COMPARISON OF EFFICIENCY OF DIFFERENT TYPE SYSTEMS FOR WASTEWATER TREATMENT

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Abstract

This study has the purpose to evaluate the efficiency of different waste water treatment plant The following wastewater treatment systems were studied: activated sludge,plant, physico-chemical treatment, biodisc and biofilter. Waste water samples were collected from treatment units and analysed for the major water quality parameters, such as biological oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), total nitrogen(N_t) and phosphorus (P_t). The efficiency of each unit in treating the pollutants was calculated.

In this paper we found that from the four types of municipal waste water treatment systems, activated sludge basins have provided most removal efficiency BOD_5 (92.09%) and phosphorus (87.41%). Municipal wastewater treatment efficiency for biodisc had the highest values for the parameters TSS (96.9%),% COD (91.6), NT (93.5%), but treatment efficiency for phosphorus removal (60.5%) was below the legal limit recommended (Directive 98/15/EEC). The maximum removal of phosphorus was for activated sludge plant(87,41%) and minimum removal efficiency was 13,3% for biofilters. For nitrogen, the higher efficiency was obtanined in biodiscs tehnology(93,5%) and the physico-chemical tehnology.had the lowest efficiency.(1,2%).

Keywords**:** *Waste water treatment plant(WWTP), biodisc, biofilter, physico-chemical treatment, activated sludge, efficiency*

INTRODUCTION

Romania's strategy regarding the sollutions for the environmental problems consider and choose the most efficient treatment technologies by conducting and commissionin new performant installations and providing services tailored to suit environmental requirements. The improvement of wastewater treatment processes is a some possible action towards the development and implementation of eco-effective strategies.

„Waste water carry appreciable amounts of nutrient and trace toxic metals”(Vinad Kumar and A.K.Chopra, 2012)

European Commission Directive 98/15/EC aims to reduce the pollution from municipal wastewater in surface water bodies, to reduce the nitrogen and phosphorus, protection against nitrate pollution of groundwater bodies used as potential drinking water resources, appropriate collection and treatment (appropriate treatment depending on the amount discharged) of wastewater from urban and industrial areas. Thus, a timetable for wastewater collection, treatment systems and the level of treatment required

was established. The process and requirements vary according to population size and sensitivity of the receiving water body.

Activated sludge treatment technology consists of mixing and aerating the mixture of wastewater with recycled activated sludge, followed by separation of wastewater of sludge. Activated sludge plants consist of two compartments. The first section is called aeration basin. Here the mixture and aeration of sludge are made. By creating appropriate shapes and introducing air, we create favorable conditions for bacterial growth in the existing aerobic wastewater that adheres to the surface of suspended solids in the form of flakes uniformly dispersed in the tank (Metcalf and Eddy Inc., 1991).

Biofiltration as a treatment technology in water and wastewater purification. The arrow indicates the direction of water flow. Biofilters contain filter medium grains (e.g., sand, granular activated carbon) that are covered with biofilms (Juan Manuel Vigueras-Corté, et al, 2013). The biofilm activities break down nutrients (e.g., nitrogen and phosphorous-containing compounds) and organic carbon as well as capture other unwanted contaminants in the influent water (Kargi, Uygur, 1997).

Biofilms are widely used in environmental engineering systems as the powerhouse of treatment processes. Biofilms are used to remove biological nutrients in wastewater treatment (Figure 1).

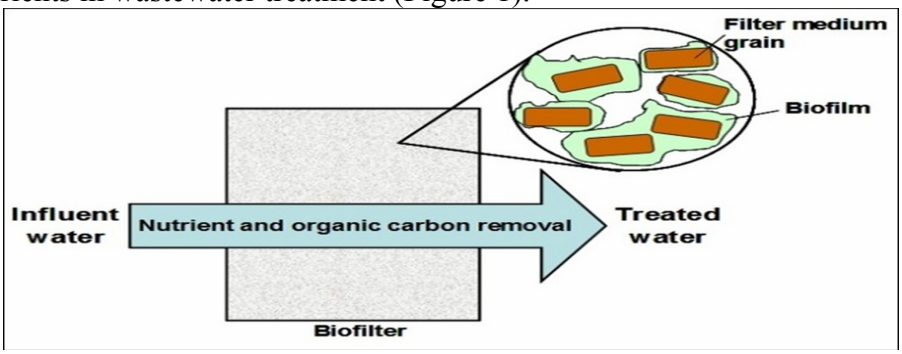

Fig. 1. Biofilms are used to remove biological nutrients in wastewater treatment *www. nature.com* (Biofiltration as a treatment technology in water and wastewater purification)

