BULETINUL INSTITUTULUI POLITEHNIC DIN IAŞI
Publicat de
Universitatea Tehnică „Gheorghe Asachi" din Iaşi
Volumul 70 (74), Numărul 4, 2024
Secţia
CONSTRUCŢII DE MAŞINI
DOI:10.2478/bipcm-2024-0027

RESEARCH ON THE TREATMENT OF WASTEWATER AND POSSIBILITIES FOR OPTIMIZING THE TECHNOLOGICAL ROUTE

BY

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Received: February 23, 2025
Accepted for publication: February 28, 2025

Abstract. Water is one of the basic resources for all living things on Earth. From historical studies it can be seen that human settlements appeared near watercourses, because no human activity is possible without water. The Earth's surface is covered in 78% water, which seems encouraging, but of this amount, only about 2.5% is considered drinkable. This distribution shows us the limiting nature of drinking water resources, which requires efficient management of this resource. Along with the development of mankind, water was used more and more in various domestic, industrial, energetic, and other activities, so that its quality was affected. Under such conditions, it has become absolutely necessary to apply wastewater treatment methods. By applying wastewater treatment methods, the aim is to improve water quality, so that it can be discharged into the emissary without being harmful to various environmental factors. This paper presents the classical methods of wastewater treatment and the possibility of optimizing the technological treatment route in a wastewater treatment plant.

Keywords: wastewater, treatment plant, conventional treatment, mechanical water treatment, pollutants.

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1. Introduction

Along with the economic and social development of mankind, it is more and more difficult to ensure the necessary water needs for domestic, industrial, energy and agricultural use, because each of these activities causes water pollution (Obidike and Madigoe, 2021). Water pollution is nowdays one of the most important environmental issues facing humanity (O'Dwyer *et al*., 2020).

Wastewater can come from three sources, namely: domestic, industrial and rainwater. Domestic wastewater is the water that ends up in the sewer from household activities. Industrial wastewater contains the water resulting from chemical processes or production processes. Storm sewage is water resulting from precipitation that has not infiltrated the soil but has flowed and reached open channels or collection pipe systems.

The basic function of wastewater treatment is to speed up the natural processes by which water is purified. This can be done by separation, removal and disposal of the pollutants present in the wastewater.

2. Wastewater treatment plant

According to the environmental regulations of the European Union, which our country adopted as a member, the processes in the treatment plants are composed of primary, secondary and tertiary treatment. Usually we can have and a preliminary phase of wastewater treatment.

After passing through each stage of the treatment flow, pollutants are removed from the wastewater so that the degree of purification increases as the process progresses.

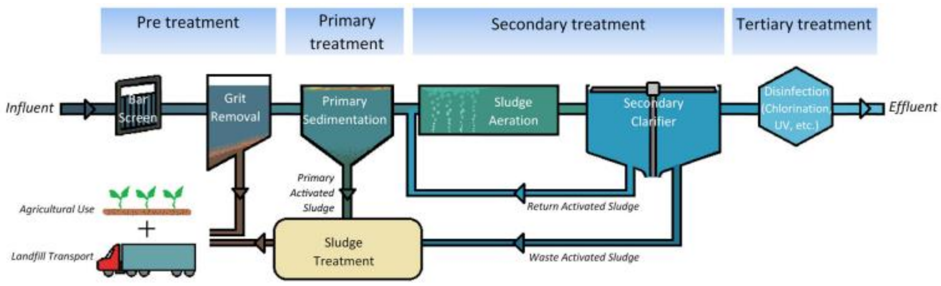


Fig. 1 – Illustration of treatment stages of a treatment plant (Birch *et al*., 2020).

The removal efficiency of a pollutant in the treatment or in a treatment stage is given by the formula (Pande and Hambarde, 2024):

$$E = \frac{C_o - C_e}{C_o} \cdot 100 \tag{1}$$

where: C_o - influent concentration of the pollutant (mg/l) and C_e - effluent concentration of the pollutant (mg/l).

In this preliminary phase of wastewater treatment a series of materials such as rags, plastic and other foreign materials are removed. The screened materials are hazardous and must be safely disposed of to prevent human health concerns, odours. Also these materials can damage the equipment of plant if they aren't removed. Screens are usually mounted in a chamber or in a channel, being placed at a certain angle to the horizontal. The tilt angle is intended to increase the retention of floating bodies and large suspensions and to facilitate the cleaning process of the screens.

The inclination also plays a role in cleaning the screen, which can be done manually or mechanically. Manual cleaning is generally found in small wastewater treatment plants. In some situations, to avoid clogging in certain treatment plants, devices are installed in addition to screen to retain and crush deposits.The wastewater flow after passing through the grates and screens reaches the grit separator area. Grit separators are special concrete basins where granular suspensions are retained, especially sand carried by the moving waters.

After passing through the grit removed, the wastewater still contains organic and inorganic materials along with other suspended solids. By reducing the flow rate, these suspensions will settle to the bottom of the tank, forming a mass of solids called sludge (Borzooei *et al*., 2019).

Secondary wastewater treatment is based on biological processes that remove both dissolved and suspended organic matter. Microorganisms are used for this purpose and the processes can be grouped into aerobic and anaerobic.

The purpose of tertiary treatment or advanced treatment, is to improve the effluent quality before it is discharged to the receiving water body or reused (Agrawal *et al*., 2017).

