Assessment of leachates from uncontrolled landfill: Tangier case study

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Abstract. Landfill site of Tangier City is non-engineered low lying open dump. It has neither bottom liner nor leachate collection and treatment system. Therefore, all the leachate generated finds its paths into the surrounding environment.
Leachate samples of landfill site were collected and analyzed to estimate its pollution potential. The analyzed samples contained a high concentration of organic and inorganic compounds, beyond the permissible limits.
Keywords: Landfill, Leachate, pollution

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Introduction

Urban waste is one of the major challenges facing our societies. The combination of factors ranging from population growth to urban expansion, to the development of socio-economic and production activities, and to changes in lifestyles and consumption, leads to an increase and waste products

Landfill was originally the technique for the disposal of the most widely used waste in the world, easy to implement and relatively (Saadi et al., 2013). In developing countries, mainly uncontrolled and open pit landfills, where all types of waste (urban, industrial hospital and agricultural) are discarded in mixed. One of the major problems associated with this landfill is the production of liquid effluents rich in organic and mineral matter called leachate or commonly "discharge juice". They come from the percolation of rainwater through the deposits and the contained water in waste and their degradation (Hakkou et al., 2001).

Indeed, as soon as the deposition phase, the waste is subjected to degradation processes linked to complex biological and physico-chemical reactions. Water infiltrates and produces leachates loaded with organic or mineral substances which generate a pollution essentially of organic and inorganic type, in relation with the natural biodegradation of the confined waste. These leachates are a source of contamination of the surrounding environments if they are not collected and processed (Hakkou et al., 2001).

In Morocco, studies carried out by Hamid Chiguer et al in 2016 on the leachates from the Essouira landfill revealed high levels of biodegradable organic matter, heavy metals, minerals and suspended matter. Those of Saadi et al, 2013 on the Oujda dump and Rassam et al, 2012 on the Hoceima landfill showed similar results.

In Algeria, work carried out by Mokhtaria et al in 2007 on the Tiaret landfill showed that leachates contain many organic and metallic contaminants (Pb, Zn, Cd, Ni, Cr + 6) that exceed the accepted standards. Those of Bennama et al, in 2010 on the El Kerma dump showed similar results.

For this purpose, this study will use the physicochemical analysis methods to characterize the pollutant load of the leachates from the Tangier dump.

Study Area

Geographic location

The public dump of Tangier was put into operation in the early 1970s. It stretches over 30 ha 5 km from the city center on the road to Tetouan. The coordinates of the location are: latitude 35°44'35.32 "N and longitude 5°45'17.39" .The site belongs to the private domain of the State. It serves the following boroughs: Charf Mghogha, Souani, Tangier Médina and Beni Makada plus waste from industrial zones.

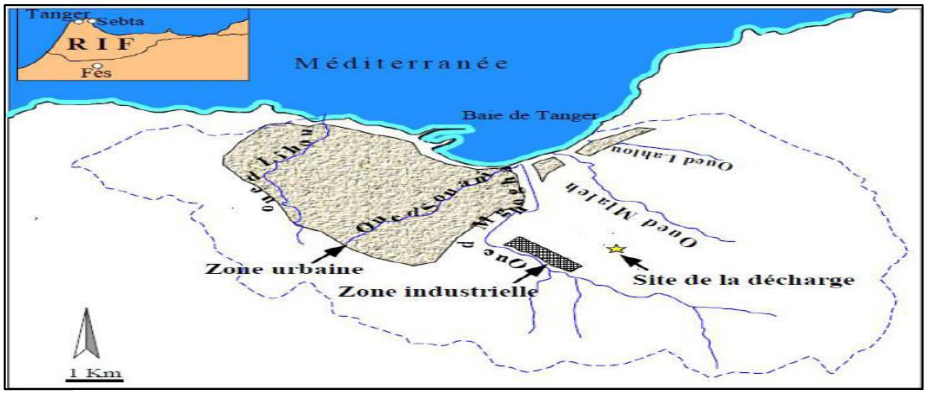


Fig.1. A map showing the location of the existing landfill of Tangier

This landfill is partially fenced and has two premises and a machine for the settlement of waste received daily.

