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EFFICIENCY OF BIOLOGICAL ACTIVATED SLUDGE TREATMENT OF WASTEWATER FROM A MEAT PROCESSING PLANT. CASE STUDY

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Abstract

Biological treatment is the technological process by which organic impurities in wastewater are transformed by a culture of microorganisms into harmless degradation products (CO_2, H_2O, other products) and new cell mass (biomass). The microorganism culture is then dispersed in the reaction volume of the sewage treatment plant, forming activated sludge. The aim of this work was to present the efficiency of wastewater treatment from the food industry using the operating principle of a biological activated sludge treatment plant in a meat processing plant. The methods of determining the indicators that highlight the quality of wastewater from the meat processing unit were those according to the STAS in force, and the determinations were carried out in the laboratory of the Călărași Environment Protection Agency. Following the analysis of the 5 wastewater samples taken in the period March-July 2023, it could be remarked that regardless of the volume of wastewater entering the treatment plant and the amount of kg of meat processed per day, the treated water leaving the treatment plant meets the requirements for discharge into the natural outfall according to NTPA - 001, except for the indicator total phosphorus, which at concentrations higher than 35 mg/L in the wastewater before treatment cannot be brought below the maximum permitted value of 1 mg/L for discharge into the natural outfall. The efficiency of the treatment plant, analyzed for 10 indicators is good, ranging from 70.22 - 99.63%. So, biological treatment with activated sludge is an efficient treatment technology in such a unit, inexpensive, clean and environmentally friendly.

Key words**:** *activated sludge, biological treatment, outfall, purified water, quality indicator*

INTRODUCTION

Food industry waters high in protein and fat can lead to the growth of bacteria and microbes in the emissaries they reach [2]. The wastewater treatment plants of medium and high size have a specific flow of sludge treatment and conditioning [1].

Monitoring of parameters in wastewater treatment processes is an essential activity in wastewater treatment plants and is closely related to the monitoring of the environment in general. Its purpose is to track compliance with legislation by monitoring water quality parameters at the outlet of the wastewater treatment plant and to track the operation of treatment processes and their efficiency by monitoring treatment process parameters [6,17]. The principle of wastewater treatment with activated sludge is that the microorganisms in activated sludge are mixed with wastewater containing organic material in the presence of oxygen, followed by flocculation of the microorganisms to form activated sludge (an active microbial mass) [16]. Activated sludge is the basic structural unit of the biological treatment process, it contains all species that in their joint activity can metabolize organic substances to CO_2 and H_2O. Active sludge can be defined by sedimentable floaters at the time of aeration interruption [22]. The colour of the floaters varies from yellow-brown to black and are obtained by the growth of a mixed population of bacteria and other microorganisms in the presence of oxygen and in the presence of biologically treated wastewater [8].

In terms of composition, the mixed population of microorganisms in activated sludge varies with the chemical nature of the substrate, flow rate, pH and temperature [10]. In the wastewater treatment process with activated

sludge, bacteria play an essential role and therefore the microbiological composition of activated sludge must be known. In a good active sludge 10^8 - 10^{10} bacteria/ml active sludge suspension are found.

The group of bacteria involved in biological treatment processes with activated sludge includes carbon oxidants, nitrogen oxidants, bacteria involved in floaters formation, aerobic bacteria, facultatively anaerobic bacteria [9]. Under optimal conditions bacteria have a high growth rate and/or a high speed of metabolic processes [18].

The kinds of bacteria commonly found in activated sludge are: *Achromobacter, Aerobacter, Alcaligenes, Arthrobacter, Bacillus, Citrobacter, Corynebacterium, Empedobacter, Esherichia, Flavobacterium, Klebsiella, Lophomonas, Micrococcus, Mycobacterium, Neiseria Paracolobacterium, Pseudomonas, Serratia, Sphaerotilus, Streptococcus, Zooglea* [4].

The most common species of fungi (from the active mud) are Sphaerotilus natans and Zooglea sp. [5].

