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PROBLEMS IN THE PROCESS OF WASTE WATER TREATMENT ON THE SUBOTICA WASTE WATER TREATMENT PLANT (WWTP)

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Abstract

The waste water treatment plant (WWTP) in Subotica has continuously been operating for 33 years. The Plant was designed for mechanical and biological treatment of municipal waste waters. The major issue in the functioning of the plant is its low hydraulic capacity and the inflow of waste waters other than municipal, and not pre-treated industrial and technological effluents respectively. Massive organic matter surges, as well as waters with toxic effect have negative impact on the micro world of the active sludge, modify the character and ability of sludge sedimentation, condition oxygen deficit in aeration tanks, which aggravate the treatment process management and result in the effluent's poor quality. The aim of this paper is to present the effects of the Subotica WWTP operation, and also the quality of technological effluents by the major industries in the city, and their impact on the treatment process in 2008.

Key words:

waste water treatment process, effects of the WWTP's operation, industrial effluents.

1. INTRODUCTION

The city's WWTP is located on the southern part of the city of Subotica, while the recipient for treated wastewaters is Lake Palic. The sewage network in Subotica is built up according to a general sewage system, meaning that the same system takes off stormwater and wastewater alike. The public sewage network comprises drains of different shape, size and material. The city is divided into eight major collection point, and the whole sewage system is gravitation-based. The lowest point in the city is its WWTP. The WWTP was commissioned late 1975 and since then it has been operating continually. The reason behind building a WWTP was a special ecological disaster in Lake Palic in 1971 with a massive pestilence of fishes. Parallel with the building of the WWTP, the lake recovery was implemented as well (desiccation and desludge of the lake-bottom), whereupon the lake was divided by dikes into four sectors. The aim of dividing the lake in such a manner was to provide a more efficient and intensive process of autopurification of the water and thus to provide the highest possible quality of water in the 4th sector, i.e. the tourist part of Lake Palic. Lake Palic is an aeolic, eutrophic lake with maximum depth of about 2.5 meters. Sufficient water quantity in the lake is provided by the inflow of treated waste water from the Plant. Excess water is evacuated through lake Omladinsko jezero via a canal to Ludas Lake, from where it is taken by the Keres streamlet to the Tisa River (Fig 1).

An imperative in the Plant's operation is the best possible quality of effluent, first and foremost, due to the recipient's high sensitivity and eutrophic character. The WWTP was designed to treat municipal wastewaters with a designed hydraulic load of 30000 m^3/day and 45000 m^3/day respectively in times of heavy stormwater, while the designed BOD of influents is 250 mg/l O_2. Waste water undergoes primary and secondary treatment, which comprise mechanical (coarse and fine screen, aerated sand trap and primary sedimentation tank) and biological (aeration tank) treatment of waste waters (Figure 2) [4]. Biological treatment is implemented by activated sludge method. Water is taken from the aeration tanks to secondary sedimentation tanks, where sludge is separated from the treated water.

The problem in the operation of the Plant and achieving water quality, which will not impair and additionally accelerate the eutrophication process of the recipient, is the lack of tertial treatment within waste water treatment (removal of nitrogen and phosphorous compounds), massive hydraulic load of the Plant and the inflow of not treated industrial effluents.

