acetone vapour desorption are increased. After that testing is repeated with other pollutants such as butanol and toluene.

To determine dependence of charge treatment efficiency on charge layer height, the concentrations of pollutants are measured in front of and behind each cartridge. For the determination of pollutant concentration, samples are to be taken in certain places, repeating each measurement 3 times.

An air sample from the air pipe is sucked through a tube made of stainless steel (d = 5 mm, l = 30 cm) into a clean 0.25 l gas pipette at a velocity of 0.25 l/min. Suction will continue for 5 minutes. When the suction is stopped, the ends of the pipette are to be sealed via silicone hose by glass plugs and, furthermore, the hoses are tightened by Moor clips. The samples will be analysed the same day.

Pollutant concentration will be determined by the gas chromatograph SRI 8610 No. 942. When starting up the chromatograph the following analysis stages are set: nitrogen gas velocity – 30 ml/min, hydrogen gas velocity – 30 ml/min, air velocity – 200 ml/min, column thermostat temperature – 100±2 °C, vaporizer temperature – 200±5 °C, detector temperature – 200±5 °C.

3. Results and discussion

After experimental investigation dependencies of the biofilter treatment efficiency on the type of pollutant, supplied into the device, were determined. Basing on the data, given in Fig. 4, a conclusion can be drawn that the best integrated by microorganisms pollutant was acetone. Acetone can be well mixed with water and is totally soluble in it, thus the vapour of acetone is better absorptive on the membrane, formed on the charge surface.

The biofilter was the most inefficient treating air polluted by toluene. Toluene is less soluble in water and its solubility reaches 0.53 g/l, thus it is not so absorptive on the bio-membrane. The biggest decrease of pollutant concentration is observed after the lowest charge layer which is made of a mixture of zeolite granules and wood chips. After that the acetone layer concentration decreased from 103 to 58 mg/m^3. In the remaining layers of the charge pollutant concentration varied evenly.

Having measured the pollutant concentrations in front of and behind each cartridge, the treatment efficiency of the biofilter was determined by having filled it with charges of a different origin. The greatest efficiency was reached treating polluted air by acetone (Fig. 4). Device treating efficiency increases most after the first cartridge, filled with activated charge of zeolite and wood chips. As zeolite is full of pores and has a large treatable surface area, therefore part of the pollutant is adsorbed on the charge surface. After the first layer filter treatment, efficiency reaches 45%, and after all the filtrating layers – 96%.

The lowest biofilter treatment efficiency of 87% was obtained while supplying into the device air, polluted by toluene. High 95% treatment efficiency of the biofilter was obtained supplying air, polluted by butanol. One can presume that a better air treatment with butanol was determined by its solubility in water. During testing it was determined that butanol solubility in water reached 3–5 g/100 ml of water. Furthermore, by experimental investigation it was established that microorganisms tended to breed in substratum with more biogenic elements melted in it. The last three layers of the charge, which were made of wood chips, could filter pollutants of a different origin fairly uniformly. A significant decrease of pollutant concentration can be observed in the second layer of the charge, consisting of a mixture of wood chips and foam. After this layer the concentration of acetone decreased from 58 to 46 mg/m^3. The decrease of pollutant concentration was influenced by a high humidity of the charge, reaching 85%, and by the amount of nutrients, melted in water, which were digested by the microorganisms during the metabolism period.

During the investigation biofilter treatment efficiency dependencies on varying concentration of a supplied pollutant were derived. This study was carried out by supplying polluted air into the device at a velocity of 0.1 m/s through volatile organic compounds. When the concentration of substratum (acetone) is big, the ferment is saturated, i.e. substratum or the molecules of the product always occupy its active center. Under such conditions further increase of substratum concentration does not affect fermentation reaction velocity any more because all active centers of the ferment are busy. Therefore, the device treatment efficiency decreases increasing the concentration of the pollutant.

Acetone is disintegrated best when the original concentration of the pollutant is lower. When the original acetone concentration was 103 mg/m^3, the treatment efficiency of the biofilter reached 96%. Increasing the original concentration to 305 mg/m^3, the treatment efficiency of the biofilter decreased to 80% (Fig. 5).

