STUDY ON MONITORING THE PHYSICO-CHEMICAL PARAMETERS OF WASTEWATER FROM THE AGNITA WASTEWATER TREATMENT PLANT

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Abstract. Within the Agnita domestic wastewater treatment plant, the treatment process takes place in the biological treatment plant with rotating biological contractors. The Agnita wastewater treatment plant is designed for a relatively small number of inhabitants (9500 LE) and only the elimination of organic and suspended matter was considered in its construction. In this study, the main parameters for characterizing the quality of wastewater were determined, treated with classic coagulant, ferric chloride min. 40% in different quantities, in the flow distribution chamber before the biological stage. The obtained results show that the Agnita Wastewater Treatment Plant is functioning properly, and the treated water meets the quality conditions imposed by the rules in force on water and environmental protection.

Keywords: wastewater, Agnita, monitoring.

Rezumat. Studiu privind monitorizarea parametrilor fizico-chimici ai apei uzate din stația de epurare Agnita. În cadrul Stației de epurare al apelor uzate menajere Agnita, procesul de epurare are loc în stația de tratare biologică cu contractori biologici rotativi. Stația de epurare a apelor uzate Agnita este proiectată pentru un număr relativ redus de locuitori (9500 LE) și la constructia ei s-a ținut cont doar de eliminarea materiilor organice și a celor în suspensie. În acest studiu, s-a determinat principalii parametrii pentru caracterizarea calității apelor uzate, la epurarea cărora s-a adăugat coagulantul clasic, clorură ferică min. 40% în cantități diferite, în camera de repartiţie debit înaintea treptei biologice. Din rezultatele obținute reiese că Stația de epurare Agnita funcţionează corespunzător, apa epurată îndeplinind condiţiile de calitate impuse de normele în vigoare privind protecția apelor și a mediului.

Cuvinte cheie: stație de epurare, Agnita, monitorizare.

INTRODUCTION

The purpose of wastewater management is to increase the degree of wastewater recycling, after having been subjected to treatment operations for the purpose of treatment, in specific installations with the lowest possible costs.

Establishing the origin and qualitative characteristics of wastewater requires knowledge of the industrial technological process for an adequate design of treatment plants. So, one should know the origin of the main tributaries and their main characteristics to define the treatment method. Reducing wastewater flows requires the use of the most advanced technologies.

From the study conducted in the treatment plant in Agnita, Sibiu County we found that the potential sources of production of substances with a high degree of pollution are nitrogen and phosphorus, which are a constant presence in both wastewater from the population and that from industry.

One of the main objectives of the Project "Extension and rehabilitation of water and wastewater networks in the regions of Mediaş, Agnita, Dumbrăveni, Sibiu County", co-financed by the Cohesion Fund of the European Union, through SOP Environment, was the construction of a treatment plant in Agnita locality and implicitly the elimination of direct discharges of wastewater directly into the emissary (BRETOTEAN et al., 2006; GAȘPAR, 2019).

According to NTPA-011 (HG188 / 2002-Annex 1) for localities with equivalent population less than 10,000 LE, both Total Phosphorus and Total Nitrogen are not required (Fig. 1).

Figure 1. Wastewater treatment plant (original).

MATERIALS AND METHODS

The collection and processing of the results were carried out for a period of 16 consecutive days in September 2021, aiming at framing the quality parameters of the effluent within the normative limits, but also in the perspective ones (in the case of phosphorus). The values obtained during this period were compared with the average values of the influent and effluent parameters.

The determinations for the characterization of the influent and effluent of the Agnita Wastewater Treatment Plant were performed on average wastewater samples, collected with hourly frequency, over a period of 8 hours.

The following parameters were followed in the analyzes performed on wastewater: CCO-Cr, CBO_5, ammoniacal nitrogen, total phosphorus, suspended solids.

