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WASTEWATER QUALITY MONITORING. CASE STUDY: CLUJ-NAPOCA

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ABSTRACT. In Romania, the critical situation of the wastewater treatment plants is caused by the old sewage networks and the purification installations, the modification of the sewage capacity without its adaptation to the constructive parameters, the poor managerial capacity and the poor financial situation of the public utility operators. The wastewater treatment plant from Cluj-Napoca, was recently upgraded, the technology was innovated and introduced the tertiary wastewater treatment stage. This unit collects and treats the wastewater from the city of Cluj-Napoca and from the adjacent areas. To evaluate the quality of the wastewater and of the treated water, the samples were collected over a period of 8 months (September 2015 - April 2016), daily, at the entrance and exit point from the treatment plant. Because our focus was mainly on the tertiary stage, the analyzed parameters were: pH, COD(Cr), BOD_5, total suspensions, ammonium, nitrates, total N, total P. With regard to the quality of the analyzed waters, it can be concluded that all of the eight analyzed parameters show high values in the wastewater and after purification the values decrease, within the maximum permissible limits given by law.

In the months with higher temperatures the quality of the wastewater is weaker, and we noticed that the monitored parameters are slightly higher but also the amount of wastewater increases. On the basis of the results we can say that the efficiency of the purification processes is very good and the tertiary stage introduced in the wastewater treatment process is of high importance especially in the reduction of the phosphorus content.

Key words: *wastewater, treatment plant, chemical parameters, Cluj-Napoca*

INTRODUCTION

This study presents a research regarding the quality of wastewater, from Cluj-Napoca and surrounding areas and the efficiency of the treatment processes and procedures for wastewater treatment, especially tertiary treatment stage.

Wastewater treatment technologies are particularly complex and sophisticated. They use unitary processes of physical, chemical and biological nature. It is a necessity to make a perfect correlation between different parameters of different nature which determines the process of purification.

The advances made today in computer development, dedicated software that appeared, modeling and process simulations have led to the elucidation of many theoretical and practical aspects that were unthinkable two decades ago (Ionescu et al., 2013).

In present, appeared new and modern processes, energy and operational efficient solutions which lead to the achievement of some outstanding performance in wastewater treatment. They can be applied in the rehabilitation of wastewater treatment plants with low implementation costs because they often do not require very large investments. It is desirable to optimize purification processes by using unconventional sources (e.g. the use of the gases from the fermentation process) (Gligor et al., 2010). The correct development of the purification processes is a result of the multidisciplinary activities performed by the operators (Ianculescu et al., 2002).

The chemical composition of household wastewater is greatly influenced by the protein, fat and hydrocarbon content from food, as well as by the composition of water in the feed, which contains carbonates, sulphates, chlorides, iron, etc. within certain limits (Gligor and Blaga, 2009).

The tertiary treatment stage is the finishing treatment that applies after the two steps of the classical purification process and consists of all the processes used for the purpose of removing from the wastewater certain substances called resistant or refractory, which once reached the receivers affects their drinking qualities. For example, the detergents that could not be retained in classical purification promote the appearance of foam at the water's surface of the receptor's, which, besides the unsightly appearance, does not allow the oxygenation of water (Robescu et al., 2011). Also, nitrogen and phosphorus compounds in the primary and secondary trap are retained within 40-50%, once they reach the receptor (especially in storage lakes or in slow flowing water) causing the eutrophication process with unpleasant consequences on water quality. Some researches shows that classical purification processes eliminate up to 50% nitrogen and 40% total phosphorus (Nourmohammadi et al., 2013). Other observations made at various treatment plants in Zurich (Switzerland) have found that the biological process of phosphorus removal (P_{total}) oscillates between 17% and 26%, but in some cases it can result much more inferior yield, as a result of mineralization of organic phosphorus, so that the final effluent contains more dissolved phosphates than the predetermined water (Wuhrman, 1974).

Tertiary treatment stage or advanced water treatment aims to remove the refractory substances from treated water, so that treated water can be reused even in the context of the current water crisis, even for drinking purposes, and the retained impurities to be completely destroyed in order not to affect, in no way, the quality of natural waters (Dima, 2005).

