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Physicochemical and bacteriological characterization of discharge's leachate of Kénitra in Morocco

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ABSTRACT

The Public discharge of kénitra city of Morocco receives a around 120 000 tonne / year of waste which generate a large volumes of leachate. The objective of this study is to determine the physicochemical and bacteriological characteristics of this leachate so as to evaluate the impact on the environment and water resources. The results shows a very high levels in terms of mineral matter (Cond = 29 ms / cm) and suspended solids (SS = 584mg / l). More or less significant levels of organic matter (BOD5 = 126 mg / l) were also detected. Concentrations recorded chlorides are very high relative to other values usually reported in the literature (Cl- max = 7323 mg / l). Concerning the heavy metals, the results shows a high concentrations of iron (200 000 mg / l), Cu (1100 mg / l), Ni (834 mg / l) and Pb (432 mcg / l). Regarding the evaluation of bacteriological characterization, the results show a very poor microbiological quality compared to the existing standards. The high toxicity of this type of leachate without any prior treatment present a real risk to the environment and water resources

Key words*:* physicochemical, bacteriological characterization, discharge kénitra, leachate,

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INTRODUCTION

In Morocco waste management has become an important issue for the preservation of the environment. The waste disposal in controlled or uncontrolled landfills remains the most common way to eliminate its solid waste, but the problem which remains linked to the landfill is the production of leachate which can severely deteriorate receiving environment.

However, the amount of municipal solid waste (MSW) is growing in line with recent rapid economic growth, and as such is a serious environmental problem that requires urgent attention [1,2]**.** There are many options available for handling municipal solid waste, namely via open dumping, incineration, gasification, sanitary landfill, grinding and anaerobic digestion, etc [3 morocco]. Originally, the landfill is the most removal technique of waste disposal used today [4]. In terms of its simplicity, as well as the low exploitation and capital costs, accounting approximately 95% of the total municipal solid waste collected worldwide [5].

Nevertheless, landfill leads to pollution problems such as leachate and landfill gas [6].

However, the production of highly contaminated leachate is a major drawback of this method [7,8].

Leachate is liquid formed primarily by the percolation of precipitation water through an open landfill or through the cap of a completed site [9].

Landfill leachate contains a large number of hazardous substances [10] resulting in the threatening of surrounding soil, groundwater, and surface water [11]. Many factors influence the production and composition of leachate[12].

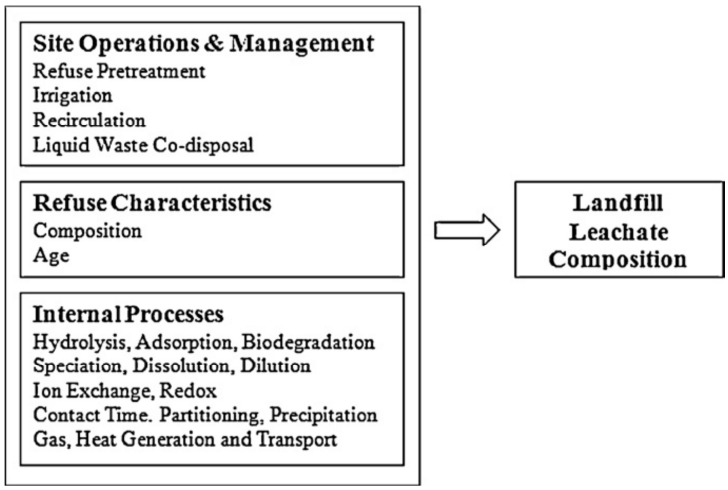

Figure. 1. Factors influencing leachate composition in landfills (El-Fadel.M, 2002)

Regardless of the concentration changes and bacteriological depending on a complex set of interrelated factors, the complexity of the landfill leachate can be categorized on the basis of four major groups of pollutants: dissolved organic matter, inorganic macro-components, heavy metals and xenobiotic organic compounds [13].

Typically, the characteristic of the landfill leachate can best be represented by chemical oxygen demand (COD), total organic carbon (TOC), biochemical oxygen demand (BOD), BOD/COD ratio, pH, suspended solids (SS), ammonium nitrogen (NH3-N), total Kjeldahl nitrogen (TKN), bacterial count, turbidity or heavy metals content [14,15], Generally, the risks of the leachate on the natural environment are determined by comparing leachate quality with standards methods of water and wastewater.

