WATER QUALITY MONITORING FROM *AVICOLA SLOBOZIA S.A.*

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Water quality monitoring is an important tool in management of wastewater in general and poultry farming specialty (Avicola Slobozia S.A). The monitoring is aimed at the generation of original experimental data which reflect the actual status of the water quality variables The experimental data are personally determined after that were processed taking into consideration the characteristics of Avicola Slobozia S.A. wastewater for the complexity of the aquatic system appreciated. The simplest procedure is interpretation of data on "trigger" value for each quality parameter. When the "trigger" value is exceeded, these data provide understanding of suitable clean water intervention in the next step of research.

Keywords: water quality, monitoring, poultry farm, environment impact, wastewater

1. Introduction

Water quality monitoring is defined as the sampling and analysis of water constituents and conditions. Water quality monitoring can be used with many final objectives such as: to identify and maintain the optimal and legal parameters of chemical pollutants in water, to establish the presence of specific pollutants and their sources, to find out how a certain parameter behaves depending on the season, by monitoring it daily, for several years. Wastewater monitoring is an important tool for researchers in the field of environmental monitoring. [1],[2]

Avicola Slobozia S.A. was established in 1990. It has its headquarters in Slobozia, Șoseaua Constanței, km 5-6, Ialomița County and is an objective organized as a company with private capital.[3]

The location of S.C. AVICOLA SLOBOZIA S.A., in the field "Facilities for intensive poultry farming with a capacity of more than 40 000 places for birds

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(without transition period)" as well as the coordinates of the farms can be found in Table 1.

Table 1

Location of Avicola Slobozia S.A. farms

The farm	Location	Emplacement	Coordinates
Farm no. 1 - breeding heavy breeds [4]	Amara	The location of the farm is located in the northern part of Slobozia. The land on which the objective is located is the property of the company, and the access is made from DN 2C Slobozia-Buzău.	44º37'12"N 27º19'12"E [5]
Farm no. 2 and farm no. 3 - raising chickens for meat [4]	Bora	The location of the farms is located in the eastern part of Slobozia, in the Bora district, 1.5 km north of the natural emissary of the Ialomița River. The land on which the objective is located is the property of the company, and the access is made from DJ Slobozia - Mărculești - Țăndărei.	44º33'29"N 27º23'48"E [6]
Farm no. 4 - raising chickens for meat [4]	Andrășești	The location of the farm is located in the northeastern part of Andrășești, within the former IAS - Andrășești and 26 km west of Slobozia. The land on which the objective is located is the property of the company, and the access is made from DN2A Slobozia - Urziceni.	44º34'37"N 27º7'36"E [7]
Farm no. 5 and farm no. 8 - raising chickens for meat [4]	Gheorghe Doja	The location of the farm is located outside the village of Perieți, on the former site of a zootechnical pig breeding complex, 16 km west of Slobozia. The land on which the objective is located is the property of the company, and the access is made from DN2A Slobozia - Urziceni.	44º36'52"N 27º10'54"E [8]
Farm no. 6 - raising chickens for meat [4]	Perieți	The location of the farm is located in the suburb of Perieți, Stejaru village, 11 km west of Slobozia. The land on which the objective is located is the property of the company, and the access is made from DN2A Slobozia - Urziceni.	44º33'59"N 27º15'45"E [9]
Farm no. 7 - raising chickens for meat [4]	Ion Ghica	The location of the farm is located in the suburbs of Ciulnița, Ion Ghica village, 10 km south of Slobozia. The land on which the objective is located, is the property of the company and the access is made from DN 21 Slobozia - Călărași, with branch on DJ 201 Slobozia - Albești - Orezu.	44º31'53"N 27º18'21"E [10]

Poultry farms within S.C. Avicola Slobozia S.A., are integrated, and are part of a technological flow in which the calendar of populations and depopulations, is drawn up for a period of at least 12 months. Within the sites, the specific activity consists in raising broilers, from 0 to 38 (40) days, in ground floor type halls, on permanently dry bedding. From the production process, birds for slaughter and slaughter result.The operating schedule is 24 hours / day; 7 days / week.

