Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 19, Issue 2, 2019
PRINT ISSN 2284-7995, E-ISSN 2285-3952

DEGREE OF WASTE WATER TREATMENT DISCHARGED INTO BORCEA BRANCH

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Abstract

Waste water quality indicators can provide information on the degree of pollution that waste water can have on the rivers where they are discharged. In this study I tried to analyze the quality of the waste water with significant contribution to the pollutants that reach Borcea branch, coming from Călărași Municipality Waste Water Treatment Station. Waste water quality indicators, which can suggest their purification, were: chemical oxygen consume, biochemical oxygen consume, total nitrogen, total phosphorus and suspended solids. The analyzed water quality indicators are included in the limits imposed by the norms in force, namely NTPA 001, but sometimes, because of the thermal regime, with oscillating temperatures and humidity, nitrogen and phosphorus exceed the limits. In the cold seasons of the year, there is a poor functioning of the biological step, leading to a low nutritional nitrogen pollution of Borcea branch. The efficiency of the treatment station, analyzed for the five indicators is good, ranging from 74.78% to 95.24%.

Key words**:** *biological step, efficiency, quality indicator, wastewater treatment, treated waste*

INTRODUCTION

Waste water treatment is the set of physical, chemical, biological and bacteriological processes, which reduces the loading in organic and inorganic pollutants as well as in bacteria for the purpose of environment protection [12]. Waste water treatment requires the use of some advanced treatment processes in treatment plants that use modern, reliable and efficient technologies and equipment to reduce the amount of chemical or microbiological impurities so that these waters meet the quality parameters of the natural waters. Following the physical-mechanical, chemical and biological purification, it results treated water and mud which are then processed to obtain thermal energy.

Treatment methods are classified according to the phenomena based on three categories [10]: physical or mechanical, biological and chemical. The combination of these three treatment phases was designed to achieve increased efficiency to remove the existing impurities, to achieve the parameters recommended by the rules in force and to render them in the surface water circuit. Effective waste water management is essential for maintaining the ecosystem integrity, improving the environment and preserving water quality so that both global and national attention is being given to increase attention to environment protection and synoptic surveillance of the changes in its quality.

About 3,600 million m^3 of water is discharged annually, of which 53% is waste water to be treated [5]. From the total volume of waste water requiring treatment, namely 1,867 million m^3/year, only 561 million m^3/ year were properly treated, namely 30%; 33.13% are un treated waste water and 37% insufficiently treated waste, so nearly 70% of the waste water reached natural receptors, especially rivers, untreated or insufficiently treated.

The average amount of organic substances in domestic water is about 100 g/day/man and contains 1 - 2% phosphorus and 5-10% nitrogen. The emissions of nutrients are 3-4 kg /year/inhabitant for nitrogen and 0.6 - 0.7 kg/ year/inhabitant for phosphorus. The treatment stations provide 90% a removal of organic layer (in primary and secondary), but

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PRINT ISSN 2284-7995, E-ISSN 2285-3952

in the case of nutrients, the efficiency is about 30%.

Reached the surface waters, the residual content of nutrients can lead by photosynthesis to form new organic compounds. By means of sedimentation, mineralization and resolubilization processes, the nutrients can form up to 140 g of organic substance/man. When compared to the 90 g/man removed by conventional treatment technologies, it can be seen that without an additional step of nitrogen and phosphorus removal, these technologies are ineffective [6]

The most important water resources of Calarasi county are Borcea branch and, of course, the Danube River. Over time, these waters were polluted by the waste water that has reached them. Consequently, it is very important to estimate the current impact of these waste waters on the two surface waters.

In recent years, Calarasi county has made great steps in infrastructure development in the water and wastewater sector. The “Master Plan” was elaborated, identifying the necessary investments for the infrastructure development, phased over 20 years, until 2026.

MATERIALS AND METHODS

In this paper we analyzed: the treatment technology used in Călăraşi Waste Water Treatment Station, loading of waste water from Călăraşi with pollutants, the efficiency in the treatment of waste water at the station, and last but not least, the quality of the water discharged into the emissary (Borcea branch) then into the Danube.

