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Septic Tank Effluent Pretreatment Using Different Filter Materials as a Prevention from Clogging

Septic tanks are common devices for primary wastewater treatment, however, they are prone to periodically raised effluent solids concentration, which can accelerate the clogging process in specific conditions. The aim of the study was to identify the impact of the secondary filter on the reduction of TS load and possibility to increase the operation time. The study was carried out in two series using six filters. In each series six filters (pipes with filtering material installed on the bottom) were used: three filters with filter mesh and the other three - with non-woven geo-textile. The filters were being filled with wastewater until clogging was achieved (wastewater table in pipes rising up to 50 cm). For the hydraulic conductivity estimation of falling water table tests were performed. Similar values of accumulated TS to dosed TS ratios were observed during the both series for the both filtering material types. The particle size distributions in the both filtering materials were similar. The fact of accumulation of particles of very small dimension (over 73% smaller than 5 μm), much smaller than the filtering material pores diameter might suggest that the process taking place was that of cake filtration. Despite the higher cumulated dry mass of filter cake and inside the filtering layer, the average hydraulic conductivity of non-woven geo-textile was higher than the average hydraulic conductivity of filter mesh. Probably thanks to the higher porosity of geo-textile higher amount of solids can be trapped inside the filtering material itself. The study showed the relatively low ratio of accumulated solids to supplied solids load; however, the accumulated mass seems to be significant for clogging prevention, especially in the case of several filtering layers usage. This way much more solids can be removed from the septic tank effluent (e.g., using four layers - about 10÷20%) and clogging process can be slowed down (two - three years longer operation time).

Keywords: **domestic wastewater, septic tank effluent, wastewater treatment, clogging**

Introduction

Septic tank is still one of the most common devices for the first wastewater treatment step/stage in Poland and several other countries in Europe. The advantage of this is low investment and operational costs, simple construction, relatively high solids and organic compounds removal efficiency on average. Unfortunately, its downside is the very wide range of solids concentration at inflow and unrecognized processes related to flow and its impact on sludge. Such installations are in use in approximately more than 30% of households in Ireland [1], 25% in the United States [2], 13% in Australia [3], as well as a few per cent in the United Kingdom [4] and Poland. ST systems are also widely used in the 246 million population of South East Asia or Brazil and Mexico [5].

Septic tank effluent (STE) poses a potential danger to human health and aquatic ecosystems if it reaches the surface or ground water without proper purification [6, 7], but the basic functions of ST are retention of solids storage of sludge and scum and then breakdown of these substances in an anaerobic digestion process, and finally discharge of the partially treated effluent to soakaway soil [7] or biological installation for further treatment. In many publications it is suggested that soil clogging is usually accelerated under increasing hydraulic loading rates of STE or under increasing concentrations of organic matter and suspended solids at a given hydraulic loading rate [8-10].

However, it is still common practice not to consider wastewater strength and hydraulic loading rate interactions, and simply apply septic tank effluent to soil or media infiltrative surfaces at the established hydraulic loading rates as a rule. Severe soil instances of clogging may result and effluent ponding may develop to the point where surfacing effluent or plumbing backups occur.

Therefore the septic tank effluent, especially suspended solids rates, may have a significant effect on the clogging and performance of a pre-treatment filter or soakaway soil. The range of average STE is from ca. 20 [11, 12] to 276 mg/L [12]. A similar range can be found in more recent literature, too [13, 14]. Septic tank effluent from a tank with an effluent filter has different characteristics from unfiltered effluent. Typical effluent concentrations from septic tanks equipped with effluent filters range from 20 to 55 mg/L for TSS [11, 15]. However, it is not rare that STE suspended solids rates are much higher, e.g. from restaurants or for black water: 372 [16], 626 [17], more than 1000 [14, 18] and even 4775 mg/L (mean 454 mg/L) [19].

The lowest values of effectiveness of suspended solids removal in septic tanks are 32 [20] and 36% [21], and the highest are 81 [22] and 88% [23].

