DOI: 10.2428/ecea.2012.19(06)065 ECOL CHEM ENG A. 2012;19(6):639-647

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EFFECTIVENESS OF THE OPERATION OF THE SEWAGE TREATMENT PLANT IN AUGUSTOW

SKUTECZNOŚĆ DZIAŁANIA OCZYSZCZALNI ŚCIEKÓW W AUGUSTOWIE

Abstract: Water is not a commercial product as any other, but rather a good that has to be protected, defended and treated as a legacy. (European Parliament Directive 2000/60/EC). The best method for protection of groundwater is its efficient using and purified sewage amount increasing.

Therefore, it is important to build the construction and modernization of wastewater treatment plants. The water law defines the criteria of cleaned sewages which flow into water and ground.

Augustow is located in the northern part of the Podlasie province on borders of The Augustow Forest, on the river Rospuda-Netta [3]. The river is the receiver set of cleaned sewage from local sewage treatment plants. Rospuda-Netta river central section runs through the area of the special protection of birds PLC 200002, and the outcome section – through the area of The Biebrzanski National Park and simultaneously through the area of PLC 200001 entering in part of NATURE 2000. This is the reason of special wastewater purification.

The aim of the study was checking, whether the sewage treatment plant supporting Augustow and nearest communes supply into the receiver (Netta river) enough cleaned sewage and whether parameters of cleaned wastewater are within in an allowed range through statement of environmental impact.

Keywords: sewage, wastewater treatment plant, pollution parameters

Introduction

The examinations were conducted in the sewage treatment plant in Augustow. Almost the entire community has water-pipe network. A distribution plumbing exists in Augustow. The net of a sanitary sewage system works by gravitational-pump system. The length of the main sanitary sewage system net in the city is 83 km [1]. One sewage treatment plant operates in the city. There is increased removing biogenes system. Its capacity reaches about 10000 m^3 per day. 22.5 thousand of the town population uses the water supply system (74 %), however from a sewer system 20.3 thousand (66.8 %) [2]. The city is under construction of local distribution gas system. To the sewage treatment

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plant flows urban sewage with little amount (of the 10 %) of industry sewage. Wastewater from not-canalized areas (about 47 m^3/d) is delivered by vacuum trucks.

The sewage treatment plant was built and started up in 1978 as mechanical-biological system, with preliminary receptacles, with chambers of active sludge at their high load, with secondary settler tank and the chamber of the sludge regeneration. In 1998 modernization of the sewage treatment plant consisting in the change of the mechanical part was finished (Fig. 1). The changes covered sieves, grit chamber and preparing the sewage treatment plant for removing compound of carbons, nitrogen and phosphorus partly on the biological and partly chemical path. An increased effectiveness of sewers cleaning allowed particularly to increase biogenic pollutant reduction. Existing objects were modernised in order to form denitrification and nitrification chamber and to carry devices out for the internal recirculation of sewers from the chamber nitrification to denitrification and for the outside recirculation of deposit from secondary tank into the denitrification chamber. A sedimentary part was also modernised and devices were installed for mechanical dehydrating deposit.

