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Efficiency and reliability of sewage purification in long-term exploitation of the municipal wastewater treatment plant with activated sludge and hydroponic system

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Keywords: wastewater treatment, activated sludge, hydroponic system, efficiency and reliability of operation, Weibull's reliability theory.

Abstract: The aim of the work was to analyze the efficiency and reliability of pollutants removal (total suspended solids – TSS, BOD_5, COD) in a collective wastewater treatment plant with activated sludge and hydroponic lagoon during its long term operation. The tested object was designed to treat wastewater inflowing through the sewerage system and wastewater delivered by the septic truck. The projected capacity of the treatment plant was 1200 $m^3 \cdot d^{-1}$. The technological system for wastewater treatment consisted of a mechanical part, a flowing biological reactor working according to the BARDENPHO process, a secondary settling tank and a hydroponic lagoon. The efficiency and reliability of pollutants removal in the analyzed treatment plant were assessed on the basis of the data concerning influent and effluent wastewater collected during the years 2011–2018. On the basis of the measurements results, there were determined characteristic values of the selected pollution indicators in wastewater and the average efficiency of pollutants removal. The technological reliability of the wastewater treatment plant was assessed for the basic pollution parameters (BOD_5, COD, TSS) in accordance with the elements of the Weibull's reliability theory, with regard to normative values of the indicators specified in the Regulation of the Minister of Environment. The analysis was carried out using the Statistica 13.1 software. It was proved that in the wastewater treatment plant with an activated sludge and hydroponic lagoon the level of organic pollutants removal expressed by BOD_5 was on average 99.5%, COD – 98.1% and TSS – 99.4%. The technological reliability of the system was 100% in terms of the removal of pollutants from the basic group, which means that during the long term operation (8 years) it provided failure--free operation and guaranteed the fulfillment of the requirements that can be found in the Polish law regulations concerning the analyzed pollutants.

Introduction

These days one of the most commonly known environmental aspects is wastewater treatment. There is a strong need to reduce, among others, the amount of organic contaminants and total suspended solids, because along with high contamination with phosphorus and nitrogen they play a main role in the process of water eutrophication. This is why wastewater rich in these substances should be effectively treated in order to prevent water reservoirs from this negative phenomenon [Jóźwiakowski et al. 2018]. Not only the growing number of people but also urban development and industry contribute to the increase in wastewater amount which without appropriate treatment can pose a serious threat to the natural water ecosystems [Dąbrowska et al. 2017, Szewrański et al. 2018].

In Poland there shall be observed a diversity in the methods of wastewater treatment depending on the kind of area. On the one hand, in rural areas with dispersed buildings the usage of collective sewerage system is not economically justified so in these cases there is observed a tendency to build household wastewater treatment plants that support up to 50 people and their maximum capacity is 5 $m^3 \cdot d^{-1}$ [Pawełek and Bugajski 2017]. In 2017 the total number of small wastewater treatment plants in Poland was about 217 000 [CSO 2017].

On the other hand, urban and rural areas with high-density housing are characterised by the implementation of sewerage system which provides wastewater collecting from all the buildings. In 2017 the total length of sewerage system in Poland was defined as 157 thousand km and it served 71% of

all the Polish inhabitants. After being collected, wastewater is carried to collective wastewater treatment plant which can be joint for the whole city, commune or another assigned area. It was estimated that in 2017 the total number of municipal wastewater treatment plants in Poland was 3,258 objects. The most commonly used were systems with biological treatment – 75% [CSO 2018].

One of the most common ways of pollutants removal is the usage of activated sludge [Di Trapani et al. 2011]. In recent years in these systems additionally there have been implemented innovative technologies with a hydroponic system [Bawiec 2019]. In typical collective wastewater treatment plants with activated sludge more and more often there is used not only a classic system for wastewater treatment (I° mechanical treatment, II° biological treatment) but there can also be found the third stage which is hydroponic lagoon. Most often hydroponic lagoons look like artificial rivers to which wastewater after biological treatment inflows. Pollutants removal occurs due to the functioning of organisms that float either on wastewater surface or on some supports made from chemically neutral materials. The abovementioned organisms can be various macrophytes, algae, minor aquatic invertebrates, protozoans and bacteria that develop in plant root systems. Preservation of constant flow, providing wastewater aeration in some chosen parts of the bed and light access enable to create appropriate conditions which are essential during self--purification processes that are similar to the ones that occur in rivers environment [Bawiec 2019].

There can occur some exploitation problems during the operation of collective wastewater treatment plants. First and foremost, people use to throw solid waste to the sewerage system, there is sometimes also a tendency to carry not only industrial wastewater without its quality control but also some excessive amounts of wastewater that is supplied from septic trucks. For this reason the efficiency of collective wastewater treatment plants often decreases and is not satisfying enough. In order to make a full diagnose of a wastewater treatment plant there is a need to assess not only the efficiency, which is described by the percentage decrease of pollutants, but also the operational reliability of a facility [Oliveira and Von Sperling 2008, Alderson et al. 2015, Jóźwiakowski et al. 2017]. The reliability level corresponds to the probability of occurring in the outflow from a wastewater treatment plant indicator values which are lower than the permissible ones. In other words the reliability can be defined as a percentage of time during which the predicted pollutants values are consistent with the law [Oliveira and Von Sperling 2008, Jucherski et al. 2017].

There can be listed numerous papers on the efficiency of activated sludge wastewater treatment plants in the world [Di Trapani et al. 2011, Ding et al. 2011, Mansouri and Zinatizadeh 2017, Marques et al. 2008, Podedworna et al. 2016]. However, the issue of the reliability of the system is still not commonly developed and there is not much research carried out on it [Marzec 2017, Jucherski et al. 2019].