In the biological treatment step, biodegradable organics (BOD_5), nitrogen are removed by nitrification and denitrification processes and phosphorus by biological processes [17].

Wastewater from the food industry is generally an ideal basis for biological treatment - a combination of anaerobic and/or aerobic, depending on local wastewater disposal requirements [19]. Aerobic biological treatment is based on the principles of the activated sludge process with biological removal of nutrients (nitrogen and phosphorus) and separate sludge regeneration [21]. Continuously supplied oxygen activates bacteria so that they can degrade the organic content, which is then converted into CO_2 and excess activated sludge. This method is the most widely used and has been developed over time, so that a large number of activated sludge variants have been achieved.

The presence of nitrogen in any form requires the application of the aerobic nitrification-denitrification biological process so that it is removed to the desired level, but at the same time the formation of this process in the final settlers must be avoided in order to prevent the active sludge from floating [11].

The chemical composition of activated sludge is expressed by the dry matter which represents the totality of organic substances and volatile substances characterising the organic content. The dry matter concentration varies widely between 0.5 - 10 g/L. A brown activated sludge contains more than 75% volatile substances. The calcined residue, what remains after calcination at 600-800ºC contains mineral salts and oxides of elements common in wastewater and which at the same time are necessary for growth. [20] The cations Na^+, K^+, Mg^{2+}, Ca^{2+}, Fe^{2+}, Al^{3+}, and anions Cl^-, PO_4^{3-}, NO_3^-, SO_4^{2-} are present. The elements that make up the organic substances of activated sludge are: C, H, O, N. [22]

The chemical composition of sludge is approximately as follows: 60% protein; 5-20% nucleic acids; 4-25% carbohydrates; 1-40% lipids based on the weight of dry sludge [13].

The activated sludge wastewater treatment plant consists of a primary clarifier, an aeration tank and a secondary clarifier. The treatment plant includes an aeration tank called aerotank, in which the wastewater from the primary settler is strongly aerated by means of air blowing devices, and a sedimentation tank - the secondary settler [7].

Wastewater is directed to the general collection basin, where all wastewater from both the cutting sections and domestic wastewater is collected. With the help of pumps, the wastewater is sent to a rotating drum filter, which is designed to retain coarse suspensions (mechanical treatment stage). The screens retain floating coarse particles suspended in the wastewater. The materials retained on the grates are discharged as such, to be landfilled or incinerated. In some cases they can be shredded by cutting to size 0.5-1.5mm in mechanical disintegrators. The wastewater is then directed to the homogenisation tank of about 190 m², where it undergoes a homogenisation process using high-power mixers, from where it is then redirected to the flotation tank. The wastewater is directed to the flotation tank of

about 25 m² (chemical treatment stage) [7]. Magnasol and zetag are used as reagents for chemical treatment.

Dosing is carried out with dosing pumps in the mixing tank into which air is bubbled. The flocs of dirt that have risen to the surface of the tank are removed into the excess sludge tank by means of scrapers. The purpose of the flotation basin is to remove from the wastewater oils, fats and, in general, all substances lighter than water, which rise to the surface of the water in quiet areas and at low horizontal water velocities [7].

In the activated sludge tank, three elements are mixed: waste water, containing organic substances that constitute the food for mineralising bacteria (the so-called organic substrate), air, which contains oxygen and is supplied by mechanical, pneumatic, mixed or jet processes, and recirculating activated sludge, which contains the living cellular material necessary to maintain a certain concentration of activated sludge in the aeration tank, corresponding to a certain degree of purification required [7].

The purified water is pumped into the settling tank of about 450 sqm, equipped with a raked bridge, which collects the excess decanted active sludge passing the aeration tank, into an excess sludge tank and with the help of a pump system the decanted sludge is redirected either into the aeration tank for the maintenance of microorganisms and the refreshment of the active sludge or into the excess sludge tank. The sludge circuit, via a set of valves, can be directed either to the aeration tank for the maintenance of microorganisms and the refreshment of active sludge, or to the excess sludge tank with recirculation pumps. The settled water is gravity fed into the final basin of the treatment plant, from where it is directed to the natural outfall in the immediate vicinity [7].