Our work focuses on the study of landfill of Ouled Berjel of Kénitra area mainly the physico-chemical and bacteriological characterization of leachate. Furthermore, comparing the results of characterization with other international landfill sites was performed and to assess the degree of pollution caused by the landfill.

MATERIALS AND METHODS

1.1. Study area

Kénitra, capital of Gharb is located in the northwest of Morocco, near the Atlantic Ocean (10 km) and 40 km north of Rabat, built on the banks of the Oued Sebou. The city of Kénitra has the only river port in the country, sixth city of the Kingdom, Population is about 400,000, is sub humid climate to semi-arid, influenced by the ocean, the average rainfall is about 600 mm the city of Kénitra is characterized by two major processes: unprecedented population growth and rapid expansion of the city; This results in a pressure on collective socio equipment and over production of solid waste[16].

The annual production of household and similar waste is about 108,000 tonnes in 2004 to 120 000 tonnes in 2011. Collection rate is 100 %.

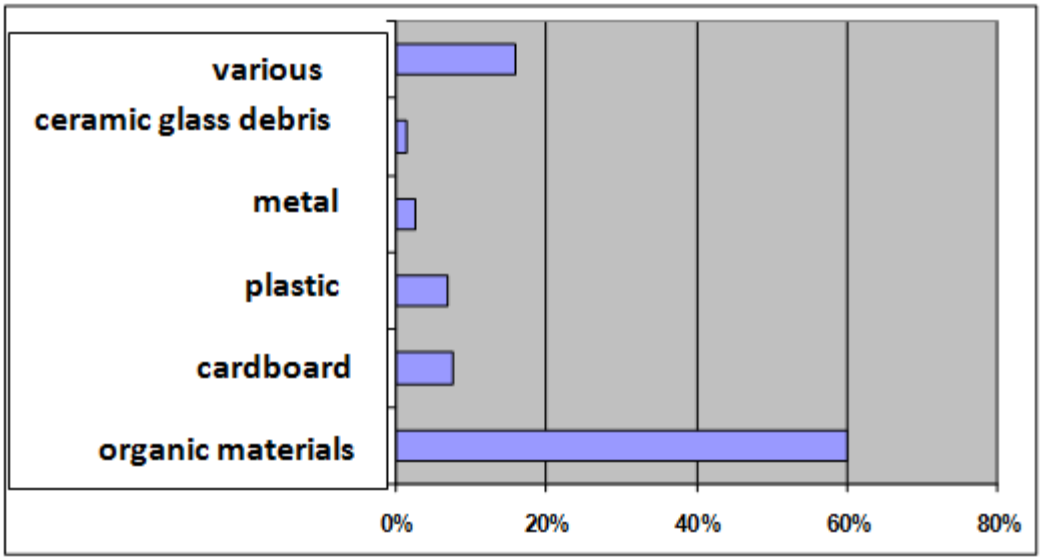

Figure 2.Composition of household waste in the city of Kénitra

2.2. Localization of the landfill of Kénitra

The discharge Ouled Berjal is Located in the North -West of the city of Kénitra on secondary road Going to Kénitra Sidi Allal Tazi , on the left bank of the estuary of the Oued Sebou . It covers an area of 20 hectares and receives an average of 329 tons per day and 120,000 tons of waste a nominal [16].

Figure 3.Kénitra Landfill with 4 storage ponds leachate (google earth)

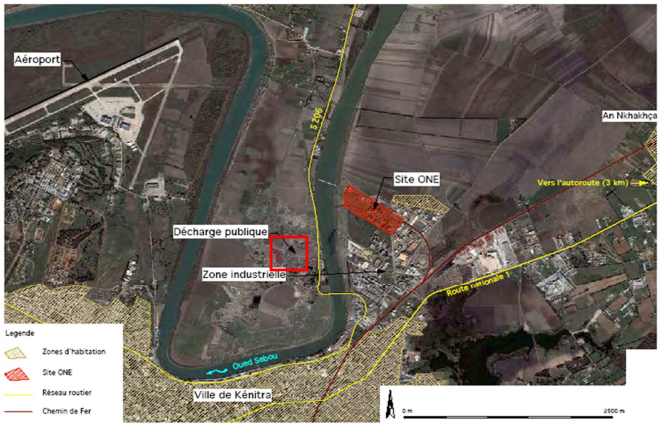

Figure 4. The discharge Ouled Berjal kénitra

2.2. Analytical parameters and methods

Physicochemical Characterization

The physico-chemical parameters are determined from samples taken weekly at the basin leachate. The conservation of leachate samples was made according to the general guide for the preservation and handling of samples according to ISO 5667/3 [17] and the good practice guide of the National Office of Drinking Water [18].Leachate samples, collected in polyethylene bottles and stored at 4 ° C, are transported to the laboratory with in a period not exceeding four hours. The parameter measurements were conducted thrice according to the Standard Method of Water and Waste water [19].