The aim of the work was to analyze the efficiency and reliability of pollutants removal (total suspended solids – TSS, BOD_5, COD) in the collective wastewater treatment plant with activated sludge and hydroponic lagoon during its long-term operation (8 years).

Materials and methods

Experimental facility

The research was conducted in the wastewater treatment plant Snopków located in the Jastków Commune in the Lublin Voivodeship in Poland at 51°18'35"N, 22°29'32"E (Photo 1).

The wastewater treatment plant has been in operation since December 2006. The treatment plant is supplied with domestic wastewater from rural areas with dispersed buildings. Some parts of the commune have connection with sewerage system and this is the way how wastewater inflows to the researched object. Moreover, wastewater from unsewered areas is also carried to the wastewater treatment plant by a septic truck. The projected capacity of this object is 1200 m^3/d and RLM is 3675. It was assessed that the average total amount of wastewater treated in the facility in the research period was 376 m^3/d, which constituted about one third of the maximum projected capacity.

There can be listed many elements which are necessary to provide the best wastewater treatment effects (Fig. 1). At start there are the devices for mechanical treatment: a vertical Huber's sieve, pumping station, and sand separator. Then, there is a flowing biological reactor with preliminary settling tank (active capacity of 85 m^3) and three separated chambers. Next stage is a secondary settling tank (active capacity of 311 m^3) and then a tank for stabilisation of excessive sludge. A quite unusual element of the wastewater treatment plant is a hydroponic lagoon. This is a 74 m long bed filled with water and hydrophilous plants. Hydroponic plants cultivation is based on water which replaces soil; in order to grow properly plants use mineral salts dissolved in water. According to the literature, most plants can be cultivated in hydroponic systems as it provides all necessary conditions. In the analyzed wastewater treatment plant Calla lily (*Zantedeschia Spreng*.) is used. The colourful flowers and leaves are greatly valued and commonly grown as ornamental plants. The hydroponic lagoon is considered the third stage of wastewater treatment. The treated wastewater after being properly prepared and controlled outflows to the receiver which is a pond with a capacity of 6600 m^3 and there further polishing and retention of effluent occurs. Finally, water from the pond is connected by an open drainage ditch with the Ciemięga River [Control Record, WIOŚ Lublin, 5/2017].

Analytical methods

In the analyzed wastewater treatment plant both the amount and the quality of wastewater were controlled before and after treatment. The sourced data is essential to assess the efficiency and reliability of wastewater treatment in a long term exploitation of the object. The tests on the wastewater treatment plant were carried out from 2011 until 2018. Four wastewater samples were taken on average per year as it is stated in Polish law regulations [Regulation of the Minister of the Environment 2014]. During the whole research period a total amount of 40 measurements of wastewater quality indicators (in inflow and outflow) was made. The first measurement point was located in the pumping station before wastewater treatment (raw wastewater) and the second one in the inflow to the receiver (treated wastewater).

The following indicators were determined in the wastewater samples: wastewater temperature, BOD_5, COD

Photo 1. The wastewater treatment plant with activated sludge and hydroponic system

and TSS – total suspended solids. During the whole research period all the indicators values were assessed according to the relevant standards. For BOD_5 it was PN-EN 1899-1:2002, for COD it was PN-ISO 15705:2005 and for TSS it was PN-EN 872:2007. Sampling and sample transportation, processing and analysis were performed according to the relevant Polish Standards of Wastewater Examination [PN-74/C-04620/00, PN-EN 25667-2], which are compatible with American Public Health Association (APHA).

Statistical analysis

The collected measurement data was used to calculate basic statistical parameters: mean, maximum, minimum, and median concentration values but also standard deviation and the coefficient of variation. Afterwards, there was a need to compare the mean concentrations of the tested pollutant parameters in influent wastewater (Cd) and in the effluent after treatment in the whole system (Co). The efficiency of pollution removal had to be calculated on the basis of the following formula: $\eta=100\cdot(1-Co/Cd)$ [%].

The next step of the research was evaluating the reliability of pollutants removal by using elements of the Weibull reliability theory [Bugajski 2014].

The Weibull distribution is an overall probability distribution that has been already widely used in reliability testing and assessment of the risk of exceeding the limit values for pollutant concentrations in treated wastewater [Jóźwiakowski et al. 2018, Jóźwiakowski et al. 2017, Jucherski et al. 2019, Jucherski et al. 2019, Bugajski, 2014]. The Weibull distribution is characterized by the following probability density function:

$$f(x) = \frac{c}{b} \cdot \frac{x-\theta}{b}^{(c-1)} \cdot e^{-\left(\frac{x-\theta}{b}\right)^c} \quad (1)$$

where: x – a variable describing the concentration of a pollution parameter in the treated effluent, b – scale parameter, c – shape parameter, θ – position parameter.

Assuming: $\theta < x$, $b > 0$, $c > 0$.

The technological reliability of the studied wastewater treatment plant was assessed for the basic pollution parameters (BOD_5, COD, total suspended solids). The reliability analysis was based on the estimation of Weibull distribution parameters using the method of highest reliability. The null hypothesis that the analyzed variable could be described by the Weibull distribution was verified with the Hollander-Proschan test at the significance level of 0.05% [Bugajski, 2014]. The values of basic pollution parameters in treated wastewater discharged to the receiver were analyzed. Reliability was determined from the distribution figures, taking into account the normative values of the parameters specified in the Regulation of the Minister of the Environment – 2014 [Regulation of the Minister of the Environment 2014] for wastewater discharged from treatment plants with p.e. 2000–9999 and specified in the water permit for wastewater treatment plant in Snopków: BOD_5 – 25 $mgO_2 \cdot dm^{-3}$, COD – 125 $mgO_2 \cdot dm^{-3}$, total suspended solids – 35 $mg \cdot dm^{-3}$). The analysis was carried out using Statistica 13.1 software.