The purpose of the paper is to collect data, documents, conduct investigations in order to quantify the negative effects on environmental factors and mainly to decide the size of the impact on the potential or actual environment of the activity of S.C. AVICOLA SLOBOZIA S.A.

The evaluation criteria considered for the interpretation of the analytical results obtained from the physico-chemical laboratory analyzes on the water samples taken were those specified in [11] and [12]. The farms in S.C. Avicola Slobozia S.A. are represented in Fig.1.

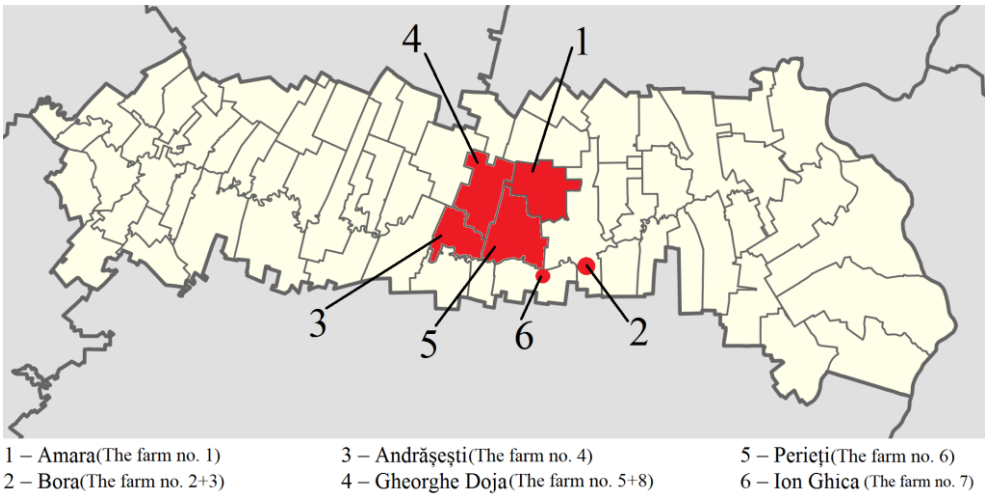

Fig. 1. Avicola Slobozia S.A. map from Ialomița county. [5] [6] [7] [8] [9] [10]

The number of series in 2019, the total number of heads, the specific water consumption in the borehole, the total area and the approximate distance to the first group of individual dwellings are presented in Table 2.

Table 2

General data of Avicola Slobozia S.A.

The farm	**Series in 2019**	**Total number of heads in 2019**	**Specific water consumption from drilling [thousand m^3/year]**	**Total area [m^2]**	**[m^2]**	**Distance approx. to the first group of individual dwellings [m]**
Amara	2 series/year	70 000	5.975	45 338	Built area – 14036 Access road surface – 9848 Free area– 21454	1 500
Bora	5 series/year	1 293 350	no water was delivered for fertigation	53 667	Built area – 20931 Access road surface – 14997 Free area– 16413 Network surface –	1 000

					1326	
Andrăș-ești	4 series/year => 210-240 tons of meat/series	485 475	4.099	17 140	Built area – 8848 Access road surface – 2083.51 Free area– 6208.49	1 000
Gheor-ghe Doja	4 series/year	2 895 820	61.382	61 100	Built area – 33600 Access road surface – 7500 Free area– 12000 Vegetable layer surface – 8000	2 000
Perieți	4 series/year => 130-140 tons of meat/series	300 919	7.338	17 097	Built area – 9800 Access road surface – 4733 Free area– 2564	1 000
Ion Ghica	4 series/year	471 730	4.766	17 739.16	Built area – 8643.67 Access road surface – 3764.76 Free area– 5330.73	300

The food on the farms is made for hygienic-sanitary purposes for employees and for biological purposes for watering birds. The water source is own, underground, a deep drilling located inside the unit.Water standard for main products of manufacture: water consumption is 0.15 L / chicken / day.

The main sources of wastewater generated at the site analyzed are: domestic wastewater, technological wastewater and stormwater.

Wastewater comes from the sanitary filter and from the washing and disinfection of the halls at the end of each production cycle.

Wastewater from the washing of the halls is collected through a system of shallow sewers and discharged into the external sewer network consisting of concrete pipes through a manhole located next to each hall; the external network is discharged into a concrete, watertight, drainable pit. Sewage is also collected and discharged into a sealed, drainable concrete pit with a smaller volume than wastewater.

