

# The Preservation of Groundwater Quality through Aerobic Treatment of Wastewater

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**Abstract**—Adrar, a city located at the extreme western south of Algeria, uses underground water as the unique source of drinking water, unfortunately, this ground water is subject to contamination by the ceaseless urban water discharged by the city. The objective of this work is to examine the efficiency of the biological treatment of this raw waste water through natural lagoon; prior to their release into the receiving environment; by the removal of elements characteristics of pollution mainly DCO, MES, P and N, we have found a removal efficiency in DCO of 63%, in MES 66%, nitrites and nitrates 70% and 40% of phosphorus. These findings are considered satisfactory and hence prevent the contamination of drinking water and preserve the quality of Adrar's ground water.

**Index Terms**—Ground water, wastewater, lagoons, environment.

## I. INTRODUCTION

Our country as many others is faced with the challenging issues of population growth and land settlement to harmoniously combine economy and ecology, that is to say, meet the needs of goods production and services without modifying or destroying the quality of water, soil, and air [1], [2].

This work attempts to apply a biological treatment in order to remove organic pollutants from wastewater discharges while safeguarding the quality of our groundwater.

### A. Presentation of Adrar: Study Area

Adrar is the first of the 48 Algerian cities according to the Algerian administrative division in 1995. It is a saharian town in the southern wester of Algeria, bordered on the north by the wilaya of El Bayedh and Ghardaia the west by Bechar and Tindouf, the east by Tamanrasset and south by Mauritania and Mali. The wilaya of Adrar covers a total area of 427,698 km<sup>2</sup> in 2008 for a global population, estimated in 2008, of more than 389.898 inhabitants. The region is formed by four major geographical areas from north to south as it is shown in the Fig. 1 and consists of 11 Da'ras, 28 towns and 299 Ksars (villages). It is characterized by a continental desert climate with rare /even insignificant rainfall, the annual average for the period 2000-2010 is 12 mm.

- The GOURARA: Timimoun Region,
- The TOUAT: Adrar region,
- The TIDIKALT: Aoulef region,

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- The TANEZROUFT: Bordj Baji Mokhtar region



Fig. 1. Input of wastewater treatment plant.

### 1) Agricultural activity

Adrar is a city with an agricultural vocation characterized by palm oasis and traditional irrigation system "Fouggara". It is known for its production of dates and tomatoes. The distribution of agricultural land in the municipality of Adrar is presented as follows in the Table I:

TABLE I: DISTRIBUTION OF AGRICULTURAL LAND IN THE MUNICIPALITY OF ADRAR

total agricultural area	43 358,5 (HA)
Usable agricultural area	1779 (HA)
Number of agricultural holdings	890
Usable agricultural irrigated area	1653(HA)

## II. METHODOLOGY

### A. Wastewater System

Before the creation of the sewerage system in the city, the inhabitants used a traditional drainage system similar to a septic tank that causes several health problems. Nowadays, about 98% of the sewerage system in the city of Adrar is bound. It forms a joint network of 178.91 km length, with diameters ranging from Ø200 and Ø600 of PVC type or cement. The daily wastewater volume is set at 80% of the volume of the consumed drinking water.



Fig. 2. Output wastewater treatment plant.

### B. Lagoon Koussen

The principle of wastewater by natural or ecological lagoon has been known since antiquity. Indeed, the

self-purification processes involved in this technique generates a chain of purifying reactions, occurs spontaneously in which micro-organics degrade the organic matter and convert it into minerals harmless to the receiving environment [3], [4] Under these conditions, it is deemed possible to obtain an excellent organic remediation, and a excellent microbial decontamination [5], [6]. The Settling ponds of Adrar consist of three (03) sets of three (03) ponds for each as it is shown in the following figures: Fig. 1, Fig. 2 and Fig. 3.

