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EVALUATION OF THE EFFICIENCY OF SELECTED WASTEWATER TREATMENT PLANT

T. Vítěz, J. Ševčíková, P. Oppeltová

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Abstract

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This paper is focused on primary, secondary, and total efficiency evaluation of the wastewater treatment process for chosen small wastewater treatment plant (WWTP) located near the Moravian Karst. Eight wastewater samples were taken during one year in three sampling profiles of WWTP: biochemical oxygen demand (BOD), chemical oxygen demand (COD), suspended solids (SS), pH, ammonia nitrogen (N-NH_4), nitrite nitrogen (N-NO_2), nitrate nitrogen (N-NO_3), inorganic nitrogen (N_{inorg}), total phosphorus (P_{total}). Treatment efficiency by reduction was calculated for all laboratory analyzed indicators and average values were determined for the whole period. Calculated treatment efficiency of indicators BOD, COD and suspended solids was compared with the permissible minimum treatment efficiency of discharged waste water by Government Regulation No. 61/2003 Coll., for the WWTP from 500 to 2 000 PE. Permissible minimum treatment efficiency is not legislatively determined for the primary and secondary level. The results of the work will be used especially to compare results with other similar works.
Analyzed values of parameters BOD, COD, suspended solids, N-NH_4 at the outflow from wastewater treatment plant were compared with the permissible maximum values at the outflow of the WWTP which the municipality has an obligation to respect according to the decision issued by the District Environment Authority.

wastewater, wastewater treatment plant, primary treatment, secondary treatment, treatment efficiency, pollution indicators

The implementation of EU Directive 91/271/EEC concerning urban waste water treatment in Member States of the European Union (EU) significantly increases the number of wastewater treatment plants (WWTP) and the amount of treated wastewater. The EU statistics shows that the percentage of population connected to wastewater treatment plants increased from 67% in 1990 to 87% in 2005 (http://water.europa.eu/). Currently in the Czech Republic more than 80% of population is connected to public sewerage witch more than 90% of water from the sewerage system is treated in wastewater treatment plants (http://www.czso.cz/).

EU Council Directive defines the requirements on the treated wastewater quality, but does not define what procedures and processes to remove unwanted substances (Sala-Garrido *et al.*, 2011). There are a lot of small municipal wastewater treatment plants in the European Community, but many of them don't work properly. For example, Tsagarakis *et al.* (2001) says that from 71 small municipal wastewater treatment plants surveyed in Greece has been in operation just 55%, of which 21% worked well, 51% sufficiently and 28% wrong. A similar study was made in Spain, where from eight investigated small wastewater treatment plants just 25% worked very well, 25% good and 50% wrong (Colmenarejo *et al.*, 2006).

The efficiency of waste water treatment is basic indicator of wastewater treatment plant function (Kaindl *et al.*, 1999). It depends on the amount and composition of waste water, on condition and type of sewer network, on producers, on used technical equipment and climatic and other conditions (Dorussen and Wassenberg, 1997; Rosén and Morling, 1998).

Permissible minimum treatment efficiency of wastewater discharged is determined for the Czech Republic in Government Regulation No. 61/2003 Coll. *Indicators and values of permissible pollution of surface water and wastewater, requisites permits for discharge of wastewater into surface water and sewerage systems and sensitive areas, as amended*.

Permissible minimum cleaning efficiency for each level of wastewater treatment is not legislatively determined and therefore is not commonly monitored. This would be better to determine the cause of low pollution reduction at the outflow of treated wastewater from WWTP. Acording to Sojka (2004) the reduction of organic pollution in sewage wastewater in a mechanical level reached up to 30%.

MATERIAL AND METHODS

Wastewater treatment plant characteristics

Monitored wastewater treatment plant is located in a village about 30 km north of Brno, situated on the Moravian Karst border. There is a single sewer system in the village. Mechanical-biological wastewater treatment plant with sludge stabilizing tank was constructed in the village. Continuous operation of the wastewater treatment plant started in January 2005. In 1995 sludge stabilizing tank dredging was done. The treatment plant is projected for 560 population equivalent (PE) and 700 village inhabitants are connected recently. The annual monitoring (March 2009–February 2010) found an average hydraulic overload of wastewater by 26%, due primarily ballast waters.