Results and discussion

The results obtained during the whole research were analyzed in three stages. At first, the values of the wastewater quality parameters were measured in influent wastewater. The second stage was assessing the values of some characteristic parameters in effluent wastewater. Then there were calculated the efficiency of BOD_5, COD and TSS removal and the frequency of the permissible values exceedance. In the last part of the analysis, there was determined the removal reliability, i.e. the probability that the investigated facility can meet the relevant requirements for each of the studied pollution parameter.

Pollutant parameters in the inflowing wastewater

The data presented in Table 1 show that the levels of pollution parameters in raw wastewater flowing into the tested facility are higher than those reported in the literature for typical domestic wastewater [Kaczor 2009, Jóźwiakowski et al. 2019]. The values of the organic parameters BOD_5, COD and TSS in the influent showed large variation (according to the interpretation scale proposed by Mucha [1994]), as shown by the coefficients of variation Cv=62% for BOD_5, Cv=89% for COD and Cv=66% for TSS.

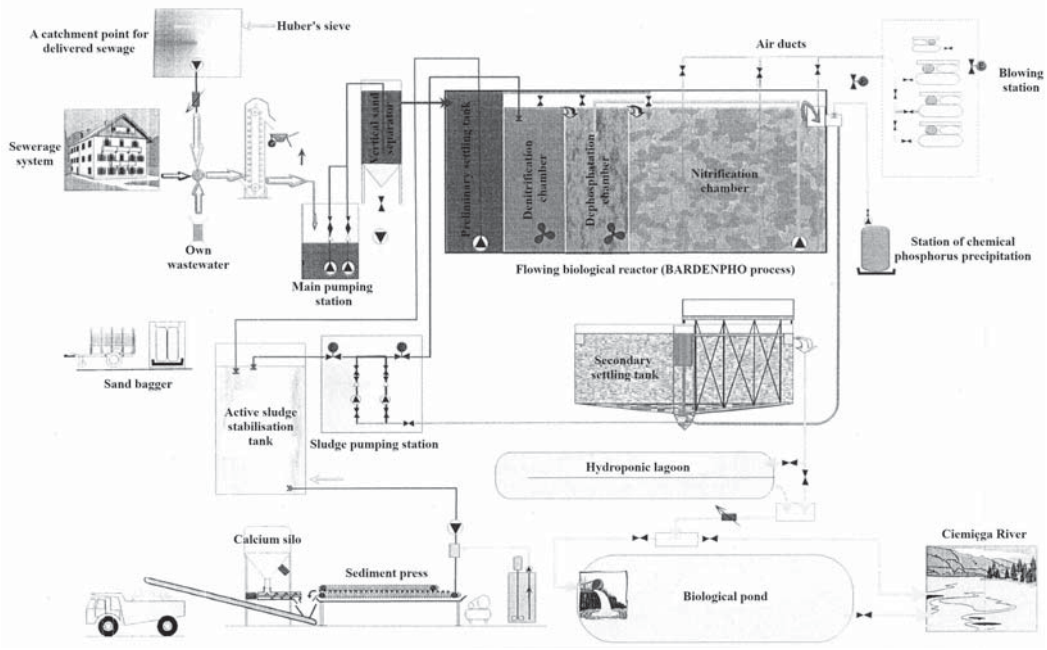

Fig. 1. Technological scheme of the wastewater treatment plant with activated sludge and hydroponic system [Control Record, WIOŚ Lublin, 5/2017]

Table 1. Basic statistics of pollutant parameters in wastewater inflowing to the wastewater treatment plant

Parameter	BOD_5	COD	TSS
	mgO_2/l	mgO_2/l	mg/l
Mean	655	1739	1004
Median	580	1276	770
Minimum	52	139	41
Maximum	1880	7230	2400
Standard deviation	405.2	1540.7	662.6
Coefficient of variation	62%	89%	66%

There were created histograms of selected value classes for BOD_5, COD and TSS in inflowing wastewater (Fig. 2). After comparing minimum and maximum values of all the analyzed indicators the frequency classes were determined on the basis of a widely known criterion connected with the number of tested samples. The frequency distribution data should give a precise and clear picture of the structure of the statistical set. For each pollution parameter there were selected 6 interval classes in accordance with the Huntsberger's suggestions [Mucha 1994]. Generally it can be stated a very high diversity in values of both BOD_5, COD and TSS.

Six interval classes with a width of 350 mg O_2/l were adopted for BOD_5. The analysis of the data showed that in inflowing wastewater samples the most common values of BOD_5 were between 350 and 700 mg O_2/l (55%). No occurrences were observed when BOD_5 values ranged from 1400 to 1750 mg O_2/l.

In the case of COD, six interval classes were established with a class width of 1400 mg O_2/l. The analysis of the data showed that in inflowing wastewater samples the most common value of COD was between 0 and 1400 mg O_2/l (65%). There were observed no occurrences when COD values ranged from 4200 to 5600 mg O_2/l and from 5600 to 7000 mg O_2/l.

For TSS, six classes with a width of 400 mg/l were established. The analysis of the data showed that in raw wastewater samples the diversity of TSS concentration was very high and there were some occurrences of all the six interval classes. The most common concentration of TSS was between 400 and 800 mg/l (35%).