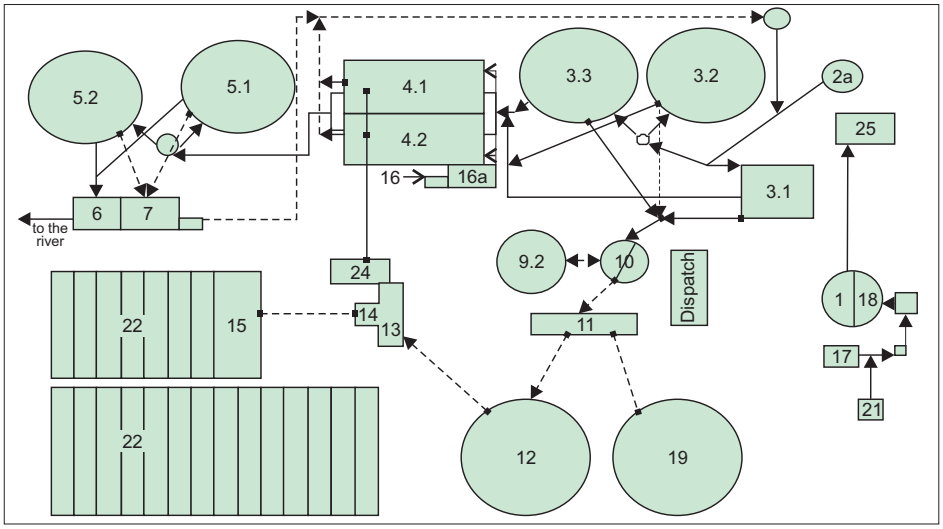

Fig. 1. The scheme of sewage treatment plant w Augustow: 1 – sewage pump house; 2a – vertical grit chamber; 3.1, 3.2, 3.3 – denitrification chambers; 4.1, 4.2 – nitrification chambers; 5.1, 5.2 – secondary settler's tanks; 6 – treated sewage pump house; 7 – sludge pump house; 9.2 – sludge disinfection; 10 – dual-purpose chamber; 11 – pump house; 12 – sludge stabilization chamber; 13, 14 – mechanical sludge drainage building; 15 – dehydrated sludge dump; 16 – PIX tank; 16a – PIX pump; 17 – septic tank; 18 – sewage pumping station; 19 – sludge tank; 21 – car washing station; 22 – sludge bed; 24 – air pomp building; 25 – sieves builing

Methodology of examinations

Samples of untreated and cleaned wastewater in the municipal sewage treatment plant in Augustow were being inspected. They were taken once a month, most often at

the beginning of every month. The research period covered years: from January 2003 up to December 2008. Untreated sewage samples were picked up from primery settler tank and cleaned sewers from the channel carrying wastewater to the receiver.

In untreated and cleaned sewage were being marked the following pollutants parameters: suspension, *chemical oxygen demand* (COD), *biochemical oxygen demand* (BOD), general nitrogen, ammonium nitrogen, phosphates and general phosphorus. Obtained research findings constitute the arithmetic mean from three conducted parallel measurements.

Obtained research findings

BOD values in untreated sewers were levelled in the period of conducted examinations. The smallest BOD value was observed for sewers picked up in 2008 in the month October, and the biggest in September of 2004 (Fig. 2). BOD values for cleaned sewers were moved close in individual years, but it is possible to observe differences depending on the date of picking up sewers. Cleaned sewers taken since January by April and since the October by December were characterized with higher value of this indicator of about 8 mg/dm^3. Sewers picked up since May by September have had a little bit lower BOD value of about 5 mg/dm^3. Therefore, the degree of removing organic compounds being characterized by a BOD value was developed on the high, close the 100 %. Considerable differences in BOD values were not stated between individual years. It is possible to notice monthly analogies, when it appears increased BOD amount in sewers knocked off to the receiver. It was observed, that change of this parameter about 1.5 mgO_2/dm^3 appeared in the October 2006, 2008, took turns in May 2007 about 2 mgO_2/dm^3, and in the October about 1 mgO_2/dm^3. The norm according to statement of environmental impact takes out 15 mgO_2/dm^3 and was not crossed, because the greatest BOD value in sewers inserted into the receiver took out 8 mgO_2/dm^3 in March 2003.

The COD indicator of untreated sewers was diversified to a little extent depending on years of conducted examinations, as well as individual months what Figure 3 shows. It developed in the majority on the level of 500–800 mgO_2/dm^3. The highest crossing 1000 mg/dm^3 was for sewers from 2003 picked up since March by July, and the smallest for sewers from October 2008. The value of this indicator for cleaned sewers was diversified in years of conducted examinations. The high value was noticed in sewers picked up in 2003 and it was about 50–80 mg/dm^3. Peculiarly it was high for sewers picked up in the month January and July. From 2006 an effectiveness of cleaned sewers improved and COD values did not cross 30 mg/dm^3. The value of this indicator was not exceeded with regard to the established norm in statement of environmental impact – 125 mgO_2/dm^3. The step of cleaning of organic compounds being characterized by a COD value developed on the high, close the 100 %.