Sampling was performed in accordance with the provisions of the standard on wastewater sampling (SR ISO 5667-10 / 1992 Water quality. Sampling. Part 10: Guide for wastewater sampling), in polyethylene containers, the volume taken being 2 liters of residual water.

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 a number of 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 color decreases.

Determination of the reagent dose - FeCl coagulant$_3$ for wastewater treatment. The determination of the dosage amount of FeCl coagulant$_3$ for the treatment of wastewater at the Agnita treatment plant was done by laboratory tests using the apparatus - the Jar Test method (STOIANOVICI & ROBESCU, 1982; GAȘPAR, 2019; GIURMA, 2000).

The "Jar Test" method is a laboratory procedure often used to determine the optimal operating conditions for water treatment or wastewater treatment. This method allows pH adjustments, variations in the dose of coagulant or polymer, alternating the rate of mixing or testing coagulants or polymers of different types, on a smaller scale, to predict the operation of such a large-scale treatment operation.

The apparatus for the 'Jar Test' method consists of 6 1-liter containers with 6 pallets which mix the contents of each container. One of the containers acts as a control point, while in the other five containers, the operating conditions may vary. A measuring instrument for determining the speed - revolutions per minute (rpm), located in the upper part of the center of the device, allows uniform control of the mixing speed in all containers.

RESULTS AND DISCUSSIONS

Wastewater quality indicators were determined based on the analysis methods, currently performing a series of analyses of the quality indicators in the laboratory. Given the lack of monitoring equipment for the Agnita treatment plant at discharge, the ferric chloride dosage min. 40% was performed against the temperature of the water in the biological reactor, the inlet flow as a percentage of 3% of the daily flow and on the measurement of the total phosphorus concentration in the effluent of the biological stage determined in the laboratory.

During the dosage of ferric chloride min.40% in the technological treatment process, good results were obtained regarding the quality of the effluent, in terms of analysis of the mentioned quality indicators CCO-Cr, CBO_5, NH_4, N total, P total and MTS. The obtained results can be found in table 1. Analysing the quality of the effluent following the 24h / 24h drip dosing of the ferric chloride precipitation reagent 40% in the technological process, from the point of view of quality indicators it can be concluded that the treatment process took place normally (IMHOFF et al., 1998; IONESCU, 2010).

From the analysis of the effluent results by dosing the $FeCl_3$ coagulant in the technological process with rotary biological contactors - in the Agnita treatment plant the following can be concluded:

Wastewater treatment is carried out accordingly, as the effluent meets the criteria of the water protection regulations in force (SIERP, 1967; MARTINEZ, 1987; ROBESCU et al., 2011).

Continuous framing within the maximum allowed limits, respectively of NTPA 001 for the indicators COD, CBO_5, NH_4, total N, total P and MTS;

Table 1 and figure 2 show the values of the main chemical parameters of the influent and effluent resulting from SEAU Agnita.

From the comparative analyses of the values of the quality indicators of the influencer - COD, CBO_5, NH_4, total N, total P and MTS – with the maximum admissible values regarding the discharges in the sewerage network (inputs to the treatment plants) it can be concluded that there are uncontrolled discharges into the sewerage network of the city of Agnita, discharges that may affect the treatment process.

Moderate loads of influenza, which can be seen as a large effect of the monitoring of economic agents and drained domestic wastewater discharged into the sewer system - in the treatment plant, lead to increased operating costs and complicate the technological process of wastewater treatment.

The flexibility of the process and its ability to cope with extreme and influential fluctuating loads in the treatment plant is extremely sensitive. To ensure the reduction of phosphorus and improve the quality of treated wastewater under the conditions required for discharge into the emissary, the biological reduction of phosphorus is supplemented by chemical precipitation, even if, under certain conditions, phosphorus can be reduced biologically to the level required for discharge.

Table 1. Daily values of chemical indicators of wastewater and treatment - SEAU Agnita during 01.09.2021-16.09.2021.

