STUDY OF THE TREATMENT PROCESS OF WASTEWATERS COLLECTED IN ORADEA

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Abstract

The subject in question is a topical one, following the line of the current innovative requirements regarding the study of wastewater treatment processes.

The main goal of this study is to analyse the chemical composition of the wastewater collected in Oradea and in the area of the effluent of its wastewater treatment plant before being discharged into Crisul Repede River.

On the course of a year, water samples were taken from the influent and the effluent of the wastewater treatment plant and analysed for major water quality parameters, such as biological oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), total nitrogen (N_t) and phosphorus (P_t).t. In order to highlight the performance of the studied wastewater treatment plants, the treatment efficiency was calculated for all analyzed parameters.

The quality of the effluent of the wastewater treatment plant in relation to the effluent discharged in the outlet (Crisul Repede River) complies with the national and international law recommendation (NTPA 001/2005).

Key words: wastewater treatment plant (WWTP), chemical characteristics, treatment efficiency

INTRODUCTION

More than ever, at the end of this millennium, humanity faces a number of global issues related to water management, its pollution, which affects the social and economic life of the planet, thus representing the common concerns whose resolution can be achieved only at a global level.

All this came into direct conflict with the limited resources of the planet and led to a number of actions at a global level to assess the situation and to establish some measures capable to reduce, if not to eliminate, the negative influences that may arise from a not too far perspective.

Generated as a result of social and industrial activities, wastewater strongly affects the environment with extreme consequences on a long term. Therefore, in order to maintain the water source in the future it is necessary to adopt suitable techniques and technologies for their treatment.

Wastewater treatment is based on a series of physical, chemical and biological processes occurring naturally in the process of self-purification of water courses. To enhance and streamline these processes, so as to achieve maximum performance at low cost prices, it is necessary to build sewage treatment plants (Harleman, Murcott, 1999).

Returning mainly at the protection of water quality, it should be mentioned that this was and still is an issue of national and international interest. The regulations in this area indicate that it is prohibited to discharge any kind of wastewater in natural receptors without a prior treatment to make it qualitatively compatible with the receiver.

Wastewater treatment aims the completion of phases in two lines) (Ionescu, 2008):

- Water line in which the retention of pollutants from wastewater takes place;

➢ Sludge line where the process of retained substances from wastewater as sludge occurs.

Romanian strategy for joining the European Union implies the necessity of solving environmental protection problems by upgrading existing technologies, by accomplishing and making operational some new and high-performance installations and by providing services tailored to environmental requirements.

The quality of wastewater that passes through all the treatment cycles can always be improved, and this improvement should be oriented towards sustainability. In wastewater treatment, as well as in other areas, sustainable objectives should be targeted in order to achieve the most efficient and legal requirements to protect natural systems, avoiding further degradation (Jetten Mike, 1997).

1. Wastewater treatment plant of Oradea

The treatment plant is located on the right side of Crisul Repede River and is designed to take over domestic and industrial wastewater in Oradea and some adjacent areas. Treatment capacity of the plant is of 2.200 l/s)(Ionescu, 2008) (Gligor., 2011)

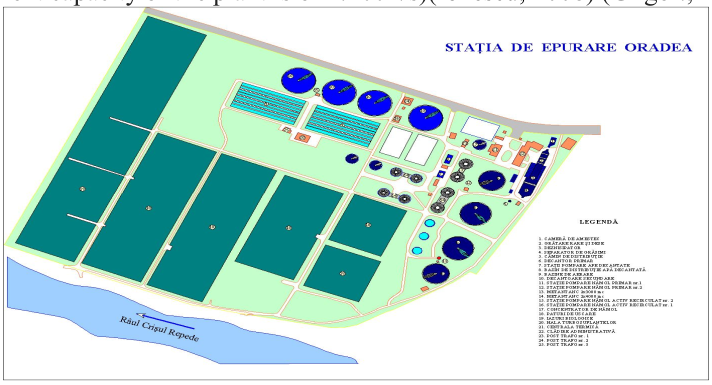

Fig. 1 Diagram of wastewater treatment plant
(http://www.apaoradea.ro/pages/statieepurare.html)

