Available online at www.scholarsresearchlibrary.com

Scholars Research Library

Der Pharmacia Lettre, 2014, 6 (3):192-199
(http://scholarsresearchlibrary.com/archive.html)

Scholars Research Library
ISSN 0975-5071
USA CODEN: DPLEB4

Analytical Evaluation of the water quality of the landfill leachate of Kénitra, Morocco

ABED Houria*, KHAOULAF Redouane, ESAMIL Abeer***, CHAHBOUN Nabila*, KHADMAOUI Abderrezak***, LAKHRISSI Bouchra* et OUHSSINE Mohammed***

**Biotechnology Laboratory, Environment and Quality, Faculty of Sciences, University Ibn Tofail, BP 133 14000 Kénitra. Morocco*
***Groupe de Spectroscopie et Chimie Théorique, Faculty of Sciences, University Ibn Tofail, BP 133 14000 Kénitra. Morocco*
****Department of medical microbiology, Faculty of Science, Ibb University, Ibb, Yemen*
*****Laboratory of Genetics and Biometrics, Faculty of Sciences, University Ibn Tofail, BP 133 14000 Kénitra. Morocco*

ABSTRACT

The infiltration of percolation of leachate from landfill waste is a source of pollution of groundwater resources. Threats are going to feel on the six components of the environment (air, soil, groundwater, plant, animal and human). This can be compounded at the time of water deficits. The landfill of Ouled Berjal is a standard model of deterioration of water resources. Leachate is contaminated; also water from agricultural practices, the result is the deterioration of groundwater quality. The depth of the water table is low (4 to 15m), so the contamination rate is fast. The analysis carried out on the samples of leachate generated by the landfill show significant average of nitrate concentrations (1518.10 mg / l), ammonium (55.37 mg / l), sodium (3577.60 mg / l), BOD_5 (41.36 mg / l) COD (850.11 mg / l), sulfide (1626.71 mg / l) and chloride (7761.74 mg / l).

Keywords: landfill, leachate, groundwater infiltration.

INTRODUCTION

In Morocco, the increasing production of household garbage and industrial wastes cause problems with critical pollution. The nature of ever more complex and the waste heterogeneous involves difficulties for their treatment and management. A great part of the waste generated by human activity arrives in a landfill. Inside uncontrolled landfill, waste dumped are rarely inert and many physic-chemical and biological reactions occur between both of the waste and the environment in which there is (rock, soil, groundwater, leachate), also within the various origins waste. The evolution of waste in landfills and their interactions with the external environment leads to the dispersion of pollutants stream essentially through the emergence of leachate resulting from the dissolution by physical and biological pathways of pollutants in the percolating water. This water loaded of organic and mineral substances; and give rise to the leachate [1]. When the Leachate seeping into the basement, resulting in a sharp decline in groundwater [2]. Similarly, the leachate by overflow and flowing of liquids may contaminate the surface water, and subsequently destroy the water system. This can happen gradually or rapidly depending on the degree of proximity

of the discharge to aquatic receiving environment. The groundwater pollution is the result of infiltration and dissemination of leachate in permeable or cracked soil. The mechanisms of dissolution and chemical precipitation occurring during infiltration are closely related to physic-chemical, biological conditions, and hydrodynamic compartments of the aquifer system, traversed by leachate (soil, unsaturated zone and the saturated zone of aquifer). These regulate the mitigation, the transfer time, the level of propagation and the final retention of pollutant [2].

Our work focuses on the landfill of Ouled Berjel of Kénitra area whose waste resulting from human activity, which can cause multiple violations:

- Human health, by releasing of odors and toxic gases
- Water and ground seepage or stagnation of leachate

We are interested in the leachate. We will perform a physicochemical characterization to deduce the extent of possible impacts on the environmental components.