DAY	COD mg O_2/l		CBO_5 mg O_2/l		NH_4 mg/l		N-total mg/l		P-total mg/l		MTS mg/l	
	Inflfuent	Efluent	Inffluent	Effluent	Inffluent	Effluent	Inffluent	Eflfuent	Inffluent	Effluent	Inflfuent	Effluent
01.09.2021	524.20	25.92			40.44	1.68	51.35	15.58	6.032	3.18	98.00	1.50
02.09.2021	534.90	28.80	400	8	21.15	1.98	34.41	16.32	6.02	3.27	88.21	3.00
03.09.2021	668.21	23.90			38.89	1.81	45.12	14.25	4.20	2.06	65.87	2.30
04.09.2021	393.30	27.65			38.07	1.21	33.26	13.65	7.08	2.00	138.00	2.25
05.09.2021	382.10	26.65	320	6	34.88	1.92	41.15	14.00	6.60	2.19	53.60	6.00
06.09.2021	480.00	28.90			50.06	1.91	58.09	13.36	4.21	2.08	207.00	9.00
07.09.2021	419.40	27.00			40.09	1.45	45.36	13.34	4.91	2.15	186.50	4.20
08.09.2021	387.20	29.35			34.86	1.44	44.25	12.68	6.70	1.68	142.90	3.65
09.09.2021	463.30	31.32			64.66	2.87	68.97	12.50	5.32	1.54	48.80	2.05
10.09.2021	460.80	26.93	300	7	67.87	1.06	66.20	11.65	5.08	1.68	98.00	3.15
11.09.2021	355.20	22.65			55.02	1.98	74.21	13.25	4.36	2.07	92.50	4.00
12.09.2021	337.00	28.20			43.45	2.40	51.27	12.50	6.10	1.64	122.80	2.20
13.09.2021	363.00	22.25	240	8	35.6	2.30	43.52	11.35	6.00	1.54	78.00	1.90
14.09.2021	303.10	20.25			38.9	1.89	43.65	12.00	5.98	1.00	68.00	0.90
15.09.2021	199.60	23.24			48.7	2.30	52.68	13.41	4.50	1.87	57.50	2.10
16.09.2021	207.36	26.35			42.10	2.20	49.67	12.55	5.90	1.94	98.23	1.98
AVERAGE	**404.91**	**26.21**	**315**	**7.25**	**43.42**	**1.9**	**50.20**	**13.27**	**5.56**	**1.99**	**102.74**	**3.13**
CMA	-	**125**	-	**25**	-	-	-	**15**	-	-	-	**35**