The technological flow of wastewater processing consists of the (water line):

1. The mechanical stage is meant to mechanically purify the wastewater that had entered the plant. It consists of:

- inlet chamber
- sparse and dense grills
- sand-clearing basin
- grease separator
- primary sediment trap
- primary sludge pumping station
- decanted water pumping station

2. Biological stage

- aeration tanks
- secondary sediment traps
- activated sludge pumping station
- excess sludge storage tank
- biological channel outlet station

3. Chemical stage**:**

- the decrease in Ptot < 1mg/l

MATERIAL AND METHODS

In order to accomplish the research topics related to this paper, experiments were performed in the chemical analysis laboratory within the Faculty of Environmental Protection Oradea. The water analyses focused mainly on the influent of the wastewater treatment plant and the effluent of the biological stage. Monitoring the operation of the wastewater treatment plant of the city was conducted during a calendar year, from January to December 2013.

The measured physico-chemical parameters are as follows: biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), total suspended solids (TSS), nitrogen (N_t) and phosphorus (P_t) following APHA methods (A. D. Eaton, L. A. Clesceri, 2005). COD parameter was measured using Romanian Standard Methods (SR ISO 15705/2002).

The results were compared with standardized level for wastewater quality found in accordance with European Commission (Directive European Commission Directive 98/15/EC amending Council Directive 91/271/EEC) and Romanian law (NTPA 001/2005).

RESULTS AND DISCUSSION

The data obtained by weekly analysis of the parameters: TSS, COD, BOD, total nitrogen and total phosphorus for the influent and effluent of the wastewater treatment plant were summarised as monthly average during the year 2013.

Table 1

Monitoring of TSS in the effluent of wastewater treatment plant

	Inflow wastewater treatment(mg/l)	*Outflow wastewater treatment(mg/l)*	*Treatment efficiency (%)*
January	258	24.8	90.38
February	257	33.5	86.96
March	227	31.1	86.29
April	252	32.4	87.14
May	223	29.7	86.68
June	210	21.4	89.80
July	194	26.8	86.18
August	225	25.9	88.48
September	245	24.9	89.83
October	196	21.4	89.08
November	213	24.5	88.49
December	218	24.1	88.94

The evolution of total suspensions, another significant parameter, monitored during 2013, indicates the fact these were within the permissible limit of NTPA 001/2005 (35 mg/l), the maximum level of 33.5 mg/l being reached in February while the minimum value was of 21.4 mg/l in June and October. By calculating the efficiency degree of the parameter total suspension matters, it was noticed that, during the monitoring period, they did not comply with the requirements (Directive 98/15/EC amending Council Directive 91/271/EEC) regarding the treatment effectiveness (90%) since a value of 90.39% was registered in January.

Table 2

Monitoring of COD in the effluent of wastewater treatment plant

	Inflow wastewater treatment(mg/l)	*Outflow wastewater treatment(mg/l)*	*Treatment efficiency (%)*
January	357	33.9	90.5
February	345	43.4	87.42
March	323	39.9	87.64
April	357	41.6	88.34
May	301	35.1	88.33
June	283	28.8	89.82
July	269	33.8	87.43
August	321	36.5	88.62
September	329	36.4	88.93
October	292	31.6	89.17
November	313	30.9	90.12
December	322	30.3	90.59

Chemical Oxygen Demand (COD) is a vital test for assessing the quality of effluents and wastewater prior to discharge (Vinod Kumar, A.K.Chopra, 2012). "Both organic and inorganic compounds have an effect on urban wastewater oxidability since COD represents not only oxidation of organic compounds, but also the oxidative of reductive inorganic compounds" (Paula Popa et al., 2012).

In this study the O.COD value is smaller than the maximum accepted value (125 mg/l) of European and Romanian Law (NTPA 001/2005) (O.COD = 125 mg/l). Similar results were obtained by Paula Popa et al., 2012 and Vinod Kumar, A.K.Chopra, 2012. The efficiency of the wastewater treatment process allows ensuring a high efficiency with values ranging from 87.42% and 90.59% (the recommendations of the Directive 98/15/EC amending Council Directive 91/271/EEC being of 75%).