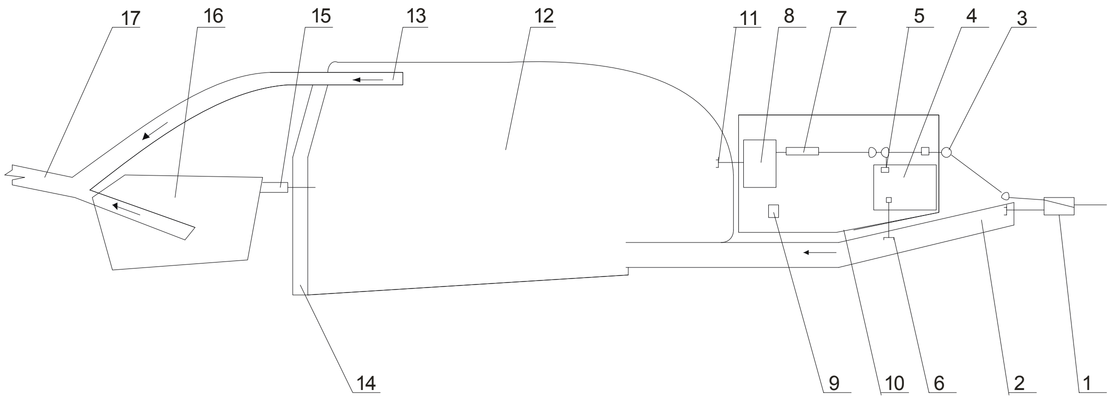
The wastewater plant contains primary and secondary level. The primary level consists of a slot sand trap, coarse screen, storm tank and combined shallow reservoir. The secondary one is formed by the sludge stabilization tank.

Sampling and analysis

To obtain the wastewater characteristic composition the samples were carried out mechanically, mixing of eight partial samples of equal in 15 min interval. During the twelve months lasting monitor period (March 2009–February 2010) eight wastewater samples were taken: at the mechanical level inflow (monitored point P1), at the outflow from the mechanical level to stabilizer tank (monitored point P2) and at the outflow from the stabilizer tank (monitored point P3). The overall WWTP arrangement with sampled profiles shows Fig. 1. Take samples were immediately transported in portable refrigerated boxes to accredited laboratories of VODÁRENSKÉ AKCIOVÉ SPOLEČNOSTI, a. s. – division Boskovice.

Eight following indicators were chosen for WWTP cleaning efficiency evaluation: BOD, COD, suspended solids, pH, ammonia nitrogen ($N\text{-}NH_4$), nitrite nitrogen ($N\text{-}NO_2$), nitrate nitrogen ($N\text{-}NO_3$), inorganic nitrogen (N_{inorg}) and total phosphorus (P_{total}). The Table I shows the acceptable "p" and maximum "m" values at the outflow of the WWTP.

The wastewater treatment plant operator, in this case the municipality, has to respect limits given by the permission to discharge wastewater into surface waters issued by the department of the Environment District Office Blansko. Following



1	Reliving chamber with lateral overflow edge	10	mechanical stage of WWTP
2	gutter bypass	11	P2 – the inflow to the stabilization tank
3	P1 – the inflow to the primary level of WWTP	12	stabilization tank
4	storm tank	13	safety overflow
5	Parshall gutter	14	stabilization tank dam
6	the outflow from the storm tank to the gutter bypass	15	P3 – cascade
7	slot sand trap and coarse screen	16	artificial wetland
8	combined shallow reservoir	17	recipient – Kotvrdovice strem
9	shelter		

1: *Situational scheme of the WWTP ()*

pollution indicators: BOD, COD, suspended solids, $N\text{-}NH_4$ are compared with legislative limits ensured in profile P3.

I: *The acceptable "p" and maximum "m" values at the outflow of the WWTP*

Indicator	"p" [mg/l]	"m" [mg/l]
BOD	25	62
COD	95	160
SS	27.6	65
$N\text{-}NH_4$	19	38

Treatment efficiency was assessed for all monitored pollution indicators. Calculated treatment efficiency of indicators BOD, COD and suspended solids was compared with the permissible minimum treatment efficiency of discharged waste water given by Government Regulation No. 61/2003 Coll., for the WWTP from 500 to 2 000 PE:

BOD 80%,
COD 70%,
suspended solids 80%.