Technological wastewater is collected in a watertight concrete basin from where it is emptied and transported to the storage basins on the platform of farm no. 5 Gheorghe Doja in two above-ground concrete decanters, for anaerobic treatment for use in fertilizing agricultural crops.

Domestic wastewater is periodically drained and transported to the Slobozia Poultry Slaughterhouse pre-treatment plant, from where it is discharged by pumping into the Slobozia sewerage network and finally reaches its treatment plant. Rainwater falling into the enclosure reaches the outside of it.[13]

2. Methods and equipments

The materials and methods used in measuring the parameters for water quality are presented in Table 3.

Table 3

Methods and equipment for measuring wastewater quality indicators

Wastewater quality	Standard	Type of method	Instruments and equipment (devices)
pH	SR EN ISO 10523:2012 – Water quality. Determination of pH	electrochemical	- pH meter - glass electrode and reference electrode - mixer or stirrer - sampling bottles - temperature measuring equipment (graduated scale thermometer with 0.5 °C division, temperature sensor)
Ammonium	SR ISO 7150-1:2001 – Water quality. Deetermination of ammonium. Part 1: Manual spectrometric method	molecular absorption spectrometric method	- spectrometer - water bath
BOD_5	SR EN ISO 1899-2:2002 – Water quality. Determination of biochemical oxygen demand after n days (BOD_n). Part 2: Method for undiluted samples	volumetric	- apparatus for determining the dissolved oxygen concentration - incubation vials (BOD type vials, with glass stopers) - incubator - cooling equipment - aeration equipment
COD-Cr	SR ISO 6060:1996 – Water quality. Determination of the chemical oxygen demand	volumetric	- reflux boiling installation - heating jacket - granules for boiling regulation - precision burette
Total suspensions	STAS 6953-81 – Surface and waste waters. Determination of suspended matter, loss of ignition and calcination residues	gravimetry	- analytical balance - porcelain crucible - thermoregulatory oven - collection flask and heating source
Phosphorus	SR EN ISO 6878:2005 – Determination of phosphorus. Ammonium molybdate spectrometric method. Part 7	molecular absorption spectrometric method	- spectrometer - filter assembly - borosilicate flask
Detergents	SR EN 903:2003 – Water quality. Determination of anionic surfactants by measurement of the methylene blue index of MBAS	molecular absorption spectrometric method	- spectrometer with selector for discontinuous variation - pH meter - gas extraction device
Extractable substances	SR 7587:1996 – Determination of the extractile compounds with solvents. Gravimetric method.	gravimetry	- analytical balance - low pressure distillation plant consisting of: distillation flask, water tube, buffer

			vessel, refrigerant, collection flask and heating source
Nitrites	SR EN 26777:2002+C91:2006 – Water quality. Determination of nitrite. Molecular absorption spectrometric method	molecular absorption spectrometric method	- spectrometer
Filtrable residue	STAS 9187-84 – Surface water, groundwater and wastewater. Residue determination	gravimetry	- water bath - adjustable electric oven - porcelain crucible or capsules - dryer - thermoregulatory oven
Nitrates	SR ISO 7890-3:2000 – Water quality. Determination of nitrate. Part 3: Spectrometric method using sulfosalicylic acid	molecular absorption spectrometric method	- spectrometer - water bath

3. Results and discussion

As the farm does not discharge wastewater into surface or groundwater, quantitative analyzes of drained wastewater will be performed. Periodic investigations for wastewater: pH, suspended solids, BOD_5, COD-Cr, NH_4^+, biodegradable active anion synthetic detergents. Five replicate samples were collected for each drain for the analysis of physico-chemical indicators, between November 2018 and December 2019.

Table 4

Physico-chemical indicators for technological wastewater from S.C. Avicola Slobozia S.A.