In wastewater treatment, nutrient removal is an essential outcome to protect the natural environment from eutrophication and unwanted contamination. Nutrient removal is achieved primarily by biological means; the most common is through the use of activated sludge, which is a mixture of flocs. Flocs are equivalent to biofilms formed in suspension, rather than attached to surfaces, where cells of various species are glued together by EPS, forming a suspended biofilm having a complex microbial community.

Biodiscs are based on aerobic bacterial activity taking place in biological film grown under conditions determined on a porous support. Bacterial culture media is achieved by a set of rotating disks, plastic porous high surface area, mounted on a horizontal axis located above and below the water level in the basin which contains the waste water. Depending on the capacity of the installation one or more sets of discs are installed. Slow rotation of the disc is conducted with a low electric power. Rotating discs will ensure the introduction of oxygen necessary for the microorganisms.

Physico-chemical treatment may constitute a single stage in the wastewater treatment process or be added as an additional treatment process during pre-treatment (to improve the biodegradation of wastewater in the biological process and secondary treatment (such as polishing).

Physico-chemical processes have been implemented for over 100 years. However in 1930, these processes were replaced by biological processes due to the high costs incurred by the treatment of large quantities of sludge. Recently, they have been reintroduced for various purposes: the elimination of phosphorus. Using this type of process it is feasible to remove 80 to 90% of total suspended solids (TSS), 40 to 70% of BOD_5, 30 to 40% of COD and 17 to 100% of nutrients (N and P), depending on the dose and type of coagulant used.

Performance evaluation of existing treatment plant is required (1) to assess the existing effluent quality and/or to meet higher treatment requirements and, (2) to know about the treatment plant whether it is possible to handle higher hydraulic and organic loadings.

Also, the socioeconomic environment has been considered as one of the important factors that could influence wastewater treatment systems and its effectiveness.

MATERIAL AND METHODS

The municipal wastewater were taken from the wastewater treatment plants in four localities in Romania with the same number of inhabitants equivalents Because the study is focused on the comparison of treatment technologies applied, samples were taken from inlet and outlet: activated sludge, biofilters , biodiscs, physico-chemical treatment.

For doing research on the topics related to this work, experiments were performed in the laboratory of the chemical analysis from Faculty of Environmental Protection Oradea.

The physico-chemical parameters which were measured are the following: biochemical oxigen demand (BOD_5), chemical oxigen demand (COD), total suspended solids (TSS), nitrogen (N_t) and phosphorus (P_t) following APHA metods(APHA, 1999).

Total Suspended Solids(TSS) refers to matter suspended within the water column and the fraction of total solids retained by a filter during sample analysis (APHA, 1999).

All the results were compared with standardized level for wastewater quality found in accordance with European Comission (Directive European Commission Directive 98/15/EC amending Council Directive 91/271/EEC) and Romanian law (NTPA 001/2005)

The removal efficiency(%) for every waste water treatment was calculated with the following formula:

$$\text{Removal efficiency}(\%) = \frac{Ci - Ce}{Ci} \cdot 100$$

where:

Ci – concentration of waste material in influent(mg/l)

Ce – concentration of waste material in efluent(mg/l)

RESULTS AND DISCUSSION

The main objectives have been to analyse the effluent collected from four wastewater treatment plant that operate with different tehnologies: activated sludge, physico-chemical, biodisc and biofilter.

Each plant in this study has specific treatment technologies and the obtained effluent quality (media for four months(March, April, May, June of year 2013) is presented in Figure 2, 3, 4, 5 with respect to the monitored main parameters.

Detection of biochemical oxygen demand(BOD_5) value in the effluent of activated sludge plant, biodisc, biofilter and physico-chemical treatment is presented in Figure 2.