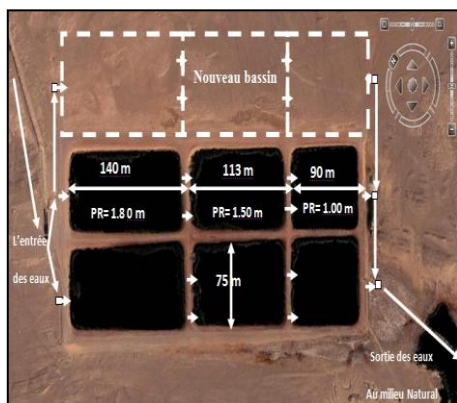


Fig. 3. Size of wastewater treatment plant of ponds.

Water quality of Ksar TIDMAINE (region of TOUAT):

Demands for fresh water are increasing every year from 4% to 5% while the natural resources remain invariable if not decreasing, due to pollution because of the infiltration of waste water. We have determined the physico-chemical composition of the water of TIDMAINE, the sample taken from the water of this region presents the physico-chemical analysis shown in Tables II, III and IV.

The different physico-chemical parameters, as it shown in Table II, of the water of Tidmaïne's region employ three main methods to mention [7]:

- Volumetric method,
- Titrimetric method
- Comolrimetric method.

TABLE II: PHESICO-CHEMICAL PARAMETERS

Global mineralization.	Result
CA[++] MG/L	123
MG [++] MG/L	77
NA [++] MG/L	229
K[+] MG/L	14
CL[-] MG/L	350
SO4[-] MG/L	395
HCO3[-]MG/L	171
CO3[-]MG/L	0
SiO2 MG/L	10.60
TH °F	62
TAC °F	14
TA °F	0
MINÉRALIZATION MG/L	1383
AMONT OF IONS MG/L	1422
MN MG/L	-

According to the values in the Table III, it is clear that the pH and conductivity are in the standards so that water is not subject to contamination by microorganisms, then it is of good quality and safe. The same applies to the turbidity of this water before settling is very low and after settling, it is zero, so the water is not charged for suspension [8].

TABLE III: FACTORS OF POLLUTION

phesico-chemical parameters	result
pH	7.14
CONDUCTIVITY ( MS/CM)	2.23
TURBIDITY (NTU)	0.22
TURBIDITY OF DECANTED	0.00
WATER( NTU)	1400.00
DRY RESIDU A 110 °C MG/L	15.5 °C
TEMPERATURE °C	

But, the values of nitrates are high by the standards, and even the oxydizable material, its value is moderately higher standards as it shown in Table IV, these results assume that the water could be contaminated?

TABLE IV: MINERALIZATION RATES

Pollution Parameters.	Results
DISSOLVED OXYGEN ( MG/L)	-
NH4[+] MG/L	ID
NO2[-] MG/L	ID
NO3[-] MG/L	62.00
PO4[-]	ID
MATTER .OX ( MG/L)	5.10
IRON (MG/L)	-

And to see better the quality of our water, with the physico-chemical parameters shown in Tables III and IV, we define the standards values of all the parameters that characterize the quality of drinking water. The following Table V shows the standards parameters of drinking water [9].

TABLE V: STANDARDS OF DRINKING WATER

Standard Parameters	OMS	French	Algeria
pH	6,5 - 9	6,5 - 8,5	6,5 - 8,5
Conductivity (µs/cm a 20 °C)	-	400	2800
Oxydizability (mg d'O2 /l)	5	5	3 to the max
Total hardness ( °F)	50	60	10 to 30
Ca++( mg/l)	-	100	75 - 200
Mg++( mg/l)	-	50	150
Alkalinity ( °F)	50	>2,5	50
Cl <sup>-</sup> ( mg/l)	250	250	200 - 500
SO <sub>4</sub> <sup>2-</sup> (mg/l)	400	250	250
Turbidity (NTU)	-	-	-
NO <sub>2</sub> <sup>-</sup> (mg/l)	40	50	50
NO <sub>3</sub> <sup>-</sup> (mg/l)	3	0,1	0,1
K <sup>+</sup> (mg/l)	-	150	200
NH <sub>4</sub> <sup>+</sup> ( mg/l)	1,5	0,5	0,5to the max
Dry residu at 180 °C (mg/l)	-	-	1500-2000

By comparing the findings of each physicochemical parameter with those of the international standards, on average the water is of drinkable quality except for the high content of nitrates which suspect pollution due to waste water infiltration [10].

