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DEVELOPMENT AND FIRST YEAR OPERATION OF EXTENDED WASTEWATER TREATMENT PLANT IN DOBRON

ROZBUDOWA I PIERWSZY ROK PRACY POWIĘKSZONEJ OCZYSZCZALNI ŚCIEKÓW W DOBRONIU

Abstract: The aim of the investigation was characterizing and operation assessment of the wastewater treatment plant in Dobron taking into consideration its flow capacity, before (350 m^3/d) and after development including building of the second technological pipe with the same flow capacity (350 m^3/d), finished in September, 2009. Concise description of the applied wastewater treatment technology and results of investigations concerning flow rates of wastewater within last few years, are presented. Example results of wastewater composition analysis and reached treatment conversion are described. Analysis results of screenings, sand removed from sand traps and stabilized sludge are shown.

Keywords: Ecolo-Chief type wastewater treatment plants, phosphorus and nitrogen reduction in wastewater, wastewater treatment

Industrial and municipal wastewater generated during new investments realization as well as development of sewerage systems in villages and towns causes the necessity of building of new wastewater treatment plants and development of existing ones. These plants include conventional mechanical and biological treatment methods (1st and 2nd stage) and guarantee removal of biogenic compounds, ie, nitrogen and phosphorus, in the third stage of treatment [1-5].

Ecolo-Chief type wastewater treatment plants are process lines designed and produced by CHIEF INDUSTRIES, INC. (Nebraska, USA). The system was modernized by Multibranch PPU Sumax, Inc. (Krakow) within the range of biogenic compounds removal and secondary settling tank operation. About 75 wastewater treatment plants using this technology, have been built in Poland [6, 7].

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Results of the treatment

The wastewater treatment plant is designed for the treatment of municipal wastewater from small and middle-sized settlements and public buildings like schools, hotels, sport-recreation objects, hospitals, etc. This plant can successfully treat wastewater from food industry or other related branches of this industry which produce wastewater with qualitative composition similar to domestic sewage. Object series of types makes the selection of wastewater systems in the range from 28÷1290 m^3/d possible. Table 1 presents the effectiveness of pollutants removal from municipal and industrial wastewater with features similar to domestic sewage, achieved in the Ecolo-Chief systems.

Table 1

Typical effectiveness of pollutants removal from municipal or industrial wastewater with features similar to domestic sewage, in the Ecolo-Chief systems

Pollution indicator in wastewater	**Raw wastewater**	**Treated wastewater**	**Pollutants removal degree [%]**
Biological Oxygen Demand (BOD_5) [mg O_2/dm^3]	400	30.0	92.5
Chemical Oxygen Demand (COD) [mg O_2/dm^3**]**	750	150.0	80.0
Total suspended solids [mg/dm^3]	435	50.0	88.5
Total nitrogen [mg N/dm^3]	15	5.0	66.7
Total phosphorus [mg P/dm^3]	60	30.0	50.0

Treatment results presented in Table 1, meet that requirements described in attachment No. 2, Table II in the decree of Ministry of the Environment of January 28, 2009 (changing the decree concerning conditions which should be fulfilled during disposal of wastewater into surface water or soil, and concerning substances especially hazardous to the water environment, or other law requirements) [8-10]. Actual removal effectiveness of BOD_5 and COD from the wastewater is usually higher than 95 and 90%, respectively.

Experimental

Biological-mechanical wastewater treatment plant with preliminary treatment of activated sludge in the degree which guarantees protection of Palusznica river (right-bank side stream of Grabia river), was put into operation on January, 1998. This treatment plant has worked smoothly for many years. However, taking into consideration an increasing amount of wastewater, it appeared, that its flow capacity should have been increased.

The aim of the investigation was characterizing and operation assessment of the wastewater treatment plant in Dobron taking into consideration its *flow capacity* (Q), before (~350 m^3/d) and after development including building of the second technological pipe with the same flow capacity (350 m^3/d), finished on 23rd September, 2009 (Fig. 1).