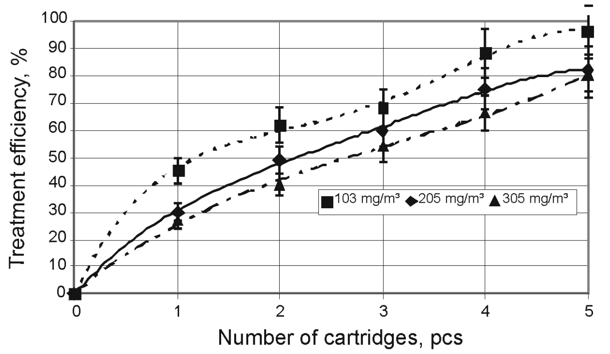


Fig. 5. Dependence of biofilter treatment efficiency on the number of cartridges when the original concentration of acetone is varying

Aiming to improve the treatment efficiency of the biofilter when the concentrations are high, it is essential to increase the number of cartridges in the device or to decrease the velocity of the supplied air flow into the device. This will increase biochemical reaction periods in the filter.

Supplying air into the device, polluted by butanol, when the original concentration of the pollutant is 104 mg/m^3, the treatment efficiency of the device after 5 layers of the charge reaches 95%, i.e. the concentration of the pollutant decreases from 104 to 10 mg/m^3. Increasing the concentration of the supplied pollutant to 310 mg/m^3, the efficiency of the filter decreases to 78% (Fig. 6), and the concentration of the pollutant – to 68 mg/m^3. Lower efficiency of butanol treatment is determined by its lower solubility in water. The concentration of butanol decreased most after the first cartridge of the biofilter, which was filled with an activated charge of natural zeolite and wood chips. After this layer of charge, the butanol concentration, having its original concentration of 105 mg/m^3, decreased to 63 mg/m^3. As butanol is less soluble in water, a big part of the pollutant was adsorbed by zeolite which has many pores in its structure and a large sorptive surface area. So carbohydrate, less soluble in water is better sorptive by the charge, composed of zeolite granules and wood chips. Butanol is locked in zeolite granules, thus it stays longer in the activated charge. In this way the periods of biochemical reactions are increased, and it improves the synthesis of the butanol as well as the treatment efficiency of the device.

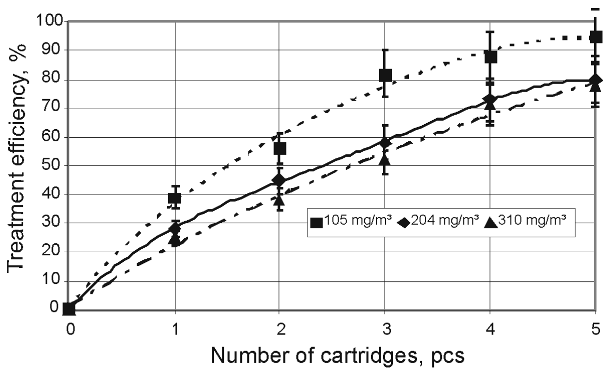


Fig. 6. Dependence biofilter treatment efficiency on the number of cartridges when the original concentration of butanol is varying

The lowest treatment efficiency of the device was obtained treating air, polluted by toluene. When the original concentration of the pollutant was 104 mg/m^3, the treatment efficiency of the device reached 87%. Having increased the concentration of toluene to 307 mg/m^3, the efficiency decreased to 75% (Fig. 7).

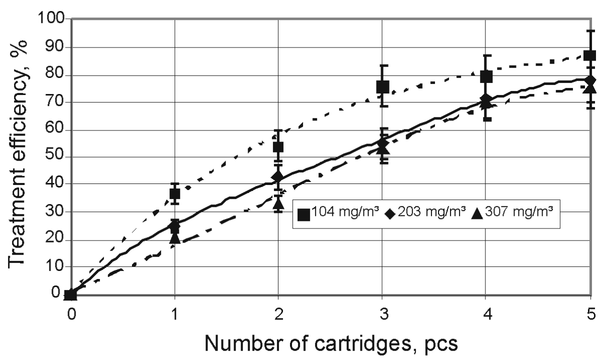


Fig. 7. Dependence of biofilter treatment efficiency on the number of cartridges when the original concentration of toluene is varying

Increasing the concentration of the supplied pollutant, the treatment efficiency of the biofilter decreases because microorganisms are not able to fully disintegrate volatile organic compounds in a short time. Pollutants were disintegrated best in the first layer of the charge, which was composed of an activated mixture of zeolite and wood chips. The second layer of the charge, which was filled with a mixture of foam cubes and wood chips, could best disintegrate acetone. As butanol and toluene are less soluble organic compounds, their concentration after the latter layer of the charge varied less than that of acetone.

