IJISRT20MAR455

by Ijisrt20mar455 Ijisrt20mar455

Submission date: 19-Mar-2020 12:14AM (UTC-0500)
Submission ID: 1277989088
File name: 1584592385.doc (1,008.5K)
Word count: 2981
Character count: 15733

International Journal of Innovative Science and Research Technology

Volume x , Issue y , Month - 2016

the purification performance of a wastewater treatment plant by natural lagoon

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***Abstract*— In order to reuse wastewater treated for irrigation and to protect the environment against pollution, we studied the treatment of wastewater by natural lagoon treatment plant "case of the Kef Eddouken". For this reason, we carried out for eight months of the year 2018 the following parameters: temperature, pH, biochemical oxygen demand, chemical oxygen demand, total suspended solids, sodium, calcium and magnesium.**

The results of the analysis show that this quality of treated water can be used in sub-irrigation, for vegetables that are eaten only cooked, and vegetables for canning or non-food processing

***Keywords*—Analysis, environment, irrigation, Kef Eddouken WWTP, natural lagoon, treated water.**

I. INTRODUCTION

Water is necessary for life and human activity but the demand for water is not uniform from one region of the globe to another and the availability of water resources even less [1]. Freshwater represents only 2.53% of all the water on the planet [2], groundwater in rural areas is a source of drinking water and irrigation, with the scarcity of fresh water, the protection and preservation of this source against all forms of pollution is the responsibility of all humanity.

Demographic, economic and urban increases are at the origin of different sources of environmental pollution (atmospheric pollution, surface and deep water pollution, soil pollution), particularly in developing countries. Among these sources of pollution the evacuation of wastewater into the environment without prior treatment since it contains many microbes, pathogens and other pollutants that can be the source of several diseases or contamination of groundwater [3], [4].

The treatment of wastewater by various techniques before being discharged into the receiving environment, one of the solutions for protecting groundwater and the environment and to reuse in many fields, including irrigation. Some processes are expensive, and they are generally effective and give good purification performance, we talk about classical intensive techniques (bacterial beds, biological disks and activated sludge). Other processes can be carried out with lower costs while maintaining the required purification standards in the treated effluent, in other words, extensive techniques such as the cultures fixed on fine support and free cultures (natural lagoon, macrophyte lagoon and aerated lagoon). The most targeted processes are those that give good purification performance and have the minimum costs in terms of energy consumption or expenses related to their commissioning and maintenance [5]

Algeria has taken the lead in ensuring sustainable development from the purification of domestic and industrial wastewater and the reuse of this treated water for irrigation, 153 wastewater treatment plants (WWTP) operating in different parts of the country (75 activated sludge stations, 75 stations by natural or aerated lagoon and 3 filters planted) [6].

This work aims to evaluate the effectiveness of one of the above-mentioned systems, treatment of wastewater by natural lagoon, case of Kef Eddoukhen in Ghardaia (southern Algeria) and to verify whether it is well adapted to the region studied. Amplest of raw and treated water were taken, respectively, at the entrance and the exit of the station throughout the period of study, to monitor the physicochemical parameters in order to calculate the elimination rates of the different pollutants and compared with those required by the standards.

II. MATERIALS AND METHODS.

A. *Station description of Kef Eddoukhe*

The WWTP Kef Eddoukhen is located about 21 km southeast of Ghardaïa, downstream from the El Atteuf dike; it occupies an area of 79 ha. It is characterized by an average flow of wastewater: 46 400 m3/day [7]. The incoming water at the WWTP drained towards the receiving medium by a gravity flow, they first submit to a pretreatment (screen and sand trap), then they pass directly to the primary treatment which contains 8 anaerobic lagoons fed in parallel, of 3.5 m of height, water stagnates in the basins for three days, then is discharged by the distributor secondary to the secondary treatment which is characterized by 8 aerobic lagoon of 1.5 m height fed in parallel and a residence time of 10 days (Fig.1).

