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THE PERFORMANCE OF FILTERS PLANTED WITH TYPHA LATIFOLIA IN THE REMOVAL OF AMMONIUM AND PHOSPHATES PRESENT IN DOMESTIC WASTEWATER

Nora Seghairi[1], Sara Badache[2], Nawel Guerrouf[3], Sara youcef[4], Leila Mimeche[5]
[1,4,5] Faculty of Science and Technology. Laboratory of Research in Civil Engineering, Hydraulics, Development, Sustainable and Environment (LARGHYDE). Mohamed Kheider University - Biskra - Algeria.
[2,3]Faculty of Exact Sciences and Sciences of Nature and Life.

***Corresponding Author:-**
Email: nora_ba2000@yahoo.fr

Abstract:-
Systems for the purification of waste water by aquatic plants, functioning as biological assimilators by eliminating both biodegradable and non-biodegradable compounds as well as nutrients and metals. Several works have proven their ability to efficiently exploit municipal wastewater and industrial effluents. It is in this perspective that the aim of this study, which is to highlight the potentialities of a filter planted with Typha Latifolia to eliminate nitrates and ammonium present in domestic wastewater, is included. This work consists in controlling the purifying power of this plant during the passage of polluted water through this filter. The results obtained show that the elimination percentages are of the order of 90.38% and 91.65% respectively for ammonium and phosphates for a period of 10 days whereas the non-planted filters showed an elimination ranging from 68.65% and 78.11%.

Key words: - *Planted filter, Typha Latifolia, wastewater, ammonium, phosphate.*

I. INTRODUCTION

The use of "constructed wetlands" to treat wastewater is a widely accepted ecological engineering approach throughout the world **[1,2,3]**. This technique, which falls within the field of phytopurification, consists of reproducing and potentiating on a small scale the purification processes that take place in natural HZs and which rely on the joint action of plants, microorganisms and soil **[4]**. The technologies developed exploit the adaptability of root systems to high pollutant loads and conditions of anoxia or hypoxia of the substrate, resulting in symbiotic relationships between microorganisms and roots that promote the elimination of pollutants **[5]**. They consist of individual basins, also called planted filters, connected to each other in series. These basins may be sub-surface or free-surface **[6]**. In subsurface flow filters (FSS), water flows by gravity, horizontally or vertically, through the substrate that hosts a procession of microorganisms living in association with plant roots **[7]**. In horizontal flow filters (FH), water enters the filter and slowly flows through the filter bed below the bed surface along a more or less horizontal path until it reaches the exit zone. Most of the bed is in a saturated zone and has anaerobic conditions, although aerobic areas are located around the roots and rhizomes that diffuse oxygen into the substrate **[8.9]**. In vertical flow (VF) filters, water is generally alternately and sequentially delivered over the entire surface of the bed, and rapidly percolates through the substrate in a more or less vertical path, creating an unsaturated medium and mainly oxidizing conditions. Of simple appearance, the operation of these planted filters involves purifying reactions that can be complex. But the basic principle remains the infiltration of a raw effluent through beds composed of a mixture of sand-gravel or soil in place, planted with macrophysics (most commonly, common reeds). The bed material and the root part of the plants serve as a support for a purifying biomass. the use of aquatic plant communities has been successfully exploited by several authors for the treatment of several types of effluents: dairy effluent **[10]**, domestic **[11, 12, 13]** and industrial effluents **[14, 15]**. The most important roles of plants are related to their physical effects, the absorption of nutrients, the release of oxygen in the rhizosphere and microorganisms **[16]**. Several studies comparing macrophytes with a wetland and having the same physical characteristics but no macrophytes have shown that their presence significantly improves the efficiency of wastewater treatment **[17, 18, 19]**. Phragmites, Typha, Papyrus and Tamarix, Arundo donax are the most common plant species used in these systems **[20,1]**. These systems allow more than 90% removal of most parameters such as (chemical oxygen demand (COD), ammonia nitrogen (NH4 C-N), phosphate and heavy metals) **[21, 22, 23, 24]**.

It is with the aim of proposing innovative and low-cost solutions adapted to the climatic and socio-economic conditions of this country that we have experimented with filters planted using a local utilitarian culture well known to the populations of sub-Saharan Africa. is the Typha Latifolia. In view of the above, the aim of this study is to evaluate the influence of this plant on the elimination of ammonium and phosphates on the one hand and to compare these results with those obtained on the release of a non-planted filter.