Filtration is a process which is used in water treatment and waste water treatment [24]. Biofiltration causes the particles to be retained within and on the surface of the filter material, unlike the living biomass contained in the biofilm removing organic substances. Filter cake is formed during the filtration on the surface of the filter material by the deposition of suspended particles [24]. This process leads to clogging and stagnancy of sewage on the filter surface. The parameter which can assess the filtration material permeability is hydraulic conductivity. There are at least two main in situ methodologies; the Constant Head method and Percolation Test to estimate this parameter [25]. The permeability of filter cake decreases in time finally to almost zero. To avoid unfavourable and dangerous process of filter cake development on the surface of soil absorption system different kinds of outflow from septic tank can be used. Pawlak et al. [26] confirmed the influence of outflow kind from septic tank on the quality of wastewater directed into the soil absorption system (SAS).

As a consequence, the application of filtration material in outflow from ST can extend the operating time of SAS. Even small particles as colloids with a size range assumed to be less than 1.2 microns according to the literature can play an important role in the permeability of SAS. Small size pores in filter cake were probably sensitive to closing or bridging by small size colloidal particles. Spychała et al. [27] reported that even a low content of colloids in outflow from septic tank can affect soil permeability, which can damage the soil absorption system. Spychała and Nieć [28] confirmed that the outflow from ST can dramatically reduce the value of hydraulic conductivity of the soil absorption system and can cause filter failure even after less than two years.

There are several different recommended clogging prevention values of STE hydraulic or TSS load. One is the maximum (total suspended solids) TSS load reported by Van Buuren et al. [29]: 4.9 kg/(m^2/d), which gives at hydraulic load 0.016 m/d maximum TSS concentration about 63 g/m^3. Unfortunately, most existing septic tanks probably do not fulfil this condition.

There is the need for reducing the solids and dissolved organic content remaining in effluents from septic tanks in many countries (e.g. in Brazil septic tanks combined with anaerobic filters are commonly used for domestic wastewater treatment [35]), therefore the problems of better solids removal from wastewater or solids dewatering by filtration are noted by many authors. Riddle [30] proposed a device utilising scrolling geo-textile fabric filter. Another interesting device was presented by Sabry [31] - a system consisting of a modified upflow septic tank followed by an anaerobic baffle reactor. Bourgès-Gastaud et al. [32] performed a pressure filtration tests using non-woven geo-textiles to filter high-clay-content sludges. The efficiency of permeable pavements equipped with geotextiles as a pollutant source control measure was studied by Tota-Maharaj et al. [33]. Mendoza et al. [34] evaluated performance of gradual concentric chambers (GCC) using gravel bed as an effluent filter.

The aim of the study was to identify the impact of the secondary filter on the reduction of TSS load and the possibility to increase the relevant operation time.

1. Methods

The study was carried out using six transparent pipes made of organic glass. The dimensions of pipes were: 50 cm in length and 2.5 cm in diameter. Two types of filtering material were investigated: filter mesh (SP 14) and non-woven geotextile (TS20) (Figs. 1, 2). The study was carried out in two series. In each series six pipes were used - three with filter mesh installed on the bottom (filters: F1, F2 and F3) and the other three with the non-woven geo-textile installed on the bottom (filters: F4, F5 and F6). The main technical characteristics of the filtering materials were: for filter mesh - material - 100% polyamide, diameter of warp and thread - 0.3 mm, number of plots for warp - 354 pieces/10 cm, thread - 55 pieces/10 cm, surface mass - 379 g/m^2, the maximum tensile strength warp - 515 daN, thread - 119 dN, relative elongation warp - 31%, thread - 24%, the air permeability - 4140 mm/s and for non-woven TS20 geotextile: material - 100% polypropylene stabilized against UV radiation; statistics puncture resistance (CBR test) (EN ISO 12236) - 1500 N; tensile strength (EN ISO 10319): MD, CD - 10 kN/m and 10 kN/m, respectively; elongation at maximum load (EN ISO 10319): MD, CD - 90 and 75%, respectively; opening size 90 (EN ISO 12956) - 0.105 mm, permeability vertical 2 kPa (EN ISO 11058) (h = 50 mm) - 115 $dm^3/m^2 \cdot s$; thickness at 2 kPa (EN ISO 9863-1) - 0.9 mm and mass per unit area (EN ISO 9864) - 125 g/m^2.