Fig. 1. Photo view of the WWTP of Kef Eddoukhen of El Atteuf (Google Earth 2019)

B. *Experimental procedure*

Sampling was done at the inlet (raw water) and at the outlet of WWTP (treated water) for eight months (May to December 2018).Samples were taken three times per month for biochemical oxygen demand (BOD5), chemical oxygen demand (COD), total suspended solids (TSS), sodium (Na+), calcium (Ca+2), magnesium (Mg+2) and daily for hydrogen potential (pH) and temperature (T).

The conservation of the wastewater samples was carried out in a cooler kept at 4 °C according to the general guide for the conservation and the handling of the samples ISO 566 /3 [8].

The analysis was carried out at the mathematics and applied sciences Laboratory of Ghardaia University, who provided the necessary chemicals and equipment, while pH and the temperature were determined in situ using a multi- parameter analyzer type Hach LT2300, the BOD_5 was measured by the manometric method based on the Warburg principle using Oxi top WTW IS-6 and the COD was analyzed by oxidation in excess of potassium dichromate at 150°C, during 2h, in acidic

medium[9] using behrotest COD workstation-6 samples, filtration on filter paper for the determination of TSS, parameters such as calcium and magnesium are analyzed by the titrimetric method with ethylene tetraacetic diammine, for sodium according to the ISO 14911 method [9] , using a PF-7 flame photometer.

The purification performance was evaluated according to the following formula [10]:

$$\text{Abatement} = (C_E - C_S) / C_E \quad (1)$$

where :

C_E concentration of raw water in mg/L and C_S concentration of treated water in mg/L.

The sodium adsorption ratio (SAR) which relates the concentrations (meq^{-1}) to sodium Na^+ (dispersion factor), calcium Ca^{+2} and magnesium Mg^{+2} (flocculants) [11] according to:

$$SAR = Na^+ / ((Ca^{+2} + Mg^{+2})/2)^{0.5} \quad (2)$$

The oxidizable matter (OM) was calculated by the following relation [12]:

$$MO = (2BOD - COD) / 3 \quad (3)$$

where:

BOD concentration of biochemical oxygen demand in mg/L and COD concentration of chemical oxygen demand in mg/L

III. RESULT AND DISCUSSION

Table 1 contains the values of all studied parameters of wastewater (the entrance of WWTP) and treated water (the exit of WWTP).

A. *pH evolution*

Measuring the pH of wastewater gives an indication of the alkalinity or acidity of these waters. It is important for the growth of microorganisms [13]. The observed values reveal that the pH is slightly alkaline for all the analysis carried out this is due to the composition of the water entering the WWTP (soap water, stool, urine, etc) [14]. Light variation of pH values was observed in the treated water, it ranged from 7.96 to 8.2; these pH values are within the normal range recommended by the Algerian regulations [15]; which is likely to favor the bacterial growth necessary for the biological degradation of organic pollutants [16]. According to our study we noticed that the pH of the treated water higher than that of the raw water, this is what we can justify by photosynthesis, consume the dissolved CO2 in the water resulting in alkalization, according to Eq. 4 below [17].

$$HCO_3\text{-} + H^+ + H_2CO_3 \rightleftarrows 2H_2O + 2CO_2 \quad (4)$$

B. *Temperature of water*

The temperature values of the treated water range from 14 to 28 °C, which represents an average of 24 °C during the study period, the variation of values related to the climatic conditions of the studied region; the maximum value recorded in summer (in August) and the minimum value in December (in winter). We also note that the temperature of the water treated is still lower than that recorded at the level of the raw water, this decrease is due to the stagnation of the treated water in the basins, on the other hand the raw water can be due to the use of hot water as well as the movement of wastewater in the sewer pipes which increase its temperature. This variations influence the rate of evapotranspiration and the biological activity of microorganisms [18] and it has a significant impact on nitrogen removal [19]. It should also be noted that in an aquatic ecosystem, thermal fluctuation has an impact on the development and repetition of algal populations [20] and to note also that recorded values are consistent with national and international irrigation standards [15], [21] respectively.