Physico-chemical indicators	U.M.	Values allowed by NTPA002	The farm*	Average values at sem. II – 2018	Average values at sem. I – 2019	Average values at sem. II – 2019
Temperature	ºC	35	Amara	20.54	22.14	22.72
			Andrășești	21.72	21.86	22.70
			Gheorghe Doja	22.60	24.70	24.52
			Perieți	20.40	22.70	22.04
			Ion Ghica	20.40	22.42	22.52
pH	pH units	6.5 – 8.5	Amara	7.7	7.04	8
			Andrășești	7.9	7.6	8.16
			Gheorghe Doja	7.92	7.78	7.94
			Perieți	7.96	7.3	7.78
			Ion Ghica	8	7.06	7.5
Ammonium	mg/L	30	Amara	21.22	< LD	32.6
			Andrășești	27.5	25.44	20.54
			Gheorghe Doja	28.38	52.7	157.2
			Perieți	27.92	40.42	112.29

			Ion Ghica	29	217.37	210.79
BOD_5	mg/L	300	Amara	180	23.21	42
			Andrășești	200.4	98.3	47
			Gheorghe Doja	99.8	12.7	120
			Perieți	290.3	360	80
			Ion Ghica	170.3	42.1	120
COD-Cr	mgO/L	500	Amara	232.96	330.4	212
			Andrășești	251.21	291.06	296.8
			Gheorghe Doja	181	141.6	275.6
			Perieți	322.25	292.64	254.4
			Ion Ghica	482.18	455.2	551.2
Total suspensions	mg/L	350	Amara	78	261	268.5
			Andrășești	279.6	314.7	295
			Gheorghe Doja	210.3	44.5	521.5
			Perieți	300.5	375.5	313.5
			Ion Ghica	347.3	330.5	895
Phosphorus	mg/L	30	Amara	0.03	0.45	0.57
			Andrășești	0.035	0.04	0.12
			Gheorghe Doja	< LD	< LD	< LD
			Perieți	0.20	0.25	< LD
			Ion Ghica	0.31	0.32	< LD
Detergents	mg/L	25	Amara	0.2	0.33	0.28
			Andrășești	0.2	0.25	0.27
			Gheorghe Doja	0.32	0.35	0.29
			Perieți	0.3	0.3	0.29
			Ion Ghica	0.27	0.31	0.25
Extractable substances	mg/L	30	Amara	< LQ	24.2	24.07
			Andrășești	26.01	23.42	25.33
			Gheorghe Doja	< LD	< LD	< LD
			Perieți	24.58	20.96	23.35
			Ion Ghica	23.88	25.2	25

*Wastewater from Bora Farms was not analyzed.
Values written in red exceed the limit allowed by law.

The technological and domestic wastewater resulting from the technological process of slaughtering poultry, from the hygienic-sanitary consumption, as well as from the related activities of the technological flow are directed to the treatment plant of the city of Slobozia. In the Slobozia sewage treatment plant, the monitoring of wastewater is performed according to the program in Table 5.

Table 5

Wastewater monitoring from the Slobozia sewage treatment plant

Hour	Sample	Parameters to be determined/ frequency of determination

		t °C	pH	ammonium	nitrites
08:00	station entrance	daily	daily	daily	-
	biological stage entry	daily	daily	daily	-
	evacuation station	daily	daily	daily	-
14:00	station entrance	daily	daily	daily	-
	evacuation station	daily	daily	daily	-
20:00	station entrance	daily	daily	daily	daily
	biological stage entry	daily	daily	daily	-
	evacuation station	daily	daily	daily	daily
02:00	station entrance	daily	daily	daily	-
	evacuation station	daily	daily	daily	-

		BOD_5	COD -Cr	phosphorus	suspensions + extractable substances	filterable residues	nitrates
08:00	station entrance	3 times/ week	1 time/ month	1 time/ week	1 time/ week	1 time/ week	1 time/ month
	biological stage entry	-	1 time/ month	-	1 time/ week	1 time/ week	-
	evacuation station	3 times/ week	2 times / month	1 time/ week	2 times/ week	2 times/ week	1 time/ month

The water quality at the entrance and exit of the treatment plant is represented by figures 2 - 12 for the period November 2018 - June 2019; the data corresponding to the second semester of 2019 and the first semester of 2020 are not yet processed. All water quality indicators are interpreted according to NTPA 002 at the exit of the treatment plant.[12] The inlet temperature in the water treatment plant in the slaughterhouse is in the range 17.4 ºC – 22.5 ºC; the outlet temperature is in the range 14 ºC – 22 ºC. In both situations, the temperature is below the limit allowed [12], where the maximum allowed temperature is 35 ºC.