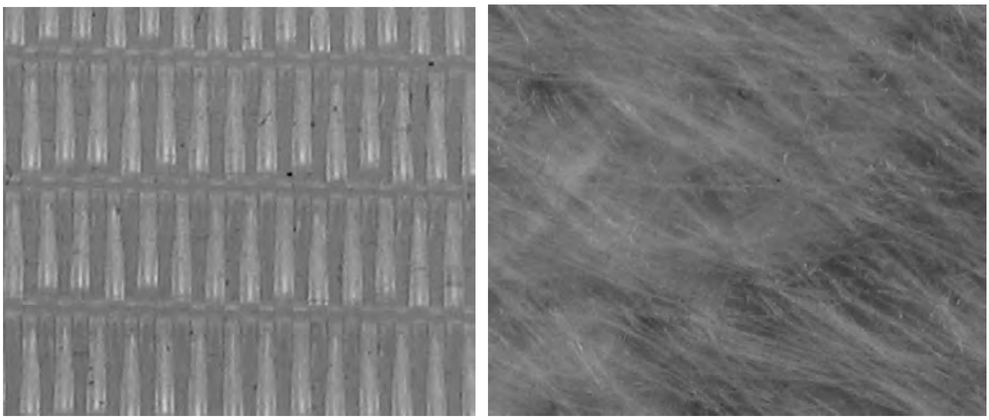

Fig. 1. Micro-photography of the filter mesh (left) and the non-woven geo-textile (right)

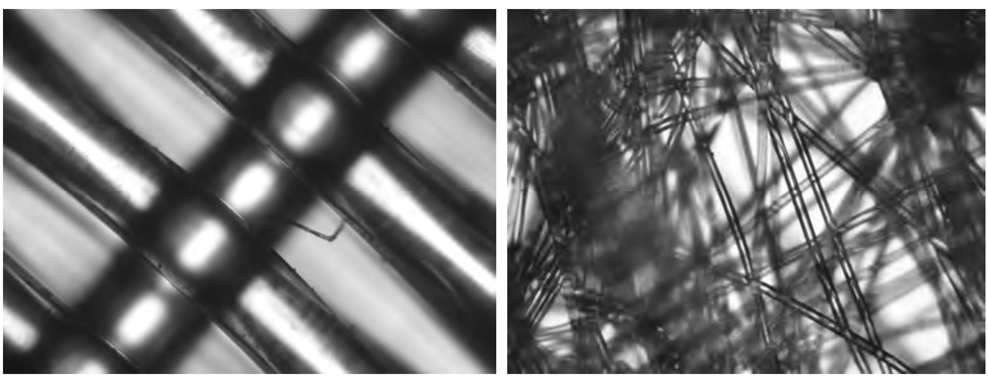

Fig. 2. Microscopic image (at magnitude x100) of the filter mesh (left) and the non-woven geo-textile (right)

Transparent cylinders of 2.5 cm in internal diameter and 50.0 cm length were used. The filters were being filled with wastewater until clogging was achieved (wastewater table close to the pipe upper edge).

For the hydraulic conductivity estimation of falling water table tests were performed. This procedure corresponded with the test method described by Li et al. [36].

The particle size distribution was made using image analysis, utilizing the ImageJ free available software. The maximum dimension of particles described as maximum Feret diameter [37] was considered as the most representative for clogging particles. Statistical analysis (t-Student's test) was performed using Statistica software.

2. Results and discussion

The detailed information related to the experiments is presented in Tables 1 and 2. The average total solids (TS) concentrations in wastewater filtered by the all investigated filters were: 203.9 ±30.5 mg/dm^3 (n = 3) in the first series and 375.2 ±16.1 mg/dm^3 (n = 3) in the second series.

The volumes of dosed wastewater were different for filters because the filters were being filled with wastewater until clogging was achieved. It is worth noting that TS load is commonly viewed as determining the clogging process (TS concentration multiplied by dose volume).

Table 1. **Data of first series of experiment (19.01)**

Data of measurement	Filter mesh		Non-woven geo-textile			Average
Filter number	F1	F2	F4	F5	F6	
Dosed volume, cm^3	5100	2265	1847	2250	1680	2628.4
TS cumulated load, mg	1039.9	461.8	693.0	844.2	630.3	733.9
Filter cake TS, mg	12.0	9.8	6.4	3.2	6.1	7.5
TS inside filtering layer, mg	3.0	1.6	6.1	7.3	4.9	4.6
Sum of filter cake TS and inside filtering layer, mg	15.0	11.5	12.5	10.6	11.0	12.1
Accumulated TS to dosed TS ratio, %	1.4	2.5	1.8	1.3	1.7	1.7
TS of filter cake to dosed TS ratio, %	1.2	2.1	0.9	0.4	1.0	1.1
Cumulated hydraulic load, cm (A_{inf} = 4.9 cm^2)	1040.8	462.2	376.9	459.2	342.9	536.4
Estimated operation time of soil filter corresponding to the hydraulic load (0.16 cm/d for fine sand and loamy fine sand), days	650.5	288.9	235.6	287.0	214.3	335.3
Estimated operation time of soil filter corresponding to TS load, years	6.7	3.0	2.5	3.0	2.3	3.5