MATERIAL AND METHODS

The wastewater entering in the treatment plant is domestic wastewater, industrial water and rainwater, coming from the city of Cluj-Napoca, Floreşti, Luna, Gilau, Baciu. Total inhabitants served 357141.

The Cluj-Napoca Wastewater Treatment Plant is located on the left bank of the Somesul Mic River downstream of Cluj-Napoca (see figure 1).

The wastewaters in the treatment plant pass through a succession of constructions and installations for cleaning purposes and finally end up in the Someşul Mic River, which is the emissary of the sewerage system of Cluj-Napoca.

To evaluate the quality of the wastewater and of the treated water and to highlight the importance of the tertiary step in the purification process the analyzed parameters were: pH, COD(Cr), BOD_5, total suspensions, ammonium, nitrates, total N, total P.

The samples were collected over a period of 8 months (September 2015 - April 2016), daily, at the entrance (1) and exit (2) point from the treatment plant (figure 1).

The pH measurements were made with a WTW inlab 7310 pH-meter. The pH meter is verified with certified reference materials, calibrated with IL.L.E. – 13. The COD(Cr), BOD_5 parameters were analyzed with volumetric methods, the total suspension with gravimetric method, ammonium, nitrates, total N and total P were determined using spectrophotometric methods (UV/VIS Perkin Elmer Lambda spectrofotometer).

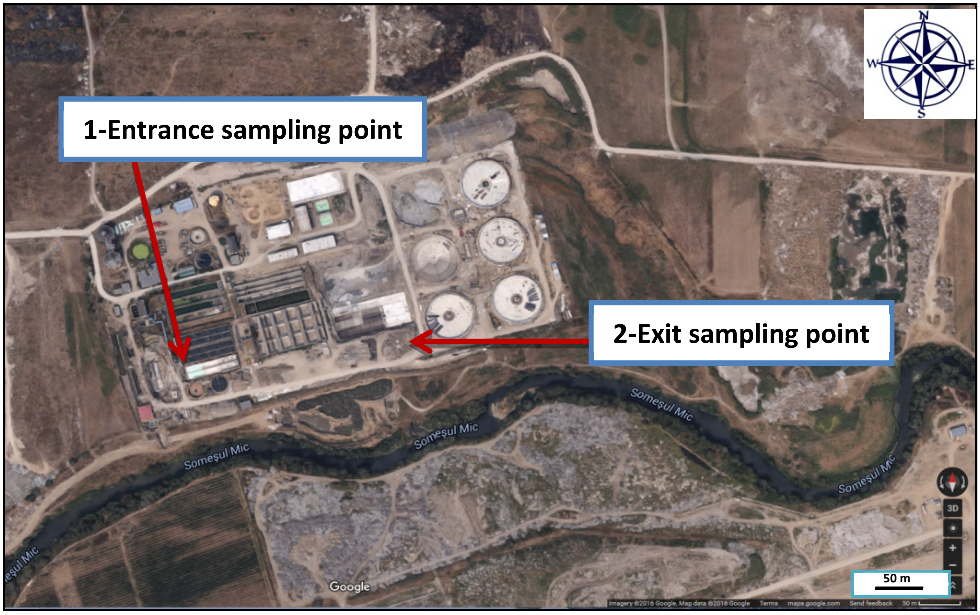


Fig. 1. *Location of sampling points (source: Google maps)*

RESULTS AND DISCUSSIONS

From the obtained results, for each analyzed parameter was calculated monthly averages and these values are shown in table 1 and 2.