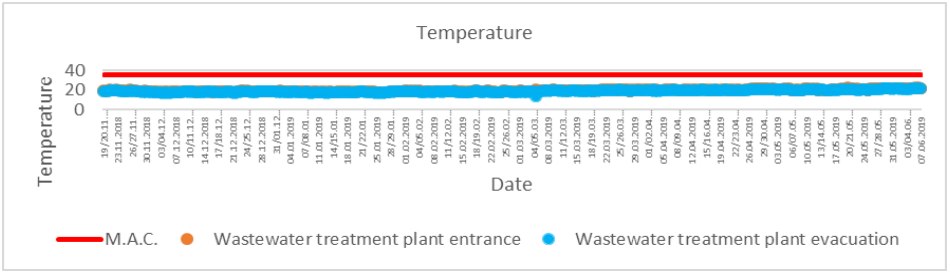

Fig. 2. Temperature monitoring

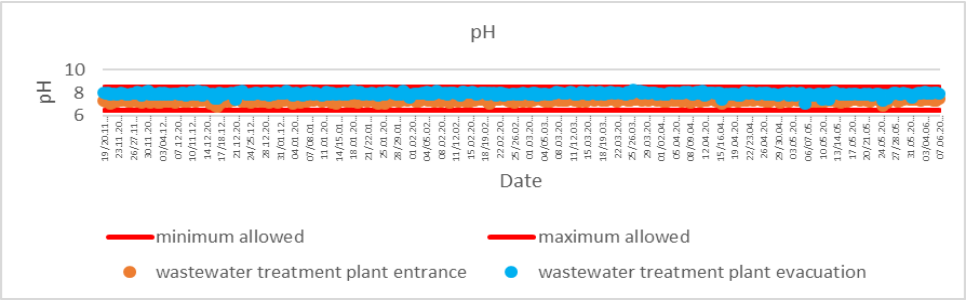

Fig. 3. pH monitoring

The pH of the inlet waters is in the range of 6.8 – 7.7 pH units; the pH of the outlet waters is found in the range of 7.5 – 8.3 pH units. In both situations, the pH is between the minimum limit (6.5 pH units) and the maximum limit allowed(8.5 pH units).[12]

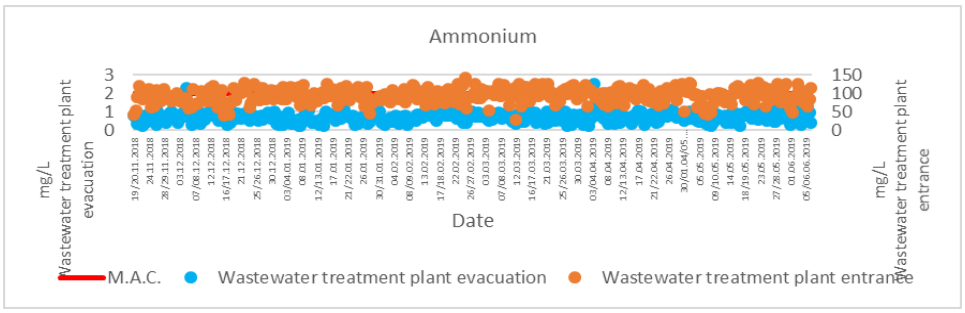

Fig. 4. Ammonium monitoring

The maximum concentration allowed is 2 mg/L ammonium in the outlet waters.[12] In the inlet waters of the slaughterhouse, a minimum concentration of 29.49 mg/L and a maximum concentration of 142.45 mg/L were found. The average ammonium concentration for the water entering the treatment plant during the whole monitoring period is 92.15 mg/L ammonium. The ammonium concentration in the wastewater from the treatment plant was found between the minimum of 0.21 mg/L and 1.38 mg/L; however, there were 3 values that exceeded the maximum concentration allowed, namely: 2.04 mg/L, 2.31 mg/L, 2.51 mg/L.