During the first series the observed ratio of TS of filter cake to dosed TS was 1.1% on average (from 0.4 to 2.1%). The observed accumulated TS to dosed TS ratio was 1.7% on average (from 1.3 to 2.5%).

The observed TS of filter cake to dosed TS ratio during second series was similar to observed during first series: 1.3% on average (from 0.8 to 2.1%). The observed accumulated TS to dosed TS ratio in second series was 2.8% on average (from 1.8 to 4.4%).

The accumulated TS to dosed TS ratio was relatively low for both filtering material types. For the same sample of wastewater (the same TS concentration) and the same type of filtering material, varied time periods for clogging appearance were observed (especially in the case of filter mesh during the first series: from 462.2 to 1040.8 cm). A similar comment can be stated for non-woven geo-textile, however the difference was smaller: 166.3 and 221.4 cm.

Table 2. **Data of second series of experiment (26.01)**

Data of the measurement	Filter mesh			Non-woven geo-textile			Average
Filter number	F1	F2	F3	F4	F5	F6	
Dosed volume, cm^3	2860	2140	2800	1085	815	955	1775.8
TS cumulated load, mg	583.2	436.3	570.9	407.1	305.8	358.3	357.1
Filter cake TS, mg	8.6	6.2	4.8	4.5	6.5	3.5	5.7
TS inside filtering layer, mg	3.5	3.8	5.4	7.7	6.9	8.2	5.9
Sum of TS filter cake and inside filtering layer, mg	12.1	10.0	10.2	12.1	13.4	11.6	11.6
Accumulated TS to dosed TS ratio, %	2.1	2.3	1.8	3.0	4.4	3.2	2.8
TS of filter cake to dosed TS ratio, %	1.5	1.4	0.8	1.1	2.1	1.0	1.3
Cumulated hydraulic load, cm ($A_{inf} = 4.9$ cm^2)	583.7	436.7	571.4	221.4	166.3	194.9	362.4
Estimated operation time of soil filter corresponding to the hydraulic load (0.16 cm/d for fine sand and loamy fine sand), days	364.8	273.0	357.1	138.4	104.0	121.8	226.5
Estimated operation time of soil filter corresponding to the TS load, years	3.8	2.8	3.7	1.4	1.1	1.3	2.4

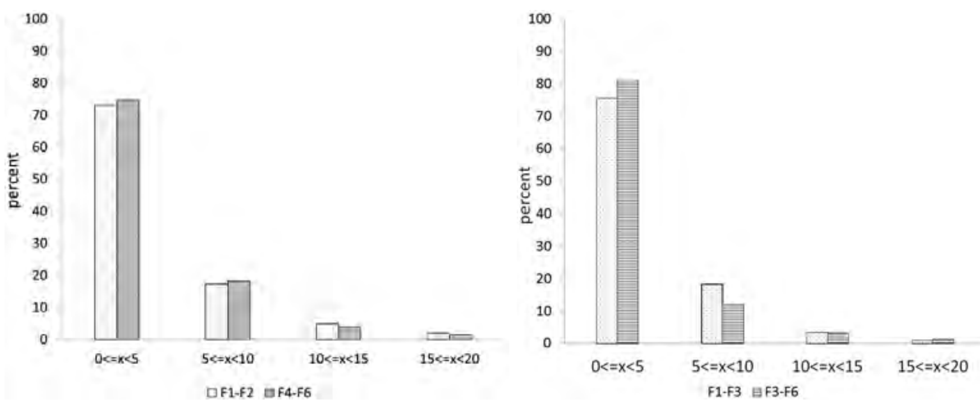

Fig. 3. The percentage of the particle size distribution for the first (left) and second series (right)

Despite the different facilities of filtering material (the filtering media were definitely different in pore volumes and porosity, as it was presented in the methods section in respect to particle size distribution) the particle size distributions in filter mesh and non-woven geo-textile were very similar (Fig. 3) This fact and the very small dimension of the greater part of particles (over 73% smaller than 5 μm) may suggest that the process taking place was that of cake filtration. This kind of filtration after a specified time of filtration is related mostly to the filter cake formation per se rather than filtering media properties.

