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Seasonal Variations of Physical, Chemical Parameters in A Wastewater Treatment Plant By Aerated Lagoons at Southern-East Of Algeria.

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ABSTRACT

Aerated lagoons are commonly used to treat the domestic sewage of small communities, and industrial wastes, when land is inexpensive, they represent low capital and maintenance costs as compared to other treatment processes. They are also simple to operate and show abilities to handle shock loads, both organic and hydraulic. However, in the arid and semi-arid regions the salination due to the evaporation is one of the main problems. This study detailed the effect under local climatic conditions on the characteristics of El-Oued aerated lagoons wastewater treatment plants (WWTPs), located in Southern East Algeria. The plant performance was evaluated through descriptive analysis with quantity and quality data of both raw wastewaters and treated effluent over a period of two years (2011 – 2013). Results showed that the removal of the BOD, TSS, COD and bacteria required 15 days retention time as the optimum operating conditions to reach 78% (COD), (BOD5) 86.5% and 85% (TSS).

Keywords: El-Oued, Seasonal variations, Wastewater, Aerated lagoon, Removal efficiency.

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INTRODUCTION

The region of El-Oued (south-east Algeria) had various water-related issues, discharging their highly contaminated wastewater in the receiving environment without any treatment. This is an issue of growing concern because of side effects that pollutants can cause environmental and health problems. The choice of a wastewater treatment system in developing countries is subject to several criteria, the most important is the treatment efficiency of the system. The wastewater treatment plant in aerated lagoons in the city of El-Oued she meets this criterion ? The purification of domestic wastewater system aerated lagoon remains among the most used in countries with hot climates arid to semi-arid processes. Since the late 2000, Algeria adopted for wastewater treatment in rural and urban centers aerated lagoon as the most suitable technical solution to the economic and climatic context. Aerobic bacteria found in the aeration lagoon aerated lagoons consume oxygen dissolved in the medium for the oxidation of organic matterin the wastewater [1-3]. Oxygenation was, in the case of the aerated lagoon, provided mechanically by a surface aerator or air insufflations. This principle differs from activated sludge only by the absence of a recycling system for sludge or sludge extraction continuously. The energy consumption of the two streams is at equivalent capacity, comparable (1.8 to 2 kW / kg BOD_5 eliminated) [4]. The objective of this study is the characterization and quantification of certain physicochemical parameters provided a preliminary assessment of the quality and the degree of water pollution. Moreover, achieving temporal variations of hot and cold period in the composition of the effluent as a measure of the overall performance for a conventional WWTP.

MATERIALS AND METHODS

Plant Location and Design Description

The plant located 7 km to the south Est of El- Oued city. It is in operation since July 2009 to serve 246,000 populations. The capacity of the plant is to treat 33,000 m^3/day wastewater horizons for 2015, but the average current rate is 13,000 m^3/day. The plant is equipped with flow meter, three mechanical screens to retain solids of more than 2.2 cm, then three sand grit removal lines in parallel series. The bottom and walls of the lagoons are sealed with sand gypsy and a synthetic liner geombran and geotextil to prevent any leakage of sewage to the groundwater.

This system consists of three stages in series; the first two are aerated, the 3rd is a maturation pond prior to discharge into the natural environment (Fig.1)

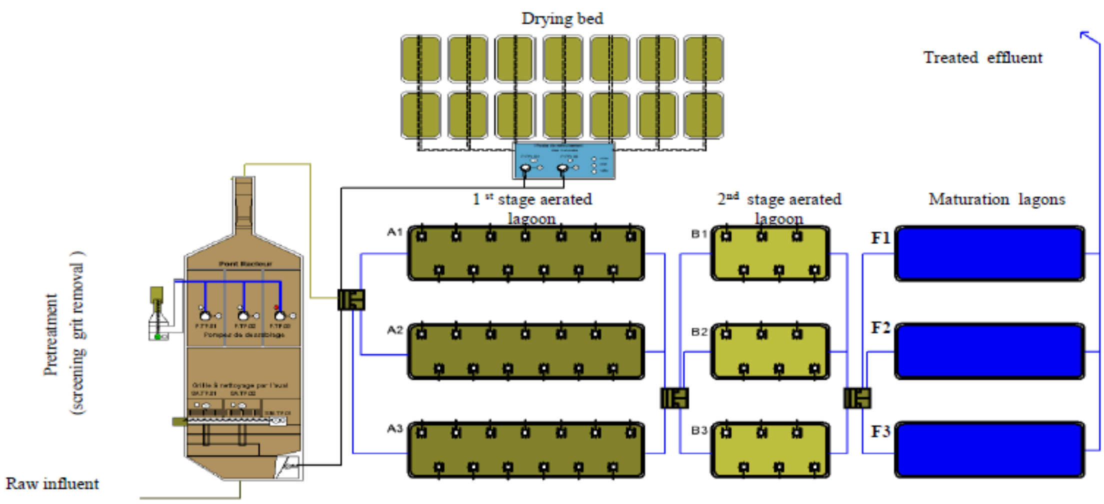

Figure 1: Localization and schematic representation of El-Oued wastewater treatment plant