The PH, electrical conductivity, Dissolved solid (SS), salinity and dissolved oxygen are determined using a multi - parameter analyzer type Consort - Model 652.The analysis of global parameters such as , BOD5 is determined by the respiratory method using a BOD meter (OxiTop) and COD according to DIN 38409 - H52 [20]. which is determined by the oxidation excess potassium dichromate at a temperature of 148 ° C , in an acid medium and boiling of the reducing substances under the conditions of the test, contained in water, in the presence of silver sulfate (catalyst) and mercury sulfate (complexing chloride ions), calcium (Ca2+),magnesium (Mg2+), were determined using the volumetric method (AFNOR, 1987). bicarbonate (HCO3-) measured By Acidimetry. The ammonium (NH4 +) were determined by calorimetric method. The total Kjeldahl nitrogen by Kjeldhal method

Sodium (Na +) and potassium (K +) were measured using a flame spectrophotometer. Determination of chloride (Cl-) (mg / l) per argentometry. Determination of total nitrogen by the Kjeldahl method. Determination of phosphorus total by automated colorimetry and the heavy metals by atomic adsorption.

Bacteriological characterization

Leachate samples are collected for bacteriological analyzes and kept in glass vials 225 ml, sterilized by heat in an autoclave at 120 ° C for 1 hour. Microorganisms including total aerobic plate counts and pathogens germs were examined by using Standard Microbiological Methods Health Protection HPA 2004 a, b, c, d [21,22,23,24]**,** HPA 2005 [25] and Difco Manual [26]. While, yeasts and moulds were determined by using NM08.0.123-2005 [27]**.**

225 mL of each sample was homogenized. Then, serial dilutions of slain solution (8.5 g NaCl, 1000 ml distilled water, pH 7.0) were made and 1ml of mother solution was transferred into 9ml serial dilutions up to 10^9 of slain solution. 1ml from each dilution was cultured for presence of potential pathogen using the selective media.

RESULTS AND DISCUSSION

3.1. Physico-chemical parameters

The chemical composition of leachate is specific to each discharge. In fact, it varies strongly with the nature and age of the landfill, the waste type and degree of decomposition, the landfill method, the nature of the landfill site and climatic conditions [28, 29, 30, and 31].

Leachate Kénitra discharge are blackish in color and smell fécaloïde. Examination of the average values of the physico-chemical parameters calculated on the fourths month of the summer season 2015 and are summarized in Table 1 and 2 shows that the leachate studied shows a diverse and high pollution load.

Table1: Averge chemical composition of the leachate of the kénitra, landfill (of June to September)

CE (ms/cm)	CL^- (mg/l)	Ca^{2+} mg/l	Mg^{2+} mg/l	HCO3- (mg/l)	NH_4^+ (mg/l)	Na^+ (mg/l)	K^+ (mg/l)		NTK (mg/l)	SS (mg/l)	SAL (g/l)	O_2dissous (mg/l)
29	7323	219	250	900	6200	1997	1956	2109	548	13.7	0.1	

3.1.1. *Conductivity*

The average conductivity is about 29 [ms/cm], indicating the mineralization of the leachate of the discharge, this mineralization is due to the presence of a great number of salts and mainly due to the presence of a high concentration of chlorides which is about 7323 mg/l. this value exceeds the standard Moroccan releases 2.7 [ms/cm]. the study of the seasonal variation of electrical conductivity; shows that there is variation in season. These results could be related to both the mineralization of organic matter and also the phenomenon of evaporation. During the winter season. We are witnessing low conductivity values which may be due to the phenomenon of dilution under the influence of due to rainfall in this période [32].