The data collected come from Călăraşi Agency for Environment Protection, which analyzes physically and chemically the waste water that reaches the emissary.

The length of the water supply network in Călăraşi county is as follows [2]: in the urban area, the length of the water supply network is 269.90 km (connecting 83,863 inhabitants, namely 66.98% of the total population); in the rural area, the water supply network is 936.2 km long (serving 119,223 inhabitants, namely 62.3% of the total population).

The population served in Călăraşi is 70,152 inhabitants (97%), the source being the Danube River, through a distribution network of 138.65 km length. There are network losses of 53m^3/ day and the population counting is 86.49% [1].

Starting with 2012, following the implementation of the European project “Extension and rehabilitation of water supply and sewerage systems in Călărași county”, co-financed by the Cohesion Fund under the “Environment” Sector Operational Programme, Călărași county has an efficient Waste Water Treatment Station, which observe the standards of the European Union.

Fig. 1. Călărași Treatment Station
Source of data: Călăraşi Treatment Station.

The technological process of sewage treatment at Călărași Waste Water Treatment Station consists of three stages: mechanical, biological and chemical. The mud treatment and its fermentation are followed, obtaining biogas. Two anaerobic fermentation tanks with a volume of 1,200 m^3 each are available for mud fermentation. The retention time of the mechanically thickened mud in the fermentation tanks is about 20 days. The calculation temperature is about 36^{o}C.

Călărași Waste Water Treatment Station is designed to operate with a water flow of maximum 21.800 m^3 per day and respectively 7,957,000 m^3/year. The influent waste water at Călărași Waste Water Treatment Station, come from the population, from the companies, public spaces, losses, infiltrations.

Treatment degree (GE) is defined as the efficiency achieved by the treatment station in the percentage reduction, of a part of the

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pollutants in the waste water, so that the part remaining in the treated water represents the admissible limit value [11].

According to the definition, the treatment degree is established with the relation:

GE = (Ci-Cf)/Ci * 100 where:

Ci - represents the initial concentration of the influent indicator in the waste water (mg/l);

Cf – value of final concentration (effluent) of the same indicator after waste water treatment (mg/l).

In order to estimate the degree of waste water treatment entering Borcea branch, we analyzed in this paper, during 2018, the variation of the most important qualitative parameters of the waste water discharged. These were: total nitrogen, total phosphorus, suspended solids, biochemical and chemical oxygen consumption.

They were compared to the maximum admissible value according to NTPA001 [4].

RESULTS AND DISCUSSIONS

During 2018, the variations of waste water influent indicators and the effluent resulted from the discharge to Treatment Station recorded the following variation which shown in Table 1.

Table 1. Biochemical and chemical consumption of oxygen in the waste water and treated in Calarasi Treatment Station, in 2018

Period	CBO_5 (mg/l)		CCO-Cr (mg/l)	
	Infl.	Efl.	Infl.	Efl.
01	176.84	6.63	333.94	38.45
02	178.98	10.12	326.36	47.76
03	180.23	9.51	342.28	47.76
04	169.44	6.62	279.24	36.62
05	157.59	5.58	305.03	30.80
06	148.70	5.37	307.31	43.51
07	150.11	5.77	279.73	34.18
08	139.81	3.22	320.52	38.06
09	145.90	4.31	268.08	37.76
10	161.35	5.03	277.32	40.18
11	199.01	4.79	278.93	31.52
12	182.56	4.55	241.96	26.50
Annual average 2018	**125.05**	**5.95**	**296.72**	**37.75**
G.E.	**95.24%**		**87.27%**	

Source: Călăraşi Treatment Station (database)

We can see in Table 1 that the efficiency of Treatment Station regarding the two parameters is over 87%.