Geological and Geographical Location of Landfil

The landfill of Kenitra " Ouled Berjal " is a uncontrolled dump where the waste is spread randomly in an anarchic way , on a site of 20 hectares; it was opened in 1970 to remove the waste of all types, domestic, industrial , hospitals , slaughterhouses , etc. It is 3 km north of the town of Kénitra. This closeness associated with the main wind direction (East and West) facilitates the spread of smoke, odors and plastic bags to the city of Kénitra. The waste amount to be stored was estimated according to the tonnage arriving at the landfill to 329 tons per day and 120,000 tons per year. This amount could rise in 2015, 510 tons per day, which means 186,000 tons per year. The discharge constituted a potential threat to the environment, whose the main risk was the contamination of aquifer which is found at a few meters off the surface (depth of 4 meters). This landfill is located within the urban perimeter of Kénitra city in a loop of the Oued Sebu (Sebu River) surrounding the sides East, South and West and not far from the port and industrial area. Concerning the soil profile, the upper horizon is sandy and the lower horizon is clay. During the winter season, the rainwater is retained by the clay horizon and the whole area is flooded. Thus water contaminated by waste conveys all pollutants to the Oued Sebu. Per location, where the power of the lower horizon is low, the sandy horizon allows direct transfer of pollutants to aquifer.

MATERIALS AND METHODS

A sampling and analysis was performed on the Leachate. The leachate was collected from the flowage near the waste. Samples taken refer to the month of March until November 2012 and focused on the major ions, nitrogen, chemical and biological oxygen demand (COD and BOD_5), organic and inorganic material and some bacteriological analyzes. The physical parameters such as electrical conductivity, pH were measured directly in situ. Water samples were collected in glass jars pre-cleaned according to the process [3]. and placed at 4 ° C in a cooler. The analyzes were performed in the lab. The biological oxygen demand (BOD5) was measured using a BOD meter. Temperature (T), the electrical conductivity (EC), the pH was measured in situ by means of a conductivity meter (type Consort C831) and a pH meter (type CONSORT C831). Sodium (Na +) and potassium (K +) were measured using a flame spectrophotometer. The nitrate (NO3-) and ammonium (NH4 +) were determined by calorimetric method. The concentrations of chloride (Cl^{-}), sulfates ($SO4^{-}$), calcium (Ca^{++}), magnesium (Mg^{++}), and the chemical oxygen demand (COD) were determined volumetrically [4].

RESULTS AND DISCUSSION

I- Descriptive analysis of separate physical and chemical parameters:

Table (1) contains the results of some statistical indicators for physic-chemical parameters selected.

It appears from these results that:

1- *Electrical Conductivity*:

The measurement of conductivity brings information about the total quantity of charged species present in the leachate. This parameter allows evaluation of the mineral load pollutant present in an effluent. During the monthly monitoring of physicochemical parameters of leachate, the values of electrical conductivity recorded show high dispersion (CV = 22%). This variation can be explained by a minimum and maximum values which recorded in March and September (17 mS / cm, 29.82 mS / cm) respectively. The obtained values in the summer remain very

high in comparison with the limit conductivity (2.5 and 25 mS.cm-1) values. This is probably due to the strong inorganic concentration in the leachate, and the high content of Chloride. the average value of 24.5 ± 1.79 ms / cm, this value is lower than that found in leachate of Fez (42.4 mS / cm) [5]. and El Hociema (7542.4 mS / cm), and consistent with that of El Jadida[6].

Table 1: Descriptive study of various physic-chemical parameters

Parameter	*N*	*Min*	*Max*	*Mean ± SE*		*Asym*	*Kurt*	*Normes*	*CV (%)*
pH	9	7,43	9,40	8,30	,20	,281	-,215	4,5 – 9	7 ,49%
CE	9	17,00	29,82	24,51	1,79	-,296	-2,116	2500 - 25000 µS /cm	22%
CL	9	5884,70	9719,00	7761,74	550,81	*,161*	*-1,858*	150 - 4500 mg/l	21%
NA	9	2342,00	4861,00	3577,60	354,54	*,219*	*-1,889*	70 - 7700 mg/l	30%
K	9	1679,60	3530,00	2591,63	261,26	*,306*	*-2,081*	50 - 3700 mg/l	30%
Ca	9	172,00	680,00	372,43	54,17	,639	,067	010/7200 mg/l	44%
Mg	9	347,00	1059,00	831,11	85,32	-,885	-,234	0,03 - 1400 mg/l	31%
NO3	9	11,76	98,20	55,37	12,05	-,114	-2,112	50 - 1800 mg/l	65%
NH4	9	778,00	2577,00	1518,10	223,18	,637	-1,004	-	44%
SO4	9	1230,00	2289,47	1626,71	123,68	,597	-,760	8-7750 mg/l	23%
BOD5	9	18,00	86,00	41,36	6,28	1,757	4,565	20 - 57000 mg/l	45%
COD	9	671,00	1010,00	850,11	37,67	-,081	-,561	140 - 90000 mg/l	13%

