WASTEWATER MANAGEMENT IN THE DUMBRĂVENI WASTEWATER TREATMENT PLANT, SIBIU COUNTY, IN THE CONDITIONS OF 2021

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Abstract. Environmental policy assigns an important role to water management, given both the protection of natural resources and the reduction of environmental impact. Wastewater management is based on the following principles: minimizing wastewater generation, wastewater must be recirculated to reduce costs, wastewater can be recirculated by separation and treatment for reuse and recirculation of treated products (both water and oil). Within the Wastewater Treatment Plant from Dumbrăveni, Sibiu County, wastewater treatment is performed through the most appropriate technologies, minimizing reuse / recirculation, and minimizing the cost of operations. Through this paper and following the analyses performed on samples collected during January-August 2021, we concluded that moderate loads of the influent lead to a treatment efficiency of 94.35% in the analysed wastewater plant.

Keywords: wastewater, monitoring, management, Dumbrăveni, Sibiu County.

Rezumat. Gestionarea apelor uzate în stația de epurare Dumbrăveni, județul Sibiu, în condițiile anului 2021. Politica de mediu a județului Sibiu acordă un rol important managementului apelor, având în vedere atât protecția resurselor naturale, cât și reducerea impactului asupra mediului. Managementul apelor uzate în județul Sibiu se bazează pe următoarele principii: minimizarea generării de ape uzate, apele uzate trebuie recirculate pentru reducerea costurilor, apele uzate pot fi recirculate prin separarea și tratarea în vederea reutilizării lor și recircularea produșilor tratați (atât ape, cât și uleiuri). În cadrul Stației de Tratare a Apelor Uzate de la Dumbrăveni, județul Sibiu, tratamentul apelor uzate se realizează prin intermediul celor mai adecvate tehnologii, minimizând reutilizarea/recircularea și minimizând costul operațiilor. Prin intermediul prezentei lucrări și în urma analizelor efectuate pe probe recoltate în intervalul de timp cuprins între lunile ianuarie-august ale anului 2021, am ajuns la concluzia că încărcările moderate ale influentului conduc la o eficiență de epurare de 94,35% in cadrul stație de epurare analizate.

Cuvinte cheie: stație de epurare, monitorizare, management, Dumbrăveni, județul Sibiu.

INTRODUCTION

Wastewater comes from loading natural water with materials and substances that change its quality indicators and pollute it (TOBOLCEA & UNGUREANU, 1993; VARDUCA, 2000; HAIDUC & BOBOȘ, 2005). The water is loaded with pollutants for various practical reasons and from the contact of meteoric waters (rain, snow) with products of human activity, which are found in the air and soil.

Wastewater is water used for domestic or industrial needs and which, due to added impurities, has changed its original chemical composition or physical properties (NEGULESCU, 1975; ROJANSCHI V. 1995; ROJANSCHI & OGNEAN, 1997; VARDUCA, 1999; IANCULESCU et al., 2001; NICOLESCU, 2002; VARDUCA et al., 2002; ROBESCU et al., 2004). The same category includes water that drains from urban areas, industrial areas and agricultural fields, following the fall of atmospheric precipitation. These waters are treated in specially designed and built stations, so that the treated water can be released in nature (usually in an emissary, but there are cases where this water is discharged into grassy areas) (TEODORESCU, 1973; ***. WTW Method Ntot. 1995; ***. 2001. MAPM Order no. 377; ***. 2001. MAPM Order no. 913; IONESCU, 2002; ***. 2008. Ministry of Environment and Water Management).

The Dumbrăveni wastewater treatment plant (Fig. 1) has the role of mechanical-biological treatment, with rotating biological contactors, to clean the wastewater collected from the sewerage network, from pollutants and impurities, in order to be returned clean into the natural circuit.

Figure 1. Dumbrăveni wastewater treatment plant (original).