Table 2. Total nitrogen, total phosphorus and suspended solids in the waste water and treated in Calarasi Treatment Station, in 2018

Period	Ntot (mg/l)		Ptot (mg/l)		SS (mg/l)	
	Infl.	Efl.	Infl.	Efl.	Infl.	Efl.
01	45.42	5.84	4.30	0.94	199.68	22.41
02	43.06	16.45	4.10	1.13	187.04	27.29
03	42.91	20.13	3.79	0.30	188.34	26.16
04	38.20	7.26	4.30	0.32	201.31	30.66
05	36.05	7.94	4.58	0.59	193.89	30.55
06	41.80	9.00	4.50	0.46	197.45	26.96
07	40.80	9.03	4.42	0.66	207.52	31.52
08	50.01	10.6	5.12	2.55	205.78	25.79
09	46.41	8.17	5.02	1.79	199.02	24.26
10	39.88	9.95	4.97	1.93	222.25	23.19
11	37.94	7.95	4.85	1.40	197.03	23.23
12	32.09	6.34	4.79	1.82	195.77	22.77
Annual average 2018	**41.21**	**9.88**	**4.56**	**1.15**	**199.59**	**26.23**
G.E.	**76.02%**		**74.78%**		**86.85%**	

Source: Călăraşi Treatment Station (database)

From Table 2 we can see that the nutrient loading (nitrogen and phosphorus) of the discharged waste water is higher, the efficiency of the station being 76.2% for nitrogen and 74.78% for phosphorus. A much better treatment degree is observed for solids in suspension (86.85%).

The concentrations of the influent load parameters of Călărasi Waste Water Treatment Station are: CBO_5 - 275 mg/l; CCO-Cr - 410 mg/l, Ntot - 46 mg/l, Ptot – 7 mg/l; SS – 320 mg/l [3].

Analyzing the biochemical oxygen consumption (CBO_5) in the water evacuated to the emissary in 2018, we noticed the evolution which is presented in Fig.2.

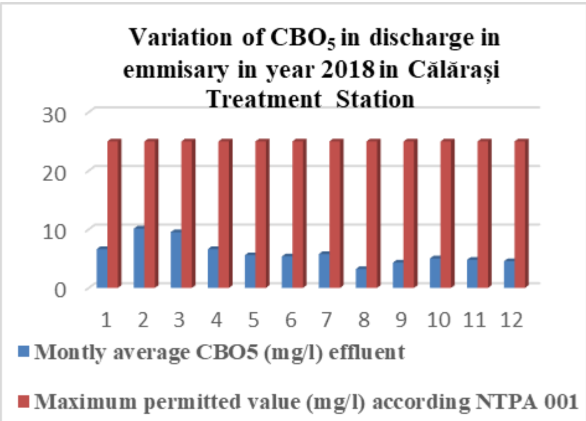

Fig. 2. Variation of CBO_5 in discharge into emissary in year 2018, in Călăraşi Treatment Station
Source: Călăraşi Treatment Station (database)

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 19, Issue 2, 2019
PRINT ISSN 2284-7995, E-ISSN 2285-3952

According to the data in Table 1 and Figure 2, you may note that the highest value of CBO_5 effluent was in February 2018 (10.12 mg/l).

The quite large variation in biochemical oxygen consumption during 2018 can be attributed to the influent flow or the variable weather conditions recorded. However, the values of this parameter were well below the maximum admitted by NTPA001 (25mg/l).

The evolution of the chemical consumption of oxygen during the analyzed period is shown in Fig.3.

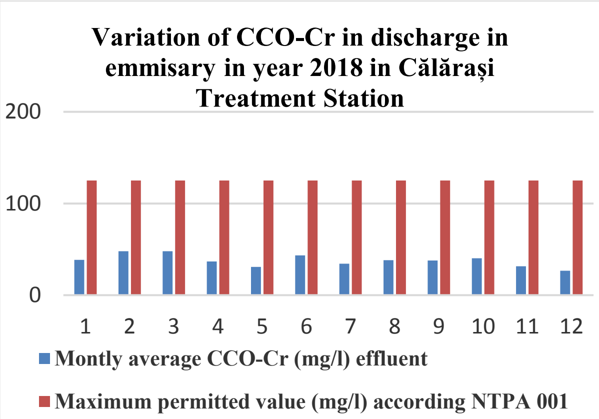

Fig. 3. Variation of CCO-Cr in discharge into emissary in year 2018 in Călăraşi Treatment Station
Source: Călăraşi Treatment Station (database)

In the case of the chemical consumption of oxygen effluent emission in the emissary (CCO-Cr), as shown in fig. 3, its values fluctuated in 2018, the highest value being recorded in February and March, namely 47.76 mg/l, but this is well below the limit required by NTPA001 (125 mg/l).