The morphometric characteristics of three stages purification of the station are summarized in Table 1

Table 1: Design description of the aerated lagoons in El-Oued

Lagoons	Aerated (A1, A2, A3)	Aerated (B1, B2, B3)	Maturation (F1, F2, F3)
Volume (m^3) of each	199413	133107	99810
Dimensions (m) of each	91×232.6×3.5	92.1×194.6×2.5	91.6×245.3×1.5
HRT (d**)**	6	5	4
Volume (m^3) of each	199413	133107	99810
No. Aerators of each	39	18	0

Sampling Methodology and Measurement

The experiments were conducted during the period from February 2011 to February 2013, the analyzes were performed at the Valuation Laboratory and Saharan Resources Promotion, University of Kasdi Merbah, Ouargla and WWTPs 01of Kouinine, El- Oued. Climate of the region is arid with an annual average temperature of 22.4 ° C, average ranges from 10.4 ° C in January and 34.5 ° C in July, during the last 10 years (2003-2013) [5]. The samples was conducted to included 24 h according to the AFNOR NF EN 25667 (ISO 5667) at the influent and the effluent of the WWTPs 01. The physicochemical parameters measured were: pH, temperature, turbidity, dissolved oxygen, COD, BOD_5, TSS, nutrients and heavy metals. Assay water standard methods [6] used are the following (Table 2)

Table 2: The parameters studied and the methods of analysis

Parameters	**Methods of analysis**	**Units**	**Sources**
Temperature	EUTECH Instruments 10 pH/mV/^{0}C	°C	[6]
pH	EUTECH Instruments 510 pH/mV/^{0}C	/	[6]
DO	WTW inoLab Oxi 730	mg/l	[6]
Turbidity	Turb 550 IR	NTU	[6]
TSS	Filtration on filter paper Whatman GF/C	mg/l	AFNOR T90-105[7]
BOD5	Instrumental method OxiTop ,WTW	mg/l	AFNOR T 90 105[7]
COD	Spectrophotometer WTW Photolab spectral	mg/l	Norme NFT 90-101
Nutrients		mg/l	HACH 2800 method digestion with kit
Heavy metals			

RESULTS AND DISCUSSION

During the present study the influent raw sewage was an average of 13000 m^3/day .The HRT was 15 day During this period, two aerated lagoons (A1, A2) in first stage , in second stage one aerated lagoon (B1 or B2) and mostly one maturation lagoon (F1 or F2) were in service. The characteristics of raw sewage and the different effluents are shown in Table 3.

Efficiency of wastewater treatment plant

The temporal evolution of the temperature of the influent and effluent the existence of mean values are high in summer (20.3 to 22.7 ° C) and low in winter (14.7 to 18.8 ° C), they are similar ambient temperatures, the temperatures of the final effluent are still lower than those recorded in the influent these values are based on the sampling time and the weather.

The turbidity values stored in the wastewater before treatment ranged from 329 to 247 NTU. Regarding the treated water, there is a net reduction of this parameter whose values are within a range that is 40 to 20 NTU, these values are still lower than the Algerian standards rejection (50 NTU) [8]. Then we see that in general a good return for their variation purified water under the effect of the temperature rise that promotes excessive algae growth, thus increasing the turbidity value is greater in hot season (40 NTU) in the cold season (20 NTU).

Table 3: Average effluent pollution criteria settings before and after the treatment with hot and cold season.

Parameters	Units	Sample numbers	Cold period			Hot period		
			Raw sewage	Final effluent	Percentage of removal (%)	Raw sewage	Final effluent	Percentage of removal (%)
COD	mg/l	72	428	67	84	354	100	72
BOD_5	mg/l	104	211	23	89	247	40	84
TSS	mg/l	104	253	15	94	245	49,8	80
NH_4 -N	mg/l	72	52.1	37.7	28	54.6	34	38
NO_3-N	mg/l	72	0.51	3.23	/	0.43	5,72	/
NO_2-N	mg/l	72	0.307	1.2	/	0.263	2	/
TN	mg/l	72	83	45.2	46	70	47	33
TP	mg/l	72	10.2	6.91	32	8.5	5.4	36
DO	mg/l	208	1.99	8.22	/	0.59	8.32	/
Turbidity	NTU	208	329	20	93	247	41,5	83
pH	/	208	7.93	7.96	/	7.8	8.01	/

NB / Hot period; spring - summer. Cold period; autumn – winter

For dissolved oxygen values obtained input from 0.59 to 1.99 mg/l, low characterizing a wastewater inlet rich in dissolved organic and inorganic matter and disruption of air exchanges in interface due to the presence of fats, detergents ... etc.) [9]. Regarding the final effluent, DO levels recorded at the outlet are substantially greater than those of the entrance, they vary between 8.22 and 8.32 mg/l, this is due to ventilation of the water level of the basin aeration related surface aerators, necessary to develop the aerobic microorganisms ensuring the oxidation of organic matter, which leads to a good biological wastewater treatment. This value is almost invariable regardless of the period, but changes depending on the incoming organic filler.