The sewage treatment plant of Dumbrăveni was designed for a relatively small number of inhabitants. The organic load for which the treatment plant is dimensioned is the one corresponding to 7100 E.I and aims to eliminate the organic matter and those in suspension. The collection, treatment, and discharge of wastewater by the Dumbrăveni Water Treatment Plant is done in compliance with Romanian and European Union (EU) standards, in accordance with the national compliance plan.

The present paper aimed at analysing the parameters of wastewater from the wastewater treatment plant in Dumbrăveni, Sibiu County. To carry out the study, average samples of wastewater were taken from the station and processed, collected with an hourly frequency of 8 hours, in a time interval of three months: January-August 2021. Sampling was done in accordance with the provisions of the standard on wastewater sampling (SR ISO 5667-10/1992- Water quality).

To follow the quality parameters of the effluent and phosphorus, the values obtained from the analyses were compared with the maximum permissible values in accordance with the norms regarding the establishment of pollutant loading limits of industrial and urban waters, at the discharge in natural receptors and in networks, sewerage/treatment plants (GD no. 188/2002 amended and supplemented by GD no. 352/2005), the values of the substances will not exceed the maximum allowed limits (***. 1991. SR ISO 5815; ***. 1996. SR ISO 6060; ***. 2000. SR ISO 7890- 3; ***. 2001. SR ISO 7150-1; ***. 2002. SR EN 26777; ***. 2009. SR EN 872).

The values obtained during the study were compared with the average values of the influent and effluent parameters, from the analysis data from the time interval between January-August 2021.

MATERIALS AND METHODS

The technological process from the Dumbrăveni Wastewater Treatment Plant involves water treatment by passing it successively through the following compartments: pre-treatment, mechanical treatment, biological treatment with rotating biological contactors and sludge treatment. For a permanent monitoring of the water within the Dumbrăveni Wastewater Treatment Plant, we performed physical chemical analyses of the wastewater within the wastewater analysis laboratory. During the determinations, physical and chemical methods provided in the internal and external standards and normative acts in force were used.

In the present study in the time interval between June-August of 2021, the relevant physical-chemical parameters for the efficiency of the station operation were determined, following the following parameters: CCO-Cr, CBO_5, ammoniacal nitrogen, total phosphorus, suspended solids.

To perform the laboratory analyses, samples were taken in polyethylene containers, the volume taken in the analysis being two litres of wastewater. The vials were filled to the brim to limit the contact of the sample with the gas phase and to reduce agitation during transport. Closing the sealed plug thus avoids several transformations that may occur in the sample, such as: change in carbon dioxide content, pH variations, hydrogen carbonates do not turn into insoluble carbonates, iron (II) has less tendency to oxidize, the tendency to change colour decreases.

The identification system has been designed and constructed in such a way as to ensure that the sample cannot be confused physically or in records, starting with the sample and throughout its storage in the laboratory for analysis. The sampling vials and the working glassware were marked with figures which, from the time of sampling, corresponded to the various samples. These identifying elements were further found in the records of the work stages.

Samples were received based on the accompanying sampling notes. At the reception, the following were considered: the integrity of the sample, its correct identification, whether the container containing the sample is appropriate. The handling of the samples was done avoiding the possibility of impurity or their chemical contamination. The samples were stored in the refrigerator, when the laboratory programme did not allow their immediate analysis. Sampling and preservation of samples was done in the laboratory.

RESULTS AND DISCUSSIONS

Chemical oxygen consumption, COD, of water was determined by the potassium dichromate method, considered as an approximate measure of the theoretical oxygen consumption, which represents the amount of oxygen consumed by total chemical oxidation of organic compounds to inorganic products. The method was applied to samples whose CCO was between 30 m/l and 700 mg/l. In the analyses, the chloride content did not exceed 1000 mg/l.

Biochemical oxygen consumption after 5 days represented the mass concentration of dissolved oxygen consumed under specified conditions, by biochemical oxidation of organic and/or inorganic substances in water. In the analysis we balanced the water sample at a temperature of 20°C. Incubation was performed at a temperature of 20°C for a period of 5 days, in the dark, in filled and sealed vials.