Pollutant parameters in the outflowing wastewater

In order to assess the efficiency of a wastewater treatment plant it is necessary not only to calculate the pollution rate index given in percent. There may be cases in which a wastewater treatment plant is characterized by a high rate of reduction of a given parameter, but still discharges effluent that exceeds the permissible limits for that parameter. The data presented in Table 2 show that the levels of pollution parameters in the treated wastewater measured in the outflow from the tested facility did not exceed the permissible values stated in Polish legal regulations [Regulation of the Minister of the Environment 2014]. There were obtained mean values of BOD_5 – 4 mgO_2/l, COD – 32 mgO_2/l and TSS – 6 mg/l ,while permissible values were, respectively: BOD_5 – 25 mgO_2/l, COD – 125 mgO_2/l and TSS – 35 mg/l. The values of the organic parameters BOD_5 and COD in the effluent showed large variation (according to the interpretation scale proposed by Mucha [Mucha 1994]), as shown by the coefficients of variation Cv=47% for COD and Cv=45% for TSS. The highest variation between individual values in the series of outflowing wastewater samples was observed for BOD_5, where the coefficient of variation was Cv=51%, which testifies to a large variation according to Mucha [Mucha 1994].

There were also created histograms of selected values classes for BOD_5, COD and TSS in treated wastewater (Fig. 3). After comparing minimum and maximum values of all the analyzed indicators the frequency classes were determined on the basis of a widely known criterion connected with the number of tested samples. The frequency distribution data should give a precise and clear picture of the structure of the statistical set. For each pollution parameter there were selected 6 interval classes. Generally it can be stated a very high diversity in values of both BOD_5, COD and TSS.

Six interval classes with a width of 1.5 mg O_2/l were adopted for BOD_5. The analysis of the data showed that in treated wastewater samples the most common values of BOD_5 were between 1.5 and 3.0 mgO_2/l (48%). In the smallest number of samples there were observed BOD_5 values that ranged from 0.0 to 1.5 mgO_2/l (3%).

In the case of COD, six interval classes were established with a class width of 15 mg O_2/l. The analysis of the data showed that in half of the treated wastewater samples the values of COD were between 15 and 30 mgO_2/l (50%). No occurrences were observed when COD values ranged from 60 to 75 mgO_2/l.

For TSS, six classes with a width of 2.0 mg/l were established. The analysis of the data showed that in the treated wastewater samples the diversity of TSS concentration was very high and there were some occurrences of all the six interval classes. The most common concentration of TSS was between 4.0 and 6.0 mg/l (28%).

Efficiency of pollutants removal in the wastewater treatment plant

In the next step of the research, the efficiency of all the tested pollutant parameters removal was assessed (Fig. 4). It was calculated on the basis of the pollutant values in influent and effluent wastewater. Generally the efficiency occurred to be very high during the research period for all the indicators. For BOD_5 it was never smaller than 95%. Most often, the smallest values of the object efficiency were observed for COD. For both BOD_5, COD and TSS there can be seen quite a sharp decline in the operational efficiency in 2012. It is hard to explain such a phenomenon, but on the basis of the tested data there are noticed clearly smaller values of all the tested parameters in raw wastewater in this year, which may probably somehow result in worse purification effects. Taking the whole research period (2011–2018) into account it was calculated that the mean efficiency of pollutants removal was respectively: 99.5% for BOD_5, 98.1% for COD and 99.4% for TSS. This can be stated as high efficiency against the background of results reported in the literature, which indicate maximum efficiencies in the range of 87–94% [Masi and Martinuzzi 2007, Gajewska and Obarska-Pempkowiak 2009, Sharma et al. 2010, Haberl et al. 1995]. Quite similar efficiency to this obtained in the research was presented in the case of a hybrid constructed wetland studied by Marzec et al. [Marzec et al. 2018] and this was respectively 99% for BOD5, 98% for COD and 92.1% for TSS. In comparison to some literature data it can be seen that the researched object enable higher efficiency of pollutants removal than one of household wastewater treatment plants analyzed by Marzec et al [Marzec et al. 2019]. The hybrid constructed wetland provides the average efficiency of BOD_5 removal at the level of 98.8%, for COD – 97.6% and for TSS – 94% [36]. Marzec et el. [Marzec et al. 2019] stated also that the effects of BOD_5, COD and TSS removal were similar to those recorded by other authors in hybrid constructed wetland systems operating under similar climatic conditions.

As mentioned above, wastewater treated in the studied wastewater treatment plant is carried by sewerage system