N: effective; Min: minimum; Max: maximum; SE: standard error; Asymmetrical asymmetry; Kurt: kurtosis; CV: coefficient of variation (%).

2- pH:

The pH is an indicator of different phases of degradation of waste. During the different phases of the evolution of a landfill, the pH decreases when the Volatile fatty acids (VFAs) become dominant (phase acid fermentation) and get back to the high value controlled by the buffering capacity of the carbonate system when (VFAs) processing methane and carbon dioxide (mechanic fermentation phase). The leachate from the landfill of Kenitra city is very basic. The pH values oscillate between 7.43 and 9.4 (CV = 7.49%). The highest pH values are recorded during the summer: pH = 8.8 in August and 9.4 in September (Table 1). The annual average is 8.30 ± 0.20. The mean value obtained is within the standards that are 4.5 and 9. We are in a phase where the methanogenic pH rises mainly during the release of volatile fatty acids (VFA). This average is higher than that found in leachate from landfill of El Hoceima [7]., and are consistent with those found by CHOFQI [6]. and [8].

3- The Chloride

Chloride ions are anions of chlorine. This element is very abundant in the environment. It is present in water, soil, rocks, in many different foods. During our follow-up, these levels of chlorides founded in leachate show that the percolate is very loaded by chloride. Indeed, these values vary between 6000 and 9719 mg / l (Table 1), with an average of 7761.74 ± 550.81 mg / l. The study of the dispersion of the concentration of chlorides has shown that this element has a marked seasonal variation (CV = 21 % of heterogeneity) (Table 1), with maximum concentrations during the summer season (9713 mg / l July 9719 mg / l) in September. These high concentrations coincide with high values of electrical conductivity. This indicates that it is largely determined by the chloride ions. In winter, we found a decrease in chlorine concentrations. As compared with the terms of standards of grid quality of surface water, it seems that our results exceed the standards (> 1000 mg / l). The values belong to the very bad class. Otherwise, our results are consistent with those of CHOFQI [6] at the El-Jadida landfill, and also synchronize with the results found by ELMARKHI MINA [9]. but they are higher than those found in El Hociema's landfills.

4- *The Sulphur*:

Sulfate ions ($SO4^{2-}$) are sulfated compounds whose presence in consumption water, resulting in a contamination, mainly related to the discharge of domestic and industrial effluents or natural phenomenon of sulfate reduction. These ions exist heavily in the leachate [10]. These elements are derived from waste -rich in sulfur such as wood and plaster. The presence of sulfates and sulfides could be proving a problem of methanation and therefore stabilization of the solid waste, in so far as sulfate-reducing bacteria are competitive methanogenic bacteria. Sulfides may, in the pH range, precipitate the heavy metals whose majority is trapped in the funds of the discharge. Table 1 show that the annual average of sulfate is 1626.71 ± 123.68 mg / l. The values in their globality oscillate between 1230 and 2289.47 mg / l, which corresponds to a coefficient of variation of 23%. Unlike chloride, the sulfate maximum values recorded during the winter 2289.47 mg / l (November). Our results are consistent with those found by CHOFQI [6]. According to the quality of grid water, the leachate greatly exceeds the standards. In fact, they are very low class. The lower levels of sulfates are recorded in summer, where the phenomena of bacterial

biodegradation are very intense (warming of leachate) and where environmental conditions are very reductive. THE sulfates are then reduced to sulfide (H_2S) which are among the gases responsible for bad odors generated by the landfill [2]; [11].

5- *Calcium, Magnesium and Sodium*
The calcium has the same seasonal variation of chloride and sodium (the maximum levels in summer and the minimum in winter (Table 2)). The values are, nonetheless, low compared to those of these two elements. The average value is 372.4 ± 54.17 mg / l, this value is higher than that found in leachate discharge of El Jadida (202.82 mg / l) [6].