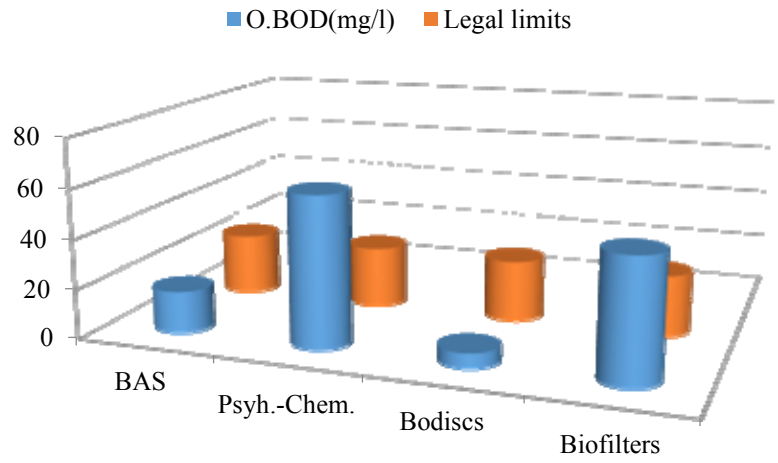

Fig. 2. Monitoring of biochemical oxygen demand in the effluent of wastewater treatment plant

The BOD_5 values are higher than maximum accepted value (25 mg/l) of the Romanian Law(NTPA 00/2005) for biofilter(BOD_5 = 49,1 mg/l) and physico-chemical treatment(BOD_5 = 60,9 mg/l). The smaller value for BOD_5 was obtained in biodisc(6,2 mg/l). Activated sludge tehnology provided a concentration of 17,1 mg/l BOD_5 in effluent.

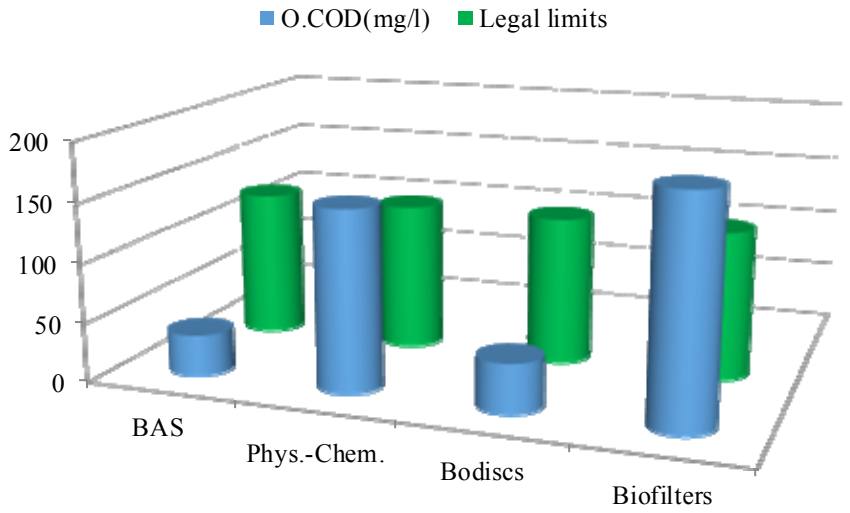

Fig. 3. Monitoring of chemical oxygen demand in the effluent of wastewater treatment plant

Chemical Oxygen Demand(COD) is a vital test for assessing the quality of effluents and wastewater prior to discharge (Vinod Kumar, A.K.Chopra, 2012). „Both organic and inorganic compounds have an effect on urban wastewater oxidability since COD represents not only oxdation of organic compounds, but also the oxidative of reductive inorganic compounds"(Paula Popa et al., 2012).

In this study the O.COD value are smaller then maximum accepted value(125 mg/l) of European and Romanian Law (O.COD = 125 mg/l) for BAS(activated sludge), O.COD=35,1 mg/l) and biodisc, O.COD = 41,8 mg/l and higher for phys-chemical O.COD = 152,4 mg/l and biofilter, O.COD = 187,7 mg/l. Similar results was obtained Paula Popa et al., 2012 and Vinod Kumar, A.K.Chopra, 2012.