Table 3

Monitoring of BOD in the effluent of wastewater treatment plant

	Inflow wastewater treatment(mg/l)	*Outflow Wastewater treatment(mg/l)*	*Treatment efficiency (%)*
January	269	19.70	92.67
February	232	22.9	90.12
March	226	16.40	92.74
April	240	22.10	90.79
May	204	22.40	89.01
June	178	13.1	92.64
July	186	18.7	89.94
August	209	19.3	90.76
September	224	15.7	92.99
October	238	14.9	93.73
November	183	10.3	94.37
December	216	9.95	95.39

As a significant indicator of the domestic wastewater treatment processes, the biochemical oxygen intake shows, for the effluent of the aerobic basin, values below the limit allowed (of 25 mg/l) for each of the months of 2013, reaching a maximum level of 22.40 mg/l in May and a minimum level of 9.95 mg/l in December. Using the activated sludge basins during the biological stage provided a treatment efficiency of 89.01% (in May) and 95.39% (in December) in relation to BOD concentration.

Table 4

Monitoring of total phosphorus in the effluent of wastewater treatment plant

	Inflow wastewater treatment(mg/l)	*Outflow wastewater treatment (mg/l)*	*Treatment efficiency (%)*
January	4.37	0.328	92.49
February	3.95	0.380	90.37
March	3.74	0.357	90.45
April	3.57	0.566	84.14
May	3.88	0.438	88.71
June	3.34	0.294	91.19
July	4.09	0.499	87.79
August	4.14	0.413	90.02
September	3.59	0.752	79.05
October	4.67	0.962	79.40
November	3.70	0.690	81.35
December	3.29	0.402	87.78

From the data presented above regarding the constant monitoring of phosphorus, one can notice that the values recorded in 2013 were within the permissible limits of NTPA 001/2005 (1 mg/l), for the effluent of the treatment plant, with a minimum value of 0.94 mg/l in June and a maximum one of 0.962 mg/l in October.

Table 5

Monitoring of total nitrogen in the effluent of wastewater treatment plant

	Inflow wastewater treatment	*Outflow Wastewater treatment*	*Treatment efficiency (%)*
January	30.0	5.73	80.9
February	39.2	9.28	76.32
March	29.1	7.42	74.5
April	15.5	6.75	56.45
May	34.8	7.10	79.59
June	34.0	6.25	81.16
July	31.5	7.24	77.01
August	21.8	6.42	70.55
September	37.5	8.09	78.42
October	37.0	8.32	77.51
November	31.7	7.70	75.7
December	30.0	5.73	80.9

By monitoring the total nitrogen, it turned out that, during 2013, the effluent of the activated sludge basin had values below the legislation limits (10 mg/l), the highest value reached for the aerobic basin effluent was of 9.28 mg/l in February and the lowest one was of 5.73 mg/l in December. With reference to the effectiveness of the total nitrogen parameter in 2013 one can notice the fact that it did not comply with the legislation entirely (70-80%), thus a minimum value of 56.45% was recorded in April and 81.6% efficiency was reached in June.

CONCLUSIONS

The wastewaters treatment cycles can always be improved and this improvement should be oriented towards sustainability. Wastewater treatment technologies must respond to the challenges of sustainable development: water shortage, the conservation of water resources, steady growth of population and wastewater treatment costs, which represent increasingly stringent regulations regarding environmental protection.

In the present paper we have analysed the variation of the main chemical parameters (TSS, COD, BOD, N_t, P_t) of the influent and effluent of the wastewater treatment plant in Oradea. Within the wastewater treatment plant of the city we found out that the adopted technology allows obtaining an effluent whose characteristics comply with the regulations on outlet water discharge (NTPA 001/2005). The effectiveness of the treatment system for the parameters COD, BOD, N_t, P_t meet the national and international requirements, except for the parameter TSS (in most cases, the treatment efficiency was less than 90%) (Directive 98/15/EC of 27 February 1998).

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