The same for magnesium, the maximum values were recorded during the summer (1045mg / l in July, 1056mg / l in August and 1059mg / l in September), and the minimum values are recorded in winter (347mg / l) . The average value is 831.1 ± 85.32 mg / l.

The sodium is one of the major constituents of the terrestrial crust and is 2.83% in all of the water, since the solubility of these salts is very high. The Leachate that generated by the landfill is rich in sodium, with an average grade of 3577.6 ± 354.54 mg / l (Table 1). The highest concentrations are recorded during summer 4861 mg / l in September, 4850 mg / l in August 4827 mg / l in July. Furthermore, the concentration of Na + ions is greater in the leachate, it exceeds Moroccan standard of water quality intended for irrigation. A large amount of sodium ions in water affects in soil permeability and poses problems of infiltration. The values found are slightly higher than those of the discharge in Jadida (2823.71 mg / l) [6].

As most of inorganic elements, the evolution of the concentrations of calcium, magnesium and sodium in the leachate is related to the content of dissolved organic substance [12]. In fact the maximum concentrations of these three elements are recorded during the summer. This may be due to the fact that, during this period, the organic material responsible for their complexes ions is still very low.

6- *The Potassium*:
The potassium is an alkaline metal that is found naturally associated with other elements in the sea water and in many minerals. It oxidizes rapidly in contact with air and reacts violently with water. The obtained value is between 1679.6 mg / l and 3530mg / l. The large increases were recorded during the summer and the low values are noticed during the winter. The same thing for sodium and potassium, the average value is to 2591.6 ± 261.26 mg / l, this value is consistent with those found by ELMARKHI MINA [9]. These concentrations greatly exceed the values of discharges of waste water recommended by the Moroccan standards 12 mg / l [13].

7- *Ammonium*:
The ammonium ion, $NH4^+$, is the reduced form of nitrogen. It comes mainly from the decomposition of the natural proteins contained in microorganisms and phytoplankton. It can also be derived from the supply of refined effluents urban, domestic waste, industrial or agricultural. The average value of the concentration of $NH4^+$ in leachate recorded during the study period is to 1518.1 ± 223.18 mg / l, this value is less than that found in the leachate of the city of El Jadida and El Hociema.

8- *The Nitrates*:
Nitrate (NO3 -) and nitrite (NO2 -) ions are naturally present in the environment. They are the result of nitrification of the ammonium ion ($NH4^+$) in the water and soil, which is oxidized to nitrite by bacteria of the genus *Nitrosomonas* and then to nitrate by bacteria of the genus *Nitrobacter* [14]. Nitrates are highly soluble in water; So they easily migrate into groundwater when the levels exceed from the needs of vegetation [14]. Nitrate toxicity resulting firstly from their reduction to nitrite and formation of methemoglobin, and, on the other hand, their possible contribution of synthesis of endogenous N-nitroso compounds. The results found vary between 11.76 mg / l and 98.2 mg / l in March, this gap results in a coefficient of variation of 65% dispersion. The average value of (NO3-) is 55.37 ± 12.05 mg / l, this value is greater than that found in leachate from El Jadida and the Fez (average 35.64 mg / l) [5].. The evolution of the nitrate concentration average in leachate exceeds the standard Moroccan of waters of irrigation [13].

9- *The Organic Matter*:
The Biological Oxygen Demand BOD_5 evaluates the biodegradability of leachate. The concentrations of biodegradable organic matter (BOD_5) in the leachate are correspondingly low. In fact, they vary between 18 and 86 mg / l (Table 1), with an average value of 41.36 ± 6.28 mg / l. The value obtained is less than that found in the discharge of El Hoceima (38 200mg / l) [7]. The values of BOD_5 decreased during the summer of 34 mg / l in July to 28 mg / l in September. In winter, there has been an increase in this parameter (Table 1): 86 mg / l in November (2012).