The amount of suspension (Fig. 2) in untreated sewers underwent fluctuations by 200–500 mgSiO_2/dm^3. Higher values of this indicator appeared in sewers picked up since June by September, lower in remaining months. Amount of suspension in sewers knocked off cleaned with regard to the norm from statement of environmental impact –

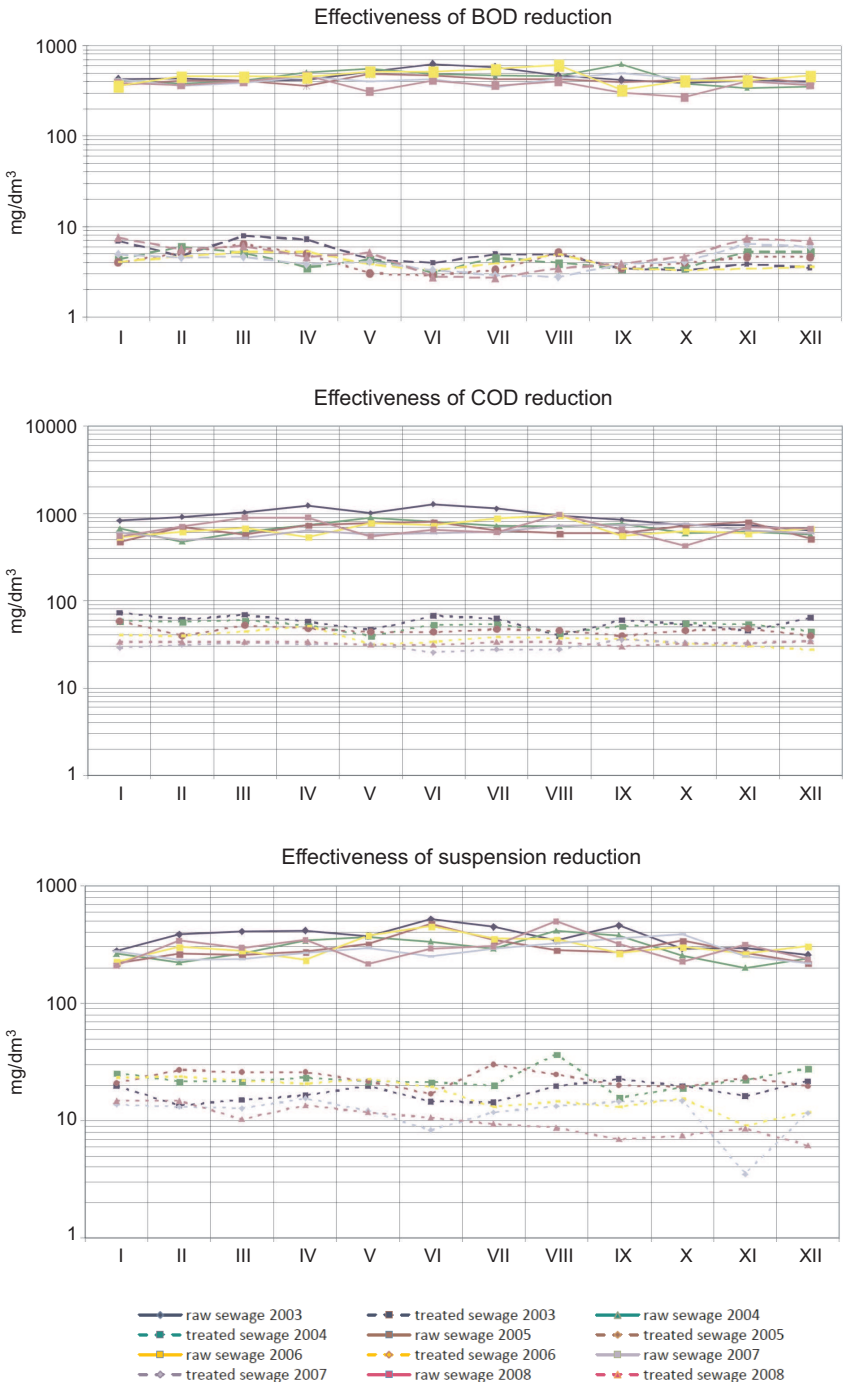

Fig. 2. BOD, COD and and suspensions values in strict and cleaned sewers

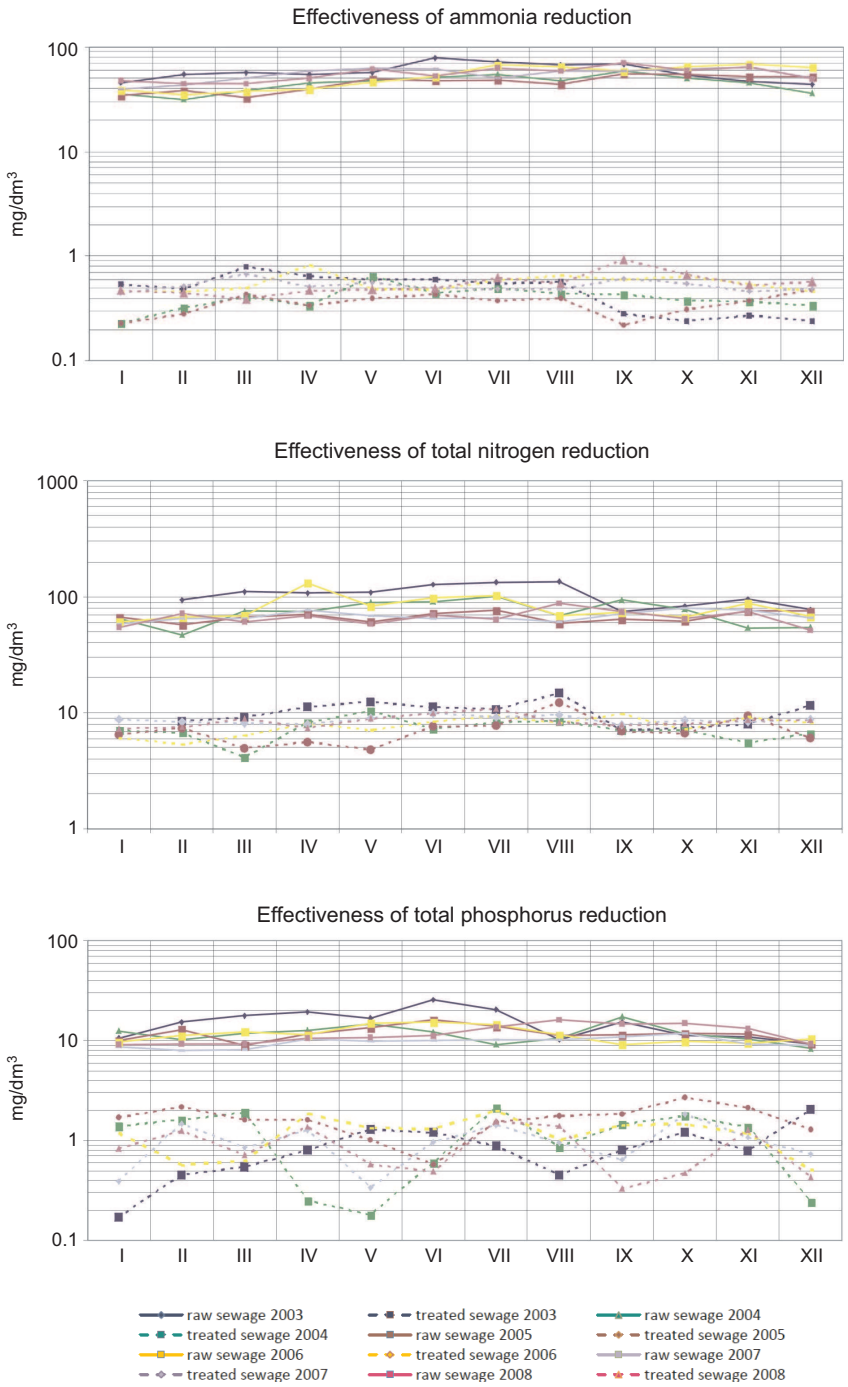

Fig. 3. Concentrations of compounds biogenic in strict and cleaned sewers

35 mgSiO_2/dm^3 was crossed in August 2004 – it was a sudden increase, because in previous months of this year the amount of suspension developed almost on the same level – 22 mgSiO_2/dm^3. The analogous big growth came in sewers picked up a year later, but it did not cross 35 mgSiO_2/dm^3 acceptable in statement of environmental impact. In 2003 the amount of suspension kept at a steady level between 14–22 mgSiO_2/dm^3. A fall in amounts of general suspension in sewers led to the receiver took place from July 2006 from about 20 mgSiO_2/dm^3 up to about 15 mgSiO_2/dm^3 and less in next months and years. The smallest amount of general suspension was observed in sewers picked up in October 2008.