Concise description of the applied wastewater treatment technology and results of investigations concerning flow rates of wastewater within last few years, are presented below. Wastewater treatment plant in Dobron (Ecolo-Chief type) operates according to the technology of low-loaded activated sludge with aerobic sludge digestion [11-14]. After the development, the wastewater treatment plant includes the following most important devices:

- 1 drainage point of supplied wastewater with storage reservoir,

- 1 wastewater pumping station with basket screen,
- 2 sand traps,
- 2 primary settling tanks,
- 2 oxygen deficiency tanks (anoxic),
- 8 aeration tanks,
- 2 tanks of aerobic sludge digestion,
- 2 secondary settling tanks,
- 2 wastewater wells for measurement of wastewater flow,
- 2 set of rotary blowers.

Technological system for sludge treatment consists of:

- 2 tanks of aerobic sludge digestion,
- 1 sludge pumping station,
- 1 tape press for mechanical removal of sludge (sludge dewatering).

Fig. 1. The view of the developed wastewater treatment plant in Dobron

The Ecolo-Chief type wastewater treatment plants guarantees the possibility of an increase in the efficiency of the basic unit by coupling of separated modules. This is especially important during a development of sludge units and gradual increase in the supplied wastewater which concerned the municipal treatment plant in Dobron. This system operates well also in such objects where seasonal supply of the wastewater, i.e., during summertime, significantly exceeds the average value of other months. The application of the treatment system with periodical recirculation of partial wastewater and sludge causes that all system operates under full loading of pollutants also in the period with lower wastewater supply [7].

Results and discussion

Annual volumes of wastewater supplied to the wastewater treatment plant in Dobron over the period from 1999 to August, 2010 are presented in the Proceedings of

ECOpole 2010 [15]. Treatment results of wastewater carried off by sewers and by waste removal transport in the wastewater treatment plant in Dobron over the period of 2009 and January-August, 2010 are shown in Table 2. Consecutive data concerning amounts of pollutants loads and formed technological wastes, are presented in Tables 3 and 4. Example results of wastewater composition, before and after the treatment as well as decrease degree of selected indicators, are shown in Tables 5 and 6. Analysis of screenings, sand removed from sand traps and stabilized sludge are shown in Tables 7-9.

Table 2

Treatment of wastewater carried off by sewers and by waste removal transport in the wastewater treatment plant in Dobron over the period of 2009 and January-February, 2010 [13, 14]

Year/Month	**Monthly wastewater supply [m^3/month]**		**Daily wastewater supply [m^3/d]**	
2009-2010	**Total**	**Transported**	**Total**	**Transported**
January	7111	923.8	229.4	29.8
February	7155.3	940.8	255.5	33.6
March	10110.7	1036.2	326.2	33.4
April	7277.5	1217.6	242.6	40.6
May	7282.2	946.4	234.9	30.5
June	7952.2	1171.7	265.1	39.1
July	6136.9	1263.6	198.0	40.8
August	7984.6	843.8	257.6	27.2
September	6903.6	875.7	230.1	29.2
October	8251	1005.9	266.2	32.5
November	8158	543.5	271.9	18.1
December	8981	1051.3	289.7	34.0
2009 Total	**93304**	**11820.3**	**255.6 (average)**	**32.4 (average)**
January	8327	1134.6	268.6	36.6
February	9083	1292.7	324.4	46.2
March	12525	1514.1	404.0	48.8
April	10982	1756.2	366.0	58.5
May	17611	801.9	568.1	25.9
June	11384	1229.3	379.5	40.9
July	10844	1500	349.8	48.4
August	11706	1223	377.6	39.5
2010 (I-VIII) Total	**92462**	**10451.8**	**379.75 (average)**	**43.1 (average)**

Table 3

Daily average load of pollutants supplied to the wastewater treatment plant in Dobron over the period of 2007-2009 [13, 14]