We determined the dissolved oxygen concentration before and after incubation and calculated the mass of oxygen consumed relative to one litre of analysed sample (***. 2002. SR EN 26777; ***. 2008. SR EN ISO 6878).

The determination of ammoniacal nitrogen was carried out by spectrophotometric measurement at about 650 nm of the coloured compound formed by the reaction of ammonium with salicylate and hypochlorite ions in the presence of sodium nitrosopentacyanoferrate (III) (sodium nitroprusside), we applied the method for ammonium

concentrations up to 1mg/l ammoniacal nitrogen. At higher concentrations we took a smaller amount of the sample to be analysed.

The determination of total phosphorus was the result of the reaction of orthophosphate ions with an acidic solution containing molybdate and antimony ions to form the antimony-phosphomolybdate complex (***. 2008. SR EN ISO 6878). The reduction of this complex with ascorbic acid forms an intense blue molybdenum complex. The absorbance of this complex was measured in order to determine the concentration in the orthophosphates present. Polyphosphates and certain organophosphorus compounds are determined after transformation, by hydrolysis with sulfuric acid, into orthophosphates which react with molybdate (***. 2002. Government Decision no. 188/MO no. 187; ***. 1996. Water Law no. 107**)**.

Many organophosphorus compounds are converted to orthophosphates by persulfate mineralization. Mineralization with nitric acid and sulfuric acid is used if a more vigorous treatment is required (***. 2000. SR ISO 7890- 3). Orthophosphate ions react in acidic medium with ammonium molybdate and antimony and potassium tartrate to form an antimony phosphomolybdenum complex, which is reduced by ascorbic acid to form a strong, blue-coloured molybdenum complex, whose absorbance is measured photometrically at 880 nm. Total phosphorus was determined after transformation into orthophosphates by strongly acidic (sulfonitric) mineralization. Phosphorus concentrations between 0.005 mg /l and 0.8 mg/l can be determined without diluting the samples. The method was applied to determine the solids content in the wastewater from the studied treatment plant.

Determination of the total suspended solids content (MTS). The water probe was filtered using a vacuum or pressure filter device, through a glass fibre filter. The filter is then dried at 105°C±2°C and the mass of the residue retained on the filter is determined by weighing. The lower limit of determination is approximately 2 mg/l (Fig. 2).

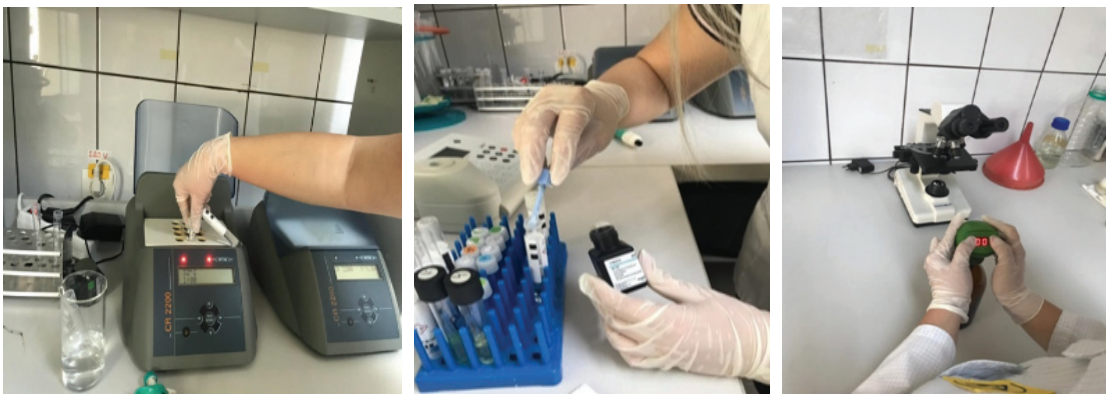

Figure 2. Determination of quality indicators (original).

It is observed that at SEAU Dumbrăveni the values of ammonium ion concentration in the effluent are, in recent years, quite close to the CMA value.

At the same time, it should be noted that a limit value for phosphorus (2 mg/l) only appears in NTPA 001, which must be considered in the continued operation of the treatment plant.