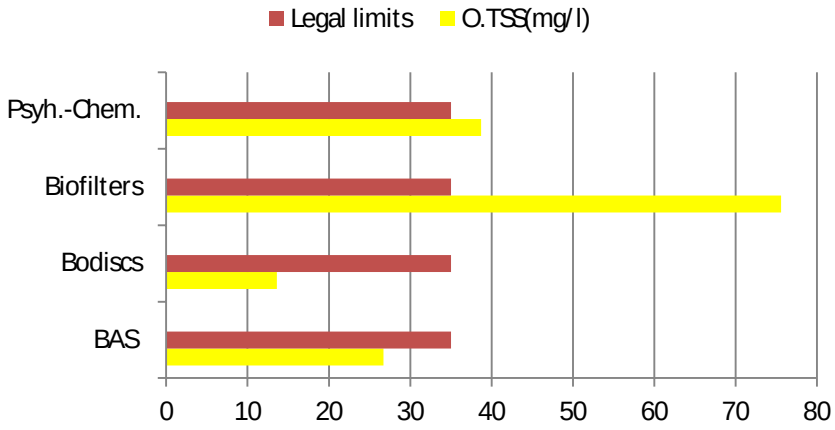

Fig.4. Monitoring TSS in the effluent of wastewater treatment plant

In this study total suspended solids (TSS) of effluents were decreased for BAS (O.TSS = 26,7 mg/l), biodiscs(O.TSS = 13,6 mg/l). In biofilters, O.TSS value was 75,6 mg/l and in phys.-chemical treatment, O.TSS was 38,7 mg/l (the O.TSS values are higher than maximum accepted value of the Romanian Law: 35 mg/l) (NTPA 00/2005).

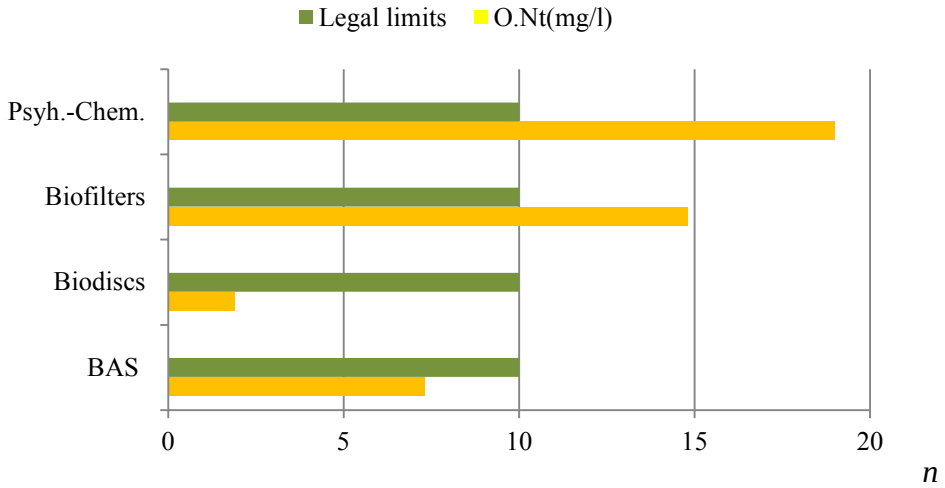

Fig.5. Monitoring the nitrogen in the effluent of wastewater treatment plant

Also, the physico-chemical tehnologies gave us the higher value(19 mg/l) for nitrogen compared with; $O.N_t$: 7.3 mg/l for BAS, 1.9 mg/l for biodiscs and 14.8 for biofilters.

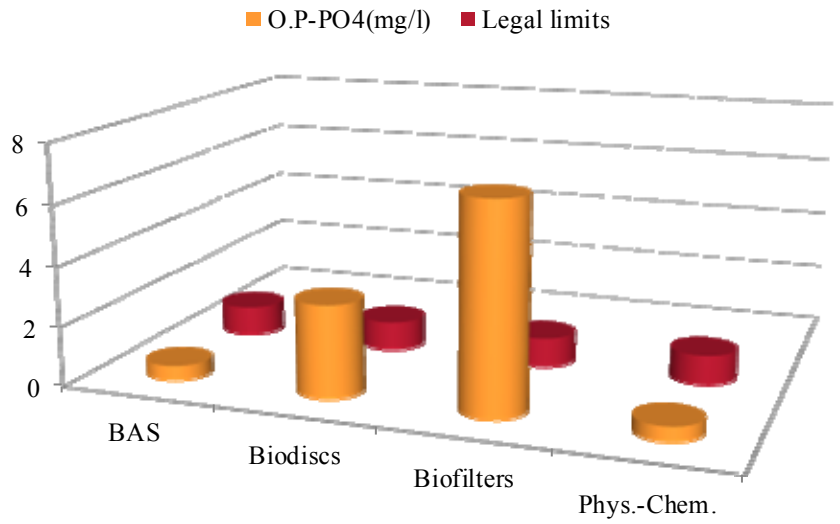

Fig.6. Monitoring of total phosphorus in the effluent of wastewater treatment plant

The most advanced technologies in terms of reducing phosphorus are activated sludge basins and physico-chemical technologies (0,5 mg/l). The phosphorus concentration in effluent from biodiscs and biofilters higher than maximum accepted value (1 mg/l) of the Romanian Law (NTPA 00/2005).