Indicator name	**Concentration [g O_2/m^3] or [g/m^3]**	**Pollutants load [kg/day]**
BOD_5	247	67.9
COD-Cr	511	140.5
TN (total nitrogen)	86.2	23.7
TP (total phosphorus)	10.4	2.9
TSS (total suspended solids)	222	61

Table 4

Waste types and amounts per month in 2009 and over the period of I-V 2010 [13, 14]

Year/Month	Waste types and amounts [Mg/month]		
2009	**Screenings**	**Sand traps contents**	**Stabilized sludge**
January	0.53	0.2	4.16
February	0.43	0.3	8.44
March	0.3	0.2	8.8
April	0.48	0.4	7.74
May	0.43	0.3	13
June	0.39	0.33	9.82
July	0.52	0.3	6.44
August	0.42	0.4	8.94
September	0.47	0.31	7.3
October	0.44	0.5	13.2
November	0.42	0.4	15.3
December	0.42	0.4	11.44
2009 Total	**5.25**	**4.04**	**114.58**
January	1.08	0.6	3.24
February	1.1	0.5	7.98
March	1.08	0.8	6.22
April	1.05	0.8	7.92
May	1.0	0.6	8.22
I-V 2010 Total	**5.31**	**3.3**	**33.58**

Table 5

Examples of composition analyses in raw and treated wastewater over the period of 2008-2010 [13, 14]

Date of wastewater sampling	Contamination indicator in raw and treated wastewater			
	pH	**BOD_5**	**COD-Cr**	**Total suspended solids**
	-	**[mg O_2/dm^3]**	**[mg O_2/dm^3]**	**[mg/dm^3]**
16.05.2008	7.4/7.4	682/10	1109/56.4	241/20
21.11.2008	7.4/7.1	319/2.7	550/17	133/14
05.02.2009	7.8/7.1÷7.3	485/8.1	804/52	34/11
14.05.2009	7.6/7.2÷7.3	739/18.0	1246/105	763/18
13.08.2009	8.0/7.8÷8.4	695/9.0	1171/45	120/13
03.11.2009	-/7.4÷7.6	-/7.03	-/40	-/6.0
16.02.2010	7.5/7.3	610/15.9	1022/72	230/6.0
10.06.2010	6.6/7.1	466/11.6	826/57	388/15
30.08.2010	7.6/7.3	366/13.8	633/64	349/5.0

Table 6

Example decrease efficiencies of selected pollutants indicators in the raw and treated wastewater over the period of 2008-2010

Date of wastewater sampling	Contamination indicator in raw and treated wastewater		
	Conversion BOD_5	Conversion COD Cr	Conversion of total suspended solids
	[%]	[%]	[%]
16.05.2008	98.5	94.9	91.7
21.11.2008	99.2	96.9	89.5
05.02.2009	98.3	93.5	91.8
14.05.2009	97.6	91.6	95.1
13.08.2009	98.7	96.2	89.2
03.11.2009	-	-	-
16.02.2010	97.4	93.0	97.4
10.06.2010	97.5	93.1	96.1
30.08.2010	96.2	89.9	98.6

Table 7

Analysis results of screenings sampled on April 22, 2010 [13, 14]

Determination type	Analysis results [mg/kg dry matter]
Chlorides	82
Fluorides	9
Sulphates	82
DOC (*dissolved organic carbon*)	198
TDS (*total dissolved solids*)	8225
Zinc	3.9
Copper	0.41
General chromium	0.34
Nickel	0.27
Lead	0.52
Cadmium	0.06
Mercury	0.0015
Molybdenum	0.08
Antimony	0.003
Selenium	0.04
Arsenic	0.04
Barium	1.8

Table 8

Constitution analysis results of sand sampled from the sand trap on April 22, 2010 [13, 14]