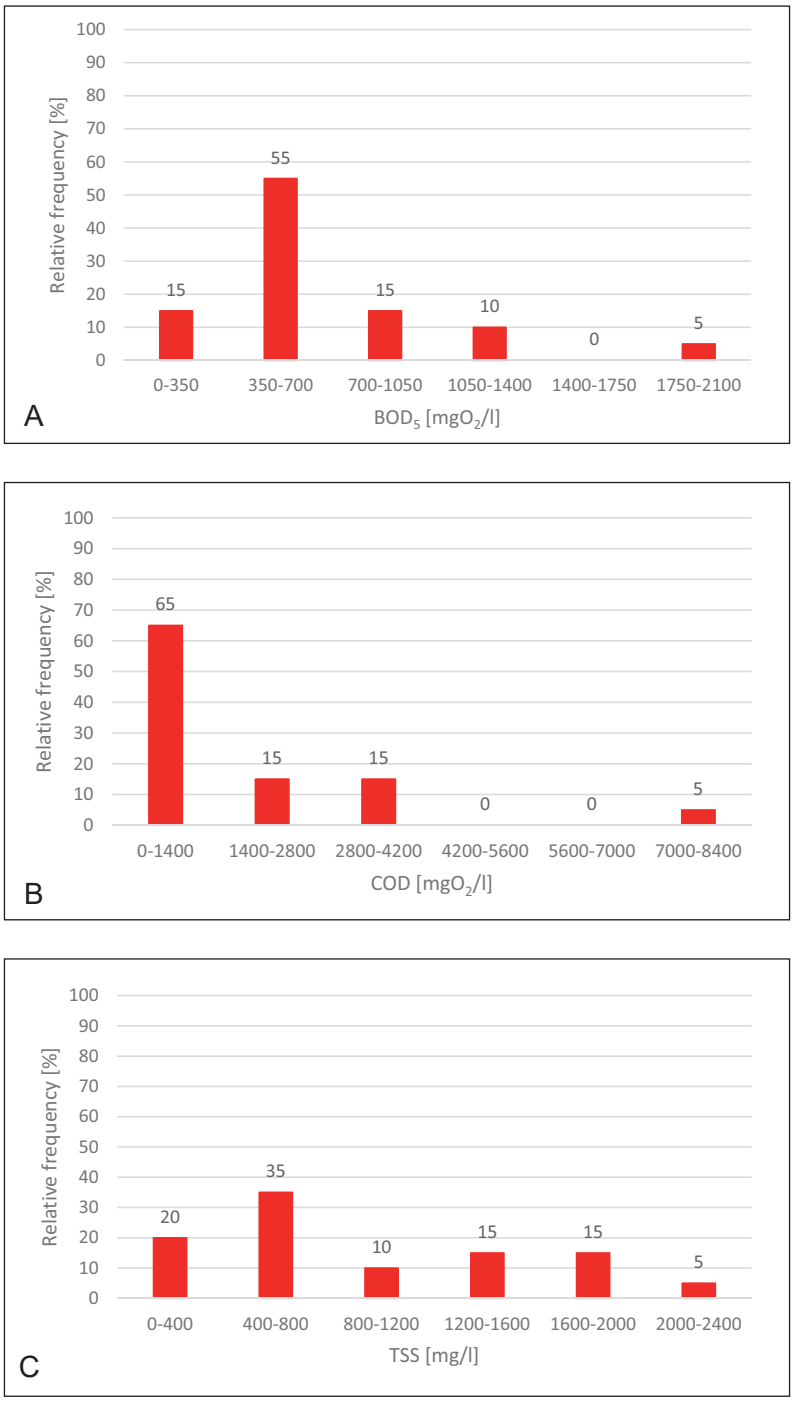

Fig. 2. A histogram of relative frequency showing the proportion of samples in a given values range for each parameter in inflowing wastewater (A – BOD_5, B – COD, C – TSS)

Table 2. Basic statistics of pollutant parameters in the outflow from the wastewater treatment plant

Parameter	BOD_5	COD	TSS
	mgO_2/l	mgO_2/l	mg/l
Mean	4	32	6
Median	3	29	6
Minimum	1	14	2
Maximum	9	82	12
Standard deviation	1.8	15.0	2.6
Coefficient of variation	51%	47%	45%

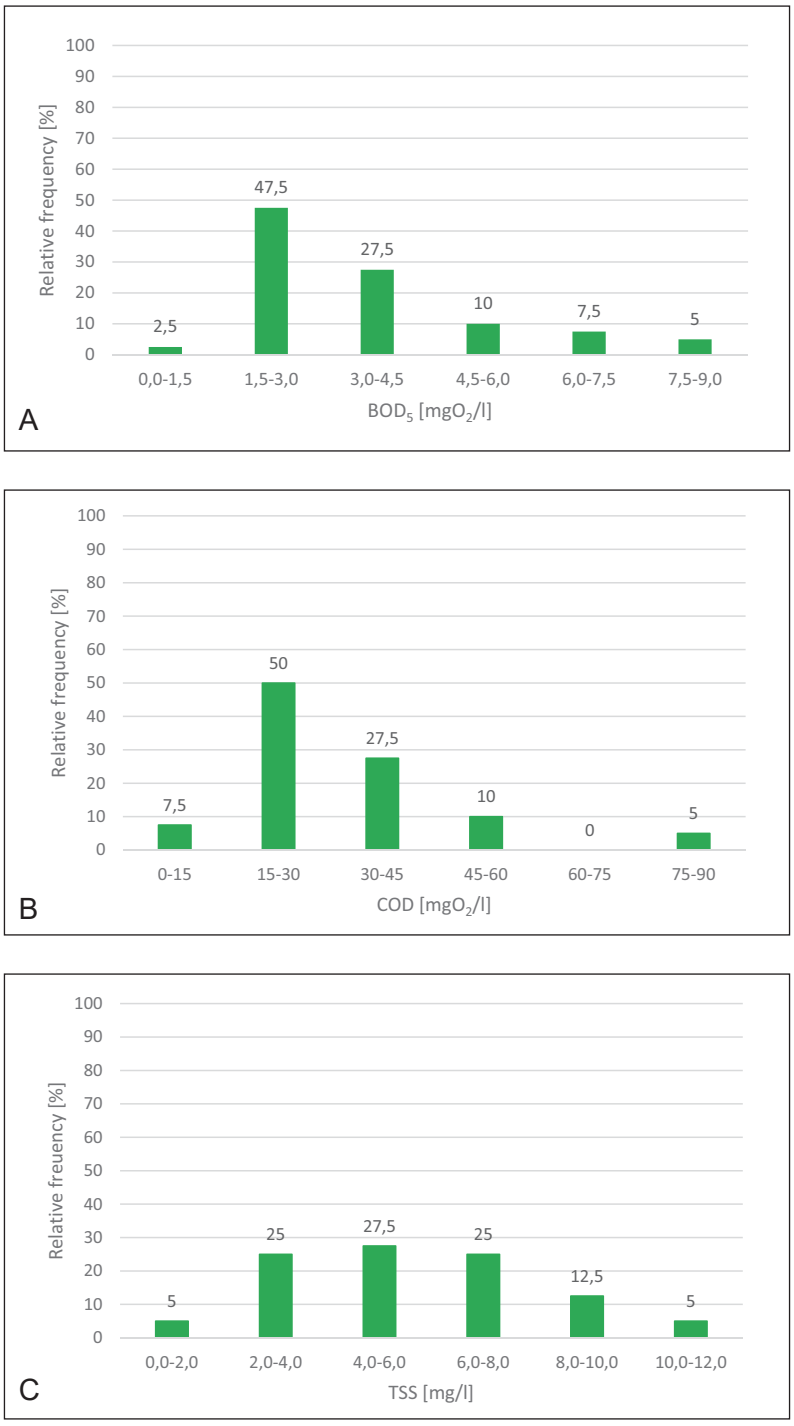

Fig. 3. A histogram of relative frequency showing the proportion of samples in a given values range for each parameter in outflowing wastewater (A – BOD_5, B – COD, C – TSS)