In this context, the purpose of the paper was to present the efficiency of wastewater treatment from the food industry using the operating principle of a biological activated sludge treatment plant in a meat processing plant. The indicators reflecting the quality of wastewater were determined using the methods specified by the STAS in force and the research was carried out in the laboratory of the Călărași Environment Protection Agency.

MATERIALS AND METHODS

The legal basis of the legislation concerning wastewater treatment is Directive 91/271/EEC of 21 May 1991, amended and supplemented by the Commission Directive 98/15/EC of 27 February 1998 [2].

In Romania, this Directive was transposed by the Government Decision No 188/2002, subsequently amended and supplemented by the Government Decision No 352/2005 and is the basis for NTPA 001 and 002 [15].

Sampling was carried out between March and July 2023 according to SR ISO 5667-10.

Part 10: Guideline for wastewater sampling, after which the wastewater was analysed in the Laboratory of Călărași Environment Protection Agency.

The methodology for carrying out the determinations was NTPA - 001/ 2002 Limit values for pollutant loading of industrial and urban wastewater discharged into natural receptors - Regulation approved by GD 188/2002 modified and completed by GD No. 352/2005.

The equivalent standards for each indicator highlighting the quality of wastewater from meat processing are shown in Table 1.

The values of these indicators were compared with the maximum permissible value according to NTPA001 [14].

pH determination was done with the INOLAB 720 pH meter, with an accuracy of 0.01units, at 25^0C.

Suspended solids were determined by filtering a given volume of wastewater through a glass fibre filter, followed by dissolving the existing salts by washing the filter with distilled water.

This is followed by drying the solids in the filter at a temperature of 100-105°C. The amount of dry substance in relation to the volume of water initially used is the final result [3].

Table 1. Indicators monitored and standards corresponding to their determination methods

Crt no	Analysed Indicators	The standards
1	**pH**	SR ISO 10523 /2012
2	**Suspended Solids**	SR EN 872/ 2005
3	**COD-Cr**	SR EN ISO 8467:2001
4	**BOD_5**	SR EN 1899-2/2002
5	**P tot**	SR EN ISO 6878/2005
6	**Substances extractable with organic solvents**	SR 7587-96
7	**Biodegradable synthetic detergents**	SR EN 903 /2003
8	**N tot**	SR EN 25663/2000
9	**$N\text{-}NH_4^+$**	SR ISO 7150-1/ 2001
10	**Chlorides (Cl^-)**	SR ISO 9297/2001

Sources: Data from Calarasi Environment Protection Agency [3].

The determination of COD-Cr in the waste water was carried out using the automatic reflux and volumetric titration system. The value of this indicator is extremely important in assessing the degree of wastewater pollution, as it expresses the amount of organic substances contained in the wastewater.

BOD_5 estimates the degree of wastewater pollution, this time the amount of biodegradable organic substances contained in the wastewater. It is a measure of the organic impurification of wastewater and is the amount of oxygen (mg/mass) required for oxidative degradation by microorganisms of the organic substances contained in a litre of water at 20^0C for 5 days (BOD_5). The determination of this indicator in wastewater was carried out using an automated dissolved oxygen consumption reading system [3].

The determination of total phosphorus in wastewater was performed by a colour reaction using the UV-VIS spectrophotometer [3]. The phosphorus contained in wastewater comes mainly from animal waste, but also from detergents or chemical fertilizers [11].