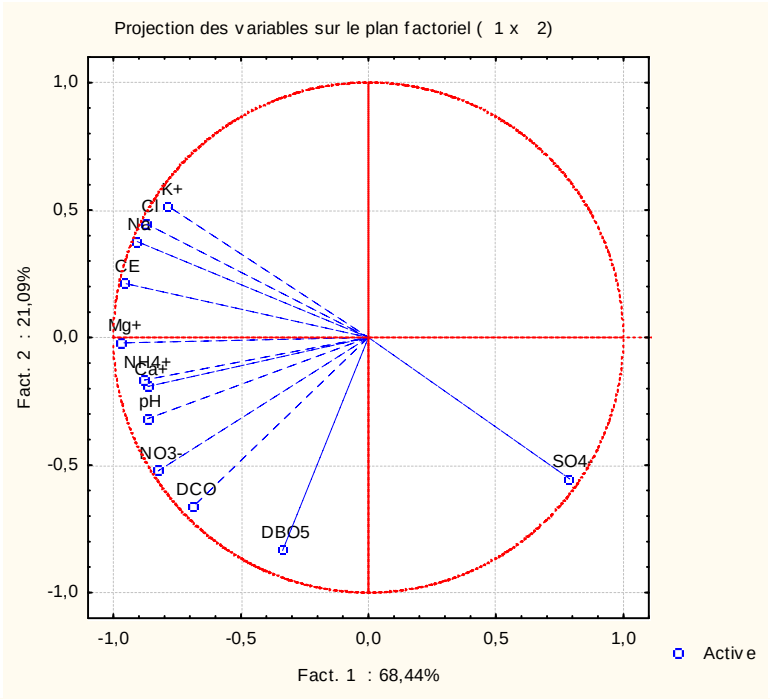
Unlike BOD_5, Chemical Oxygen Demand, COD measures the oxidation state of the substances present in the leachate. The contents of oxidizable organic matter (COD) are significant, with an average equal to 850.1 ± 37.67 mg / l, this value is less than that found in the landfill from Fez (4260 mg / l) by CHTIOUI [5]. and that found in the El-Hociema landfill (76 450mg / l) [7]. These concentrations vary between 671 and 1010 mg / l (2012). Maximum values are recorded in March (998mg / l) and November (1010 mg / l). In contrast to BOD_5, there has been an increase in this parameter during the summer (Table 1).

For the landfill of Kenitra, it is an old landfill that currently crosses the methanogenic stage (BOD_5 / COD equal to 0.04). The basic pH (8.30 on average), measured, reflects the phase of biological evolution. This explains the low values founded of BOD_5, which continue to decline during the time. We can conclude that the Landfill leachate of Kenitra is an old and stabilized leachate, characterized by low biodegradability and complex organic load. The decrease of BOD5, after biodegradation, resulted in a relatively large Production in nitrogen and ammonium. According to [15], [16] reported by [17], the composition of leachate is not constant during the time, it changes according to the state of degradation of waste.

II- CONJOINT ANALYSIS OF PHYSICAL AND CHEMICAL PARAMETERS
The principal component analysis of the various physicochemical parameters and their corresponding individuals shows that the two factorial designs 1 and 2 absorb 89.53% of the total variation.

* According to the factorial plan 1, we could distinguish two groups moving in the opposite direction, a group composed of only the parameter SO_4^- located on the positive side and a second group containing the remaining parameters, located on the negative side.

* Based on 2 factorial plans, two groups of correlation are formed, a group consisting of the following parameters: K^+, Cl, Na^+, EC, Mg and the second includes the remaining parameters.