The cooperation of average value with standard error of particle size of filter cake on the filter mesh and non-woven geo-textile measured in two series are presented in Figure 4.

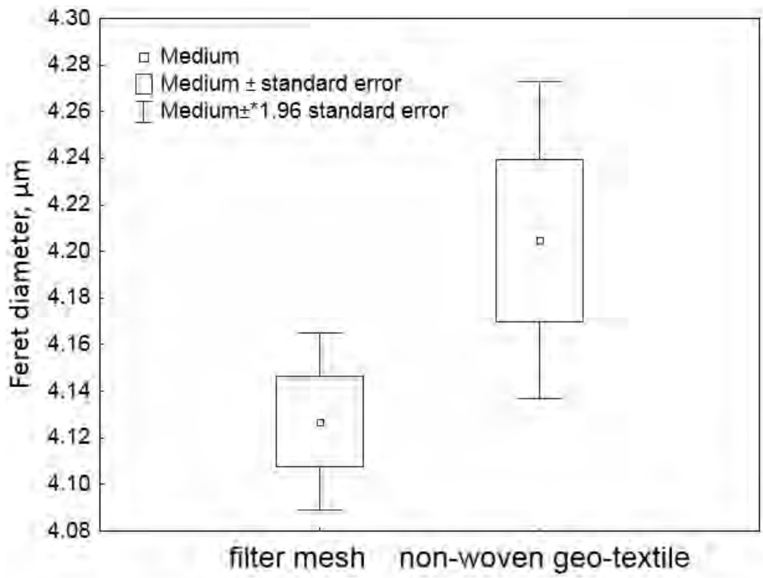

Fig. 4. Particle size of filter cake on the filter mesh and non-woven geo-textile (average of two series)

The average values of filter cake particle size on the filter mesh and non-woven geo-textile were: 4.13 ±6.07 μm and 4.20 ±10.22 μm, respectively.

The results of measurement were statistically analysed. Once particle size distribution due to sample size is large enough, it was decided to apply the Central Limit Theorem [38], which assumes a normal distribution sample and performed parametric statistics. The results of statistical analyses were shown in Figure 5 and presented in terms of medium and standard error. The results of hydraulic conductivity were verified, using the t-Student test and showed no significant difference between the analysed average at level of significance $\alpha = 0.05$.

Despite the higher cumulated dry mass of filter cake and inside the filtering layer, the average hydraulic conductivity of non-woven geo-textile (0.0013 m/d) was higher than the average hydraulic conductivity of filter mesh (0.00067 m/d), however, the difference was not confirmed statistically. The higher permeability at higher accumulated mass could be related to the higher porosity of geo-textile than porosity of filter mesh per se. Probably thanks to this property higher amount of solids can be trapped inside the filtering material itself.

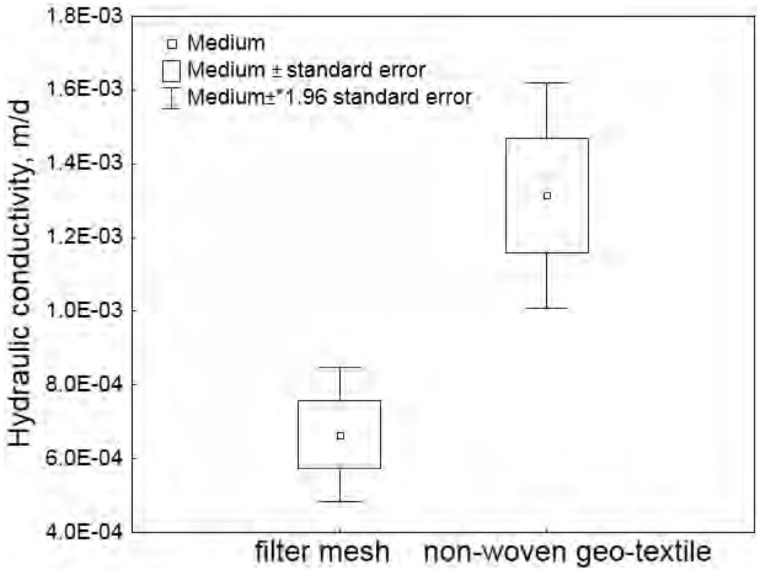

Fig. 5. Hydraulic conductivity of the filter mesh and non-woven geo-textile (average of two series)