II. METHODS

II.1. Establishment of the experimental device

The experimental tests were carried out in the experimental station of the Department of Civil and Hydraulic Engineering at the University of Biskra, specially designed for the trials of Phytopurification. The city of Biskra is located in the south-east of Algeria, it occupies an area of 21,671 Km2, its altitude is 128 meters / level of the sea. It is characterized by a cold climate in winter, hot and dry in summer. The region of Biskra constitutes the transition between the folded atlasic areas of the north and the flat and desert area of the Sahara in the south. It is limited by Batna and M'Sila to the North; Khenchela to the East; Djelfa to the Southwest and El Oued to the South. Otherwise ; it should be noted that Biskra is characterized by heterogeneous soils consisting mainly of alluvial and silty soils favorable to agriculture, gypseous limestone ridges and sand deposits at the foot of the adjacent mountains.

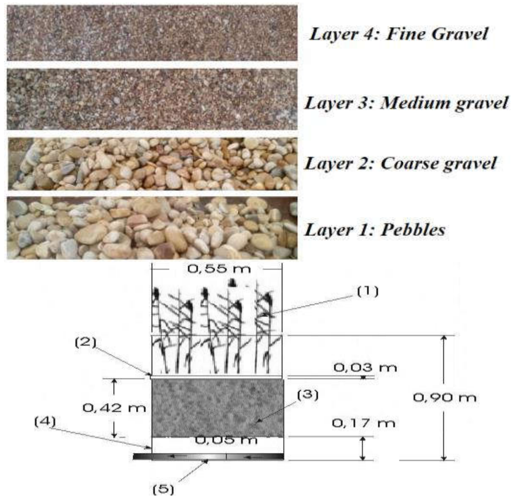

Figure 1: General scheme of the experimental filter

The diameters of the gravel forming the substrate vary between 3 and 6 mm. The material of the pans used is in treated plastic with a height of 0.90m and the surface of the bed is 0.95m2. The tank is filled with alluvial substrate. The first layer is 0.17m (0.05m thick coarse gravel placed at the distribution valve to facilitate the passage of the effluent and 0.12m a layer of diameter which from 5 to 6mm) and the second layer of 0.42m filled with fine substrate (Fig.1).

II.2. *Choice of plants*

Macrophytes indirectly contribute to the degradation of organic matter in the raw effluent, these plants have a very dense root system that improves oxygenation filters, a sine qua non for the development of microorganisms adequate. Pursuing their growth even in winter, the rhizomes finally ensure the permanent operation of the treatment plant thus limiting the clogging of the filtering surfaces **[25,26]**. Generally the choice of plants to be planted is based on a number of important criteria: Adaptation to local climatic conditions; duration of the growing cycle; growth rate; ease of export of produced biomass and purification efficiency. The plant material used is a species of the Typhacea family.

Cattails or Typha (picture 1) are monocotyledonous plants, also called cattails, have narrow leaves (less than 1 cm wide). Cattails are wetland plants that have a rhizome. They have a typical inflorescence: dense and cone-shaped, in which the female and male flowers are clearly separated (monoecious), the male flowers being placed above the female flowers at the end of a flowering stem. The leaves are flat (or slightly triangular) and grow at the base of the plant. They form a sheath that surrounds the stem.

Picture 1: (a) Planted filter of Typha Latifolia (b) Massette (Typha)

III.RESULTS AND DISCUSSION

The evaluation of the effectiveness of the treatment results from the determination of a certain number of physicochemical parameters characterizing this wastewater before and after treatment. Water samples at the inlet and outlet of the planted and non-planted filter were measured for pH, electrical conductivity, Ammonium (NH_4^+) and Phosphates (PO_4^{-3}).

III.1. Variations of the physicochemical indicators of pollution at the exit of filters planted with Typha

The operation of the experimental pilot was controlled by the measurement of the physicochemical parameters of the wastewater, the samples are taken at the entrance and exit of the planted Typha filter and the naked filter considered as a control. Domestic waste is the source of wastewater to be treated by phytopurification in our station. The waters of this discharge are discharged into the natural environment without any prior treatment. For the various physicochemical analyzes, we have taken samples of wastewater from the planted filter of Typha and not planted after purification, as well as the raw wastewater depending on the residence time, which varies from 2 days to 10 days. Table (1) groups the results of the physicochemical parameters obtained at the inlet and the outlet of the filters.

Table 1: Physicochemical parameters obtained at the inlet and the outlet of the filters

Parameters	Raw waste water	Filters	Residence time (day)			
			2	5	7	10
pH	7.76	Planted filter of Typha	7,25	6.99	6.91	7.00
		Non-planted filter (control)	7,67	7.24	7,10	7.33
Conductivity (mS/cm)	2.78	Planted filter of Typha	5.33	7.44	7.07	9.44
		Non-planted filter (control)	4.75	5.19	6.30	6.51
Temperature (C°)	23.6	Planted filter of Typha	22.25	21.50	21.2	17.50
		Non-planted filter (control)	22.4	21.8	21.30	17.40

The results obtained show that:

a) **The average pH** of the raw sewage at the entrance to the treatment system is 7.76. While the average pH of purified wastewater at the outlet of typha filters decreases from 7.25 to 6.91 a residence time of 2 days to 10 days. So we see a slight decrease in pH for the non-planted system.