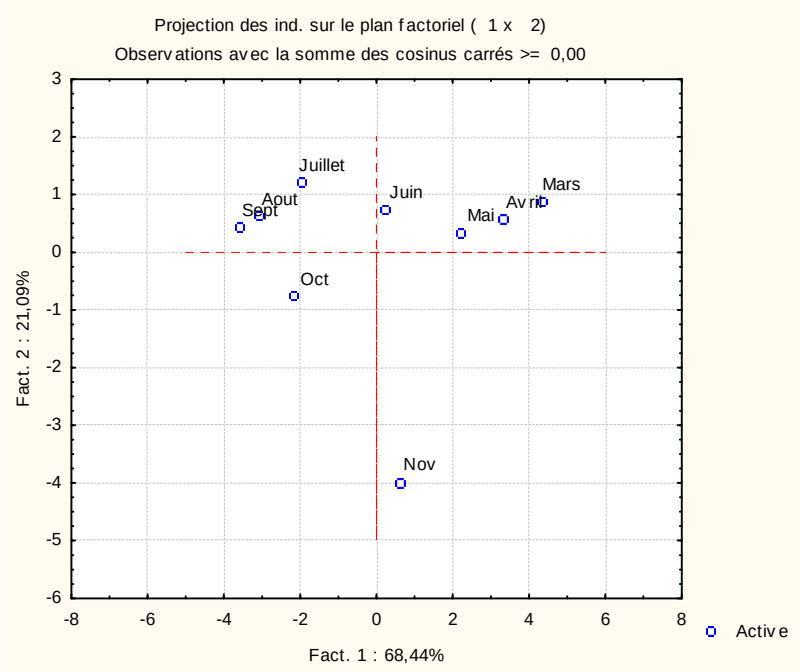


Figure (1) shows the Principal Component Analysis of the different physicochemical parameters and the corresponding individuals.

The IDs projection "month" on the factorial plan (1x2), distinguishes two groups evolving in opposite directions. The first group consists of the months of summer (July, August and September) and the second group consists of the months of spring (March, April and May).

The conjoint analysis of the two projections allows learning that the hot months are characterized by high rates of all physicochemical parameters and a low rate of SO_4 and inversely for the months forming the second group.

Strong correlations between different parameters are also determined:

When the pH is low, the organic load of the leachate is high, as well as the high concentration of soluble salts (chloride), whereas the organic load, the salt content decreases, and the concentration of nitrate and sulfate ions is increased, resulting in a return to higher redox potential in the landfill. The monitoring of the pH is consequently indicator of biological and biochemical decomposition [18]. The high contents of chlorides are recorded during the summer and coincide with the maxima temperatures. This can be explained, firstly, by the fact that during this time of year (summer), there is an almost total lack of precipitation phenomena that can lead to dilution of the percolate, whence the leachates become increasingly rich in chlorides. On the other hand, the increasing of the temperature seems to stimulate the oxidation reactions, hydrolysis and waste remineralisation by bacteria (bacterial stimulation of enzymatic activity), where the leachate is rich in minerals such as chlorides [19] and [2]; [11]. The evolution of chloride concentrations appears to influence the electrical conductivity of which is determined mainly by these ions. Indeed, they have the same seasonal variations. This close relationship between the chloride contents and the conductivity was demonstrated by KHATTABI [2] on the Etueffont site. The organic matter content of the leachate from the landfill, expressed as BOD_5 and COD are relatively low. The seasonal variation of BOD_5 shows that it has the lowest values during the summer. KHATTABI showed that there was a clear correlation between the increase in the temperature and decrease of BOD_5. Indeed during this period, there is a warming of water leachate and this allows for increases in microbial activity. These will allow for the degradation of biodegradable organic matter exist in the percolate. In winter, the temperature of the juice of landfill start to decrease, thus constitutes a limiting factor of the bacteria which become increasingly unable to transform the biodegradable organic matter, and this leads to increase of BOD_5 values during this period. On contrast to BOD_5, there is an increase of COD probably due to the products of incomplete biodegradation compounds by bacteria [2]. Whenever this ratio increased, the leachate became more biodegradable. This ratio is generally correlated with the age of leachate and therefore the degree of completion of the stabilization of massive [16]. BOD_5 / COD the ratio decreases with the age of the waste.

CONCLUSION

The landfill of Ouled Berjal forms part of the urban area of the city of Kenitra. It is uncontrolled Type. Due to the permeability of the soil, lack of drainage, lack of recuperation device and the purification, the leachate can cause serious environmental problems.

The leachate constitutes a potential threat to the environment; the main risk is the contamination of groundwater, which is a few meters from the surface. Indeed, the percolate accumulates at the bottom of waste and infiltrate through the soil to reach the bottom layer thus leading to its contamination and the degradation of its physico-chemical quality.