from the communes located nearby but also some part of wastewater is delivered by septic trucks. Figure 5 shows the participation of wastewater delivered by septic trucks in the total amount of sewage treated in the tested facility through the whole research period from 2011 until 2018. There can be observed an increase in the total amount of wastewater treated in the tested wastewater treatment plant. Especially the years 2014 and 2017 were characterized by very high amount of inflowing sewage. In 2014, the daily average total amount of inflowing wastewater was 5132 m^3 and daily average amount of wastewater delivered by septic trucks was 1314 m^3. In 2017, the daily average amount of wastewater delivered by septic trucks was 1009 m^3, whereas daily average total amount of inflowing wastewater was 5423 m^3.

On the basis of some literature data it can be seen that the optimum proportion between wastewater delivered by a septic truck and wastewater transported by sewerage system should be determined independently for every facility. The participation of wastewater delivered by septic trucks in total amount of wastewater treated in the researched facility was compared to another collective wastewater treatment plant with activated sludge in Nowe Brzesko (Poland), where the analyzed value

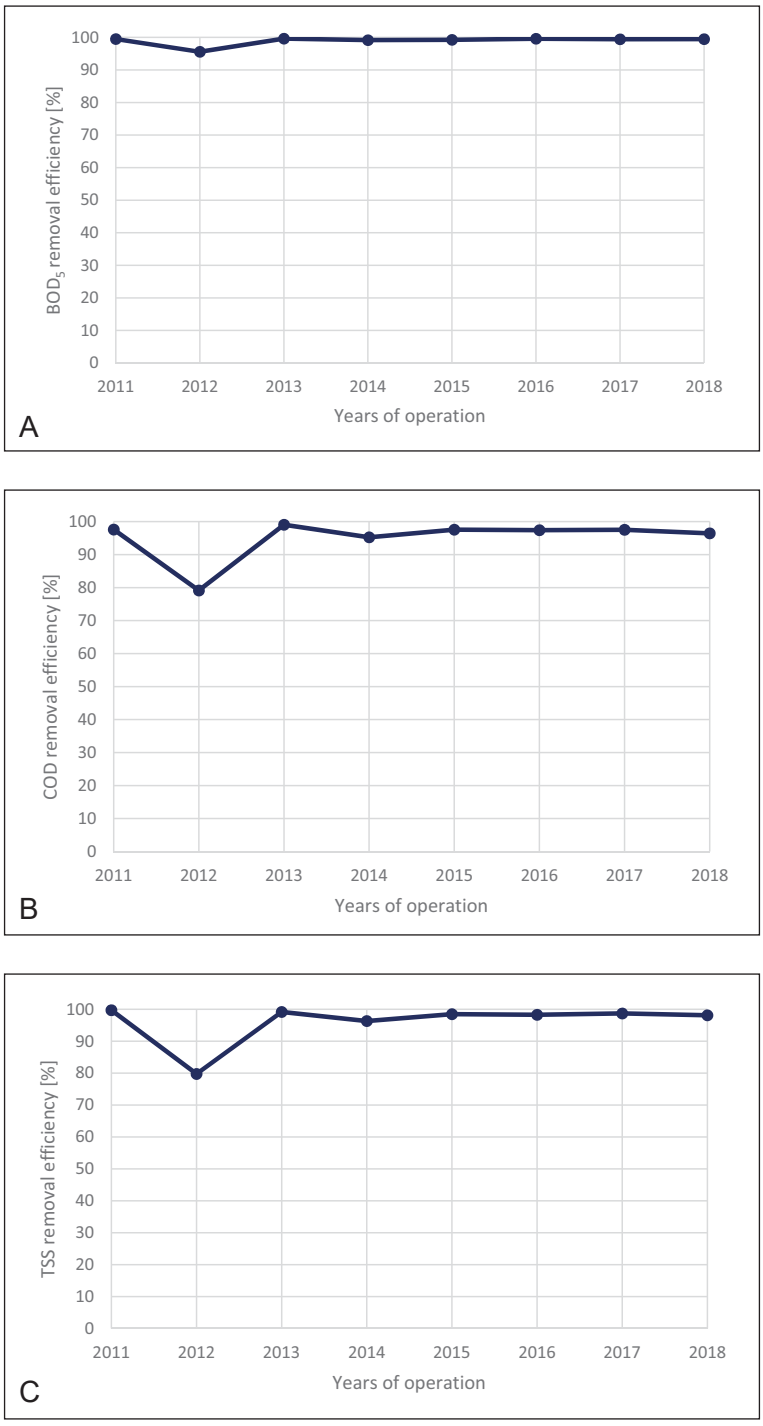

Fig. 4. The efficiency of pollution removal during the long-term operation of the wastewater treatment plant (A – BOD_5, B – COD, C – TSS)

was between about 8 and 12% [Bugajski and Satora 2009]. This proportion was then much smaller than in the case of the researched facility, where wastewater delivered by septic trucks constituted between 14 and 53% of total wastewater amount, on average it was 28%. It is difficult to assess whether the discussed value attained during the research provides the best possibilities for wastewater treatment.