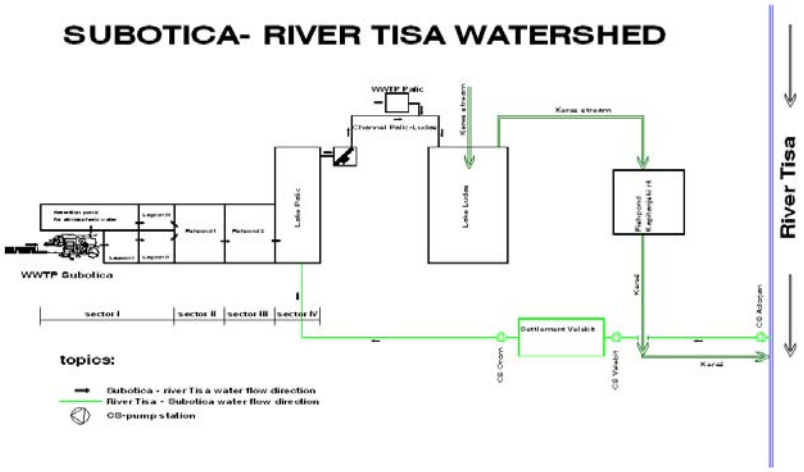

Figure 1. Subotica-River Tisa Watershed

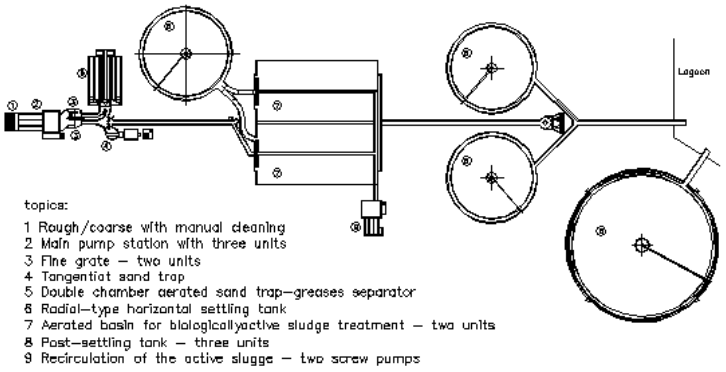

Figure 2. The Wastewater Treatment Plant of the City of Subotica

The aim of this paper is to present the effects of the Subotica WWTP operation, and also the quality of technological effluents by the major industries in the city, and their impact on the treatment process in 2008.

2. MATERIAL AND METHOD OF WORK

Analyses of the Plant's operation are permanently made by the internal laboratory for the quality control of waste and surface waters in the Subotica Waterworks PUC. The laboratory is equipped for physical, chemical and hydro biological analyses. Physical and chemical analyses cover a set of relevant parameters, first pH, organic load, oxygen concentration, total nitrogen and phosphor content in the waste and treated water, as well as dry matter content and sedimentation volume of the bioactivated sludge, and are defined by the recommended standard methodology. Instantaneous and 24-hour composite samples are processed per each treatment phase. Samples of industrial effluents are taken once or twice a month. The selection of parameter volumes for the analyses of industrial effluents is made depending on the type of industry, and mostly, it includes basic parameters.

Biological analyses include microscopic quality control of the bioactivated sludge according to the recommended methodology [3]. Analyses are made on a daily basis, while samples are taken from the aeration tanks and the recirculating sludge. Fresh, native and coloured preparations are analysed. Photos of the samples are taken daily, and data are kept in a database. Toxicological tests of industrial effluents are also made. Toxicity level is determined by standard short (24h) tests on aquarium fish *Lebistes reticuatus*. LC-50 is defined (concentration of chemicals which kills 50% of the organisms in a specific time). Results are expressed in %Tlm which is conversely proportional to toxicity level, and in Dil. Tlm indicates indicates the number of times the water is to be diluted in order to achieve LC-50.

3. RESULTS AND DISCUSSION

The operation of the WWTP

The average quantity of intake water on the Plant was 39155 m^3/day, while an average quantity of 32375 m^3/day of waste waters was treated in 2008 [2].

The quality of intake water was varied over the year. Moderate content of organic matters, with time-to-time surges of organically highly loaded waters was characteristic for the raw waste water. The tendencies of average and maximum organic load values for the raw and treated waste water are shown in Table 1.

Table 1: Organic load values of influent and effluent waste waters and Sludge Volume Index

Parameters	BOD (mg/l)	BOD (mg/l)	BOD (mg/l)	BOD (ml/g)	SVI (ml/g)
	Influent average	Influent max.	Effluent average	Effluent max.	
January	228	390	16		228
Febr.	207	332	14		240
March	208	332	17		279
April	197	233	7		261
May	219	318	20		326
June	161	282	14		354
July	205	302	22		555
Aug.	211	341	11		378
Sept.	232	382	16		368
Oct.	260	352	34		519
Nov.	248	347	31		452
Dec.	203	424	15		325

From the aspect of impact on the aquatic eco-system of Lake Palic, it is essential to emphasise that there is a relatively high nitrogen and phosphor content in the city's waste waters. In the total nitrogen content its ammonium form is dominant. The average concentration of total nitrogen in inlet water was 44,2 mg/l. Thereof ammonium nitrogen made up 29,2 mg/l or 66%. The total nitrogen concentration in treated water was 30,7 mg/l , and 23,5 mg/l, or 76% of this was ammonium nitrogen. The effect of total nitrogen decrease was 30% in the Plant. The total nitrogen concentration in treated water was 6,61 mg/l , and 3,41 mg/l of this was ammonium nitrogen. The effect of total phosphor decrease was 50% in the Plant [2].