The determination of organic solvent extractable substances in wastewater was done gravimetrically by filtration and oven drying. They are represented by animal fats, hydrocarbons, organic compounds with nitrogen, insecticides, soaps, which are solvent extractable and found in wastewater [12]. The determination of anionic surfactants (detergents) was done by the methylene blue index measurement method [3]. The method to determine total nitrogen in wastewater was IR analysis - oxidative combustion. The gases from the combustion tube, after passing through IR detection for CO_2 analysis, are sampled and introduced into a chemiluminescence detector, used for nitrogen analysis [3]. Determination of ammonia nitrogen in wastewater was performed by volumetric analysis method, by distillation and titration [3].

Chlorides in wastewater were determined by silver nitrate titration using chromate as an indicator (Mohr method) [3].

In order to find out the efficiency of the treatment plant, we calculated the average values of the analysed indicators and then estimated the degree of treatment for each of them. The degree of purification (GE) is the efficiency of the wastewater treatment plant in reducing, in percent, a part of the pollutants in the wastewater, so that the remaining part in the treated water represents the permissible limit value [17]. According to the definition, the degree of purification is determined by the relation:

$$\mathbf{GE = (Ci\text{-}Cf)/Ci*100} \quad \text{.....(1)}$$

where:

Ci – represents the value of the initial concentration of the influent indicator in the wastewater (mg/L);

Cf - represents the value of the final concentration (effluent) of the same indicator after wastewater treatment (mg/L).

RESULTS AND DISCUSSIONS

For an accurate assessment of the impact of wastewater discharge in Călărași municipality on the outfall into which it flows, both the influent wastewater and the effluent from the wastewater treatment plant of the enterprise under study were chemically analyzed. Between March and July 2023, 5 samples of wastewater, influent and effluent were taken

and the wastewater treatment capacity of the analysed unit was monitored using the activated sludge biological treatment method [7]. A total volume of 529 m^3 wastewater was treated during this period and the amount of meat processed was 6,370 kg (82 slaughtered animals).

Factors influencing the values of influent indicators were analysed. The values of the effluent concentrations were analysed in relation to the average value (calculated for the 5 days analysed) and the maximum allowable concentration of NTPA 001.

Table 2. Parameters depending on the situation during the sampling

Crt no	Date of waste water sampling	Quantity of treated wastewater (m^3)	Number of slaughtered animals	Quantity of processed meat (Kg)
1.	15th March 2023	102	18	1,320
2.	12th April 2023	93	16	1,210
3.	17th May 2023	201	29	2,320
4.	15th June 2023	84	12	960
5.	20th July 2023	49	7	560

Sources: Internal meat processing plant data [7].

On 15th March 2023, wastewater samples were taken from both the inlet and outlet of the treatment plant. During this period, 102 cubic meters of wastewater were treated and 18 animals were slaughtered (quantity of meat processed 1,320 kg).

Analysing the data in Table 3, we can see:

- a high value at the inlet to the treatment plant of the analysed indicators: suspended matter, chemical oxygen consumption (COD-Cr), biochemical oxygen consumption (BOD_5), total phosphorus, total nitrogen, ammonia nitrogen (NH_4^+) due to the contribution of organic matter from the fat solubilised after the washing of the installations and nutrients from the blood;
- the concentration of the indicators analysed at the outlet of the treatment plant: pH, chemical oxygen consumption (COD-Cr), biochemical oxygen consumption (BOD_5), total phosphorus, ammoniacal nitrogen (NH_4^+), extractable substances with organic solvents, shows a slight increase, insignificant compared to the average value at the outlet of the treatment plant, due to the contribution of organic matter from the fat solubilised after washing and nutrients in the blood;
- the concentration of the analysed indicators at the outlet of the treatment plant: biodegradable synthetic detergents, total nitrogen, suspended matter, chlorides (Cl-) shows a slight decrease, insignificant compared to the average value at the outlet of the treatment plant, probably due to the physico-chemical treatment with the flocculation agent magnasol and the cationic polyelectrolyte zetag - used in wastewater treatment;
- the concentration of the analysed indicators at the outlet of the treatment plant shows low values compared to the maximum allowed concentration values, except for the indicator total phosphorus, which at concentrations higher than 35 mg/L in the wastewater before treatment cannot be brought below the maximum allowed value of 1 mg/L when discharging water into the outfall, according to NTPA - 001/ 2002, Regulation approved by GD 188/2002 amended and supplemented by GD No. 352/2005.