3.1.2. 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 [33]. the average of chloride concentration is about 7323 mg/l. It is higher than that found in El-Kerma Oran (Algeria) 3379mg/l [34] in Oujda (Morocco) 5798 mg/l, and in AlHoceima (Morocco) 3000 mg/l [35].

These high concentrations coincide with high values of electrical conductivity. This indicates that it is largely determined by the chloride ions. As compared with the terms of standards of grid quality of surface water, it seems that our results exceed the standards (> 1000 mg / l).

3.1.3. Calcium, Magnesium and Sodium

The average value in term of calcium is 219 mg/l , this value is similar than that found in leachate discharge of El Jadida 202.82mg/l[31] and low then that found in China, Tunisia and in Turkey with respectively 525-2933 mg/l [36], 370.8 mg/l [37] and 250-900 mg/l [38]

For magnesium the average value is 250 mg/l .these value is similar than that found in Tunisia 258 mg/l [37] .It is low than that found in china 311-670 mg/l[36]And in Turkey 420-600 mg/l[38].Then it is higher than that found in Iran 1.432 mg/l [39].

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 1997 mg/l (Table 1).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 [31].

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 [40]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 [33].

3.1.4. 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 averge value is 1956 mg/l , this value is consistent with those found by EL Marrkhi [32] and Houria abed [33]. These concentrations greatly exceed the values of discharges of waste water recommended by the Moroccan standards 12 mg/l [41].

3.1.5. 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 6200 mg/l , this value is less than that found in the leachate of the city of El Jadida [31] and El Hociema [35].

3.1.6. Bicarbonate

The average value in term of bicarbonate is 900 mg/l , these concentrations greatly exceed the limits recommended by Moroccan standard in water for irrigation 518 (Ministry of the Environment., 2002). our results are slightly consistent with that found by Elmarkhi mina [32]

3.1.7. Salinity

The averge salinity is about 13, 7g/l . These results were correlated with results of conductivity 29 ms/cm. Increasing salinity is controlled by a temperature increase, the decrease is due to occasional rainfall diluting medium. Salinity could be attributed to the contribution of urban waste.

3.1.8. Suspended solid

SS, are all inorganic and organic particles contained in the leachate. Their effects on the physical and chemical characteristics of water are very harmful (change in turbidity, reducing light penetration thus photosynthesis). Analysis of the results shows that the leachate from the city of keintra have an average concentration of 584 mg/l. This result is often linked to heavy load in organic and inorganic materials generated by the population.

3.1.9. Dissolved oxygen

The dissolved oxygen concentrations measured in the leachate of the locker are lower and vary from 0.11 to 0.19 mg/ l, that is likely due to the use of bacteria of the oxygen during the degradation of organic matter.

3.1.10. Total Kjeldahl nitrogen

The content of NTK raw sewage from kénitra is about 2109 mg /l. These values are extremely higher than those found in Jebel Chékir Tunisia 991 mg / l [42] and in Eljadida (Morocco) 140 mg / l [43] and less than that found in fez (morocco) 4000 mg /l [44].

Table 2 : Temporal evolution of the pH, COD and BOD5 of leachate of kénitra

Parameter	June	July	August	September
pH	8.5	8.7	8.8	8.7
COD	6400	5015	5510	4900
BOD5	136	116	134	118
BOD5/COD	0.02	0.02	0.02	0.02

3.1.11.hydrogen potential

The pH is an indicator of different phases of degradation of waste. The leachate from the landfill of Kénitra city is very basic. The pH averge is 8.6, This average is higher than that found in leachate from landfill of El Hoceima [35], and are consistent with those found by CHOFQI [43] MEZOUARI and ABED [33].

3.1.12.Chemical Oxygen Demand COD

COD represents the amount of oxygen consumed by the chemically oxidizable materials contained in water. It is representative of the bulk of the organics and oxidizable inorganic salts **.** The recorded contents are between 4900 and 6400 [mg d'O2/L].

It is lower than those found in EL-Kerma Oran (western Algeria) 19333 [mgd'O2 / L] **[**34]**.** in Djebel chékir (Tunisia) 14400 [mg d'O2/L] [42] and higher than those found in Oujda (Morocco) in 1000 [mgd'O2 / l] [43]. This difference may be related to age, the nature and quantity of waste and the various climatic factors such as rainfall, humidity and temperature. Indeed, according to Christensen and al [44]**,** these factors are the basis of variability in pollutant loads.