The efficiency of cleaning process *E* [%] is defined by the standard ČSN 75 6401 as the ratio between removed concentration of polluting and their initial concentration. The removed efficiency of component A in the system is given by the equation (Methodological Instruction ME):

$$E_A = \frac{C_{A1} - C_{A2}}{C_{A1}} \cdot 100, \quad [\%] \tag{1}$$

where: C_{A1} is the mass concentration of component A at the system input [mg/l] and C_{A2} is the mass concentration of component A at the system output [mg/l].

RESULTS AND DISCUSSION

Total efficiency of WWTP

Measured values of all monitored pollution indicators for evaluation of the total efficiency of the wastewater treatment plant are shown in Table II.

Biochemical oxygen demand

The average value of BOD during the monitored period was 8.6 mg/l at the inflow to the primary level of WWTP and 5.6 mg/l at the outflow. The measured values do not exceed the allowable (25 mg/l) and maximum (62 mg/l) values at the ouflow from the WWTP. The total efficiency of WWTP for BOD reducing was 34.1%. The permissible minimum treatment efficiency, determined for the discharge of waste water, must be at least 80% in the case of BOD. Waste water treatment plant does not meet the mandated limit of 53.9%.

Chemical oxygen demand

The average value of COD during the monitored period was 35.1 mg/l at the inflow to the primary level of WWTP and 29.1 mg/l at the outflow. The measured values do not exceed the allowable (95 mg/l) and maximum (160 mg/l) values at the ouflow from the WWTP. The efficiency of waste water treatment plant for COD reduction was 17.1%. The permissible minimum treatment efficiency, determined for the discharge of waste water, must be at least 70% in the case of COD. Waste water treatment plant does not meet the mandated limit of 52.9%.

Suspended solids

The average value of suspended solids (SS) during the monitored period was 9.6 mg/l at the inflow to the primary level of WWTP and 4.4 mg/l at the outflow. The measured values do not exceed the allowable (27.6 mg/l) and maximum (65 mg/l) values at the ouflow from the WWTP. The efficiency of waste water treatment plant for suspended solids reduction was 53.7%. The permissible minimum treatment efficiency, determined for the discharge of waste water, must be at least 80% in the case of SS. Waste water treatment plant does not meet the mandated limit of 26.3%.

Nitrite nitrogen

The average value of nitrite nitrogen during the monitored period was 0.358 mg/l at the inflow to the WWTP and 0.422 mg/l at the outflow from the WWTP. The efficiency of the WWTP for nitrite nitrogen can not be quantified. The results shows, that there was an increased level of this indicator at the outflow from the WWTP by 0.064 mg/l.

Nitrate nitrogen

The average value of nitrate nitrogen during the monitored period was 9.26 mg/l at the inflow to the WWTP and 6.80 mg/l at the outflow from the WWTP. The efficiency of the WWTP for nitrate nitrogen reducing was 26.6%.

Ammonia nitrogen

The average value of ammonia nitrogen during the monitored period was 6.44 mg/l at the inflow to the WWTP and 5.81 mg/l at the outflow from the WWTP. The measured values do not exceed the allowable (19 mg/l) and maximum (38 mg/l) values at the ouflow from the WWTP. The efficiency of the WWTP for ammonia nitrogen reducing was 9.8%.

Inorganic nitrogen

The average value of inorganic nitrogen during the monitored period was 16.00 mg/l at the inflow to the WWTP and 13.10 mg/l at the outflow from the WWTP. The efficiency of the WWTP for inorganic nitrogen reducing was 18.6%.

The total phosphorus

The average value of the total phosphorus during the monitored period was 1.09 mg/l at the inflow to the WWTP and 1.01 mg/l at the outflow from the WWTP. The efficiency of the WWTP for the total phosphorus reducing was 6.9%.

Table II shows that in all observed indicators of pollution is reduction of pollution at the outflow from the WWTP very low. In many cases, the values of indicators of pollution are even higher at the outflow, sampling profile (P3), than at the inflow of wastewater to the WWTP, sampling profile (P1). This is probably cause by inflow of untreated wastewater into the stabilization tank through the bypass and also by leaching of sediments from the stabilization tank. For this reason, wastewater treatment plant does not meet the minimum acceptable treatment efficiency of discharged wastewater according to Regulation No. 61/2003 Coll., as amended. Measured values of pollution indicators BOD, COD, SS, N-NH_4 did not exceed permissible "p" and maximum "m" values at the outflow of the WWTP during the monitored period, according to the decision of Environment Department of Blansko District Office.