Table 1. *Average values for the analyzed parameters from sampling point 1 (entrance - wastewater)*

Month	pH	COD (Cr) mg/l	BOD_5 mg/l	Total susp. mg/l	Ammonium mg/l	Nitrate mg/l	Total N mg/l	Total P mg/l
Sept. 2015	7.66	223.58	99.57	110	27.39	6.1	27.03	3.73
Oct. 2015	7.64	234.79	100.08	111	26.36	4.07	30.95	3.43
Nov. 2015	7.63	230.97	96.95	112	28.22	3.02	31.64	3.73
Dec. 2015	7.62	255.68	121.76	122	30.29	3.53	30.15	3.82
Jan. 2016	7.61	241.72	106.16	110	32.69	3.02	34.02	3.91
Feb. 2016	7.63	244.57	107.33	134	28.31	3.91	33.48	4.63
Mar. 2016	7.66	232.28	100.25	119	29.06	4.1	30.12	3.71
Apr. 2016	7.67	287.95	140.53	144	25.4	4.84	31.27	3.74

Table 2. *Average values for the analyzed parameters from sampling point 2 (exit – treated water), and the MCL (maximum contaminant level according to NTPA-001/2005) for evacuated water*

Month	pH	COD (Cr) mg/l	BOD_5 mg/l	Total susp. mg/l	Ammonium mg/l	Nitrate mg/l	Total N mg/l	Total P mg/l
Sept. 2015	7.57	25.09	2.66	11.12	0.19	15.8	4.43	0.66
Oct. 2015	7.53	18.46	1.54	7.09	0.22	13.4	4.17	0.35
Nov. 2015	7.59	25.98	2.89	14.24	0.2	12.17	4.24	0.44
Dec. 2015	7.6	22.88	1.9	6.55	0.2	12.39	3.58	0.36
Jan. 2016	7.54	20.07	2.67	7.83	0.42	13.55	4.8	0.41
Feb. 2016	7.61	20.63	1.98	5.68	0.41	13.2	4.2	0.45
Mar. 2016	7.58	20.85	2.6	7.5	0.59	13.56	4.56	0.48
Apr. 2016	7.68	29.28	3.77	13.58	0.36	16.54	5.73	0.51
MCL level	**6.5-8.5**	**125**	**25**	**35**	**2**	**25**	**10**	**1**

The pH of the analyzed water samples ranges between 7.5 to 7.7 at both entrance and exit point (see figure 2). In view of this parameter there is no deviation from the legal norms.

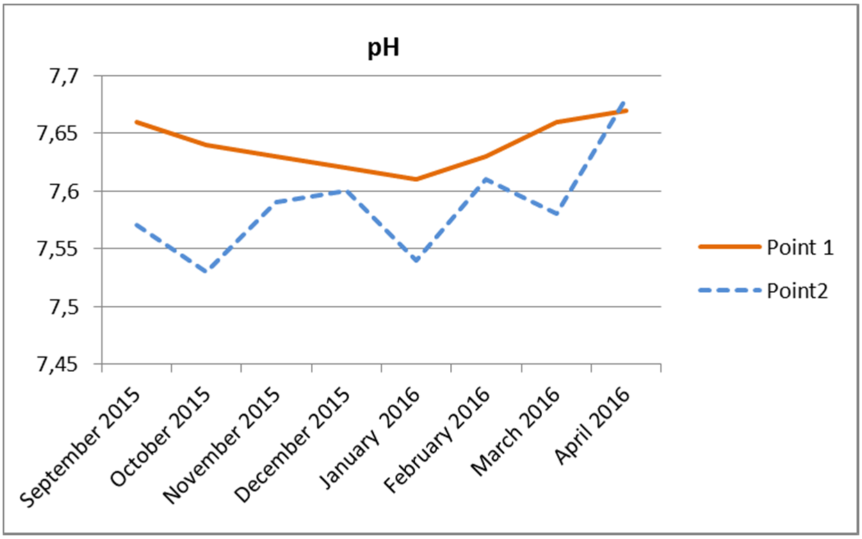
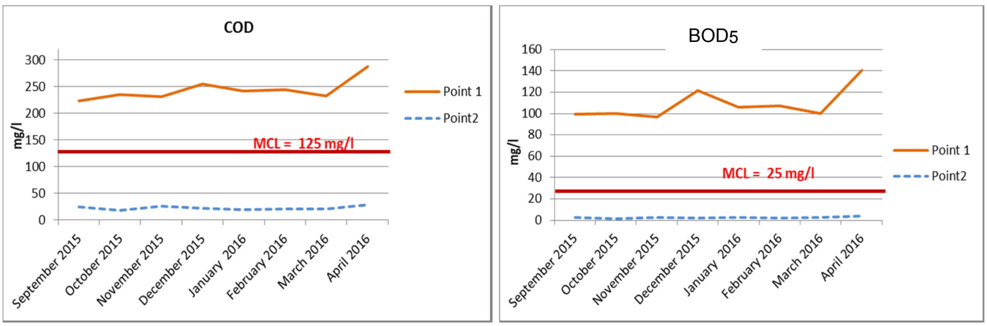