Table 1 presents the values of the main chemical parameters of the influent and the effluent resulting from the laboratory analyses of the wastewater from the Dumbrăveni Wastewater Treatment Plant.

Table 1. Average values of chemical indicators of wastewater and treatment - SEAU Dumbrăveni in 2021 January – August.

Year	**COD mg O_2/l**		**CBO_5 mg O_2/l**		**NH_4 mg/l**		**P-total mg/l**		**MTS mg/l**	
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
January	213.89	47.70	147.50	12.50	78.66	4.19	9.85	4.61	207.50	1.20
February	312.37	60.81	170.00	17.50	59.20	10.61	9.20	4.55	250.13	1.51
March	299.36	48.07	175.00	12.50	56.94	3.90	6.86	4.48	216.75	2.57
April	416.16	29.06	240.00	8.67	37.03	3.07	4.14	1.49	286.18	2.46
May	499.70	57.72	287.50	13.75	89.28	2.68	8.54	2.20	146.65	2.34
June	*401.33*	*48.77*	*230.00*	*14.33*	*76.04*	*2.53*	*10.04*	*4.11*	*68.96*	*2.61*
July	*383.83*	*53.55*	*222.50*	*12.50*	*79.25*	*2.67*	*11.59*	*3.38*	*87.31*	*2.27*
August	*351.20*	*43.10*	*220.00*	*11.50*	*93.65*	*2.55*	*8.90*	*4.18*	*127.66*	*1.60*
Average	**359,66**	**48,59**	**211,56**	**12,90**	**71,25**	**4,02**	**8,64**	**3,62**	**173,89**	**2,07**
MPC	-	**125**	-	**25**	-	**3**	-	-	-	**35**
NTPA 001	-	**125**	-	**25**	-	**3**	-	**2**	-	**35**

The analysis of the genotypes under very different climatic conditions, allows to identify possible genotypes with a good general adaptation capacity. Thus, the lines To 2027/10 and To 2208/02 show a high yield capacity and a good adaptability to the various environmental conditions. In addition to these lines, we can mention the reselection of the Jubilee variety, which in favourable areas to the spring barley crop can produce high yields quantitatively.

From the results obtained in table 1 and figure 3, we notice that following the dosing of the ferric chloride precipitate 40% and in 2021 in the technological process of the Dumbrăveni treatment plant, the values of ammonium ion and total phosphorus concentration have been close to CMA and NTPA 001 respectively.

To follow the quality parameters of the effluent and phosphorus, the values obtained from the analyses were compared with the maximum permissible values in accordance with the norms regarding the establishment of pollutant loading limits of industrial and urban waters, at the discharge in natural receptors and in networks sewerage/treatment plants (GD no. 188/2002 amended and supplemented by GD no. 352/2005), the values of the substances will not exceed the maximum allowed limits.