Efficiency of primary level of WWTP

Measured values of all monitored pollution indicators for evaluation of the efficiency of the primary level of the wastewater treatment plant are shown in Table III.

Biochemical oxygen demand

The average value of BOD during the monitored period was 8.6 mg/l at the inflow to the primary level of WWTP and 8.5 mg/l at the outflow from the primary level of WWTP. The efficiency of the primary level of WWTP for BOD reducing was 0.6%.

Chemical oxygen demand

The average value of COD during the monitored period was 35.1 mg/l at the inflow to the primary level of WWTP and 34.6 mg/l at the outflow from the primary level of WWTP. The efficiency of the primary level of WWTP for COD reducing was 1.4%.

II: *The values of indicators of pollution from sampling profiles P1 and P3 and the efficiency of WWTP*

Date of sampling	BOD [mg/l]		efficiency [%]	COD [mg/l]		efficiency [%]	SS [mg/l]		efficiency [%]	N_{inorg} [mg/l]		efficiency [%]
	P1	P3		P1	P3		P1	P3		P1	P3	
25. 3. 2009	5.1	4.7	7.8	21	20	4.8	6	8	0.0	19.8	18.4	7.1
29. 4. 2009	11.2	9.1	18.8	42	41	2.4	5	10	0.0	19.0	13.3	30.0
10. 6. 2009	13.0	6.9	46.9	56	40	28.6	14	2	85.7	17.0	14.0	17.6
1. 7. 2009	4.3	2.8	34.9	27	32	0.0				15.3	11.2	26.8
4. 8. 2009	3.2	2.2	31.3	35	25	28.6	3	3	0,0	15.2	10.1	33.6
13. 10. 2009	8.5	6.1	28.2	38	37	2.6	10	4	60.0	16.0	12.4	22.5
17. 11. 2009	5.9	3.1	47.5	14	8	42.9	4	2	50.0	9.8	10.4	0.0
9. 2. 2010	17.2	10.2	40.7	48	30	37.5	25	2	92.0	16.2	14.7	9.3
min.	3.2	2.2		14	8		3	2		9.8	10.1	
max.	17.2	10.2		56	41		25	10		19.8	18.4	
median	7.2	5.4		37	31		6	3		16.1	12.9	
average	8.6	5.6	34.1	35.1	29.1	17.1	9.6	4.4	53.7	16.0	13.1	18.6

Date of sampling	N-NH_4 [mg/l]		efficiency [%]	N-$N0_2$ [mg/l]		efficiency [%]	N-NO_3 [mg/l]		efficiency [%]	P_{total} [mg/l]		efficiency [%]
	P1	P3		P1	P3		P1	P3		P1	P3	
25. 3. 2009	1.57	1.05	33.1	0.075	0.112	0.0	18.11	17.21	5.0	0.4	0.4	0.0
29. 4. 2009	9.70	3.36	65.4	0.762	0.876	0.0	8.55	9.11	0.0	1.4	0.7	50.0
10. 6. 2009	13.04	12.72	2.5	0.367	0.149	59.4	3.92	0.94	76.0	1.8	2.3	0.0
1. 7. 2009	2.18	3.97	0.0	0.242	0.314	0.0	12.85	6.90	46.3	0.5	0.7	0.0
4. 8. 2009	4.10	2.67	34.9	0.624	0.653	0.0	10.45	6.73	35.6	0.7	0.4	42.9
13. 10. 2009	9.08	11.23	0.0	0.364	0.083	77.2	6.57	1.04	84.2	1.4	2.0	0.0
17. 11. 2009	2.40	2.02	15.8	0.116	0.248	0.0	7.26	8.18	0.0	0.5	0.4	20.0
9. 2. 2010	9.47	9.46	0.1	0.311	0.939	0.0	6.39	4.29	32.9	2.0	1.2	40.0
min.	1.57	1.05		0.075	0.083		3.92	0.94		0.4	0.4	
max.	13.04	12.72		0.762	0.939		18.11	17.21		2.0	2.3	
median	6.59	3.67		0.338	0.281		7.91	6.82		1.1	0.7	
average	6.44	5.81	9.8	0.358	0.422	0.0	9.26	6.80	26.6	1.09	1.01	6.9

Suspended solids

The average value of suspended solids during the monitored period was 9.9 mg/l at the inflow to the primary level of WWTP and 10.6 mg/l at the outflow from the primary level of WWTP. The efficiency of the primary level of WWTP for suspended solids can not be quantified. The results shows, that there was an increased level of this indicator at the outflow from the primary level of WWTP by 0.7 mg/l.