On the basis of the result data given in Fig. 8 it can be observed that treatment efficiency of the biofilter depends on the period of filtration – pollutant's contact with the charge. The longer the filtration period, the higher treatment efficiency of the device. Filtration period of polluted air is dependent on the velocity of air flow passed through the biofilter. The best treatment efficiency of the device was obtained passing polluted air through the charge at a velocity of 0.1 m/s. At such an air-flow velocity pollutant filtration period reaches 7 s, and the concentration of acetone after filtration decreases to 96%, of butanol – to 82%, and of toluene – to 79%. The lowest treatment efficiency of 67% was obtained filtering through the charge air, polluted by toluene, with filtration period reaching 1.4 s.

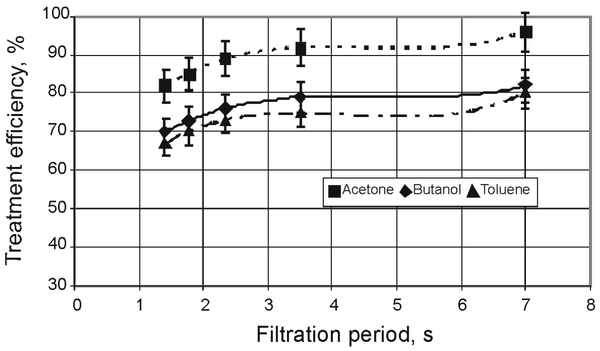


Fig. 8. Dependence of biofilter treatment efficiency on the filtration period when the concentration of the supplied pollutant is 104±5 mg/m^3

On the other hand, the highest treatment efficiency of 82% was obtained disintegrating acetone. Increasing the velocity of air-flow, passed through the charge, to 0.3 m/s, with pollutant filtration period reaching 2.3 s, the treatment efficiency of the biofilter removing acetone increases to 89%. It is safe to say that prolonging of the filtration period increases the treatment efficiency of the device. Decreasing the velocity of air flow, passed through the device, to 0,1 m/s, the treatment efficiency increases even in the cases of such disintegrable pollutants as toluene. Furthermore, toluene belongs to the group of aromatic carbohydrates with molecules which are hexanomial benzene ring. Carbohydrate, having more elements in the ring of benzene, is more complicated, and that is why it is disintegrated worse by microorganisms. A lower treatment efficiency of the biofilter, when filtering air polluted by toluene, can be observed in Fig. 9.

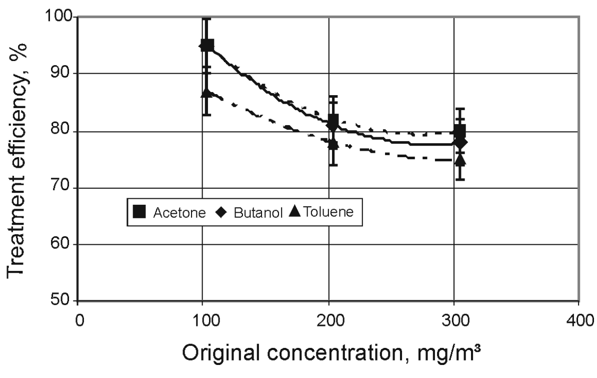


Fig. 9. Dependence of biofilter treatment efficiency on the concentration of the supplied pollutant

When increasing the contretation of the polutant fed into the device, the treatment efficiency of the biofilter decreases. Supplying air, polluted by acetone with concentration of 103 mg/m^3, to the biological air-treatment device, its efficiency reaches 96%. Having increased the pollutant concentration to 305 mg/m^3, the efficiency of the treatment decreases to 79%. The lowest device treatment efficiency of 87% was obtained by treating air, polluted by toluene. Having increased the original concentration of this pollutant to 307 mg/m^3, the treatment efficiency of the filter will decrease to 75%. Therefore, to increase the treatment efficiency, it is essential to reduce the concentration of the pollutant supplied to the device. Furthermore, it is needed to use in the biofilter charges, having good sorptive characteristics. The investigation has shown that, simultaneously combining biological and adsorptive treatment methods, very high treatment efficiency can be obtained. Using natural zeolite the charge service period can be prolonged as well as mixing it with wood chips a good microbiological activity of the charge can be obtained.