Table 3. The value of the indicators analyzed on 15th March 2023

Crt no	Analysed Indicators (U.M.)	Station input values	Station output values	Average output value	Maximum permitted conc.
1.	pH (pH Units)	6.69	7.48	7.41	6.5 – 8.5
2.	Suspended Solids (mg/L)	1,618	11.350	32.556	60
3.	COD-Cr (mg O_2/L)	3,526.016	53.203	33.662	125
4.	BOD_5 (mg O_2/L)	1,516.410	22.450	14.581	25
5.	P tot (mg/L)	37.326	1.838	1.099	1.0
6.	Substances extractable with organic solvents (mg/L)	79.167	4.333	1.396	20
7.	Biodegradable syntetic detergents (mg/L)	0.958	0.050	0.214	0.5
8.	N tot (mg/L)	46.616	1.541	6.541	10
9.	N-NH4+ (mg/L)	45.236	0.193	0.151	2.0
10.	Chlorides (Cl^-) (mg/L)	590.165	175.748	192.237	500

Source: Determinations in the laboratory of the Environmental Protection Agency Calarasi [3].

It shows an exceeding of the maximum allowed concentration by 83.8%.

Wastewater treatment in the physico-chemical and biological step is effective for phosphorus of organic nature, phosphorus of inorganic nature remains however solubilized in the treated water.

On 12th April 2023 influent and effluent wastewater samples were taken. During this period a quantity of 93 cubic meters of wastewater was treated and the number of animals slaughtered was 16 (quantity of processed meat 1,210 kg).

Table 4. The value of the indicators analyzed on 12th April 2023

Crt no	Analysed Indicators (U.M.)	Station input values	Station output values	Average output value	Maximum permitted conc.
1.	pH (pH Units)	6.73	7.36	7.41	6.5 – 8.5
2.	Suspended Solids (mg/L)	1,026	30.4	32.556	60
3.	COD-Cr (mg O_2/L)	3,473.365	32.819	33.662	125
4.	BOD_5 (mg O_2/L)	1,458.660	16.8	14.581	25
5.	P tot (mg/L)	32.067	0.881	1.099	1.0
6.	Substances extractable with organic solvents (mg/L)	173.167	1.333	1.396	20
7.	Biodegradable syntetic detergents (mg/L)	128	0.189	0.214	0.5
8.	N tot (mg/L)	41.728	6.043	6.541	10
9.	N-NH4+ (mg/L)	39.478	0.128	0.151	2.0
10.	Chlorides (Cl-) (mg/L)	621.987	195.858	192.237	500

Source: Determinations in the laboratory of the Environmental Protection Agency Calarasi [3].

Following the analyses carried out, according to the data in Table 4, the following were found:

- a high value at the entry to the treatment plant of the concentration of the analysed indicators, greatly reduced after the treatment process (especially in the case of indicators showing organic material in the influent wastewater: chemical oxygen consumption (COD-Cr), biochemical oxygen consumption (BOD_5), ammonia nitrogen (NH_4^+), suspended solids);
- a slight increase in the biochemical oxygen consumption (BOD_5) at the outlet of the wastewater treatment plant, probably due to the contribution of organic matter from fat solubilised by the washing of the machinery used in the technological flow;
- concentration of analysed indicators at the outlet of the treatment plant: pH, suspended matter, chemical oxygen consumption (COD-Cr), extractable substances with organic solvents, total phosphorus, total nitrogen, ammoniacal nitrogen (NH_4^+), synthetic biodegradable detergents, chlorides (Cl^-) - shows a slight decrease compared to the average value, because the amount of processed meat is lower than the average value;
- the concentration of the indicators analysed at the outlet of the treatment plant show values close to the average values and are within the limits of the water discharge into the outfall, according to NTPA - 001/ 2002 Regulation approved by GD 188/2002 modified and completed by GD No. 352/2005, except for the indicator total phosphorus which exceeds the alert threshold value (0.7 of the maximum allowed value of 1 mg/L).