3.1.13.Biological Oxygen Demand BOD5

The Biological Oxygen Demand BOD5 evaluates the biodegradability of leachate. The concentrations of biodegradable organic matter (BOD5) in the leachate are correspondingly low. In fact, they vary between 116 and 136 [mg / l]. (Table 2), with an average value of 126 [mg / l]. The value obtained is less than that found in the discharge of El Hoceima (Morocco) 38 200 mg / l [35] and in Ivory Coast 576 mg / l [46].

For one of the most representative parameters to municipal solid waste leachate, the BOD/COD ratio which is directly related to the biodegradability of organic substances, freach leachate first possesses high concentrations of easily biode-gradable matters, whereas the ratio will decrease with the ageing time [47]. The mature leachate is thus usually characterized by relatively lower COD (<4000 mg/l), lower biodegradability (BOD/ COD<0.1), and slightly more basic pH (>7.5) [48].

For the landfill of Kénitra, it is an old landfill that currently crosses the methanogenic stage (BOD5 / COD equal to 0.02). The basic pH (8.6 on average), measured, reflects the phase of biological evolution. This explains the low values founded of BOD5, which continue to decline during the time. We can conclude that the Landfill leachate of Kénitra is an old and stabilized leachate, characterized by low biodegradability and complex organic load.

3.2. Heavy metals

The analysis of the composition for heavy metals in leachate (Table 3) showed the large metal loading of these percolates. Iron is the most abundant metal (200000 µg / l), which is not the case for leachate generated by a discharge phase anaerobic digestion.

This is likely due to the fact that the discharge continues to receive waste containing iron.

Leachate of Kénitra also have relatively high grades for copper = 1100 µg / l
nickel = 834 µg / l and lead = 432 mg / l.

The metallic composition of the leachate from the landfill Kénitra is typical of a domestic nature discharge dominant [52, 53, 54, 40].

Classification of heavy metal concentrations of these leachates in ascending order is as follows: Fe> Cu> Ni> Mn> Zn> Pb> Cd. Therefore, the presence of heavy metals in landfill leachate inhibit microbial growth and interfere representative results of BOD5.

Table 3: Comparaison of metal concentration of kénitra landfill leachates in relation to others national and in maghreb landfills

Concentration of heavy metals in leachate (µg/l)	Landfill of Kénitra	Landfill of Oujda	Landfill of El jadida	Landfill of Djebel chékir Tunisia	Landfill of El kerma Algeria
Cu	1100	93.9	187	_	600
Mn	825	1763	5800	_	140
Zn	750	1506	_	440	330
Cd	25	<0.5	12	_	400
Pb	432	102.7	297	480	170
Fe	200 000	89 900	23 000	7400	7770
Ni	834	115.6	134	_	1280

The metal charge, however, a huge risk to groundwater due to the shallow groundwater flowing in the discharge area and the moderate permeability of the soil texture of the landfill that favor phenomena of infiltration and percolation of leachate and their metallic charge.

3.3. Bacteriological parameter

Examination of bacteriological characterization results of leachate discharge of Kénitra (tab. 4) show a very poor microbiological quality of existing standards far seen high levels of coliforms, streptococcus, staphylococcus, clostridiums and the presence of salmonella. What makes these highly toxic leachate and thus present a permanent danger to the environment and the underground aquifer and therefore require treatment.

Despite such high levels of pathogenic microorganisms these results are less than those found in the literature in the case of landfill leachate, this is explained by the presence of high concentration in heavy metals loading that previously mentioned.

Table 4 : Results of microbiological analysis of the leachate of kénitra samples

APC (UFC/ml)	TC (mg/l)	FC mg/l	SF mg/l	STF (mg/l)	CL (mg/l)	VC (mg/l)	SAL (mg/l)
96.10^4	$\mathbf{95.10^3}$	$\mathbf{77.10^2}$	$\mathbf{3{,}1.10^3}$	$\mathbf{15.10^2}$	+	-	+

APC: Aerobic Plate Count, TC: total coliforms, FC: fecal coliforms, STF: Staphylococcus aureus., SF: Streptococcus faecalis, Sal: Salmonella, VC. Vibiro Choleric CL: Clostridium.