At a distance of 100m, the landfill is limited to the south by a quarry of clay extraction and by the industrial district about 1km to the southwest. To the west of the dump, at a distance of about 200 meters, is a small residential area. To the west of the main entrance to the garbage dump is the shelters of ragpickers, which are built either of metal or wood. The perimeter of the landfill is only fenced to the south, on the other sides, the landfill is bounded by natural obstacles (valley floor to the north, cutting of a slope to the west), so it is easily accessible to the public.

Hydrographic network

The hydraulic network consists of two wadis around the landfill: Mghogha and M'laleh. The surface water and the leachate flowing over the area of the Tangier landfill flow into the Wadi Ayn At-Taleb Ahmed of Wadi Mghogha, which leads to the bay of Tangier in the immediate vicinity of the residence Sanaa Beach (Figure1).

Field geology

The unity is characterized by a vast schistous or clayey clay mass of the upper Cretaceous. The hills are surrounded by the Wadi Moghogha and Ghir Boudra valleys in the south and the wadis of Mlaleh and Khandak Bou Hajjar in the east. (GIZ Report, 2006).

Materials and Methods

Sampling of the leachates were carried out on April 2017, the samples were taken from polyethylene bottles, before the bottles were filled, the samples were washed with the sample to be taken, the bottles were filled edge and then the plugs aims to avoid any gaseous exhaust with the atmosphere. The leachate samples were stored in a cooling apparatus at 4°C during transport to the laboratory, they were analyzed immediately.

To avoid the evolution of the samples the conductivity, PH, dissolved oxygen and the temperature were measured in situ using a multi-parameter Brand HACH HQ40d. The physical parameters tested for included:

Color, Conductivity and Temperature. Chemical parameters analyzed were PH, Dissolved oxygen (DO) According to “NM ISO 10523” and ISO 5814 respectively , Nitrate, Nitrite, Chemical Oxygen Demand (COD), Ammonium Ions, Sulfures and Azote were analyzed using Quick method LCK,. HACH LANGE.

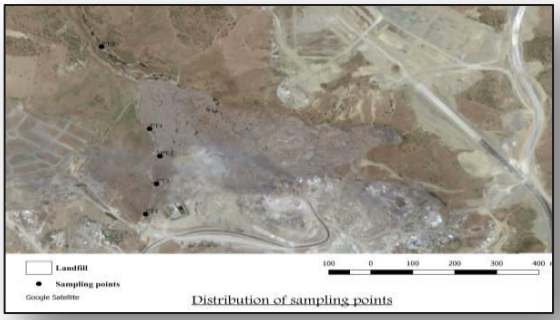


Fig.2. Distribution of sampling points

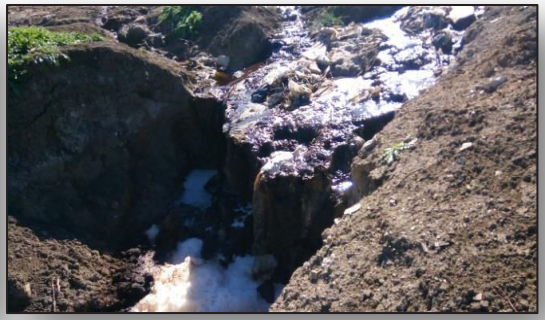


Fig.3. flow of leachate from Tangier discharge

Results and Discussion

In the landfill, through rainfall, rainwater is loaded with pathogenic germs, organic pollutants and minerals (Ozane, 1990, Martens et al., 1995).

The chemical composition of the leachates is specified at each discharge. Indeed, it varies closely with the nature and age of the landfill, the type of waste, degree of decomposition, method of landfilling, nature of landfill and climatic conditions (Navarro et al 1988, Matejka et al. al. 1994; Khattabi 2002; Aluko et al. 2003; Chofqi et al. 2004; Kurniawan et al. 2006; Renou et al. 2008).