Table 5. The value of the indicators analyzed on 17th May 2023

Crt no	Analysed Indicators (U.M.)	Station input values	Station output values	Average output value	Maximum permitted conc.
1.	pH (pH Units)	6.82	7.39	7.41	6.5 – 8.5
2.	Suspended Solids (mg/L)	1,102.8	33.68	32.556	60
3.	COD-Cr (mg O_2/L)	3,678.9	34.987	33.662	125
4.	BOD_5 (mg O_2/L)	1,545.78	14.689	14.581	25
5.	P tot (mg/L)	35.987	0.987	1.099	1,0
6.	Substances extractable with organic solvents (mg/L)	196.9	1.569	1.396	20
7.	Biodegradable syntetic detergents (mg/L)	1.59	0.234	0.214	0.5
8.	N tot (mg/L)	42.78	6.768	6.541	10
9.	N-NH4+ (mg/L)	41.56	0.156	0.151	2.0
10.	Chlorides (Cl^-) (mg/L)	688.6	203.89	192.237	500

Source: Determinations in the laboratory of Calarasi Environment Protection Agency. [3].

According to the data in Table 5, the following was found: On 17th May 2023 wastewater samples were taken from the inlet

and outlet of the treatment plant. During this period a quantity of 201 m^3 waste water was treated and the number of animals slaughtered was 29 (quantity of meat processed 2,320 kg)

- high values at the entrance to the treatment plant of the analysed indicators: suspended matter, chemical oxygen consumption (COD-Cr), synthetic biodegradable detergents, extractable substances with organic solvents, biochemical oxygen consumption (BOD_5), total nitrogen, ammoniacal nitrogen (NH_4^+), chlorides (Cl^-), due to the contribution of organic matter from fat solubilised after washing and nutrients in the blood, which are greatly reduced by the biological treatment process with active sludge;
- high values at the inlet to the treatment plant of the analysed indicators: suspended solids, chemical oxygen consumption (COD-Cr), synthetic biodegradable detergents, extractable substances with organic solvents, biochemical oxygen consumption (BOD_5), total nitrogen, ammoniacal nitrogen (NH_4^+), chlorides (Cl^-), due to the contribution of organic matter from the fat solubilised after washing and nutrients from blood;
- the concentration of the total phosphorus indicator at the exit of the station shows a slight decrease compared to the average value of this indicator; the concentration of the other indicators at the exit of the station showed higher values compared to the average values, this is due to the higher quantity of meat processed that day;
- the concentration of the indicators analysed at the outlet of the treatment plant shows values close to the average value and is in line with the discharge of water into the outfall according to NTPA - 001/ 2002 Regulation approved by GD 188/2002 modified and completed by GD No. 352/2005.

On 15th June 2023 influent and effluent wastewater samples were taken. During this period, 84 cubic meters of wastewater were treated and the number of animals slaughtered was 12 (quantity of processed meat - 960 kg).
Following the analysis, according to the data in Table 6, we can conclude the following:

- high values of influent indicators, considerably reduced as a result of the purification process;
- a slight increase at the outlet of the treatment plant in the indicators analysed: p_H, suspended solids, total nitrogen, biodegradable synthetic detergents, chlorides (Cl^-) due to the contribution of organic matter from fat solubilised after washing and nutrients in the blood;
- the concentration of the analysed indicators: chemical oxygen consumption (COD-Cr), biochemical oxygen consumption (BOD_5), extractable substances with organic solvents, total phosphorus, ammoniacal nitrogen (NH_4^+) shows a slight decrease compared to the average value, probably due to the lower quantity of processed meat;
- the concentration of the indicators analysed at the outlet of the treatment plant shows values close to the average values and are within the limits of the water discharge into the outfall according to NTPA - 001/ 2002 Regulation approved by GD 188/2002 modified and completed by GD No. 352/2005, except for the indicator total phosphorus, which exceeds the alert threshold value (0.7 of the maximum allowed value of 1 mg/L).