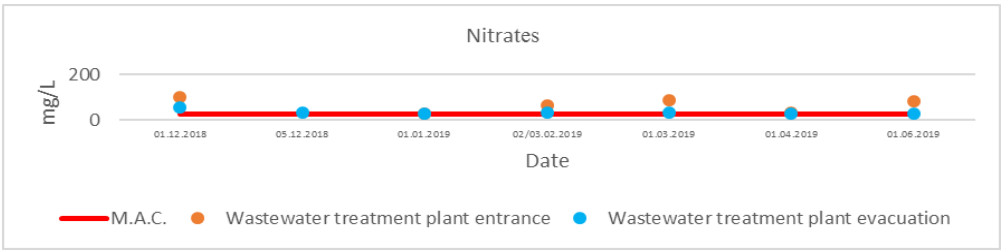

Fig. 5. Nitrate monitoring

The concentration of nitrates present in the water entering the treatment plant was found between the minimum of 30.98 mg/L and the maximum of 102.7 mg/L. All the values of nitrate concentrations in the wastewater from the treatment plant exceeded the limits allowed (M.A.C. nitrates = 25 mg/L).[12] The nitrate concentration in the outlet waters was from 27.89 mg/L to 56.22 mg/L.

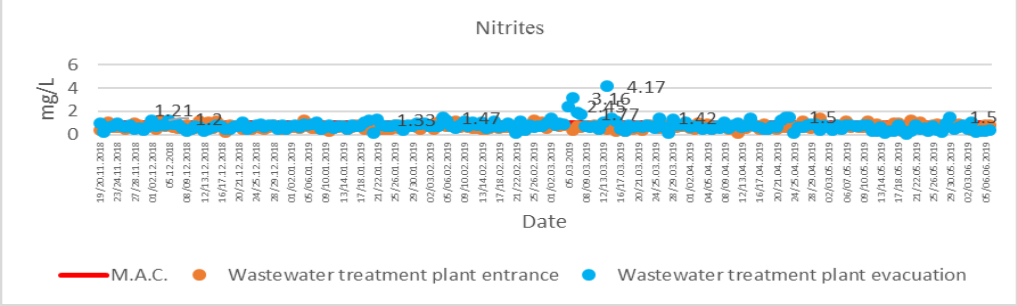

Fig. 6. Nitrite monitoring

The maximum concentration of nitrites allowed in the water discharged from the treatment plant is 1 mg/L.[12] At the entrance to the treatment plant, concentrations between 0.17 mg/L - 1.45 mg/L were found. At the exit from the treatment plant, concentration values between 0.07 mg/L and 4.17 mg/L were found. Out of 205 measured values, 36 exceed the limit allowed by law. The values that exceed the limit allowed are between 1.01 mg/L and 4.17 mg/L.

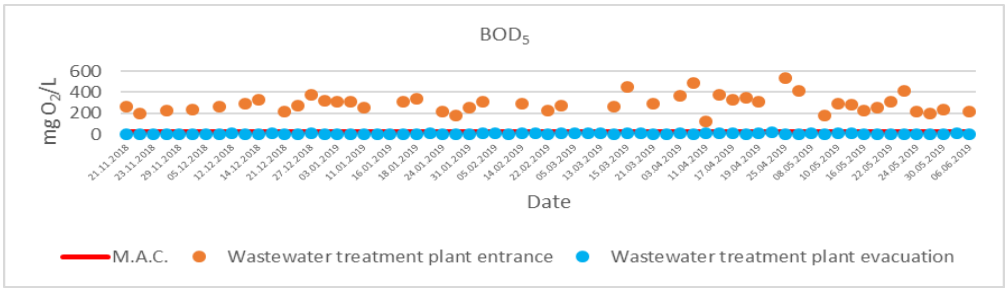

Fig. 7. BOD_5 monitoring

The maximum concentration of BOD_5 allowed is 25 mgO_2/L.[12] At the entrance to the treatment plant, concentrations with values between 124.65 mgO_2/L and 537.13 mgO_2/L were found. At the exit from the treatment plant, values between 1.87 mgO_2/L and 19.15 mgO_2/L were found. All values fall within the limits allowed.