CONCLUSION

The characterization of leachate generated by the landfill of Kénitra (Morocco) showed that it is an old and stabilized leachate, conveying an important mineral pollutant load, organic, metallic and microorganisms (total and faecal germs). These leachates high pollution load could contaminate groundwater and surface water because the discharge is near the sebou river and also presents a risk of contamination of bathing waters across the groundwater flow toward the ocean.

The basic character of the leachate (pH = 8.6) and the ratio of BOD5 / COD = 0.02 shows that this is an old landfill currently passing through the stage of fermentation methane from anaerobic degradation. The results obtained in kénitra discharge level were compared with those collected at other discharges, and showed that the metallic composition of the leachate discharge kénitra is typical of a discharge Household dominant.

The results of physicochemical analyzes, bacteriological and heavy metals revealed that these effluents are highly toxic and thus present a constant danger and potential health and the surrounding environment.

REFERENCES

[1] TA.Kurniawan, Lo.wh. *adsorption treatment water Res*, **2009**, 43, 4079 -4091
[2] G.M Zeng., M Chen., Z.T Zeng., Risks of neonicotinoid pesticides Science,**2013**,1340- 1403).
[3] K.Foo.,B.Hameed. *J. Hazard. Mater*., **2009**, 171, 54–60
[4] S.Saadi,M. Sbaa, M. EL Kharmouz, Physico-chemical characterization of Oujda city landfill leachates (Eastern Morocco ScienceLib Editions Mersenne, **2013**,5, N ° 130517ISSN 2111-4706
[5] TA.Kurniawan, Lo.W.H., GYS.Chan, *J. Hazard. Mater*, **2006**, 129 (1–3) 80–100.
[6]. Xiao-Song He, *Chemosphere*, **2016**, 144, 75-80
[7] J.Wiszniowski,D.Surmacz-Gorska, J.-VRobert, The effect of landfill leachate composition on organics and nitrogen removal in an activated sludge system with bentonite additive Manage, **2007**, 85, 59–68
[8] F.Mezouari., Conception et exploitation des centres de stockage des déchets en Algérie et limitation des impacts environnementaux. **2011.**
[9] A.Shuokr Qarani and all. *Journal of Environmental Management*, **2010**, 91, 2608-2614
[10] He .P.J, J.F. Xue, L.M. Shao, G.J. Lia, D.J. Lee *water Res.*, **2006**, 40, 1465-1473
[11] O.Aktas¸F.Cecen, *J. Chem. Technol. Biotechnol*. **2001**, 76, 793–802.
[12] M.El-Fadel, E. Bou-Zeida,W. Chahineb, B. Alaylic, *Waste Manage*. **2002**, 22 (3), 269–282.
[13] TH.Christensen , P. Kjeldsen, H.J. Albrechtsen, G. Heron, P.H. Nielsen, P.L. Bjerg,P.E. Holm, *Crit. Rev. Environ.Sci. Technol*, **1994**, 24 (2) ,119–202.
[14] A.Z Gotvajn , T.Tisler, T.Koncan, *J. Hazard. Mater*. **2009**, 162, 1446–1456.
[15] H. Alvarez-Vazquez, B. Jefferson, S.J. Judd, *J. Chem. Technol.Biotechnol*, **2004**,79, 1043–1049.
[16] Presentation of the Urban Commune of Kénitra: Problems of waste management at the Urban Commune of Kénitra. environnementcommunekénitra@yahoo, Site web: www.kénitra.ma
[17] ISO 5667/3 Water quality - Sampling - Guidance on the preservation and handling of samples. 1994.
[18] ONEP quantitative and qualitative Caractérisation of wastewater. Good practice guide. **1999**
[19] Standard Methods for the Examination of Water and Wastewater. (APHA. 2005)