During removal of solids from the filtering material it was observed that removal was much easier for filter mesh than for geo-textile. The reason for this fact was probably also the higher mass content trapped in higher pore volume. So the conclusion can be drawn that filter mesh enables the removal of a lower mass of solids than geo-textile but it can be easier to remove (by spreading with tap water). Further studies therefore should be focused on the usage of more than one filtering layer. This should be verified but we can suppose that e.g. four layers instead of one can remove from the septic tank effluent about four times more solids mass - about 10÷20% and such a value can be thought as significant in relation to clogging time (two-three years longer operation time). Additionally (it was not investigated during this study but other studies showed this, such as Spychała and Łucyk [39]), the filtering material, especially thicker than 1÷2 mm, can significantly remove dissolved substances such as organic matter.

In the authors' opinion there is a need to look for an efficient material filtering STE so as to prevent infiltration systems from clogging. One of the possibilities in this context is the usage of filter mesh or geo-textile (several layers) inside the septic tank, near the outflow.

Conclusions

The study showed the relatively low ratio of accumulated solids to supplied solids load.

Similar values of accumulated TS to dosed TS ratios were observed for both filtering material types. The particle size distributions in the both filtering materials were also similar. The accumulation of particles dimension much smaller than the filtering material pores diameter could be related to cake filtration process.

References

[1] Gill L., Johnston P., Misstear B., O'Suilleabhain C., An investigation into the performance of subsoils and stratified sand filters for the treatment of wastewater from onsite systems, Report Prepared for the Environment Protection Agency 2004. Project 2000-MS-15-M1.

[2] D'Amato V.A., Bahe A., Bounds T., Comstock B., Konsler T., Liehr S.K., Long S.C., Ratanaphruks K., Rock C.A., Sherman K., Factors affecting the performance of primary treatment in decentralized wastewater systems, WERF, Final Report, 2008.

[3] Dawes L., Goonetilleke A. An investigation into the role of site and soil characteristics in onsite sewage treatment, Environmental Geology 2003, 44, 467-477.

[4] DEFRA - Department of Environment, Food and Rural Affairs. Sewage treatment in the UK. Waste water collection and treatment, and disposal of sewage sludge - United Kingdom 2000, (http://www.defra.gov.uk/publications/files/pb6655-uksewage-treatment-020424.pdf). Accessed on February 2015.

[5] Kjellén M., Pensulo Ch., Nordqvist P., Fogde M., Global review of sanitation system trends and interactions with menstrual management practices, Report for the Menstrual Management and Sanitation Systems Project, Stockholm Environment Institute, Sweden, Project Report - 2011.

[6] Withers P.J.A., Jordan P., May L., Jarvie H.P., Deal N.E., Do septic tank systems pose a hidden threat to water quality? Frontiers in Ecology Environment 2014, 12(2), 123-130.

[7] Richards S., Paterson E., Withers P.J.A., Stutter M., Septic tank discharges as multi-pollutant hotspots in catchments, Science of the Total Environment 2016, 542, 854-863.

[8] Siegrist R.L., Boyle W.C., Wastewater induced soil clogging development, Journal of Environmental Engineering 1987, 13(3), 550-566.

[9] Duncan C.S., Reneau R.B., Hagedorn C., Impact of effluent quality and soil depth on renovation of domestic wastewater, On-Site Wastewater Treatment: Proceedings of the Seventh National Symposium on Individual and Small Community Sewage Systems. American Society of Agricultural Engineers (ASAE), 1994, St. Joseph, MI, 219-228.

[10] Eliasson J., Septic effluent values, Rule Development Committee Issue Research Report, Washington State Department of Health 2004.

[11] Crites R., Tchobanoglous G., Small and Decentralized Wastewater Management Systems, McGraw Hill, Boston 1998.

[12] Lowe S., Rothe N.K., Tomaras J.M.B., Dejong K., Tucholke M.B., Drewes J., Mccray J.E., Munakata-Marr J., Influent constituent characteristics of the modern waste stream from single sources: literature review, Report WERF 04-DEC-01a, IWA Publ., London 2007.