There was also performed an analysis in order to find some correlations between the participation of wastewater delivered by septic trucks in total amount of wastewater treated in the tested wastewater treatment plant and the efficiency of its operation. For BOD_5 there was proved the existence of a very weak positive correlation (coefficient of correlation 0.18) which means that along with the bigger participation of delivered wastewater the efficiency of BOD_5 removal increases. The opposite situation was discovered for TSS and for this parameter the correlation was negative (coefficient of correlation -0.20), which means that the more wastewater was delivered by septic trucks to the facility the worse were TSS removal effects. For COD no statistically relevant correlation was observed between the tested values as the coefficient of correlation was smaller than the adopted significance level ≥0.05.

Reliability of the wastewater treatment plant operation

There was a need to assess the reliability of the studied wastewater treatment plant with regard to the removal of BOD_5, COD and TSS. For this purpose the Weibull reliability theory was used. A hypothesis that the Weibull distribution could be used to approximate the empirical data was tested for the estimated distribution parameters. The distribution of the data obtained in the Hollander-Proschan goodness-of-fit tests for the individual parameters showed a high goodness of fit ranging from 62.64 to 95.80%, at the significance level 0.05, as shown in Table 3.

The technological reliability of the investigated wastewater treatment plant, i.e. its ability to remove contaminants to the required limit level, obtained from the cumulative distribution functions of the Weibull distribution was 100% for BOD_5, COD, and for TSS (Fig. 6). This means that during the whole research period (2011–2018) there were no occurrences that the quality of treated wastewater outflowing from the wastewater treatment plant did not meet the requirements stated in the legal regulations in Poland [Regulation of the Minister of the Environment 2014].

In comparison to some household wastewater treatment plants, it can be seen that the researched facility guarantees stable results and quality of treated wastewater in accordance with the applicable regulations. On the other hand, for instance Jucherski et al. [Jucherski et al. 2019] stated that the SBBR system provided the following levels of technological reliability: 77.5% for BOD_5, 97.8% for COD, and 100% for TSS, which means it was a bit less reliable than the tested object. Small facilities with activated sludge, biological deposit or a hybrid reactor are characterized by very low reliability of BOD_5, COD and TSS removal, usually within the range of 60 to 70% [Marzec 2017]. The above-mentioned household wastewater treatment plants generally operate in natural conditions, the most often in open space. The researched facility, which is a collective wastewater treatment plant, is closed in a building which enables to maintain stable conditions such as air temperature and quite regular wastewater inflow through the whole year.

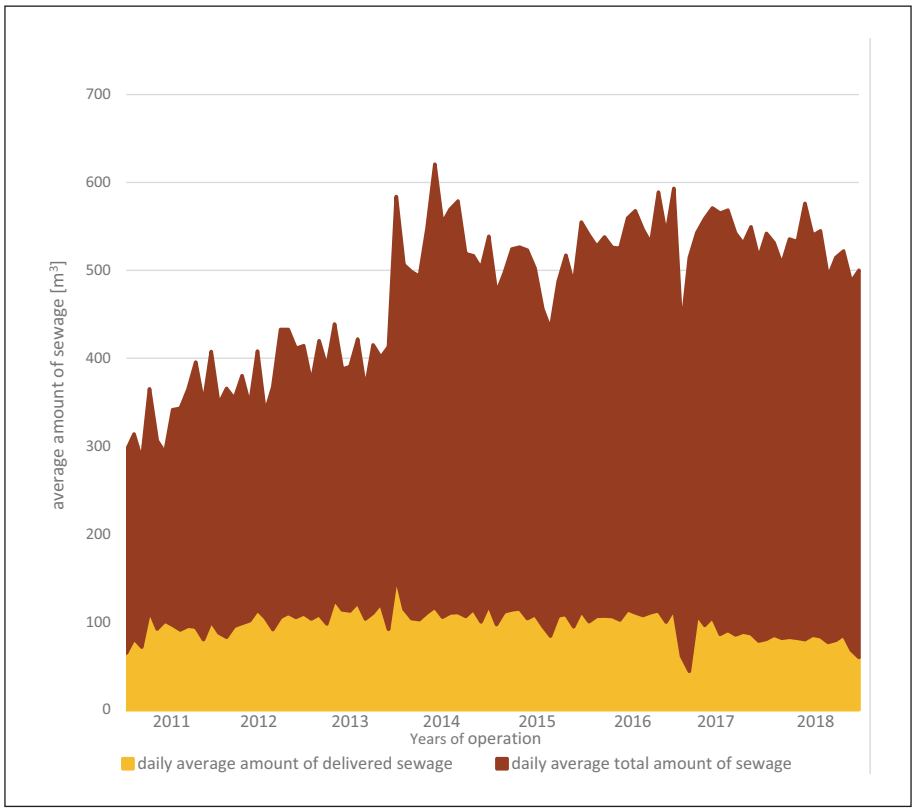

Fig. 5. Participation of wastewater delivered by septic trucks in the total amount of wastewater treated in the tested facility during long-term operation

Table 3. Parameters of the Weibull distribution and the Hollander-Proschan goodness-of-fit test

Parameter	Parameters of Weibull distribution			Hollander-Proschan goodness-of-fit test	
	θ	c	b	stat	p
BOD_5	0.5556	2.1169	4.0691	0.4867	0.6264
COD	12.5450	2.2739	36.4351	0.3854	0.6999
TSS	1.5909	2.4240	6.4917	0.0527	0.9580

Symbols: stat – value of the test statistic, p – significance level of the test; when $p \leq 0.05$ the distribution of data is not Weibull distribution