Fig. 2. *Average pH values in the sampling point 1 and 2*

In all the wastewater samples, at each sampling, the content of organic substances is very high, with higher values observed between March and April 2016 due to higher temperatures. The monthly average values for COD(Cr) are between 223 and 287 mg/l. After the treatment of the wastewaters, we observed a significant decrease in the organic substance content, resulting values between 18-29 mg/l (see figure 3a). There is no exceeding of the maximum admissible value (125 mg/l) at the exit point.



a b

Fig. 3. *Average COD and BOD_5 values in the sampling point 1 and 2*

The values of BOD_5 vary similar with those of COD(Cr), with high values at the entry point (ranging between 97 to 141 mg/l) and small values at the discharging point (between 1.5 to 4 mg/l). These low values are due to the consumption of organic matter by the microorganisms responsible for the treatment. There are no exceedings of the maximum contaminant level (25 mg/l) at this parameter at the discharge point (figure 3 b).

The total suspended materials are found in high concentration in wastewater, especially during the periods of snow and periods of heavy rainfall. The salt and sand mixture used in winter contributes to this indicator and during the rain the sewage is "washed", so all the deposits suddenly reach the station. At the sampling point 1 (wastewater), for total suspensions the values range between 110 to 144 mg/l (figure 4).

As a result of mechanical and biological processes, the suspended materials are in small concentrations at the exit point (treated water), with values between 6 and 14 mg/l (under the MCL limit of 35 mg/l given by NTPA 001/2005).

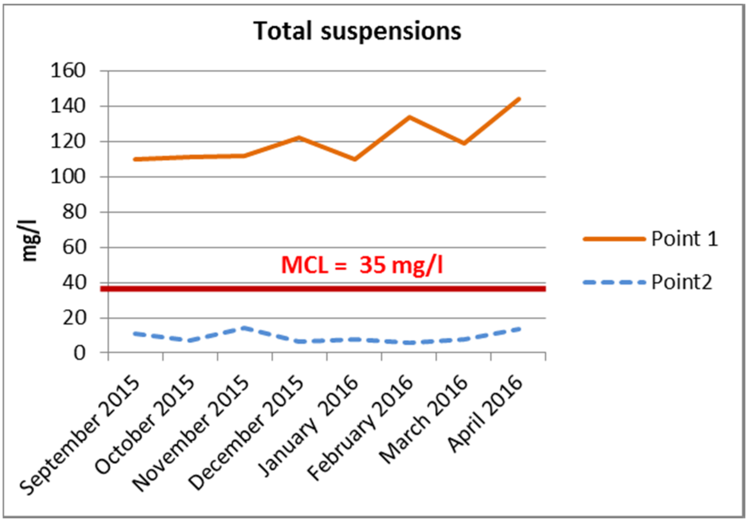


Fig. 4. *Average total suspensions values in the sampling point 1 and 2*

Ammonium values are between 25-33 mg/l at the entrance point, and after nitrification this parameter reach very low values of 0.2-0.6 mg/l at the exit point (under the MCL= 2 mg/l) (figure 5 a).

The nitrate concentrations at the entrance point are small, ranging between 3-6 mg/l due to the lack of the chemical industry in Cluj. Following the nitrification and de-nitrification processes, the nitrate concentrations at the exit point, are higher, with values ranging from 12 to17 mg/l, beneath the MCL = 25 mg/l (figure 5 b).