The value of ammonium nitrogen and general nitrogen fluctuations was portrayed in years of conducted examinations (Fig. 3). Both indicators depict one group of pollutants and should be considered simultaneously. The content of general nitrogen in untreated sewage was moved close in all years, however the highest crossing was noticed in 2003 since March by August (about 100 mgN/dm^3), in remaining months there took place a distinct fall in the content of nitrogen. The lowest contents of this indicator appeared in sewers picked up in February 2004. Diversified concentrations of ammonium nitrogen in untreated sewage divided every year of examinations in three parts. This indicator had the lowest values in months since December up to March, the highest from April by September, next then again decreasing since October by November. The greatest concentration was noticed in June 2003, the lowest in February both March 2004 and 2005. From 2007 there was observed a stabilization of the ammonium and general concentration of nitrogen.

In spring-summer months general nitrogen was removed in the worst way. Its concentration in cleaned sewage knocked off to the river only in August achieved 2003 acceptable maximum in statement of environmental impact – of 15 mg/dm^3. In sewers from remaining years this norm was not exceeded. This indicator surrendered considerable for fluctuations in cleaned sewers: by 4–5 mgN/dm^3 in early-spring months in 2004–2005 years to 13–15 in summer months of 2003. In years 2003–2005 there was observed swings of amounts of general nitrogen in sewers knocked off to the receiver in individual months, however in next years this tendency underwent the levelling out and fluctuated between 7–10 mg N/dm^3.

Concentrations of ammonium nitrogen in purified sewage in summer periods underwent the stabilization, however their fluctuations in every year were observed within the limits of 0.4–0.6 mgNH_4/dm^3. Amplitude tarsometatarsuses of the fluctuations appeared since September by April. The greatest was determined in September 2008 – concentration about 1 mgNH_4/dm^3. The lowest value of this indicator in cleaned sewers was in January 2004 and 2008 – about 0.2 mgNH_4/dm^3. On the basis of concentrations was calculated the removing ammonium nitrogen degree of sewage and it is shown on graphs. It took out over the 98 %.

In Figure 3 there were described values of general phosphorus concentrations. In untreated sewers concentrations of this indicator was levelled in the entire research period. The exception constitutes 2003, when in June a high concentration was noticed about 12 mgP/dm^3. In sewers from remaining years values of this indicator fluctuated from 8 mgP/dm^3 in January and March 2007 to 10 mgP/dm^3 in June, August and

September in 2006 and 2008. Phosphorus is a biogene surrendering in the course of conducted research works for the greatest hesitations in cleaned sewers. In 2005 the maximum concentration, agreeable from water law (2 mgP/dm^3), was crossed in February and October, slight crossed in August 2004 and December 2003, and resembled to the maximum value in August 2006. The lowest values about 0.15 mgP/dm^3 was noticed in sewers picked up in January 2003 and May 2004.

Discussion

The effectiveness of cleaning sewage in existing objects of the sewage treatment plant is the subject of the research of many scientists from the entire country [4–6]. In the Podlasie province were conducted inspections of untreated sewers reaching to the sewage treatment plant and cleaned sewers by Dabrowski [7], Boruszko [8], Dzienis [9], Wawrentowicz [10], Skoczko [11] and others. According to the literature, applied biological system is enjoying considerable influence to the effectiveness of cleaned sewers in the given sewage treatment plant. Shore-out to zones: anoxic, anaerobic and aerobic is important too. For removing phosphorus the significance has an application of appropriate coagulant. Its correct acting is also affecting the operation of the part of the mechanical sewage treatment plant [7] and work of secondary chamber [9].