Nitrite nitrogen

The average value of nitrite nitrogen during the monitored period was 0.358 mg/l at the inflow to the primary level of WWTP and 0.497 mg/l at the outflow from the primary level of WWTP. The efficiency of the primary level of WWTP for nitrite nitrogen can not be quantified. The results shows, that there was an increased level of this indicator at the outflow from the primary level of WWTP by 0.139 mg/l.

Nitrate nitrogen

The average value of nitrate nitrogen during the monitored period was 9.26 mg/l at the inflow to the primary level of WWTP and 9.51 mg/l at the outflow from the primary level of WWTP. The efficiency of the primary level of WWTP for nitrate nitrogen can not be quantified. The results shows, that there was an increased level of this indicator at the outflow from the primary level of WWTP by 0.25 mg/l.

Ammonia nitrogen

The average value of ammonia nitrogen during the monitored period was 6.443 mg/l at the inflow to the primary level of WWTP and 5.550 mg/l at the outflow from the primary level of WWTP. The efficiency of the primary level of WWTP for ammonia nitrogen reducing was 13.9%.

Inorganic nitrogen

The average value of inorganic nitrogen during the monitored period was 16.04 mg/l at the inflow to the primary level of WWTP and 15.50 mg/l at the outflow from the primary level of WWTP. The efficiency of the primary level of WWTP for inorganic nitrogen reducing was 3.4%.

III: *The values of indicators of pollution from sampling profiles P1 and P2 and the efficiency of the primary level of WWTP*

Date of sampling	BOD [mg/l]		efficiency [%]	COD [mg/l]		efficiency [%]	SS [mg/l]		efficiency [%]	N_{inorg} [mg/l]		efficiency [%]
	P1	P2		P1	P2		P1	P2		P1	P2	
25. 3. 2009	5.1	6.0	0.0	21	24	0.0	6	8	0.0	19.8	20.0	0.0
29. 4. 2009	11.2	13.5	0.0	42	38	9.5	5	16	0.0	19.0	17.5	7.9
10. 6. 2009	13.0	14.7	0.0	56	61	0.0	14	18	0.0	17.0	13.0	23.5
1. 7. 2009	4.3	4.5	0.0	27	32	0.0	12	14	0.0	15.3	15.3	0.0
4. 8. 2009	3.2	3.0	6.3	35	30	14.3	3	4	0.0	15.2	15.4	0.0
13. 10. 2009	8.5	7.6	10.6	38	35	7.9	10	9	10,0	16.0	14.0	12.5
17. 11. 2009	5.9	5.1	13.6	14	12	14.3	4	6	0,0	9.8	12.9	0.0
9. 2. 2010	17.2	13.6	20.9	48	45	6.3	25	10	60.0	16.2	15.9	1.9
min.	3.2	3.0		14.0	12.0		3	4		9.80	12.90	
max.	17.2	14.7		56.0	61.0		25	18		19.80	20.00	
median	7.2	6.8		35.5	33.5		8	9.5		16.10	15.35	
average	8.6	8.5	0.6	35.1	34.6	1.4	9.9	10.6	0.0	16.04	15.50	3.4