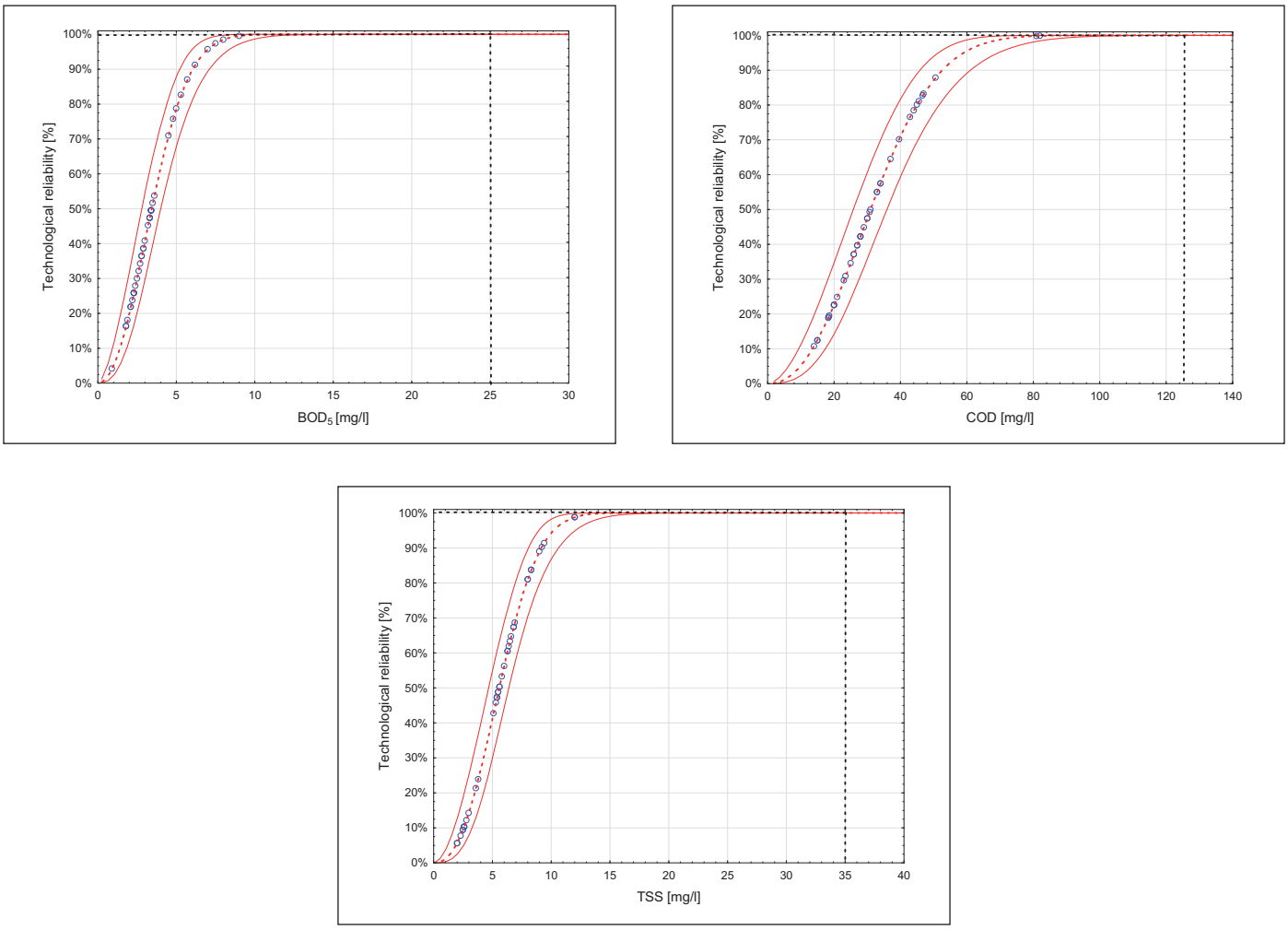

Fig. 6. Weibull cumulative distribution functions and the technological reliabilities determined for each pollution parameter (A-BOD_5, B-COD, C-TSS)

Conclusions

On the basis of the research that was carried out in years 2011–2018 on the collective wastewater treatment plant with activated sludge and hydroponic lagoon it can be stated that the facility meets all the needed requirements. It provides the removal of such biological pollutants as BOD_5, COD and also TSS. The efficiency occurred to be very high during the whole research period for all the indicators, but generally the best effects were gained for BOD_5 removal – on average 99.5%, for TSS 99.4% and for COD 98.1%.

The levels of pollution parameters in treated wastewater measured in the outflow from the tested facility did not exceed the permissible values stated in Polish legal regulations. There were obtained mean values of BOD_5 – 4 mgO_2/l, COD – 32 mgO_2/l and TSS – 6 mg/l, while permissible values were, respectively: BOD_5 – 25 mgO_2/l, COD – 125 mgO_2/l and TSS – 35 mg/l. For BOD_5 there was proved the existence of a very weak positive correlation, which means that along with the bigger participation of wastewater delivered by septic trucks the efficiency of BOD_5 removal increases. The opposite situation was discovered for TSS, so that the more wastewater delivered by septic trucks was treated in the facility the worse were TSS removal effects. On the basis of the conducted research there was presented no influence of the participation of wastewater delivered by septic trucks on the COD removal effects. The Weibull distribution analysis allowed to assess the reliability of the researched facility and it showed that all the requirements for the removal of TSS, COD and BOD_5 were met. There were obtained maximum reliability levels of the discussed pollution parameters removal and these were: 100% for BOD_5, COD and for TSS. As a result of the conducted analysis high efficiency and reliability of wastewater treatment were gained. Satisfactory effects of wastewater treatment enable to state that the researched facility pose no threat to the natural environment. Effluents can be carried by an open drainage ditch to the existing receiver, which is the Ciemięga River and this should not have any negative impact on the water quality.

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