3. The choice of the most appropriate wastewater treatment technology

In order to choose the optimal variant of the technological purification route, the values of the pollutants in the used water to be treated must be known several possible options must also be analyzed. For the exemplified case, a technological scheme consisting of two treatment steps is considered, more exactly one mechanical and the other biological (Cetkovic *et al*., 2023).

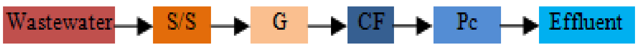
Mechano-biological processes are based on the joint action of mechanical and biological processes and can take place in natural conditions (irrigation or filtration fields, biological ponds, etc.) or in artificial conditions (biological filters or aeration basins with activated sludge). Under normal operating conditions, the efficiency of such a treatment step, expressed by the degree of purification achieved, can be estimated at over 90%. Natural mechano-biological treatment is a solution that lends itself to small capacity treatment plants.

For a given situation, we know from the monitoring station, the composition of the wastewater that must be introduced into the treatment plant (Mng'ombe *et al*., 2024), more exactly: the concentration of suspended solids (C_{SS}=184 mg/l), biochemical oxygen demand in five days (BOD_5=321 mg/l), chemical oxygen demand (CCO-Cr=398 mg/l), concentration of ammonium (NH_4=18 mg/l). Starting from these wastewater data, four technological treatment flows are proposed which are presented in Figs. 2 - 5.

Legend: S/S: screen and sieve; G: grit; Pc: Primary clarifier.

Fig. 2 – The first technological route option.

Using relation (1) we will calculate the efficiency of each technological flow proposed in the four schemes. For each component of the technological flow, we have the standard efficiency so that we can determine the concentration of pollutants when passing through that component. The respective concentration will be considered the input concentration in the next component of the flow.

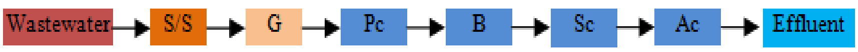


Legend: S/S: screen and sieve; G: grit;
CF: Coagulation and flocculation Pc: Primary clarifier.

Fig. 3 – The second technological route option.

Legend: S/S: screen and sieve; G: grit; Pc: Primary clarifier;
Asp: Activated sludge process; Sc: Secondary clarifier.

Fig. 4 – The third technological route option



Legend: S/S: screen and sieve; G: grit; Pc: Primary clarifier; B: biofilter;
Sc:s econdary clarifier; Ac: Activated carbon.

Fig. 5 – The fourth technological route option.

The results of the pollutant concentrations calculated for the technological flow diagrammed in Fig. 2 are presented in the second column of Table 1, so var. 1.

Similarly, for the other variants, the results are given in Table 1. On the other hand, European Council Directive 91/271/2002 transposed by Government Decision 188/2002 is the legal basis of community legislation on wastewater (Zăbavă *et al.*, 2016) and from this document, the admissible values of the monitored quality parameters are given in the last column of Table 1 (NPTA).

Table 1
The values of the pollutants resulting from the calculation and the allowed limits

Indicator	var. 1	var. 2	var. 3	var. 4	NPTA
SS	*43.5*	*21.9*	*8.7*	*8.7*	*35*
BOD_5	*146.05*	*73*	*29.2*	*9.1*	*25*
CCO-Cr	*181.09*	*90.5*	*36.2*	*13.6*	*125*
NH_4	*76*	*2.3*	*2.3*	*1.3*	*10*

Comparing the obtained results, it is found that var. 4 is the only one in which the obtained values are all, lower than the admissible limits**.**

4. Conclusions

Water is an important resource, but if it is used improperly and discharged without going through a treatment plant, it can be a problem for the health of people and animals and for the environment in general.

Comparing columns var.3 and var.4, it can be seen that in column var 3, the biological oxygen demand parameter is the only one that does not fall within the permissible limits.

Since in Fig.5 corresponding to var.4 the technological route is provided with a biological filter and adsorption with activated carbon, the BOD parameter has a value lower than the admissible value.

For an optimal route of the used water through the treatment plant, it is necessary to permanently monitor the degree of pollution of the water to be treated. Based on these values, the optimal technological flow through the wastewater treatment plant can be determined.

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CERCETĂRI PRIVIND TRATATREA APELOR UZATE ȘI POSIBILITĂȚI DE OPTIMIZARE A TRASEULUI TEHNOLOGIC

(Rezumat)

Apa este una dintre resursele de bază pentru toate ființele vii de pe Pământ. Din studiile istorice se poate observa că în apropierea cursurilor de apă au apărut așezări umane, deoarece nicio activitate umană nu este posibilă fără apă. Odată cu dezvoltarea omenirii, apa a fost folosită din ce în ce mai mult în diverse activități casnice, industriale, energetice și de altă natură, astfel încât calitatea ei a fost afectată. În astfel de condiții, a devenit absolut necesară aplicarea metodelor de tratare a apelor uzate. Prin aplicarea metodelor de epurare a apelor uzate se urmărește îmbunătățirea calității apei, astfel încât aceasta să poată fi deversată în emisar fără a fi dăunătoare diverșilor factori de mediu. Această lucrare prezintă metodele clasice de epurare a apelor uzate și posibilitatea de optimizare a traseului tehnologic dintr-o stație de epurare.