Date of sampling	$N\text{-}NH_4$ [mg/l]		efficiency [%]	$N\text{-}N0_2$ [mg/l]		efficiency [%]	$N\text{-}NO_3$ [mg/l]		efficiency [%]	P_{total} [mg/l]		efficiency [%]
	P1	P2		P1	P2		P1	P2		P1	P2	
25. 3. 2009	1.57	1.49	5.1	0.075	0.083	0.0	18.11	18.43	0.0	0.4	0.4	0.0
29. 4. 2009	9.70	7.39	23.8	0.762	1.387	0.0	8.55	8.76	0.0	1.4	1.3	7.1
10. 6. 2009	13.04	10.55	19.1	0.367	0.639	0.0	3.92	2.20	43.9	1.8	1.8	0.0
1. 7. 2009	2.18	2.26	0.0	0.242	0.277	0.0	12.85	12.72	1.0	0.5	0.5	0.0
4. 8. 2009	4.10	4.51	0.0	0.624	0.734	0.0	10.45	10.14	3.0	0.7	0.7	0.0
13. 10. 2009	9.08	6.80	25.1	0.364	0.374	0.0	6.57	6.86	0.0	1.4	1.2	14.3
17. 11. 2009	2.40	2.09	12.9	0.116	0.131	0.0	7.26	10.69	0.0	0.5	0.4	20.0
9. 2. 2010	9.47	9.31	1.7	0.311	0.354	0.0	6.39	6.24	2.3	2.0	1.4	30.0
min.	1.57	1.49		0.075	0.083		3.92	2.20		0.4	0.4	
max.	13.04	10.55		0.762	1.387		18.11	18.43		2.0	1.8	
median	6.590	5.655		0.338	0.364		7.905	9.725		1.05	0.95	
average	6.443	5.550	13.9	0.358	0.497	0.0	9.26	9.51	0.0	1.09	0.96	11.5

The total phosphorus

The average value of the total phosphorus during the monitored period was 1.09 mg/l at the inflow to the primary level of WWTP and 0.96 mg/l at the outflow from the primary level of WWTP. The efficiency of the primary level of WWTP for the total phosphorus reducing was 11.5%.

Efficiency of secondary level of WWTP

Measured values of all monitored pollution indicators for evaluation of the efficiency of the secondary level of the wastewater treatment plant are shown in Table IV.

Biochemical oxygen demand

The average value of BOD during the monitored period was 8.50 mg/l at the inflow to the stabilization tank and 5.60 mg/l at the outflow from the stabilization tank. The efficiency of the secondary level of WWTP for BOD reducing was 33.7%.

Chemical oxygen demand

The average value of COD during the monitored period was 34.60 mg/l at the inflow to the stabilization tank and 29.10 mg/l at the outflow from the stabilization tank. The efficiency of the secondary level of WWTP for COD reducing was 15.9%.

Suspended solids

The average value of suspended solids during the monitored period was 10.10 mg/l at the inflow to the stabilization tank and 4.40 mg/l at the outflow from the stabilization tank. The efficiency of the secondary level of WWTP for suspended solids reducing was 56.3%.

Nitrite nitrogen

The average value of nitrite nitrogen during the monitored period was 0.49 mg/l at the inflow to the stabilization tank and 0.42 mg/l at the outflow from the stabilization tank. The efficiency of the secondary level of WWTP for nitrite nitrogen reducing was 15.2%.

Nitrate nitrogen

The average value of nitrate nitrogen during the monitored period was 9.51 mg/l at the inflow to

IV: *The values of indicators of pollution from sampling profiles P2 and P3 and the efficieny of secondary level of WWTP*

Date of sampling	BOD [mg/l]		efficiency [%]	COD [mg/l]		efficiency [%]	SS [mg/l]		efficiency [%]	N_{inorg} [mg/l]		efficiency [%]
	P2	P3		P2	P3		P2	P3		P2	P3	
25. 3. 2009	6.0	4.7	21.7	24	20	16.7	8	8	0.0	20.0	18.4	8.0
29. 4. 2009	13.5	9.1	32.6	38	41	0.0	16	10	37.5	17.5	13.3	24.0
10. 6. 2009	14.7	6.9	53.1	61	40	34.4	18	2	88.9	13.0	14.0	0.0
1. 7. 2009	4.5	2.8	37.8	32	32	0.0				15.3	11.2	26.8
4. 8. 2009	3.0	2.2	26.7	30	25	16.7	4	3	25.0	15.4	10.1	34.4
13. 10. 2009	7.6	6.1	19.7	35	37	0.0	9	4	55.6	14.0	12.4	11.4
17. 11. 2009	5.1	3.1	39.2	12	8	33.3	6	2	66.7	12.9	10.4	19.4
9. 2. 2010	13.6	10.2	25.0	45	30	33.3	10	2	80.0	15.9	14.7	7.5
min.	3.0	2.2		12.0	8.0		4	2		12.9	10.1	
max.	14.7	10.2		61.0	41.0		18	10		20.0	18.4	
median	6.8	5.4		33.5	31.0		10	3		15.4	12.9	
average	8.5	5.6	33.7	34.6	29.1	15.9	10.1	4.4	56.3	15.5	13.1	15.7