4. Conclusions

1. Combining biological and adsorptive air treatment methods a high treatment efficiency of 96% of the biofilter can be obtained as well as the period of charge service can be prolonged.
2. The highest treatment efficiency of 96% of the biofilter was obtained when treating air, polluted by the acetone.
3. Treating air polluted by toluene, when the original concentration of the pollutant is 104 mg/m^3, the treating efficiency of the device reaches 87%. Lower treating efficiency is influenced by a poorer pollutant solubility in the bio-medium.
4. The first layer of the biofilter was the most sorbent when filled with a mixture of zeolite granules and wood chips. This layer of the charge is significant by its good biological and sorptive characteristics.
5. Increasing the concentration of supplied pollutant, the treatment efficiency of the device decreases. Increasing the concentration of supplied to the biofilter acetone from 103 to 305 mg/m^3, the treatment efficiency decreased from 96 to 80%. Whereas microorganisms are not able to oxidize organic compounds, the filter is more efficient with smaller pollutant concentrations.

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BIOLOGINIO ORO VALYMO ĮRENGINIO SU AKTYVINTA SKIRTINGOS KILMĖS ĮKROVA VALYMO EFEKTYVUMO TYRIMAI

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Santrauka

Eksperimentiniams tyrimams atlikti buvo naudotas biologinis oro valymo įrenginys – biofiltras užkrautas skirtingos kilmės įkrova, sudaryta iš ceolito, porolono ir medienos drožlių. Poroloną ir ceolitą maišant su medienos drožlėmis lakiesiems organiniams junginiams valyti iš oro taikomas ne tik biologinis, bet ir adsorbcinis oro valymo metodas. Kompleksiškai taikant skirtingas valymo technologijas pagerinamas įrenginio valymo efektyvumas ir įkrovos naudojimo laikas. Tyrimai parodė, kad biologinio valymo procese vyraujantys mikroorganizmai gali daugintis ir neorganinės kilmės įkrovose, sudarytose iš gamtinio ceolito bei porolono. Įkrovoje kultivuojant savaiminių mikroorganizmų asociacijas nustatytos biofiltro valymo efektyvumo priklausomybės nuo tiekiamo teršalo rūšies, koncentracijos, filtracijos laiko. Geriausiai įkrova filtravo 0,1 m/s greičiu į įrenginį tiekiamą acetonu užterštą orą. Valant iš oro acetoną, kai pradinė teršalo koncentracija yra 103 mg/m^3, filtro valymo efektyvumas siekė 95 %. Mažinant į biofiltrą tiekiamų teršalų koncentracijas ir didinant jų filtracijos laiką, įrenginio valymo efektyvumas didėja.

Reikšminiai žodžiai: biofiltras, lakieji organiniai junginiai, biodegradacija, ceolitas, adsorbcija, mikroorganizmai.

ИССЛЕДОВАНИЕ ЭФФЕКТИВНОСТИ УСТАНОВКИ ДЛЯ БИОЛОГИЧЕСКОЙ ОЧИСТКИ ВОЗДУХА С АКТИВИРОВАННОЙ ЗАГРУЗКОЙ РАЗЛИЧНОГО ПРОИСХОЖДЕНИЯ

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Р е з ю м е

Для выполнения экспериментальных исследований использовалось биологическое устройство для очистки воздуха – биофильтр, загруженный загрузкой различной породы, состоящей из цеолита, поролона и древесины. При смешивании поролона, цеолита и древесины для очистки воздуха от летучих органических составов применялся не только биологический, но и адсорбционный метод очистки воздуха. При совместном применении разных технологий очистки улучшается эффективность устройства и продлевается срок действия загрузки. Исследование показало, что микроорганизмы могут размножаться и на загрузках неорганического происхождения, состоящих из природного цеолита и поролона. При выращивании самопроизвольных ассоциаций микроорганизмов установлены зависимости эффективности очистки воздуха от вида поступающего загрязнителя, концентрации и периода фильтрации. Фильтрация была наилучшей, когда воздух, загрязненный ацетоном, подавался в биофильтр со скоростью 0,1 м/сек. Эффективность биофильтра при очищении воздуха от ацетона, первоначальная концентрация которого составляла 103 мг/м^3, достигала 95%. Эффективность очищения воздуха в устройстве увеличивается, когда концентрация поставляемых в биофильтр загрязнителей уменьшается, а период фильтрации продлевается.

Ключевые слова: биофильтр, летучие органические составы, биологический распад, цеолит, адсорбция, микроорганизмы.

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