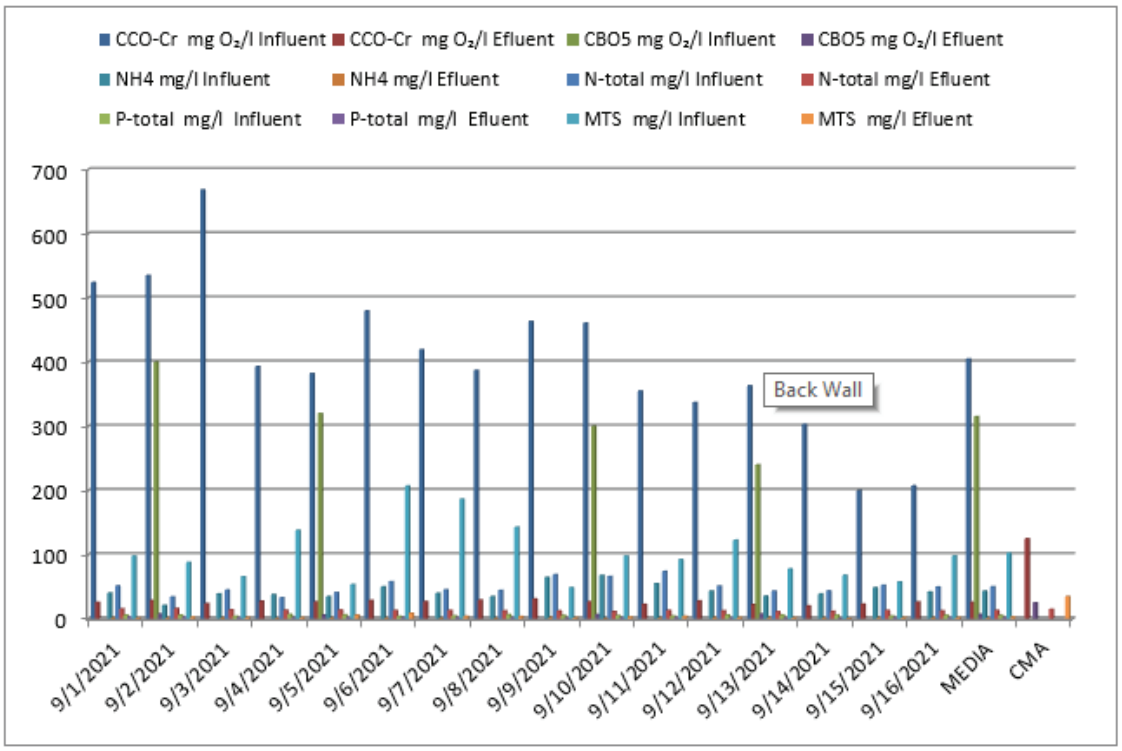

Figure 2. Evolution of quality indicators registered at the Agnita treatment plant.

An improved operation of the technological process with rotary biological contactors was achieved by dosing the coagulant of ferric chloride 40% as the advantages of chemical precipitation are numerous:

- the total phosphorus can be reduced below the allowed values

-the efficiency of the treatment plant also increases in the field of organic matter removal
-it prevents the excessive proliferation of filamentous microorganisms
-it helps to form sludge with good settling qualities
-it increases the dry matter content of the sludge, corrects the density and the degree of dehydration.

It is observed that at SEAU Agnita the concentration values of the quality indicators – in this case the total nitrogen in the effluent – are quite close to the CMA value.

In order 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 (table 2; Fig. 3).

Therefore, the situation at SEAU Agnita in September 2021 has considerably improved the values of wastewater quality indicators, which were monitored by daily samples at the discharge from the treatment plant in the emissary according to CMA, respectively NTPA 001, compared to September year 2015 without dosing the ferric chloride coagulant 40% in the technological process (***. NTPA 001/2005; ***. NTPA 002/2005).

Table 2. Comparative average values regarding the effluent quality
at the Agnita Wastewater Treatment Plant, in September 2015, September 2021.

SEPTEMBER	**COD mg O_2/l**		**CBO_5 mg O_2/l**		**N-total mg/l**		**MTS mg/l**	
	Effluent 2015	Effluent 2021	Effluent 2015	Effluent 2021	Effluent 2015	Effluent 2021	Effluent 2015	Effluent 2021
AVERAGE	**50.3**	**26.21**	**31.5**	**7.25**	**28.9**	**13.27**	**8.3**	**3.13**
CMA	**125**	**125**	**25**	**25**	**15**	**15**	**35**	**35**