The situation of Augustow and his special character of the holiday town have a significant influence to the amount of delivered sewage, peculiarly in summer months. Augustow is a recognised spa and tourist city what in the holiday season is pursuing residents for doubling the number. It is transferred into the growth of the amount of sewage in July and August. Literature inform that the composition of untreated sewage depends from industrializing the region of both sewage amount and quality [7, 8]. This statement has a distinct reflection in case of Augustow. On all described graphs it is possible to notice an increase of the number of pollutants indicators in untreated sewers in summer months, when a number of sewers delivered to the sewage treatment plant is rising with sanitation means of transporting. This growth has an influence on cleaned sewers quality. Only phosphorus concentrations is independent of these hesitations, because according to literature [7] the effectiveness of dismissing its depends on the optimum selected dose of coagulant and on correct time of keeping sewers in the secondary chamber.

Analysing obtained research results of untreated and cleaned sewers in years 2003–2008, it is possible to state that satisfying effects of removing individual compounds from sewage were achieved in the sewage treatment plant in Augustow. It has, of course, more distant influence on the state of water in the receiver. The research results were comparing with permissible norms from statement of environmental impact [1] and with the permissible highest values of indicators from the Regulation of the Environment Secretary from day 8th July 2004. “In the case of conditions which should be met by sewage inserting to water or to the soil and in the case of substances which are particularly harmful to the environment of water” [12] it is possible to state, that permissible values of pollutants indicators in sewage carried to the receiver in statement

of environmental impact are lower. On the other hand the concentration of general phosphorus was exceeded in some months, in comparing with requirements statement of environmental impact. However it towards the regulation did not cross the maximum size of 3.0 mg P/dm^3 which is in enclosure no. 1 to this regulation.

Conclusions

1. Cleaned sewage knocked off has not an influence on the class of receiver water which is staying the COD on the level of the III class largely disqualified by the indicator.

2. Flowing sewage to the receiver occasionally exceeds norms. Pollution of general phosphorus concerns the exceeding what does not agree with values allowed by the Regulation of the Environment Secretary from 8th July 2004.

3. In the period of conducting research worsening the quality of cleaned sewers was not observed, however the distinct growth of inspected indicators concentrations were ranked as well as large amounts of sewers delivered in the summer season.

4. Rainwater both from the city of Augustow and nearby towns are affecting the quality of water in the receiver – the Netta River.

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SKUTECZNOŚĆ DZIAŁANIA OCZYSZCZALNI ŚCIEKÓW W AUGUSTOWIE

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Abstrakt: Woda nie jest produktem komercyjnym, takim jak każdy inny, lecz raczej dobrem, które musi być chronione, bronione i traktowane jak dziedzictwo. (Parlament Europejski i Rady Unii Europejskiej: „Ustanowienie ram dla działalności Wspólnoty w dziedzinie polityki wodnej", Dyrektywa 2000/60/EC) Najlepszą metodą służącą do ochrony wód jest jej oszczędne używanie oraz zwiększenie ilości poprzez oczyszczanie ścieków, czy innego rodzaju zanieczyszczonych wód powierzchniowych. Z tego względu tak ważna jest budowa i rozbudowa oczyszczalni ścieków. Kryteria, jakim muszą odpowiadać ścieki oczyszczone, które odprowadzane są do wód i ziemi, określa prawo wodne.

Augustów położony jest w północnej części województwa podlaskiego na obrzeżach Puszczy Augustowskiej, nad rzeką Nettą, będącą jednocześnie odbiornikiem ścieków oczyszczonych lokalnej oczyszczalni. Środkowy odcinek Rospudy-Netty przebiega przez obszar specjalnej ochrony ptaków PLC 200002 „Puszcza Augustowska", a odcinek ujściowy – przez obszar Biebrzańskiego Parku Narodowego i jednocześnie obszar PLC 200001 „Dolina Biebrzy", wchodzące w skład Europejskiej Sieci Ekologicznej NATURA 2000.

Celem prowadzonych prac badawczych było zatem sprawdzenie, czy oczyszczalnia ścieków Augustów obsługująca teren miasta i gminy wprowadza do odbiornika ścieków (rzeki Netty) ścieki wystarczająco oczyszczone i czy uzyskane parametry ścieków oczyszczonych mieszczą się w zakresie dopuszczonym przez operat wodno-prawny.

Słowa kluczowe: ścieki, oczyszczalnia ścieków w Augustowie, wskaźniki zanieczyszczeń