[20] Determination of Chemical Oxygen Demand (COD) to DIN 38409-H52.National Laboratory of Environment. Ministry of Environment Rabat. Morocco (DIN 1992).
[21] National Standard method F 11 issue . Health Protection Agency (HPA), 2004a http://www.hpastandardmethods.org.uk/.pdf_sops.asp.
[22] National Standard method D 4 issue 2, http://www.hpa-standardmethods.org.uk/
[23]National Standard method F 12 isse 1. .pdf_sops.asp. Health Protection Agency (HPA), 2004b, http://www.hpa-standardmethods.org.uk/.pdf_sops.asp Health Protection Agency (HPA)c, 2004
[24] National Standard method w isse3. http://www.hpa, standard methods.org . uk/.pdf_sops.asp. Health Protection Agency (HPA)d, 2004
[25].Standard Methods for Food Products.Issue, 3.1.HPA, London. Available from: http://www.hpa-standardmethods org.uk/documents/food/pdf/F13.pdf accessed 06.12.2012.). . Health Protection Agency (HPA), 2005
[26]Difco Manual, 1998. Dehydrated Culture Mdia and Reagents for Microbiology. Difco, 11 Ed., Detroit, Michigan: Difco Laboratories
[27]Microbiologie des aliments-Dénombrement des levures et moisissures par comptage des colonies à 25°C - Méthode de routine, sprouts from retail establishments. International pp: 6. .NM 08.0.123, 2005.
[28] A.Navarro , D.Bernard, N.Millot. Les problèmes de pollution par les lixiviats de décharge. T.S.M.-L'eau, **1988**, 11:541–546
[29] G.Matejka, M.Rinke, R.Mejbri , H.Bril. *Environ. Technol*, **1994**, 15:313−322
[30] OO.Aluko, MKC Sridhar , PA.Oluwande. *J. Environ. Health Res*. **2003**, 2(1):32−37
[31] A. Chofqi and all, 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.
[32] M. Elmarkhi and all, *nternationa journal of scientific & technology research* , **2014** volume 3, issue 7.
[33]. H.ABED and all *Der Pharmacia Lettre*, **2014**, 6 (3):192-199
[34] T. Bennama and all, *Water Qual. Res. J. Can*. **2010** ,45, 1, 81–90
[35] A Rassam, characterizattion oof landfill leachate in Morocco and treatment solutions : the case leachate of the city of Al Hoceima, ScienceLib Editions Mersenne, **2012**,4, 2111-4706.
[36] Liu JY, Luo JH, Zhou JZ, Liu Q, Qian GR, Xu ZP. *Bioresour Technol* **2012**;113:239–43.
[37] S.Imen, T.Ismail,S.SamiS,A.Fathi,, et al. *Desalination* **2009**;246, 417-24.
[38] A.Gunay, D.Karadag ,I.Tosun ,M.Ozturk, *Clean-Soil AirWater* **2008**,36, 887–92.
[39]S. Kheradmand , A.Karimi-Jashni ,M.Sartaj . *WasteManag*,**2010**; 30:1025–31.
[40] T.HChristensen, R Kjeidsen, P L Bjerg, D L Jensen, J B Christensen, A Baune, et al.. *Appl Geochemistry*, **2001**, 16, 659-718.
[41] Ministre de l'environnement. Normes marocaines, Bulletin Officiel du Maroc », N°5062 du 30 ramadan 1423. Rabat, **2002**
[42] N. Tchich, A. Echchelh, Y. Rannane, C.Cordonnier, A.Rassam, M.Ohssine, A. Chaouch, W. Hubert. *Environ Sci Ind J*, **2014**: 9, 10
[43] A. Chofqi. *Journal of African Earth Sciences* , **2004**,39 509–516
[44] T.H.christensen, P.Kjeldsen, P.L.Bjerg.,D.L Jensen, J.B.Christensen et all. *Appl. Geochem.*, **2001**, 16, 659-718.
[45] H. Chtioui1 and all.Evaluation de la pollution générée par les lixiviats de la décharge publique de la ville de Fès, déchets –revue francophone d'écologie industrièlle-N° 496 1er trimestre **2008**-reproduction interdite.
[46] A.E KOUASSI . *Larhyss Journal*, **2014**,19, 63-74.
[47] FN.Ahmed,CQLan. *Desalination*, **2012**; 287:41–54.
[48] LJinghuan , Q.Guangren, L.Jianyong,X. ZhiPing. *Renewable and Sustainable Energy Reviews*, **2015**, 49,21–28
[49]R.Kerbachi , M.Belkacemi . Caractérisation et évolution des lixiviats de la décharge de Oued-Smar à Alger. Techniques, Sciences et Méthodes – L'Eau, **1994**,11, 615–618
[50].P.Christensen . *Application Geochemistry*, **2001**, 16, 659–718.
[51].A.ATatsi , A.Zouboulis . *Greece.Adv. Environ. Res*, **2002**, 6, 207-219