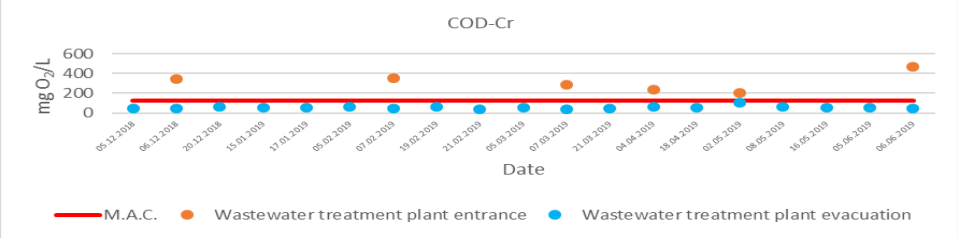

Fig. 8. COD-Cr monitoring

The maximum concentration allowed for COD-Cr in the water leaving the water treatment plant is 125 mgO_2/L.[12] All measured values are within the limits allowed. At the entrance to the treatment plant, concentrations of COD-Cr in the range of 202.04 mgO_2/L - 465.86 mgO_2/L were found. At the exit of the water treatment plant, COD-Cr concentrations were found in the range 36.89 mgO_2/L - 101.02 mgO_2/L.

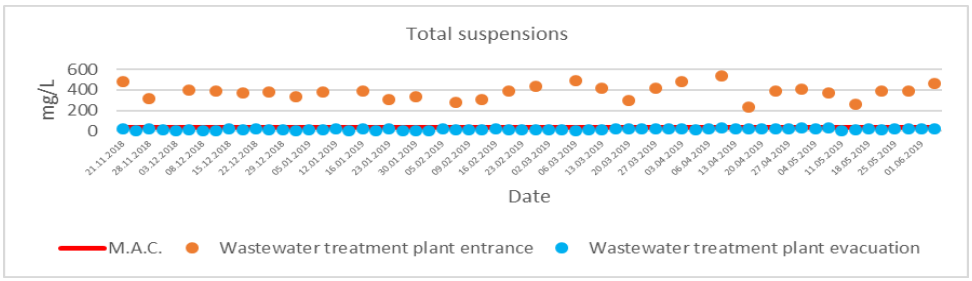

Fig. 9. Monitoring of total suspensions

The maximum concentration allowed for the total suspensions of the water leaving the water treatment plant is 35 mg/L.[12] All measured values are within the limits allowed. At the entrance to the treatment plant, concentrations of total suspensions were found in the range of 238 mg/L - 533 mg/L. At the exit of the water treatment plant, concentrations of total suspensions in the range of 1.0 mg/L - 34 mg/L were found.

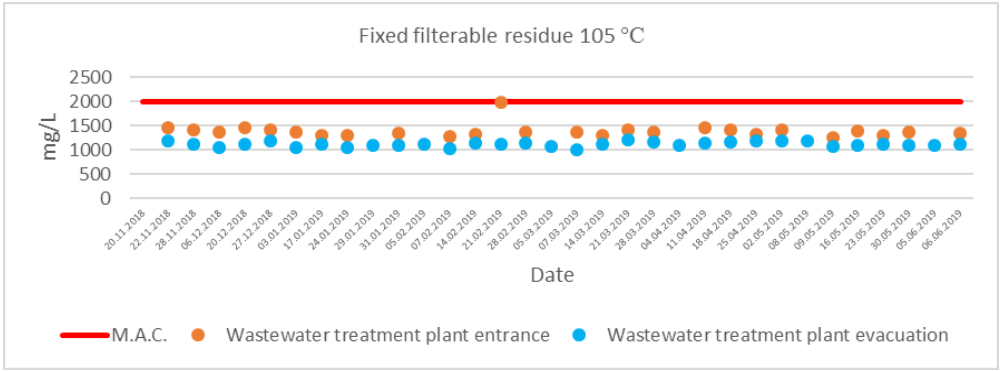

Fig. 10. Fixed filterable residue monitoring

The maximum concentration allowed for the fixed filterable residue in the water leaving the water treatment plant is 2000 mg/L.[12] All measured values are within the limits allowed. At the entrance to the treatment plant, concentrations of the fixed filterable residue were found in the range of 1250 mg/L - 1980 mg/L. At the exit of the water treatment plant, concentrations of the fixed filterable residue in the range of 996 mg/L - 1208 mg/L were found.