Table 6. The value of the indicators analyzed on 15th June 2023

Crt no	Analysed Indicators (U.M.)	Station input values	Station output values	Average output value	Maximum permitted conc.
1.	pH (pH Units)	6.67	7.43	7.41	6.5 – 8.5
2.	Suspended Solids (mg/L)	1,043.8	32.80	32.556	60
3.	COD-Cr (mg O_2/L)	3,568.49	31.98	33.662	125
4.	BOD_5 (mg O_2/L)	1,498.67	13.430	14.581	25
5.	P tot (mg/L)	34.876	0.912	1.099	1.0
6.	Substances extractable with organic solvents (mg/L)	183.7	1.340	1.396	20
7.	Biodegradable synthetic detergents (mg/L)	1.457	0.245	0.214	0.5
8.	N tot (mg/L)	42.100	6.679	6.541	10
9.	N-NH4+ (mg/L)	40.457	0.145	0.151	2.0
10.	Chlorides (Cl^-) (mg/L)	645.790	197.890	192.237	500

Source: Determinations in the laboratory of Calarasi Environment Protection Agency[3].

On 20th July 2023, wastewater samples were taken from both the inlet and outlet of the treatment plant. During this period, 49 cubic meters of wastewater were treated and the number of animals slaughtered was 7 (quantity of processed meat 560 kg).

Table 7. The value of the indicators analyzed on 20th July 2023

Crt no	Analysed Indicators (U.M.)	Station input values	Station output values	Average output value	Maximum permitted conc.
1.	pH (pH Units)	6.56	7.40	7.41	6.5 – 8.5
2.	Suspended Solids (mg/L)	1,032.7	31.89	32.556	60
3.	COD-Cr (mg O_2/L)	3,345.76	30.845	33.662	125
4.	BOD_5 (mg O_2/L)	1,405.22	13.390	14.581	25
5.	P tot (mg/L)	33.46	0.876	1.099	1.0
6.	Substances extractable with organic solvents (mg/L)	178.9	1.34	1.396	20
7.	Biodegradable syntetic detergents (mg/L)	1.345	0.218	0.214	0.5
8.	N tot (mg/L)	41.679	6.675	6.541	10
9.	N-NH4+ (mg/L)	39.876	0.134	0.151	2.0
10.	Chlorides (Cl^-) (mg/L)	681.568	187.8	192.237	500

Source: Determinations in the laboratory of the Environmental Protection Agency Calarasi [3].

Following the analyses carried out, according to the data in Table 7, the following was found:

- high values of influent indicators, especially those indicating organic matter in the influent;
- a slight increase at the outlet of the treatment plant of synthetic biodegradable detergents used for washing machines and total nitrogen;
- all other indicators analysed at the outlet of the treatment plant: extractable substances with organic solvents, pH, suspended matter, chemical oxygen consumption (COD-Cr), biochemical oxygen consumption BOD_5), total phosphorus, total nitrogen, ammoniacal nitrogen (NH_4^+), chlorides (Cl^-) show a slight decrease compared to the average value, because the amount of meat processed is lower than the average value;
- the concentration of the indicators analysed at the outlet of the treatment plant shows values close to the average values and is within the limits of the discharge of water into the outfall according to NTPA - 001/ 2002 Regulation approved by GD 188/2002 modified and completed by GD No. 352/2005, except for the indicator total phosphorus which exceeds the alert threshold value (0.7 of the maximum allowed value of 1 mg/L).