C. *Sodium (Na^+), calcium (Ca^{2+}), magnesium (Mg^{2+}) and alkaline risk*

The alkaline risk is characterized by the sodium adsorption ratio which relates the concentrations (meq/L) to sodium Na^+ (dispersion factor), calcium Ca^{+2} and magnesium Mg^{+2} (flocculation agents) [11]. From our results the average values are 312.62 mg/L, 179.8 mg/L and 253.69 mg/L for Ca^{+2}, Mg^{+2} and Na^+ respectively, this values give SAR values between 2.8 and 3.38 with an average of 3.05, this SAR values leads us to a class of fable alkaline hazard (SAR <10) [11] (Fig. 2). As can be seen in the FAO standard, for very low salt water with low SAR should be avoided, an excessive relative concentration of sodium (alkaline risk) can cause the dispersion of clay minerals and lead to degradation of the soil structure, but very salty water with high SAR needs to be carefully managed.

On the other hand the sodium concentrations that are lower than 1000 mg/L meet the Algerian standard of irrigation [15].

D. *Evolution of Total Suspended Solids*

The reported raw influent content is between 73 and 124 mg/L and between 57 and 88 mg/L for treated water. These concentrations are superior to the normal range of allowable loads by Algerian regulation of irrigation and domestic rejection [15], [22]. But the TSS in the treated water remains lower than that of the raw water. The change in TSS content of incoming water at the WWTP according to the quality of the waste water produced by the population. On the other hand we noticed slight variations of these contents in the treated waters that are due to the presence of the algae in the basins where the green color of the water appears in the final rejection.

The treatment rate during the monitoring year (2018) is limited between a maximum value of 42% observed in December and a minimum value of 4% observed in August, with an average of 22%.

E. *Biological oxygen demand at five days*

The biological oxygen demand expresses the amount of oxygen required for the degradation of the biodegradable organic matter of water by the development of microorganisms [23]. The observed values of BOD_5 do not comply with Algerian standards [15], [22]. For raw water they are between 71 and 203 mg/L with an average of 143.63 mg/L, these values remain within the reference range for domestic wastewater

(100 to 400 mg/L) [24]. The high value of the BOD_5 at the entrance to the station is quite understandable, because domestic wastewater is loaded with biodegradable organic matter, and the variation of BOD_5 of the raw is due to the amount of incoming wastewater at the WWTP. For treated water the BOD5 values between 31 and 61 mg/L. The decrease in BOD5 for treated water is due to the degradation of organic matter by aerobic bacteria (the secondary treatment ponds). Regarding the purification rate, it oscillate between 56 and 81%, with the average yield during this period is about 69%.

F. Chemical oxygen demand

COD values range from 80 to 185 mg/L for raw water, from 53 to 89 mg/L for treated water.

These raw water values remain within the reference range for domestic wastewater (300 to 1000 mg/L) [24]. The COD values of raw water show a significant variation over the study period, which can be explained by a variation in the quality of the wastewater produced. These domestic waters (laundry, dishes and wastewater) are generally loaded with more or less biodegradable substances, cleaning products, disinfectants and descaling agent as well as fertilizers, pesticides. These waters may also contain cosmetic and medicinal pollutants.

The COD content of treated water meets national and international irrigation standards [15], [21] respectively. The elimination yield varies between 34 and 61% and the best recorded in June and July.

G. Organic matter and COD / BOD ratio

The significance of the biodegradability of wastewater evaluated by COD/ BOD ratio. Our results show that the values of this ratio vary between 1.41 to 2.31 with values of the oxidizable matter ranged between 108 and 194.33 mg/L. These results indicating wastewater entering the WWTP (M'zab Valley water) is moderately biodegradable [12].

IV. CONCLUSION

The results of the physicochemical parameters of the treated water by the kef Eddoukhen treatment plant, during the period study (from May to December 2018) which allowed the conclusion that most of parameters respond to the standards except for TSS (because the existing of algae in pools) and the DBO5 where the values exceed 30 mg/L. Through this study which recommend the adding of pool filtration to reduce the load of TSS.

Whence the quality of water used in agricultures and according to national and international recommendations of irrigation [15], [20] respectively. So, the water not suitable for sprinkler irrigation but can be used for sub irrigation for vegetable which eaten only cooked.

Finally, it's obligatory to inform the farmers about each change of the treated water quality because it changes according to year's seasons.

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