Color and odor

The leachate from Tangier dump is blackish in color and has a fecal odor. The smell is due to the presence of organic acids from the decomposition of the highly concentrated organic matter in the waste. The dark color in landfill leachate is also associated with the high concentration of the organic substances (Aziz H.A et al., 2007).

PH

PH is an indicator of the different phases of waste degradation. During the various phases of the evolution of a landfill, the pH values obtained in the leachate could be related to the low concentration of volatile organic compounds. Indeed, during the acid fermentation phase of anaerobic decomposition of waste, young leachates are rich in volatile organic compounds. During this phase, the pH values are generally lower than 4 (Tchobanoglous et al., 1993). As they age of the landfill, leachate is depleted of volatile organic compounds. This will then cause a rise in pH = 7 or above (Kjeldsen et al., 2002). The pH varied according to the age of landfills (Kulikowska D et al., 2008).Generally, the pH of a stabilized leachate is higher than that of a young leachate (Poznyak T.G et al., 2008). In general, leachates have pH between 4.5 and 9 (Christensen T.H et al., 2001). The pH of young leachate is less than 6.5 whereas, pH of old landfill leachate has pH higher than 7.5 (Abbas A.A et al., 2009). Initial low pH is due to high concentration of volatile fatty acids

(Bohdziewicz J et al., 2008). Stabilized leachate shows fairly constant pH with little variations and it may range between 7.5 and 9.

The PH values of the leachate vary between 7,81and 8, 3 which is suitable for methanogenic bacteria. Similar results were obtained by El Khamlichi et al. (1997) on the landfill in Rabat (Morocco) and also Trankler et al. who found that leachate samples had a slightly high pH and remained in the range of 7.0–8.0 during the operations which indicates the short acidic phase and early methanogenic phase. On the other hand, Bahaa-eldin et al. found that the average value of pH was 6.7 for the municipal landfill leachate in Malaysia indicating the young leachate and the waste degradation was at its late stage of acidic phase.

Conductivity

The electrical conductivity reflects the mineralization of the sample analyzed. It assesses the overall mineralization and estimates the total water soluble salts, the values of the recorded electrical conductivity fluctuate between 20007-28002 µs / cm) with a mean value of 22072 This mean value is lower than that recorded in Malaysia discharge (31.68 lS/cm) (Bahaa-eldin et al., 2010) and also considerably lower than those recorded in the discharge of Agadir (64650µs / cm), (Commune urbaine d'agadir, 2010). The results obtained show an important mineralization of the leachate of the public dump in the city of Tangier.

Chemical Oxygen Demand COD

The COD represents the amount of oxygen consumed by the oxidizable materials chemically contained in the water. It is representative of the majority of organic compounds and oxidizable mineral salts (Makhoukh & al, 2001). In general, young landfill leachate (the acid-phase landfill, <5 years) contain large amounts of biodegradable organic matter. More than 95% of the dissolved organic carbon (DOC) consists of volatile fatty acids, and some high molecular weight compounds. In mature landfills (the methanogenic-phase landfill), the organic fraction in the leachate becomes dominated by refractory compounds, and the DOC content consists of high molecular weight compounds (Wang F et al.,2003; Wang F et al.,1997).

The high COD values obtained indicate a high organic load; The COD levels recorded in our study range from 1525-9800 mgO2 /L they are higher than those reported by (Kouadio & al,2000) in the Akouedo-Abidjan landfill (between 310 and 2495 mg / l) and by (Mekaikia & al, 2007) in the Tiaret landfill. Algeria (1048 mg / l), and also by (Commune urbaine d'agadir, 2010) in the Agadir landfill (6220 to 7640 mg / l).