b) **The electrical conductivity** of wastewater purified by filters planted with typha is greater than that of wastewater treated by the non-planted filter and that of raw wastewater. This increase is related to excessive mineralization of the organic matter and the evapotranspiration phenomenon which tends to concentrate the effluent further, because of the high temperature. According to **[27, 16, 13]**, an increase in the conductivity, wastewater treated by plantations of (Typha, Phragmites, Roseau, papyrus and tamarix), is associated with the evapotranspiration phenomenon of the vegetation and also by the beginning adaptation and development of plants.

c) **The temperature** at the outlet of the two systems (planted and non-planted) shows a slight decrease compared to that of raw wastewater. This is due to the impact of the vegetal cover which constitutes a screen limiting the penetration of the solar radiation source of heat in the depth of the basin. Temperature plays an important role in the quality of purification and it reduces clogging. Indeed, **[28]** showed that the purification capacity depends on the temperature that seems to influence the oxidation kinetics of the dissolved pollution. A low temperature slows the activity.

III.2. The rate of abatement of ammonium and phosphates at the outlet of planted and non-planted filters

The results obtained are shown in (Figure 2) show a sharp increase in ammonium removal efficiencies of the order of 90.38% and 68.65% respectively at the output of planted and unplanted filters for a residence time. 10 days. The nitrification - denitrification sequence is considered to be the major long - term nitrogen removal process **[29, 30]**. Under anaerobic conditions, nitrates can be removed by microbial denitrification. This explains the decrease in nitrogen ammonia by the substrate and filters planted. Ammonium uptake by typha results from the temporary removal of an available portion of nitrate and ammonium. However, unless the plants are plucked, a significant portion of the fixed nitrogen can return to the system in dissolved form **[31]**.

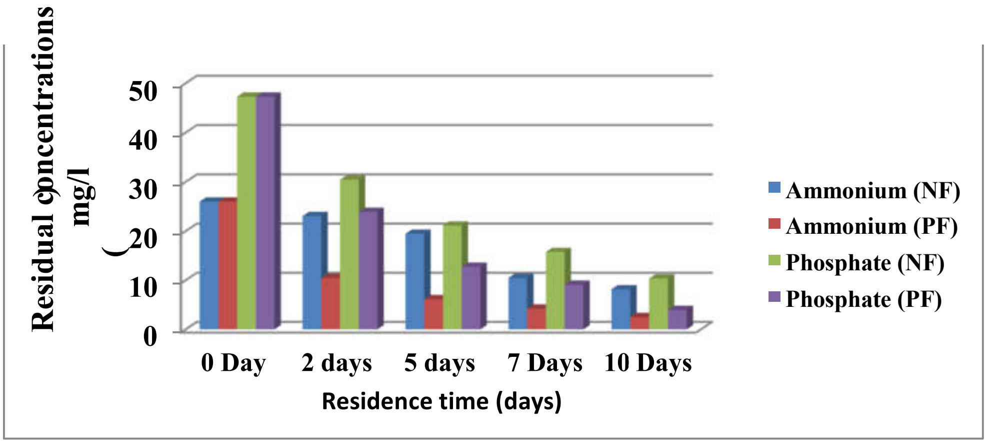

Figure 2: Influence of the residence time on the removal of ammonium and phosphate on unplanted (NF) filters and planted with Typha Latifolia (PF)

According to the same figure 2, presented above, we notice that the phosphate at the exit of the planted and unplanted filters, has a decrease compared to the raw water. This decrease could result from bacterial and / or plant uptake and the absorption of PO4-3 in the planted filter. Corresponding treatment efficiencies are higher in filters planted 91.65% compared to non-planted filters with a reduction percentage of 78.11%. According to [1,13,16], some plants consume an appreciable amount of phosphorus during their growth. They can store it in roots and rhizomes, stems and leaves. A high proportion of phosphorus is stored by the emergent plants in their roots during wilting.

IV. CONCLUSION

Overall, be it the physicochemical parameters of the wastewater at the inlet and outlet of the filters. We observed a very clear increase in ammonia nitrogen removal efficiencies of 90.38% for Typha and 68.65% for non-planted filter. The corresponding phosphate abatement rate is higher in filters planted with a reduction percentage of 91.65% and 78.11% respectively for Typha and the naked filter. Plants of all sizes (microscopic algae, aquatic plants, trees ...) found in a humid environment favor the establishment of an entire ecosystem necessary for the development of microorganisms. Depending on the sector, they contribute in particular to distribute the effluents homogeneously, oxygenate the environment, and infiltrate the water within these devices. The results obtained will confirm the purifying power of the Typha plant filter of domestic wastewater for reuse in a phytopurification station in semi-arid regions.

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