Microscopic sludge analyses serve system status assessment based on quality of floc and microorganism composition. High hydraulic load and frequent surges of high concentrations of organic matters condition system overload and oxygen drop in aeration tanks, which are reflected in the qualitative and quantitative composition of microbe community in the activadet sludge [1]. Filamentation index [3] (total number of filamentous bacteria) was increased over the whole year (FI=6). *Thiothrix* spp., was dominant, and it is a sulphuric bacterium, which, with the contexture of its long and thick filaments changes sludge characteristics and aggravates sludge sedimentation and it is reflected in increased SVI over the whole year (Figure 3b). Frequent occurrence and higher number of type 1863 was recorded as well, since it grows on hydrophobic substrates (grease) and, due to its morphology, it floats up and creates foam. The size, shape, structure and stability of flocs were satisfactory most of the year, yet sludge age was constantly old with frequent occurrences of sludge decay signs (Figure 3a). Numerous low diversity colonies (as a consequence of uniform substrate) occurred during the year as well. The number of free cells in supernatant was constantly increased (indicating system overload) From the protozoa, flagellates (indicators of overload) also occurred frequently, while amoebae were recorded infrequently and in smaller number. Free-living ciliates occurred sporadically, mostly *Colpidium* spp. and *Euplotes* spp. From the crawling ciliates, *Aspidisca costata* was dominant, which was permanently present and sometimes achieved high numbers.

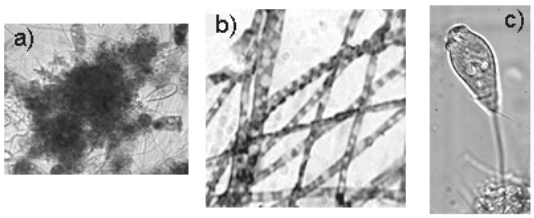

Figure 3. Activated sludge microorganisams: a) sludge floc, b) Thiothrix spp., c) Vorticella microstoma

Most frequently, the total number of fixed ciliates was higher than 20000/ml, sometimes reaching a value over 120000/ml (which also indicates sludge ageing). During May, June and July, the number of this indicator groups of organisms dropped (to below 10000/ml), due to the toxic influence of the influent water quality. Dominant were *Vorticella microstoma* (Figure 3c), *Opercularia* spp. and *Vorticella convalaria*.

Industrial Effluent Analysis

A total of 104 wastewater samples of industrial origin were analysed in the wastewater quality control laboratory. Quality incompliance of effluents to the prescribed values is determined on the base of permitted maximum concentration (PMC) set in Article 18 of the Decision on Public Sewage (the Official Journal of the Subotica Municipality no. 39/2001). The effluent quality of controlled industrial polluters deviated from the prescribed PMC values in the following parameters: low and

high pH values, high organic load, grease and oil, sedimentary matters, inorganic soluble salts, total nitrogen and phosphor and AA detergents [2]. Effluents coming from process industry (milk processing, flour and fruit processing, beverage production) had the most significant negative impact on the Plant's operation. (Table 2).

About 70% of the analysed samples showed satisfactory quality in view of toxicity (atoxic or oligotoxic water levels I and II) and did not disturb the Plant's operation [2]. In average, the highest toxicity level over the year was in food processing industries, i.e. dairy and flour processing (farina production) and in the textile industry, while maximum toxicity level was also recorded in fruit processing industry and beverage production, where it amounted to %Tlm=1,41, which corresponds to mesotoxic water level V. If %Tlm value is lower (>100), the analysed sample is of higher toxicity level (Table 2).

Table 2. Demonstrated maximum values of critical physical and chemical parameters and toxicity level of dominant industries in Subotica in 2008

Sampling spot-industrija Parameters	Flour Processing Industry	Milk processing Industry	Fruit Processing and Beverage Production	PMC
max. pH	6,31	7,85	10,12	8,5
min. pH	3,58	4,48	1,52	6,5
BPK_5 (mg/l)	13900	65668	2082	-
Total N (mg/l)	334	873	28,8	50
Total P (mg/l)	142	71	1,90	12
Grease (mg/l)	-	7177	-	30
Total Sedimentary Matters (mg/l)	12520	1380	110	100
%Tlm	3,17	3,17	1,41	100
Toxicity Level	Mesotoxic Level V	Mesotoxic Level V	Mesotoxic Level V	-

4. CONCLUSION

WWTP in Subotica received higher quantities of water than the designed ones during 2008.

Unlike municipal wastewaters, which are mostly uniform in their physical and chemical composition, the character of industrial effluents significantly varies in quality and quantity. The WTTP cannot treat adequately the diverse composition of industrial effluents, hence these aggravate the treatment process by making it slower and more expensive.

The lack of tertial water treatment is the cause of high total nitrogen and phosphor concentration in the effluent over the whole year.

Due to the above indicated, effluent quality during 2008 was not always satisfactory, yet treatment effects, express through the decrease in total organic load of the water, amounted to 92%.

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