Analyzing the average concentration of the indicators taken in the study, both at the inlet to the treatment plant and at the outlet and calculating the degree of treatment (efficiency of the biological treatment plant with active sludge):

Table 8. The mean concentration of indicators analyzed

Crt no	Analysed Indicators	U.M.	Average conc. Influent	Average conc. effluent	GE (%)
1	pH	pH Units	6.69	7.41	-
2	Suspended Solids	mg/L	1,164.66	32.556	97.20%
3	COD-Cr	mg O_2/L	3,518.506	33.662	99.04%
4	BOD_5	mg O_2/L	1,484.948	14.581	99.02%
5	P tot	mg/L	34.743	1.099	96.84%
6	Substances extractable with organic solvents	mg/L	162.367	1.396	99.14%
7	Biodegradable syntetic detergents	mg/L	1.326	0.214	83.86%
8	N tot	mg/L	42.981	6.541	84.78%
9	N-NH4+	mg/L	41.321	0.151	99.63%
10	Chlorides (Cl^-)	mg/L	645.622	192.237	70.22%

Source: own calculation.

It should be noted that the yield of all the indicators determined in Table 8 is within the maximum concentration allowed by the legislation in force. The quantity of wastewater varies within very wide limits, depending on the number of animals cut on the day. The wastewater from the meat processing plant, however, is much more concentrated than the wastewater and contains almost only organic substances, both in suspension and in solution.

The pH of the influent water, slightly acidic - 6.69, was brought to an average value of 7.41 after the treatment process - this means neutral water discharged into the outfall.

We can see from Table 8. that throughout the period under analysis, from the determination

of the yield of each indicator, according to the specified formula (1), the efficiency of the treatment plant in terms of the degree of purification of the main indicators is noted, which was between 70.22% - in the case of chlorides and over 99% - in the case of COD-Cr, BOD_5 and substances extractable with organic solvents. The high content of chlorides is due to the salt used in the technological process. The high concentration of chlorides has, by increasing the ionic strength, a role in the extraction and presence of proteins in wastewater.

A percentage of 83.86% represents the purification efficiency of biodegradable synthetic detergents used for sanitizing premises, and the purification efficiency of total nitrogen is determined at a percentage of 84.78%. (Nitrogen - is present in high concentrations in influent wastewater, representing an indication of the presence of proteins in the water).

The degree of purification of 84.78% - corresponding to total nitrogen, and 96.84% - corresponding to total phosphorus, may mean that there are still nutrients in the waters in question that can cause a weak eutrophication process in the outfall into which they are discharged.

We can see the efficiency of the treatment plant by the way the analyzed indicators are reduced to very low concentrations at the outlet of the treatment plant according to NTPA - 001.

CONCLUSIONS

The quality indicators of the wastewater discharged into the outfall, regardless of the volume of treated water, are within the limits imposed by the regulations in force, i.e. NTPA 001, with the exception of total phosphorus, particularly in March 2023, when it exceeded the maximum permitted value by 83.8%. At concentrations higher than 35 mg/l in wastewater before treatment, total phosphorus cannot be brought below the maximum permitted value of 1 mg/l when discharging water into the outfall.

The efficiency of the treatment plant, analysed for the 10 indicators is good, ranging from 70.22-99.63%.

Advantages of the biological treatment process with activated sludge: it is a clean process, leading to a non-putrescible effluent; odours emitted are reduced; the degree of nitrification is controllable; treatment efficiency can be high for BOD_5 - 99.02% and for settleable suspensions - 97.2%; low investment cost.

Disadvantages of biological treatment with activated sludge: requires highly qualified personnel and careful supervision; must be continuously managed and controlled; high operating costs; large amount of sludge formed - difficult to handle and stabilise; process is sensitive to influent composition and concentration; small amounts of nutrients (phosphorus or nitrogen) may remain in the effluent, which may cause a weak eutrophication process in the outfall water.

Biological treatment remains an efficient, economical and least polluting method of removing organic substances from wastewater.

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