The pH values of wastewater before treatment are between 7.8 and 7.93, the most favourable to bacterial action, aerobic and anaerobic treatment process [10]. While the pH of the aeration basin water becomes alkaline, values can reach an average annual 8.03, it is almost constant during period's studies. This increase can be explained by an intense microbial activity in the activation lagoon where oxygen consumption therefore importance of a significant release of CO_2. These results are consistent with those reported in the literature [11]. According, Sevrin Reyssac et al [12], the alkaline pH and moderate temperature environment are ideal conditions for the proliferation of microorganisms which establish a perfect biological stability, allowing the degradation of organic matter resulting in the decontamination of water.

Organic Matter

Results in Table 3, show that the raw sewage from the town of El-Oued were not loaded with organic matter and suspended solids. Indeed, the ratio between COD and BOD_5 can characterize the nature of the effluent entering the WWTPs 01 Kouinine, it averages 1.72 <2 lead to the conclusion that this is a gross impact readily biodegradable. It is interesting to note that there is reduction of all parameters characterizing the organic load (COD, BOD_5 and TSS). The overall removal efficiency of organic load in the system by 15 days retention time was 86.6% of BOD5, 78% of COD and 85% of TSS. Note that the values of BOD_5 treated water are variable 23 mg / l in the cold period and 40 mg / l in the hot period. This increase is associated according to the algae in the pond due to the increase of the oxygen concentration and the photosynthetic phenomenon [13] .According Bliefert and Perraud [14], the values of COD and BOD_5 treated water are typical municipal water after biological treatment.

Nitrogen and Phosphorus Removal

The raw sewage at the entrance of the aerated lagoon treatment at El-Oued present average of ammonia nitrogen in the range of 53 mg/l. This concentration is almost invariable regardless and the period increases with respect to the content of nitrate and nitrite, which are of the order of 0.51mg /l and 0.307 mg/l respectively. We find that the reduction is small. But , there is an increase of nitrite and nitrate levels after treatment .These levels are the result of the factors affecting the growth of nitrifying bacteria, are the substrate content, temperature, DO and pH, in accordance with the observations reported by Zidane et al [15]. For The average phosphorus content in the level between influent and effluent of the WWTPs 01 are not negligible; they vary between 5.4 and 6.9 mg / l, this concentration is almost invariable regardless of the period, thus corroborating the work of Johansson [16].

Heavy Metals Removal

Monitoring of heavy metals of influent and effluent of the WWTPs 01 Kouinine during the study period, in order to assess their percentage removal by aerated lagoons and whether the purified effluent meets the standards for heavy metals, reuse in irrigation. The average values of heavy metal content in the wastewater (influent and effluent) as shown in Table 4. It is noted that apart from Fe, Cu, Sn and Cd, heavy metals are removed over 50% of the wastewater treatment plant Aerated lagoon. This reduction of heavy metals is managed mainly by complex physical and chemical processes in the aeration basin as:

- Absorption TSS settling;
- Liaison with low soluble mineral complexes;
- Precipitation as hydroxides;
- Complexation by diverse organic material or can be set by biomass. [17.18]

Heavy metals in treated water compared to the standards recommended for Algerian irrigation water (Official Journal of Republic of Algeria No. 41) [19] are safe toxicity as the reuse of this water in ground irrigation.

Table 4: Heavy metals in the raw sewage and final effluent of the aerated lagoons system in El-Oued

Locations	Pb	Cu	Fe	Ni	Cd	Sn
Raw sewage (mg/l)	0.35	1.85	3.8	3.61	0.397	1.05
Final effluent (mg/l)	0.16	0.01	0.22	2.60	0.105	0.5
Percentage of removal (%)	54	99	94	28	74	52

CONCLUSION

The results presented show that the aerated lagoon process is effective in the treatment of urban waste water under the climatic conditions of the city of El-Oued, considering the physicochemical amount of treated effluent, the world of conduct of the treatment system will generally depend on the season. Indeed, the elimination of the organic load and suspended solids is important and has periods of good and bad operating on accumulation of algae. Note that of the final effluent is rich in nutrient while on nitrogen (NH_4-N, NO_3-N, NO_2-N). The treated wastewater poses no risk of toxicity of heavy metals in trace. In the end, working with epidemiologists to determine additional risks such as the possibility of infiltration of nitrates and nitrites into groundwater and accumulation of heavy metals in the soil and vegetation, monitoring of gut parasites (helminths and protozoa ...) can run farmers and consumption; following the use of wastewater for irrigation.

Nomenclature

BOD_5: The 5-day Biochemical Oxygen Demand
COD: Chemical Oxygen Demand
DO: Dissolved oxygen
HRT: Hydraulic Retention Time
ISO : International Organization for Standardization
NTU: Nephelometric Turbidity Unit
TP: Total Phosphorus
TN: Total Nitrogen

TSS: Total Suspended Solids
WWTPs : Wastewater treatment Pants

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