Date of sampling	$N\text{-}NH_4$ [mg/l]		efficiency [%]	$N\text{-}N0_2$ [mg/l]		efficiency [%]	$N\text{-}NO_3$ [mg/l]		efficiency [%]	P_{total} [mg/l]		efficiency [%]
	P2	P3		P2	P3		P2	P3		P2	P3	
25. 3. 2009	1.49	1.05	29.5	0.083	0.112	0.0	18.43	17.21	6.6	0.4	0.4	0.0
29. 4. 2009	7.39	3.36	54.5	1.387	0.876	36.8	8.76	9.11	0.0	1.3	0.7	46.2
10. 6. 2009	10.55	12.72	0.0	0.639	0.149	76.7	2.20	0.94	57.3	1.8	2.3	0.0
1. 7. 2009	2.26	3.97	0.0	0.277	0.314	0.0	12.72	6.90	45.8	0.5	0.7	0.0
4. 8. 2009	4.51	2.67	40.8	0.734	0.653	11.0	10.14	6.73	33.6	0.7	0.4	42.9
13. 10. 2009	6.80	11.23	0.0	0.374	0.083	77.8	6.86	1.04	84.8	1.2	2.0	0.0
17. 11. 2009	2.09	2.02	3.3	0.131	0.248	0.0	10.69	8.18	23.5	0.4	0.4	0.0
9. 2. 2010	9.31	9.46	0.0	0.354	0.939	0.0	6.24	4.29	31.3	1.4	1.2	14.3
min.	1.49	1.05		0.083	0.083		2.20	0.94		0.4	0.4	
max.	10.55	12.72		1.387	0.939		18.43	17.21		1.8	2.3	
median	5.655	3.665		0.364	0.281		9.725	6.815		0.950	0.700	
average	5.55	5.81	0.0	0.497	0.422	15.2	9.51	6.80	28.5	0.96	1.01	0.0

the stabilization tank and 6.80 mg/l at the outflow from the stabilization tank. The efficiency of the secondary level of WWTP for nitrite nitrogen reducing was 28.5%.

Ammonia nitrogen

The average value of ammonia nitrogen during the monitored period was 5.55 mg/l at the inflow to the stabilization tank and 5.81 mg/l at the outflow from the stabilization tank. The efficiency of secondary level of WWTP for ammonia nitrogen can not be quantified. The results shows, that there was an increased level of this indicator at the outflow from the secondary level of WWTP by 0.3 mg/l.

Inorganic nitrogen

The average value of inorganic nitrogen during the monitored period was 15.50 mg/l at the inflow to the stabilization tank and 13.10 mg/l at the outflow from the stabilization tank. The efficiency of secondary level of WWTP for inorganic nitrogen reducing was 15.7%.

The total phosphorus

The average value of the total phosphorus during the monitored period was 0.96 mg/l at the inflow to the stabilization tank and 1.01 mg/l at the outflow from the stabilization tank. The effeciency of secondary level of the waste water treatment plant for parameter P_{total} can not be quantified, the results show increased level of this parameter at the outlet of the WWTP by 0.05 mg/l.

pH

The average value of pH measured on the sampling profile P1 was 7.32, on the sampling profile P2 was 7.36 and on the sampling profile P3 was 7.47. The measured values correspond to the range of pH values of waste water, which is 6.8 to 7.5. All measured values of pH for sampling profiles P1, P2 and P3 are shown in the Table V.

The main reason why the water pollution at the inflow to the WWTP is low can be found directly by the inhabitants of the village. Most of them own 2–3 chamber septic tanks through which pre-treated waste water is discharged into the sewerage system. It is prohibited according to the Act No. 274/2001 Coll. on water supply and sewerage systems for public use, as amended, § 18 The removal of waste water, paragraph 4, which directly states that if there is sewerage system which ends at the waste water treatment plant it is not allowed to discharged waste water through septic tanks or cesspools.