On the other hand, they are much lower than those of the Mohammedia landfill (51456 mg/l), and also in Oujda dump (68036mg / l), and 20468 mg O2 / L at the discharge of Fes (Chtioui H et al., 2008). This difference could be related to the age, nature and quantity of the waste, as well as the various climatic factors such as rainfall, air humidity and temperature. Indeed, according to (Christensen et al. 2001), these various factors underlie the variability of pollutant loads.

Nitrate

Nitrates are the final stage of oxidation of nitrogen and represent the form of nitrogen with the highest degree of oxidation in water. The levels recorded ranged from 32,7to 73,1mg / L with an average grade of 53.14 mg / L. This value is considerably higher than the maximum concentration allowed by WHO (1980) which is 50 mg / L. Nitrites are derived either from nitrate reduction or incomplete oxidation of ammonium ions (Rodier, 1996).

The NO2 - leachate levels are low and range from 1,26to 4,24mg / L. These low levels are due to the low values of dissolved oxygen and the redox potential in the leachate.

In the leachate of the public dump in the town of Mohammedia, nitrates reached a concentration of 71 mg / L (Sabine, 2002). According to (Suabi et al., 2011), the leachate from a waste repository can reach a maximum value of 845 mg / L, High concentrations of nitrates in rivers lead to eutrophication, resulting in a significant development of microorganisms and algae, disrupting natural ecological equilibria (El Kharmouz et al., 2013).

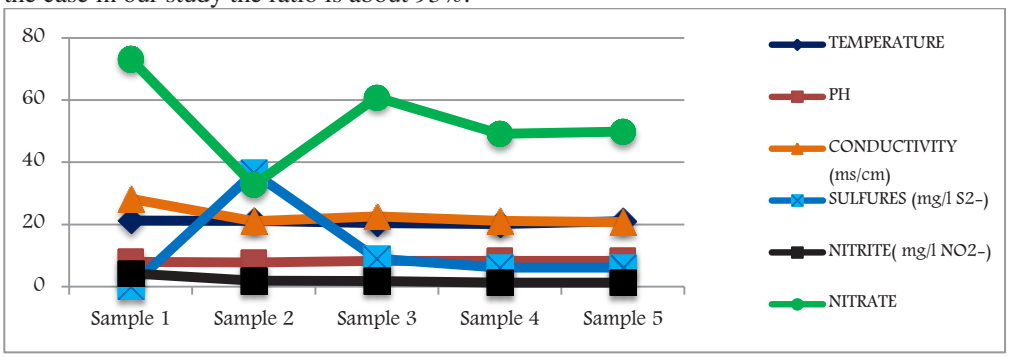
Ions Amonium

In fact, due to the reducing conditions of the anaerobic reactor, only the reduced forms of nitrogen are encountered very high concentrations of ammonia nitrogen which is one of the delicate problems of leachate treatment.

Observed ammonia concentrations ranged from 875 to 1055 mg/l with a mean value of 990 mg/l. At this concentration the methanogenic is only slightly inhibited by ammonia, this chemical is the main reducing agent in landfill leachate and is a long-term pollutant (Christensen et al., 2001) lower mean values of ammonia concentrations (600 mg/l) than those reported in the present study were obtained by Hassan and Ramadan .

Total Kjeldahl Nitrogen and phosphate

In the present study, it is expected that the mean values of total Kjeldahl nitrogen (1060, 8 mg/l) and phosphates (19.19 mg/l) decrease during the stabilization process as found by Hassan and Ramadan (mean values of 973 mg/l for total nitrogen and 0.33 mg/l for total phosphate). This may be attributed to the compaction of the wastes in the landfill. In mature leachate ammonia-NH3/total Kjeldahl nitrogen ratio is usually greater than 70%. Which is the case in our study the ratio is about 93%.