[13] Rodgers M., Walsh G., Healy M.G., Different depth sand filters for laboratory treatment of synthetic wastewater with concentrations close to measured septic tank effluent, Journal of Environmental Science and Health, Part A: Toxic/Hazardous Substances and Environmental Engineering 2011, 46(1), 80-85.

[14] Pawlak M., Charakterystyka ścieków oczyszczonych w osadnikach gnilnych, Nauka Przyroda Technologie 2011, 5/5, #92.

[15] Stuth W.L., Operation, limitations, and recovery of sand filters, Proceedings of the Tenth Northwest On-Site Wastewater Treatment Short Course, College of Engineering, University of Washington, Seattle 1999, 327-340.

[16] Siegrist R.L., Anderson D.L., Converse J.C., Onsite treatment disposal of restaurant wastewater, Small Scale Waste Management Project, University of Wisconsin, Madison, Wisconsin 1984.

[17] Converse M.M., An evaluation of single pass sand filters in a northern climate, M.S. Thesis, Biological Systems Engineering, University of Wisconsin, Madison 1998, 1-121.

[18] Sharma M.K., Tyagi V.K., Saini G., Kazmi A.A., On-site treatment of source separated domestic wastewater employing anaerobic package system, Journal of Environmental Chemical Engineering 2016, 4, 1209-1216.

[19] Matejcek B.C., Erlsten S., Bloomquist D., Determination of properties and the long term acceptance rate of effluents from food service establishments that employ onsite sewage treatment, Department of Health, 2000, University of Florida, Phase 2 Report for the Florida.

[20] Boyer J., Rock C.A., Proceedings of the 7th NW Onsite Wastewater Treatment Shortcourse, Seattle, WA 1992.

[21] Chmielowski K., Bugajski P., Efektywność usuwania zanieczyszczeń w osadnikach gnilnych typu „Duofilter", Infrastruktura i ekologia terenów wiejskich, 5, PAN Oddział w Krakowie, 2008, Komisja Technicznej Infrastruktury Wsi, 41-49.

[22] Seabloom R.W., Bounds T.R., Loudon T.L., Septic tanks, [In:] University Curriculum Development for Decentralized Wastewater Management, eds. M.A. Gross, N.E. Deal, National Decentralized Water Resources Capacity Development Project. Fayetteville (AR), University of Arkansas, 2005, 38-39.

[23] Heidrich Z., Stańko G., Warężak T., Goleń M., Zawadzki A., Leksykon przydomowych oczyszczalni ścieków: poradnik inwestora, Wydawnictwo Seidel-Przywecki, Warszawa 2013.

[24] Grabarczyk C., Hydromechanika filtrowania wody, Wydawnictwo Naukowo-Techniczne, Warszawa 2010.

[25] Reynolds W.D., A unified Perc Test-Well Permeameter methodology for absorption field investigations, Geoderma 2016, 264, 160-170.

[26] Pawlak M., Skiba M., Spychała M., Nieć J., The investigation of density currents and rate of outflow from a septic tank, Journal of Ecological Engineering 2015, 16, 4, 103-110.

[27] Spychała M., Nieć J., Walczak N., Marciniak A., Colloids in septic tank effluent and their influence on filter permeability, Journal of Ecological Engineering 2015, 16, 4, 74-80.

[28] Spychała M., Nieć J., Impact of septic tank sludge on filter permeability, Environment Protection Engineering 2013, 39, 2, 77-89.

[29] Van Buuren J.C.L., Willers H., Luyten L., van Manen M., The pathogen removal from UASB effluent by intermittent slow sand filtration, Anaerobic Treatment a Grown-up Technology, Conference papers, Aquatech 1986, Schiedam, The Netherlands, 707-709.

[30] Riddle C.S.A., Scrolling Geotextile Fabric Filter Device for Primary Clarification, This thesis is submitted to the faculty of Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of: Master of Science, 2002.

[31] Sabry T., Evaluation of decentralized treatment of sewage employing. Upflow Septic Tank/Baffled Reactor (USBR) in developing countries, Journal of Hazardous Materials 2010, 174, 500-505.

[32] Bourgès-Gastaud S., Stoltz G., Sidjui F., Touze-Foltz N., Nonwoven geotextiles to filter clayey sludge: An experimental study, Geotextiles and Geomembranes 2014, 42, 214-223.