So the need and the urgency to treat waste water before being discharged into the receiving environment, Adrar choses to purify the natural waste water rejection by lagoon,

and hence, preserves the drinkable water quality coming from the underground layers [11].

### III. INTERPRETATION OF RESULTS

The physico-chemical analyses are conducted on several samples taken during the month of May 2011, the sampling was done in two different points, the first is the upstream part of the basin and the second is the downstream parts. The following Table VI summarizes the physico-chemical characteristics of a representative sample (wastewater) before and after the biological treatment.

TABLE VI: PHYSICO-CHEMICAL CHARACTERIZATION OF THE WASTE BEFORE AND AFTER TREATMENT WITH NATURAL LAGOON WATER

	upstream of the basin	Downstream of the basin
pH	8.10	8.03
T °	27.80	27
G (MS/CM)	1.82	0.74
NH <sub>4</sub> <sup>+</sup> (MG/L)	2.20	1.30
NO <sub>2</sub> <sup>-</sup> (MG/L)	0.19	0.04
NO <sub>3</sub> <sup>-</sup> (MG/L)	7	2
PO <sub>4</sub> <sup>3-</sup> (MG/L)	14.80	8.60
DCO (MG/L)	249	90
TUB (MG/L)	60	20

The raw wastewater of 27 °C of temperature is rich in organic matter and alkaline nature of pH 8. In addition, this wastewater has high concentration in nitrate and phosphate.

At the end of the treatment and at the exit of the treatment plant, purified wastewater becomes poor in organic matter, phosphates, nitrates and suspended solids; this aerobic treatment enabled the elimination of this harmful pollution and the preservation of the groundwater and the environment as well.

For a more understanding of the effectiveness of this biological treatment, we calculated the removal efficiency of each pollution characteristic as it is demonstrated in the following Table VII.

TABLE VII: EFFICIENCY OF THE BIOLOGICAL TREATMENT

Param ètres de pollution	Efficiency (%)
DCO (MG/L)	63.85
TUR (MG/L)	66.67
NO <sub>2</sub> <sup>-</sup> (MG/L)	78.94
NO <sub>3</sub> <sup>-</sup> (MG/L)	71.43
PO <sub>4</sub> <sup>3-</sup> (MG/L)	41.89

We notice from the Table VII, that the removal efficiency of pollution parameters is good. This aerobic biological treatment allowed maximum removal of the organic matter, turbidity present and existing forms of nitrogen in the waste water, however the removal efficiency of phosphate is average.

Nitrogen and phosphorus are essential growth elements for microorganisms used in wastewater treatment; therefore, during all biological treatment, some level of nutrient removal occurs[12].

Aerobic biological treatment is effective for this type of climate as well as the nature of physico-chemical [13] of the raw wastewater indicated in Table III and IV above.

### IV. CONCLUSION

The population growth led to an increase in water consumption, therefore, an increase in the volume of waste water discharged into receiving environments. The Coverage for drinking water and sanitation becomes a goal hard to achieve in our country. To this end the waste water presents a serious threat to public health, ecosystems, and even the economy. Faced with growing water needs, our country is bound to preserve the quality of drinking water especially groundwater and developing various methods to get it from sea water and wastewater under technically, economically and environmentally permissible conditions.

Water consists the essence of our life; however, it can be a source of disease. As far as Adrar city is concerned, groundwater is the only source of drinking water and even if the water is deep underground, it may be contaminated by the infiltration of domestic waste water discharged by the city. For the prevention of ground water contamination, the city of Adrar resolved this issue by treating the discharge of urban waste water through biological treatment and more specifically by natural lagoon. This treatment resulted in almost complete degradation of pollutants.

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