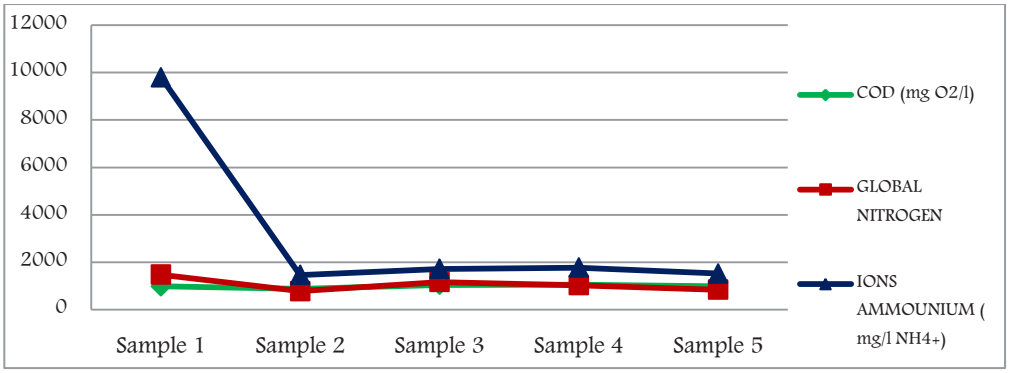


Fig.4. Results of physico-chemical analyzes

Table1. Physicochemical characteristics of leachate from various discharges in the world

Parameters	Unit	OUJDA (KHARMOUZ, 2013)	AGADIR (Y. JIROU 1, 2014)	KERMA ALGERIE (TAHAR BENNAMA, 2011)	HOCEIMA (A. RASSAM, 2012)	AKOUEDO (ABIDJAN-CÔTE D'IVOIRE)(A.E. KOUASSI ET AL.2014)	RABAT (EL KHAMLICHI ET AL, 2007)	OUJDA (SAADI ET AL, 2013)	SOUIRA (HAMID CHIGUER1, 2016)	FES (F. KHALIL ET AL ,2015)	MOHAMEDIA (ABDELAZIZ MADINZI, 2014)	AGADIR (ELKADI ET AL 2015)	TANGER (ELKADI ET AL 2015)	ETUEFFONT 2009
PH	-	-	4,3	8,19	6	7,68	7,8	5,59-6,08	8,44	7,66	8,27	7,6-7,9	6,8-7,6	7,69
Temperature		17,7	19,2-20,8	23,7	-	29,8	-	14,9-15,7	-	-	-	20,9	27,6	18,3
conductivity	US/cm	170	14,6	120,3	75	78,05	23,13-74,6	4,8-3,7	39,9	-	-	58,65	33,23	30,06
COD	mg/l	-	72000	19333	76450	1306,25	260-50112	68036 - 89472	10361	5400	2473,9	38496	16810	355
BDO5	mg/l	13520	44000	3301	38200	588,08	5-10500	38188 ,7	632	1700	400,8	25395	2000-30000	36,7
Nitrite	mg/l		0,125	43	-	0,69	-	-	-	-		-	-	9,58
Nitrate	mg/l	50	62	0,93	-	92,92	-	-	-	-	173,2	-	-	126
Phosphates	mg/l	-	188,4	1,84	-	128,74	-	-	-	-	-	-	-	
NH4	mg/l	-	0,1	-	-	388,4	-	-	-	-	723	-	-	65,4
Sulfates	mg/l	-	-	1717	-	-	-	-	0,73	-	156,04	-		260

All the results show that besides methanogenesis, is active in the discharge and that this discharge is an old discharge. The basic pH character of these leachates reflects this phase of biological evolution. The results of leachate analyzes have also shown that percolates are very poor in nitrite. On the other hand, the concentrations of COD, ammonia nitrogen and organic nitrogen (NTK) are relatively high. We can conclude that the leachate from the Tangier landfill is an old leachate, stabilized and characterized by low and difficult biodegradability and a very complex organic load.

Conclusion

The characterization of the leachates generated by the uncontrolled discharge and open pit of Tangier has shown that it is old and stabilized leachate, conveying a large mineral, organic, metallic pollutant load. These leachates with a high polluting charge risk contaminating the water table under medium permeable bedrock.

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