[33] Tota-Maharaj K., Grabowiecki P., Babatunde A., Coupe S.J., The performance and effectiveness of geotextiles within permeable pavements for treating concentrated stormwater, Sixteenth International Water Technology Conference, IWTC 16 2012, Istanbul, Turkey.

[34] Mendoza L., Carballa M., Sitorus B., Pieters J., Verstraete W., Technical and economic feasibility of gradual concentric chambers reactor for sewage treatment in developing countries, Electronic Journal of Biotechnology 2009, 12, 2, 1-13.

[35] da Silva F.J.A., Lima M.G.S., Mendonça L.A.R., Gomes M.J.T.L., Septic tank combined with anaerobic filter and conventional UASB - results from full scale plants, Brazilian Journal of Chemical Engineering 2013, 30, 01, 133-140.

[36] Li W., Kiser C., Richard Q., Development of a filter cake permeability test methodology, American Filtration and Separations Society, International Topical Conferences and Exposition, September 19-22, Ann Arbor, Michigan 2005.

[37] Pabst W., Gregorová E., Characterization of Particles and Particle Systems, ICT, Prague 2007.

[38] Chudzik H., Kiełczewska H., Mejza I., Statystyka matematyczna w przykładach i zadaniach, Wyd. Uniwersytetu Przyrodniczego, Poznań 2006.

[39] Spychała M., Łucyk P., Effect of thickness of textile filter on organic compounds and nutrients removal efficiency at changeable wastewater surface level, Nauka, Przyroda, Technologie 2015, 9/3, 44, 1-21.

Podczyszczanie odpływu z osadnika gnilnego z użyciem różnych materiałów filtracyjnych w celu zapobiegania kolmatacji

Osadniki gnilne to powszechnie stosowane urządzenia do wstępnego oczyszczania ścieków, jednak są one podatne na okresowe odprowadzanie zwiększonych stężeń zawiesin, co może w specyficznych warunkach przyspieszać procesy kolmatacji. Celem badań było określenie wpływu filtra wtórnego na zmniejszenie obciążenia zawiesiną i możliwość zwiększenia czasu eksploatacji. Badania przeprowadzono w dwóch seriach przy użyciu sześciu filtrów. W każdej serii użyto sześciu filtrów (rury z materiałem filtrującym zainstalowanym na dnie): trzy filtry z filtrem siatkowym, a pozostałe trzy - z geowłókniny. Filtry były zapełniane ściekami aż do uzyskania kolmatacji (zwierciadło ścieków w rurach sięgało do 50 cm). Dla oszacowania przewodności hydraulicznej opadającego zwierciadła wody zostały przeprowadzone testy. Zaobserwowano podobne wartości zawiesin zgromadzonych proporcjonalnie do dozowanych podczas obu serii oraz dla obu typów materiałów filtrujących. Rozkład wielkości cząstek w obu materiałach filtracyjnych był podobny. Fakt zgromadzenia cząstek o bardzo małych wymiarach (ponad 73% poniżej 5 µm), znacznie mniejszych niż średnica porów materiału filtracyjnego, może sugerować, że odbywający się proces dotyczy placka filtracyjnego. Pomimo wyższej skumulowanej suchej masy placka filtracyjnego i tej wewnątrz warstwy filtracyjnej, średnie przewodnictwo hydrauliczne geowłókniny było wyższe niż średnie przewodnictwo hydrauliczne filtra siatkowego. Prawdopodobnie dzięki wyższej porowatości geowłókniny większa ilość zawiesin możne zostać zatrzymana wewnątrz samego materiału filtrującego. Badania wykazały stosunkowo niski współczynnik nagromadzonych cząstek stałych do dostarczonych; jednak skumulowana masa wydaje się istotna dla zapobiegania kolmatacji, zwłaszcza w przypadku wykorzystania kilku warstw filtrujących. W ten sposób o wiele więcej zawiesin można usunąć z odpływu z osadników gnilnych (na przykład dla czterech warstw - około 10÷20%) i proces kolmatacji może zostać spowolniony (dwa-trzy lata dłuższy okres użytkowania).

Słowa kluczowe: **ścieki bytowe, odpływ z osadnika gnilnego, oczyszczanie ścieków, kolmatacja**