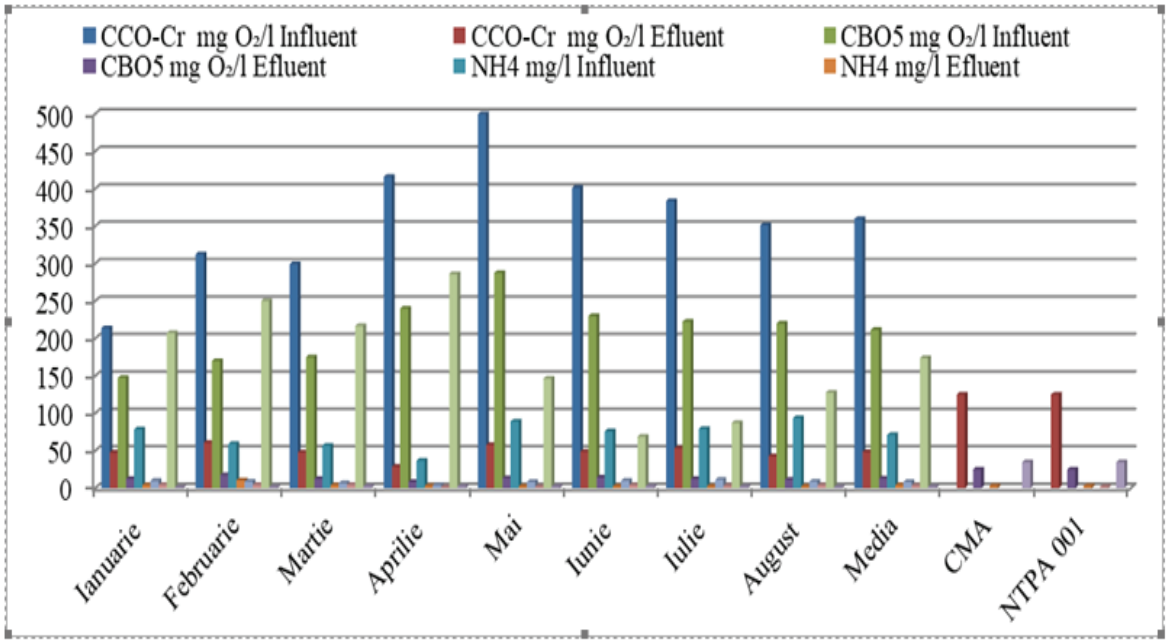

Figure 3. The evolution of quality indicators during January-August 2021.

This way of presenting the results allows both the immediate comparison of the parameters of water entry and exit in the station, and the calculation of the treatment efficiency, considering these parameters, according to the formula:

$$\text{Treatment efficiency} = \frac{C_i - C_f}{C_i} \times 100 \quad (\%)$$

Where:

C_i = initial value of the parameter considered (influent)

C_f = initial value of the parameter considered (effluent)

Considering the indicators that were frequently monitored according to the water management authorization and calculating the average of the monitored period, table 2 presents the values of the efficiency of ammoniacal nitrogen and phosphorus treatment, at SEAU Dumbrăveni.

Table 2. Comparative values regarding the quality of the influent and effluent at the Dumbrăveni Wastewater Treatment Plant, during January-August 2021

Indicator, mg/l	**Average load Influent**	**Average load Efluent**	**Regulated loading HG no. 352/2005**
COD	359,66	48,59	125
CBO_5	211,56	12,90	25
Ammoniacal nitrogen	**71,25**	**4,02**	**3**
Total phosphorus	**8,64**	**3,62**	**2**
TSM	173,89	2,07	35
Treatment efficiency, N ammoniacal	94,35 %		
Treatment efficiency, P - total	58,10%		

Currently, the moderate loads of influent, which can be seen as a large effect of the monitoring of economic agents and drained domestic wastewater discharged into the sewerage network in the treatment plant, lead to a treatment efficiency of 94.35% for the ammonia nitrogen indicator within the Dumbrăveni Wastewater Treatment Plant.

The difference between the load that should be retained in accordance with the legislation in force to achieve compliance with existing quality standards and the one currently retained through the treatment process at the Dumbrăveni treatment plant is 26.64%. The efficiency of phosphorus removal is also very low and needs to be improved.

CONCLUSIONS

The values of the influent indicators are largely within the limits regulated by the legislation in force, the loads being generally moderate and due to the high dilution of industrial effluents with domestic or rainwater.

The lack of limits, seen for ammoniacal nitrogen, can be correlated with the activity of economic agencies normally connected to the municipal sewerage network, whose wastewater has not been properly pre-treated as well as the discharge of drains into treatment plants directly downstream of rare grills.

Regarding the effluent of the Dumbrăveni Wastewater Treatment Plant, the values of the quality indicators, except for ammoniacal nitrogen, are within the normative limits. The phosphorus concentration in many cases is above those allowed by NTPA 001. To reduce the phosphorus concentration, we tried to introduce ferric chloride, in a single dose per day, taking into account the flow and loading of the influent.

The results are promising, but we believe that the addition of $FeCl_3$ should be done in several instalments, or continuously, drop by drop. The optimal amount and dosage will be the scope of future research.

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