Treatment efficiency

In order to highlight the performance of the studied wastewater treatment plants, the treatment efficiency was calculated for all analyzed parameters.

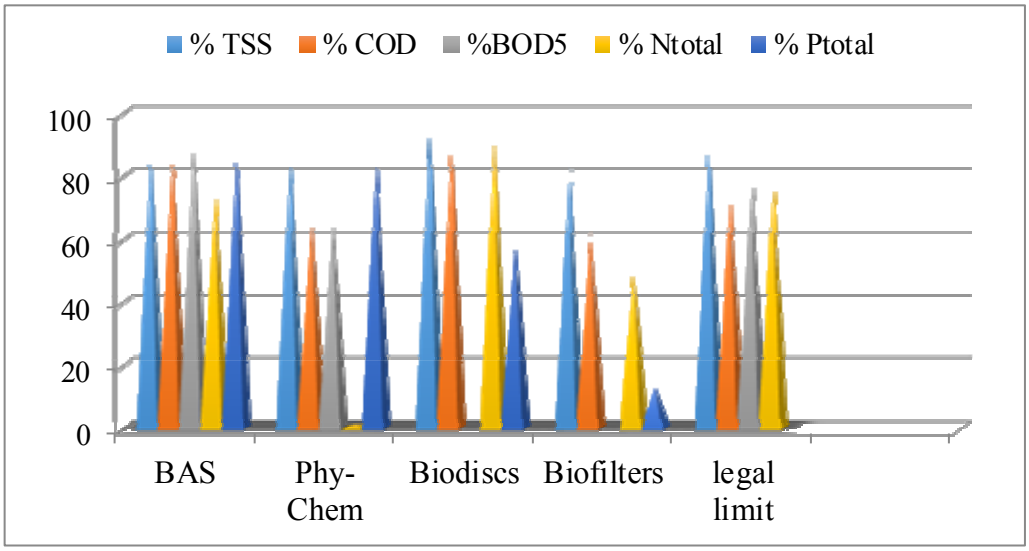

Fig.7. Monitoring of treatment efficiency of wastewater treatment plant stages of wastewater treatment

The effluent quality does not always depend on the efficiency of the treatment processes. *Figure 7* shows that the activated sludge treatment plant ensures high efficiency.The biodiscs ensured the maximum removal of TSS(96,6%), COD(91,6%) and nitrogen(93,5%). The maximum removal of phosphorus was for activated sludge plant(87,41%) and minimum removal efficiency was 13,3% for biofilters.

CONCLUSIONS

In this paper we found that of the four types of municipal waste water treatment systems, activated sludge basins have provided most removal efficiency BOD_5 (92.09%) and phosphorus (87.41%). Municipal wastewater treatment efficiency for biodisc had the highest values for the parameters TSS (96.9%),% COD (91.6), NT (93.5%), but treatment efficiency for phosphorus removal (60.5%) was below the legal limit recommended (European Commission Directive 98/15/EC of 27 February 1998 amending Council Directive 91/271/EEC of May 1991). The maximum removal of phosphorus was for activated sludge plant(87,41%) and minimum removal efficiency was 13,3% for biofilters.

For nitrogen, the higher efficiency was obtanined in biodiscs tehnology(93,5%) and the smaller efficiency had physico-chemical tehnology.(1,2%).

The analysis the average values of the main parameters monitored have highlighted that the technology that provides the best quality effluent

treatment plant is the activated sludge technology. The municipal waste water treatment can always be improved, and this improvement should be oriented towards sustainability. A sustainable urban wastewater system should not have negative effects on the enironment even on a long turn perspective, while providing required services, protecting human health and the environment with a mínimum of scarce resource use.

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