The landfill which exists since 1973 covers an area of 20 ha and receives on average 329 tons per day and 120,000 tons per year of waste of all kinds: domestic, industrial, hospital, slaughterhouses, trade and roads. This amount could rise in 2015, 510 tons per day or 186,000 tons per year.

The analytical results show that all parameters analyzed values are in fairly significant levels, indicating the importance of risks associated with this type of production. The leachate is then a potential source of contamination to the environment and especially to the groundwater.

The landfill has classified the city of Kenitra in the category of the producing towns of old stabilized leachate.

REFERENCES

[1] Ph Thonarth, E Steyer, R Driou Et S Hiligsmann. **1997**. La Gestion biologique d'une décharge, Tribune de l'eau N° 590/591.
[2] Khattabi, **2002**. Intérêts de l'étude des paramètres hydrogéologiques et hydrobiologiques pour la compréhension du fonctionnement de la station de traitement des lixiviats de la décharge d'ordures ménagères d'Etueffont (Belfort, France).Thèse, Université de Franche Comté, France
[3] Rodier, **1996**. L'analyse de l'eau « eau naturelle, eau résiduaire, eau de mer » (8éme édition) Paris :Dunode .1434 pages
[4] Afnor, **1989**. Eau, méthodes d'essai, Association Française de Normalisation. Édition 1989, Paris.
[5] H Chtioui. **2008**. Evaluation de la pollution générée par les lixiviats de la décharge publique de la ville de Fés.

[6] Chofqi, **2004**. Mise en évidence des mécanismes de contamination des eaux souterraines par les lixiviats d'une décharge incontrôlée (El Jadida-Maroc) : Géologie, hydrogéologie, Géoélectrique, Géochimie et Épidémiologie. Thèse Univ. El Jadida, Maroc, 250p.
[7] Rassam,et al **2012**. Caractérisation des lixiviats et évaluation de la pollution de la décharge de la ville d'al Hoceima /Maroc Volume 4 , N ° 120602 ISSN 2111-4706
[8] Mezouari F, **2011**. Conception et exploitation des centres de stockage des déchets en Algérie et limitation des impacts environnementaux.
[9] M Elmarkhi. **2011**. Caractérisation physico-chimique du lixiviats de la décharge d'ouled berjal (Kenitra, Maroc). Volume 5 , N ° 130203 ISSN 2111-4706
[10] L Robinsonet, **1985**. *Water Sciences Technology*, 17, 477-492
[11] TAZI, **2002**. Déchets solides : Étude d'impact sur l'Environnement (sol, eaux souterraines) et traitement par voie de compostage. Thèse Univ. El Jadida, Maroc, 224p.
[12] T H Christensen, R Kjeidsen, P L Bjerg, D L Jensen, J B Christensen, A Baune, H J Alberchtsen, G Heron. **2001**. *Appl Geochemistry*, 16, 659-718.
[13] MINISTERE de l'ENVIRENNEMENT, **2002**. Normes marocaines, Bulletin Officiel du Maroc », N°5062 du 30 ramadan 1423. Rabat, 2002
[14] Sante Canada, **1992**. Le nitrate et le nitrite. Recommandations pour la qualité de l'eau potable au Canada - Documentation à l'appui, Accessible à: www.hcsc.gc.ca/ehp/dhm/catalogue/dpc_pubs/rqepdoc_appui/nitrate.pdf, Consulté en: Mai 2002.
[15] Millot, **1986**. Les lixiviats de décharges contrôlées. Caractérisation analytique et étude des filières de traitement .Thèse de doctorat, INSA Lyon, 180 pages.
[16] F Ramade.**1998**. Dictionnaire encyclopédique des sciences de l'eau : biogéochimie et écologie des eaux continentales et littorales. *Ediscience*, 354-356.
[17] Berthe, **2006**. Etude de la matière organique contenue dans des lixiviats issus de différentes filières de traitent de déchets ménagers et assimilés. Thèse de doctorat, Université de Limoges.
[18] Charnay. **2005**. Compostage des déchets urbains dans les PED: Elaboration d'une démarche méthodologique pour une production pérenne de compost. Thèse de doctorat. Université de Limoges.
[19] Mattias ET Nilson, **1997**. *J. Envir. Eng. Div. Assce*, p. 892-900.