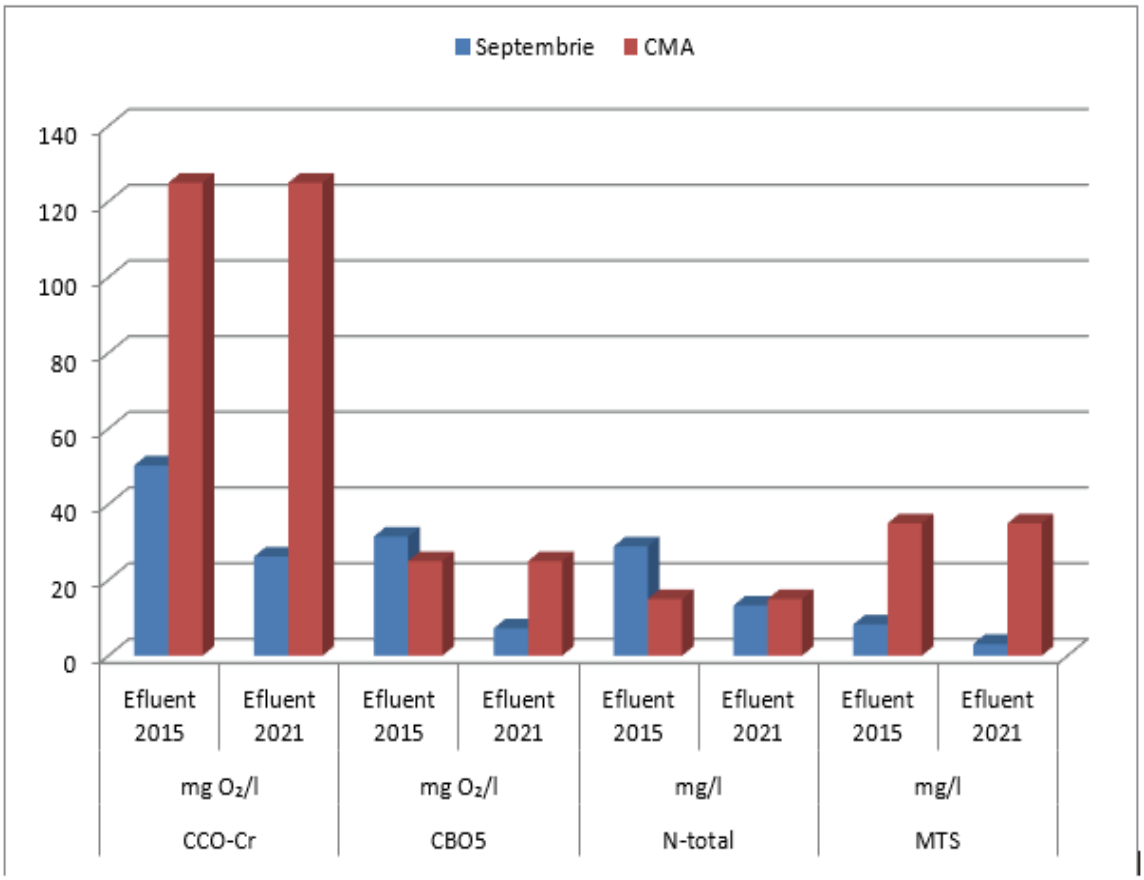

Figure 3. Evolution of quality indicators in September 2021 with $FeCl_3$ dosing compared to September 2015 without $FeCl_3$ dosing.

The purification process proved the high efficiency for the analysed quality indicators during the monitored period – daily samples, an aspect that can be followed figure 4.