There is a single sewer system in the village, so the influent wastewater is diluted not only by rain water, in case of rain, but also by water from a safety overflow of the pond, which is lead directly into the sewerage system. This excessive amount of diluted wastewater cause hydraulic overloading of the WWTP, which can explain the low efficiency of all stages of the WWTP.

Inflow of wastewater to the WWTP is so high, that it overflows from the overflow side edge, which is the existing sewer outfalls, wastewater flows almost all year long through bypass directly into the stabilization tank. It can explain, in some of indicators of pollution, their higher average values at the outflow from the secondary level than at the inflow or outflow from the primary level. A large proportion of ballast water in the wastewater also causes cooling of wastewater, which is undesirable for the correct efficiency of wastewater treatment plant.

V: *The pH measured on the sampling profiles P1, P2 and P3*

Date of sampling	number of report	pH	number of report	pH	number of report	pH
	P1		P2		P3	
25. 3. 2009	0847/2009	7.46	0848/2009	7.36	0849/2009	7.38
29. 4. 2009	1125/2009	7.45	1126/2009	7.38	1127/2009	8.61
10. 6. 2009	1501/2009	7.48	1502/2009	7.49	1503/2009	7.46
1. 7. 2009	1704/2009	6.89	1705/2009	7.15	1706/2009	7.17
4. 8. 2009	275/4O1/09	6.72	276/4O1/09	6.77	277/4O1/09	6.96
13. 10. 2009	3103/4O1/09	7.45	585/4O1/09	7.60	586/4O1/09	7.58
17. 11. 2009	753/4O1/09	7.74	754/4O1/09	7.61	755/4O1/09	7.47
9. 2. 2010	144/4O1/10	7.34	145/4O1/10	7.55	146/4O1/10	7.15
Average		7.32		7.36		7.47

SUMMARY

This paper deals with the evaluation of primary, secondary and total efficiency of cleaning process of selected small waste water treatment plant. At the present, the minimum acceptable treatment efficiency is determined only for the discharge of waste water, in Government Regulation No. 61/2003 Coll. Indicators and values of permissible pollution of surface water and waste water, requisites permits for discharge of wastewater into surface waters and sewerage systems and sensitive areas, as amended. By tracking the effeciency of individual parts of wastewater treatment plants could be easier to determine the cause of low pollution reduction in the outflow of treated wastewater from WWTP. The goal of our work was to obtain data from selected WWTP for this purpose 8 samples was collected 8 to take eight samples of wastewater during the 12 months in three sampling profiles (P1, P2 and P3), followed by determination of values for the parameters of waste water pollution (BOD, COD, SS, pH, NH_4-N, N-NO_2, NO_3-N, N_{inorg}, P_{total}) and calculate the efficiency of the cleaning process. This is according to the Methodical instructions ME defined standard CSN 75 6401. Calculated efficiency for the indicators BOD, COD and SS is compared with the permissible minimum treatment efficiency of discharged wastewater by Government Regulation No. 61/2003 Coll., for the WWTP from 500 to 2000 PE. This Regulation sets minimum acceptable treatment efficiency of wastewater for BOD at 80%, for COD at 70% and for SS at 80%. The efficiency of the waste water treatment plant was in the monitored period very small and did not meet the minimum acceptable treatment efficiency of discharged wastewater. The values of parameters BOD, COD, SS, N-NH_4 in profile P3 were compared with the permissible maximum values and the outflow of the WWTP, which the municipality has an obligation to respect the decision paper by the environment of the District Office. Average measured values exceeded the limits. By evaluating of the effeciency of primary and secondary treatment was found that the reduction of pollutants is very low. This is due to hydraulic overloading of waste water treatment plant and a very low metabolic load of wastewater entering the WWTP. The results of the work will be used for comparsion of the efficiency of the cleaning process with other waste water treatment plants.

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Address

Ing. Tomáš Vítěz, Ph.D., Ing. Jana Ševčíková, Ústav zemědělské, potravinářské a environmentální techniky, Ing. Petra Oppeltová, Ph.D., Ústav aplikované a krajinné ekologie, Mendelova univerzita v Brně, Zemědělská 1, 613 00 Brno, Česká republika, e-mail: tomas.vitez@mendelu.cz