The total nitrogen values (Ntot) effluent in the emissary, recorded in 2018 the levels shown in Fig.4.

We can see in Figure 4 the exceeding of the total nitrogen values (15 mg/l) in February and March, with 1.45 mg/l (9.66%) and respectively 5.13 mg/l (34.2%). Certainly, this exceeding may be due to too low temperature of the waste water at the entrance to the Waste Water Treatment Station (average temperature 6-7^{0}C, min. 3-4^{0}C). Increasing the concentration of nitrogen in the effluent can be attributed to the decrease in the intensity of the biological processes (which at these temperatures are largely slowed down) and thus, to a decrease in the biodegradation efficiency of the organic compounds. [9]

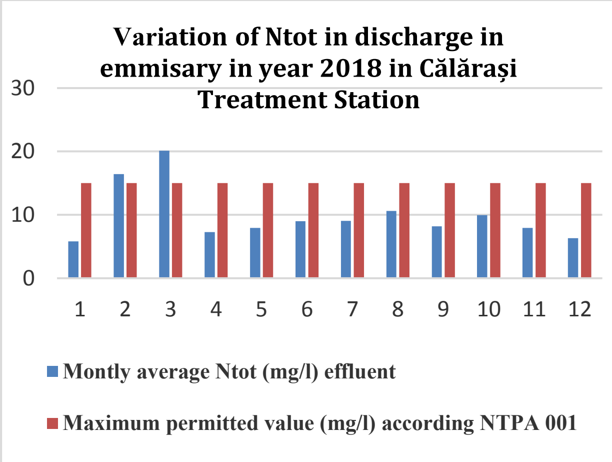

Fig. 4. Variation of Ntot in discharge into emissary in year 2018, in Călăraşi Treatment Station
Source: Călăraşi Treatment Station (database)

Regarding the phosphorus content of the treated water in Calarasi Waste Water Treatment Station, its dynamics is presented in Fig.5.

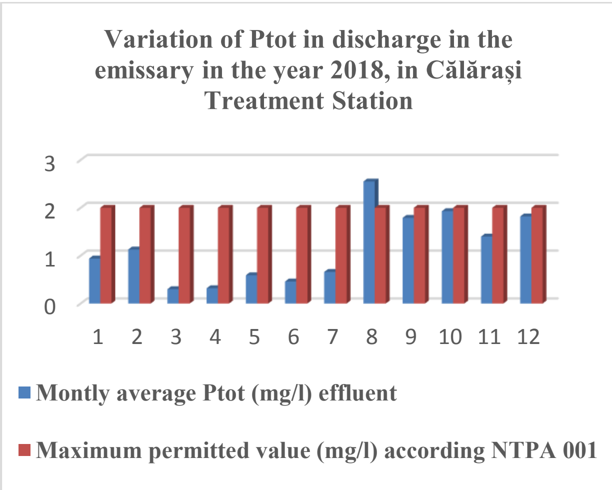

Fig. 5. Variation of Ptot in discharge in emissary in year 2018, in Călăraşi Treatment Station
Source: Călăraşi Treatment Station (database)

The amount of total phosphorus evacuated in the emissary in 2018, as seen in Figure 5, exceeds the maximum admissible value according to NTPA001 of 2 mg/l in August 2018 by 0.55 mg/l (27.5%).

The increased value in August 2018 is due to the increase of the influent flow, but the concentration of the waste water was weaker, thus, the microorganisms, with insufficient

consumption substance, the biological process of phosphorus removal was negatively influenced [8].
Regarding the solid particles in suspension, during the studied period they recorded the variation presented in Fig.6.