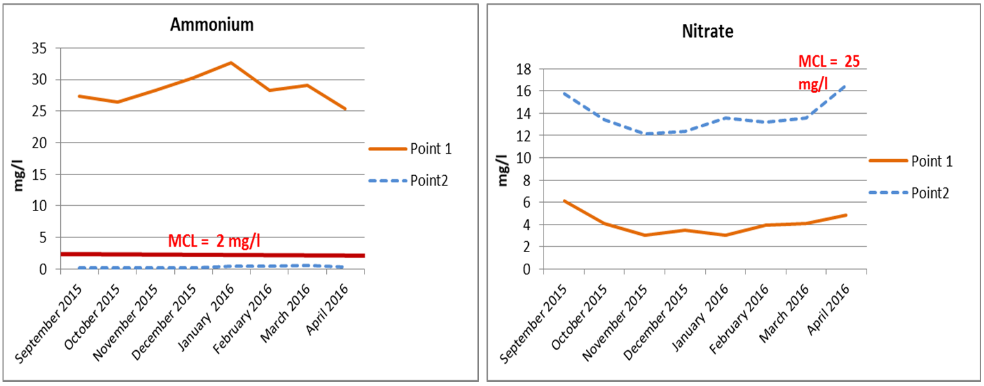


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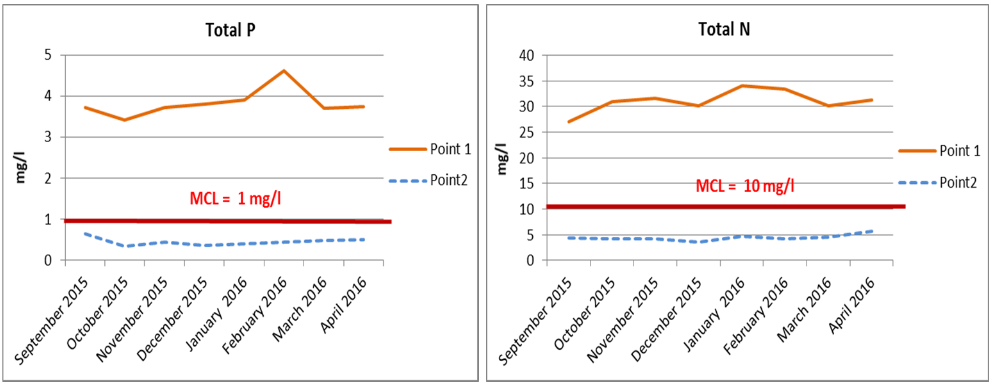
Fig. 5. *Average ammonium and nitrate values in the sampling point 1 and 2*

The concentrations of Total N and Total P decrease significantly after the treatment processes (figure 6a). At the entrance point Total N has values between 27-34 mg/l and after treatment the values drop to 4-6 mg/l, and in the case of Total P, at sampling point 1, the values were between 3-5 mg/l, and drop to 0.3-0.7 mg/l after the biological and chemical processes (figure 6b).



a b

Fig. 6. *Average Total P and N values in the sampling point 1 and 2*

CONCLUSIONS

As a result of the demographic growth and of the uncontrolled discharges of industrial wastewater or chemical pollutants from agriculture, water sources are increasingly contaminated and the amount of wastewater is increasing. Urban and industrial wastewater treatment is a necessity of a constantly developing contemporary society.

In Romania, the critical situation of the treatment plants is generated by the age of the sewage networks and of the purification systems, the modification of the treatment capacity, without its adaptation to the constructive parameters, the poor managerial capacity and the poor financial situation of the public utility operators.

Romania's accession to the European Union has implied and implies the need to solve the problems of environmental protection by modernizing the existing technologies, by creating and putting into operation of some new advanced installations and by providing services adapted to the requirements of the environmental norms.

By assessing the quality of wastewater coming from Cluj-Napoca and from the adjacent localities as well as the treated water quality, it can be concluded that all of the parameters (pH, COD(Cr), BOD_5, Total suspensions, Ammonium, Total N and P) have high values in the wastewater and after its purification the values decreases significant and are within the maximum permissible limits due to the rehabilitation of the station, by modifying its capacity and because of the new introduced technology. In the months with higher temperatures the quality of the wastewater is weaker, we have noticed that the monitored parameters are slightly higher but also the amount of wastewater increases.

On the basis of the results we can say that the efficiency of the purification processes is very good and the tertiary stage introduced in the wastewater treatment process is of high importance especially in the reduction of the phosphorus content.

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