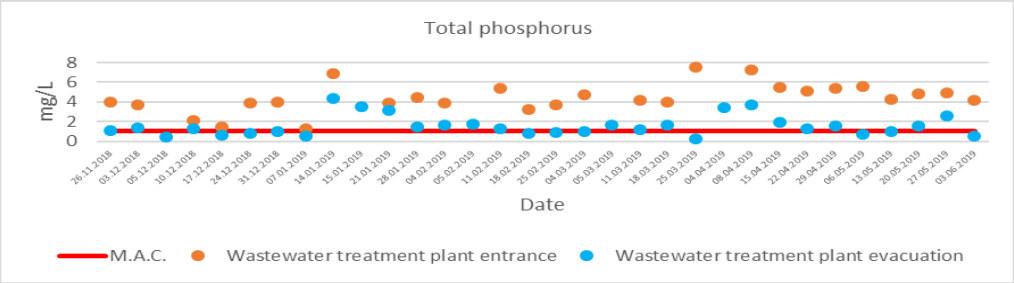

Fig. 11. Total phosphorus monitoring

The maximum concentration allowed for the total phosphorus in the water leaving the water treatment plant is 1 mg/L.[12] Few measured values fall within the limits allowed. At the entrance to the treatment plant, concentrations of total phosphorus were found in the range of 1.25 mg/L - 7.51 mg/L. At the exit of the water treatment plant, total phosphorus concentrations were found in the range of 0.2 mg/L - 4.35 mg/L. Out of 31 measured values, 21 of them exceed the maximum concentration allowed by law. Values in excess of M.A.C. is in the range of 1.02 mg/L - 4.35 mg/L.

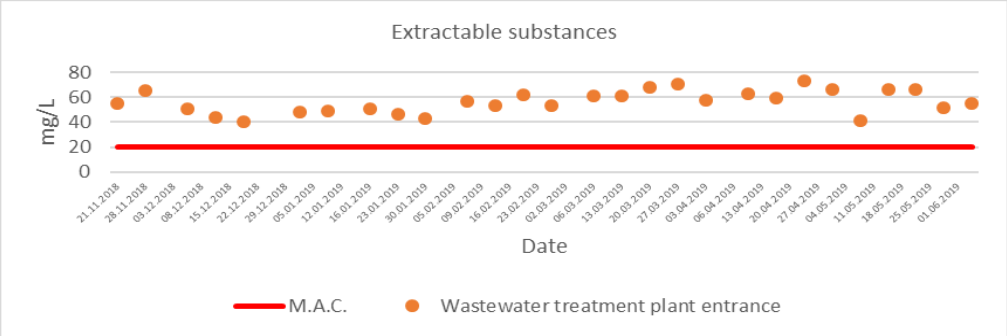

Fig. 12. Monitoring of extractable substances

The maximum concentration allowed for the substances extractable from the water leaving the water treatment plant is 20 mg/L. All measured values are within the limits allowed.[12] At the entrance to the treatment plant, concentrations of extractable substances in the range of 40 mg/L - 73 mg/L were found. At the exit of the water treatment plant, concentrations of extractable substances lower than 20 mg/L were found. Following the monitors made, higher

concentrations are observed for phosphate, ammonium, nitrites and nitrates ions. Polyatomic ions and voluminous, generally present in soluble compounds and for this reason the classical treatments used in the treatment plant did not have the expected effect, obtaining effluents unsuitable according to the quality conditions, in accordance with the legislation in force. Future experimental research is based on these arguments, research that will propose a combined procedure for removing ions of interest. A similar situation is presented in a case study on the removal of inorganic pollutants from leaching waters.[14]

4. Conclusions

Following the monitoring of the incoming and outgoing waters from the treatment plant, the water quality parameters: temperature, pH, BOD_5, COD-Cr, COD-Mn, total suspensions, filterable residue, as well as extractable substances are within the limits provided by law.[12] Quality parameters: ammonium, nitrates, nitrites and total phosphorus, exceed the maximum allowed concentrations, being outside the limits provided by the Romanian legislation in force, and the "trigger" values was exceeded. This involves the next stage of research, in order to reduce the concentrations to those established by law.

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