Determination type	**Analysis results [mg/kg dry matter]**
Chlorides	51
Fluorides	0.6
Sulphates	51
DOC (dissolved organic carbon)	112
TDS (total dissolved solids)	1124
Zinc	2.7
Copper	0.29
General chromium	0.21
Nickel	0.19
Lead	0.46
Cadmium	0.002
Mercury	0.0009
Molybdenum	0.06
Antimony	0.002
Selenium	0,03
Arsenic	0.02
Barium	2.4

Table 9

Example results of wastewater sludge analysis [13, 14]

Determination type	**Determination unit**	**Analysis of sludge sampled on February 6, 2009**	**Analysis of sludge sampled on February 16, 2010**
pH	-	7.54	7.2
Dry matter content	[%]	26	15.2
Organic substances content	[%]	54	68.3
Total Kjeldahl nitrogen	[%]	1.66	6.91
Ammonia nitrogen	[%]	2.6	0.46
Lead	[mg/kg d.m.*]	16.8	< 12
Nickel	[mg/kg d.m.]	4.7	< 8
Zinc	[mg/kg d.m.]	0.2	< 20
Copper	[mg/kg d.m.]	0.9	< 2
Cadmium	[mg/kg d.m.]	0.003	< 8
Chromium	[mg/kg d.m.]	n.d.**	< 8
Mercury	[mg/kg d.m.]	n.d.	0.003
Salmonella type bacteria	-	n.d.	n.d.
Parasite ova	-	n.d.	n.d.

* d.m. - dry matter
**n.d. - not detected

Increasing amount of wastewater carried off by sewerage or supplied by waste removal transport as well as wastewater load forced making a decision concerning the development of the wastewater treatment plant in Dobron (Tables 2 and 3). Before the development, this plant was gradually approaching to the limit of the maximum loading (350 m^3/d), especially in periods of increased supply of the wastewater. Beginning from September, 2009, the plant can treat the wastewater in the amount of 700 m^3/d. The increased flow capacity guarantees achievement of satisfactory values of the operating indicators over a dozen years. The composition of the wastewater disposed to Palusznica river fulfills law requirements [8-10] and does not raise any doubts. This plant is not hazardous for inhabitants taking into consideration odours, due to the applied treatment technology and favourable location. This is proved by lack of inhabitants' complaints about the plant operation. Up to now, no hazard of the plant to the quality of underground and surface water was found. Solid wastes (screenings, sand from sand traps and stabilized sludge) are carried outside the plant to another firm in order to utilize them.

Conclusions

The increased flow capacity of the plant to 700 m^3/d guarantees the achievement of satisfactory operation indicators. The plant operation is not odour hazardous for inhabitants due to its proper location to other buildings (lack of inhabitants' complaints). No hazard to the quality of surface and underground waters resulting from the treatment plant operation was found so far. Analysis results of screenings, sand removed from sand traps, and stabilized sludge are shown. Solid wastes formed during the technological process of the wastewater treatment (screenings, sand from sand traps and stabilized sludge) are disposed outside the plant in order to utilized them.

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ROZBUDOWA I PIERWSZY ROK PRACY POWIĘKSZONEJ OCZYSZCZALNI ŚCIEKÓW W DOBRONIU

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Abstrakt: Celem pracy była charakterystyka i ocena funkcjonowania oczyszczalni w gminie Dobroń (biorąc pod uwagę jej przepustowość) przed rozbudową (~350 m^3/d) i po rozbudowie o drugą nitkę technologiczną (także 350 m^3/d), zakończoną we wrześniu 2009 r. Oprócz zwięzłego opisu realizowanej technologii oczyszczalnia ścieków, przedstawiono wyniki badań natężenia ich przepływu z ostatnich kilku lat. Ukazano także przykładowe rezultaty analiz składu ścieków surowych oraz uzyskane stopnie ich oczyszczenia. Przedstawiono rezultaty analizy składu skratek, piasku usuwanego z piaskowników i ustabilizowanego osadu ściekowego.

Słowa kluczowe: oczyszczalnie typu EcoloChief, redukcja fosforu i azotu w ściekach, oczyszczanie ścieków