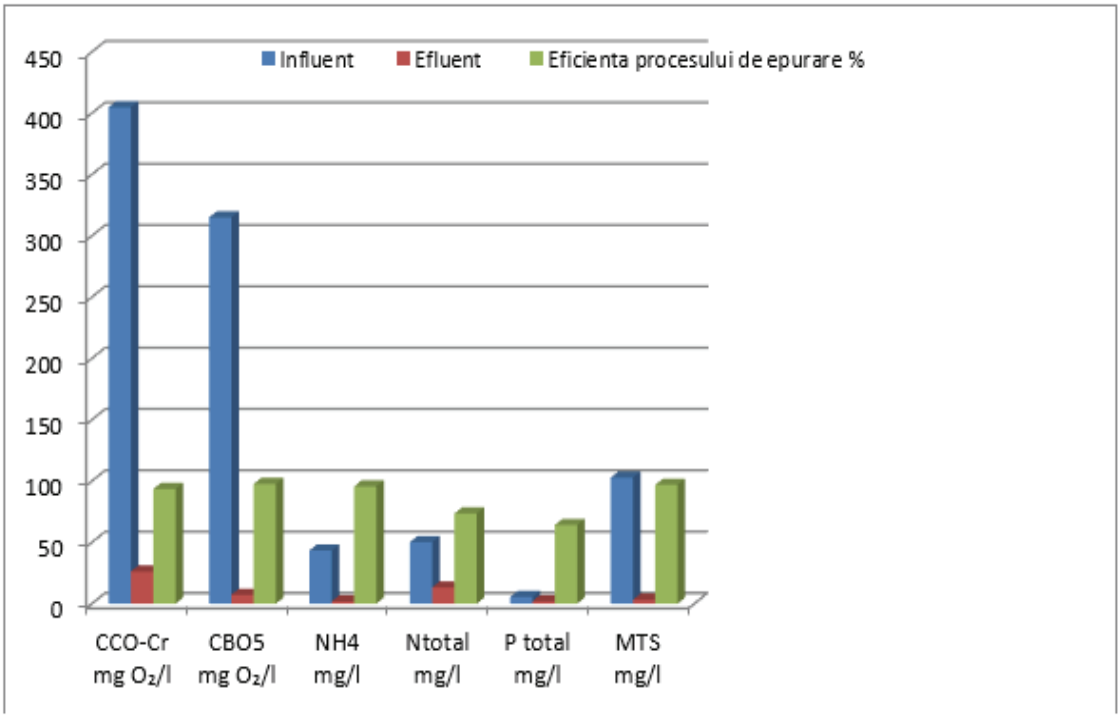

Figure 4. Purification efficiency.

It can be noticed that, during the monitoring period, the Agnita treatment plant functioned properly, as the effluent was within the normal parameters.

In the analysed period all the values were within the imposed limits, therefore it can be concluded that the use of the classic coagulant, ferric chloride min. 40% in different quantities in the technological process highlights the improvement of quality indicators, of treated wastewater discharged into the emissary.

From the obtained results and graphs, the consumption of $FeCl_3$ can be estimated depending on the load of the influent. Further measurements are made for the most conclusive results.

The increasingly strict provisions of the European Union, which are or will be implemented in Romania, impose strict limits for nitrogen (total or ammonia) as well as for phosphorus.

By dosing ferric chloride min.40% in the technological process with rotating biological contactors - in the Agnita treatment plant, Sibiu County, the obtained results are promising, which is noticeable both by decreasing the maximum allowed concentrations of pollutants in the effluent, but especially by respecting the obligation (according to the Water Management Authorization - CMA) that the treated water should meet certain quality conditions in terms of the total nitrogen indicator.

CONCLUSIONS

The Agnita treatment plant was operated with the influence from the sewerage network of the city of Agnita, taking into account the climatic conditions and the composition of the station.

In this study, the main parameters for characterizing the quality of wastewater were determined, which was treated with classic coagulant, ferric chloride min. 40% in different quantities, in the flow distribution chamber before the biological stage.

In order to maintain at least the existing quality class of the Hârtibaciu River, it is necessary to provide chemical treatment to remove nutrients (N and P) from wastewater entering the SE, although the technological process of the Agnita treatment plant, with rotary biological contactors, had less than 10,000 LE.

The option to introduce ferric chloride min. 40% in the technological process of the Agnita treatment plant is a necessary and sufficient measure to reduce the cumulative negative impact on the quality of the receiver into which the treated water is discharged. The obtained results are promising, for a better accuracy we consider that measurements should be made over several years, in order to be summed and normalized.

Following the study and the interpretation of the results obtained from laboratory 166nalyses, it appears that the Agnita Wastewater Treatment Plant operates in the appropriate parameters, and the treated water meets the quality conditions imposed by the rules on water protection and environmental protection.

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