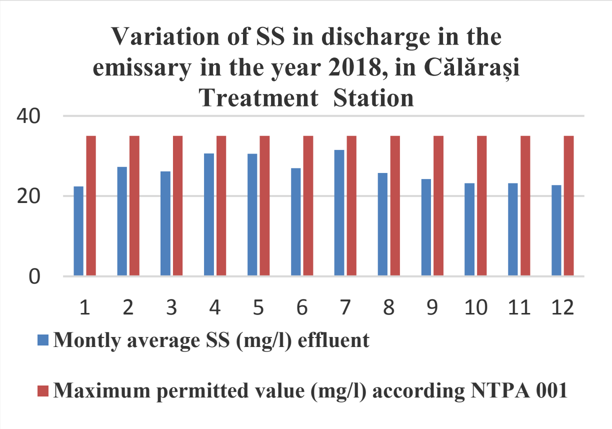

Fig.6.Variation of SS in discharge in emissary in the year 2018 in Calarasi Treatment Station.
Source: Calarasi Treatment Station Database.

Solids in suspension evacuated in the emissary in 2018 record oscillating values, the highest level being in July (31.52mg/l), as we can see in figure 6, but it is within the maximum admissible value according to NTPA001, of 35 mg/l.

CONCLUSIONS

The study elaborated in Călăraşi Waste Water Treatment Station on the main indicators responsible for the quality of treated and discharged waters, namely the biochemical oxygen consumption (CBO_5), the chemical oxygen consumption by oxidation (CCO-Cr), the total nitrogen (N_{tot}), the total phosphorus P_{tot}), solids in suspension (SS), aimed at highlighting the level of waste water contamination in Călăraşi county.
The main nutrients that cause eutrophication are ***phosphates*** and ***nitrates***. Nitrates come from agriculture and animal breeding, and phosphates mainly from detergents, from chemicals used to combat corrosion. Other sources of origin are: transport, population or mud resulting from waste water treatment and deposited on the soil.

Based on the analysis carried out, we can conclude the following:
- over 2018, the real loading of the station influent is lower than the designed one, as follows:
➢ biochemical oxygen consumption (CBO_5) by 55%;
➢chemical oxygen consumption by oxidation (CCO-Cr) by 28%;
➢ total nitrogen (N_{tot}) by 10%;
➢ total phosphorus (P_{tot}) by 35%;
➢ solids in suspension (SS) by 38%.
- the quality indicators of the waste water at the entrance to the station are within the limits required by the current legislation on the quality of the waste water discharged into the sewerage network or directly into the treatment station.
- the quality indicators of waste water discharged into the emissary are within the limits required by the norms in force, respectively NTPA 001, except for total nitrogen in February-March 2018 and total phosphorus in August 2018.
- the efficiency of the treatment station analyzed for the five indicators is good, varying from 74.78% to 95.24%.
- the difficult operation of the biological step in the winter months due to the too low temperature of the waste water entering the Waste Water Treatment Station, which leads to the reduction of the biodegradation efficiency of all organic compounds and thus to the increase of the nutrient concentration in the effluent: nitrogen and phosphorus - knowing that they are the basis of eutrophication. [7]
- during the cold periods, a malfunctioning of the biological step is recorded with the following consequences: heavier fermentation of the mud, high energy consumption, production of a smaller amount of biogas.
Călărași Waste Water Treatment Station operates on the basis of mechanical, chemical and biological processes, as well as mud treatment and fermentation processes in order to obtain biogas and fertilizer for agriculture.
The smooth running of these processes must be ensured by conscious exploitation and maintenance.

In order to preserve the quality of surface water, it is essential to evacuate chemical wastewater, without nutrients. Only in this way the integrity of ecosystems and a clean environment can be maintained.

A solution for the problems identified in Călărași Waste water Treatment Station would be the production during the cold season of a higher amount of biogas and electricity from the resulting organic mud - by stimulating the biological step, with the inoculation of microorganisms.

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