J. Mater. Environ. Sci. 3 (1) (2012) 115-120
ISSN : 2028-2508
CODEN: JMESCN

Assessment of physicochemical and biological parameters of Al Ghassani hospital wastewaters, Fez – Morocco

E. M. Tahiri [1], L. Benaabidate [1]*, C. Nejjari [2], K. Fikri Benbrahim [3]

[1] *Laboratory of Georesources and Environment, Faculty of Sciences and Technology, USMBA. P.O. Box: 2202 Fez 30000 Morocco*

[2] *Department of Epidemiology, Faculty of Medicine and Pharmacy, P.O. Box: 1893, Fez, Morocco*

[3] *Laboratory of Microbial Biotechnology, Faculty of Sciences and Technology, USMBA. P.O. Box: 2202 Fez 30000 Morocco*

Received in 14 Aug 2011, Revised 29 Sept 2011, Accepted 29 Sept 2011.
Corresponding Author: Email : benaabidate@yahoo.fr ; Tel : +212 535 610 935, Fax : +212 535 608 214

Abstract

The factors of sanitary risks bound to environment constitute important determinants of population health state, and are a source of daily preoccupation of this population. Indeed, the garbage of activities of cares can have a negative impact for human health, notably by the contamination of surface waters (i.e. stream, lakes etc…) following a dismissal of hospital wastewaters, containing medicines residues, chemical reagents, antiseptics, detergents, etc…, with no previous treatment. In Morocco, establishments of health are only mobilized partially on environmental management. Solid garbage is subjected to a flow management and a follow-up until their treatment. These establishments of health act to two levels on aquatic ecosystems, certainly, they have an important demand in drinking water and thereafter they produce liquid sewages, polluted by pathogenic microorganisms and by chemical substances not always biodegradable. The hospital Al Ghassani is an establishment covering a surface of 14 hectares and has a capacity of 400 beds. Its consumption in water is estimated to 458 m3/day, at the rate of 1.14 m^3/day/bed. Liquid wastes of this hospital are poured in the purification network that is connected to a network of collection of pluvial waters. Obtained results shows that the COD/BOD_5 ratio is 2.83 mg/l whereas for analyzed heavy metals alone mercury displayed a value of 0.75 µg/l. This last value lets predict that these dismissals constitute a risk on environment. Microbiological study revealed the existence of pathogenic microorganisms in the order of 102 to 106 germs/ml, notably Escherichia Coli, Klebsiella, Salmonella, Shigella and Enterococcus.

Key words: Morocco, Fez, Hospital, wastewater, contamination, heavy metals, microbiology.

Introduction

Hospital establishments reject various types of pollutes solid garbage and / or toxic of which the management and the treatment, present a big complexity, considering the specificity and constraints dealing with rejected products [1].

The microbiological and toxicological pollutions, added to the importance of volumes of produced sewages with is about 1 m^3/day/bed lead to ask several questions both on their potential risk for the people and the environment and on their negative influence on the biologic treatment in stations of water removal of a toxic elements[2].

The chemical substances used in hospitals for cares activities and for medical research are the more often recovered in the liquid sewages. Even though the raised volume of wastewaters, generated by these establishments, assure an important dilution of the present pollutants, the dismissal of these sewages in the local purification network or in the nature represents a meaningful contribution to the general contamination of environment, and more especially of the aquatic media.

ISSN : 2028-2508
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Indeed, the hospitals have been identified like an incontestable source of chemical compounds in the aquatic ecosystems. Contamination the most frequently met is made of micro - pathogenic organisms (of which some are multi resistant to antibiotics), metals [3], the x-ray isotopes [4], detergents, the organohalogenous compounds and residues of medicines [5].

The present work aims to determine the quality of the physicochemistrial and biological compounds of wastewaters issued from Al Ghassani hospital complex.

Situation of wastes in Morocco

In Morocco the hospital wastes, their management and treatment are today in the focus of the public power's preoccupations of the Ministry of Water and Environment within sight of issued problems, pollutions and nuisances.

The integration for wastes management that makes the daily question to which must make face and take the efficient measures of the analysis and the good management, regarding the increase of there wastes in term of quantity and impact on environment [6].

The hospital wastes are produced mainly by public and private hospitalian infrastructures. The quantity of produced wastes is of 3 kg/bed/day (4,5 for hospitals of more than 1000 beds) which is about 38 325 tonnes/an, what represents less than 1% of the total of wastes issued from the kingdom. These waste are constituted by medical wastes, that have an annual production of about 12 000 tons and composed of wastes with risks (5 to 10%) and specific wastes (25 to 30%), and domestic or assimilated wastes (60 to 65%) (Chefil, 2005) *in* [7].

Materials and methods

1. Presentation of Al Ghassani Hospital

Al Ghassani hospital is a public establishment that was opened in 1935, and it has been a regional hospital until 1999, then it was named Fez Jdid prefectural hospital. In 2001 it was transformed in an academic hospital centre (CHU) and put in service August 2002. It's located in Dhar Mahraz area at the north-eastern part of Fez (Fig.1). With an area of 14 hectares, it has a capacity of 400 beds with a mean occupation rate of 70% a mean length of stay of 4 days. Its consumption in water is estimated to about 458 m^3/day, at the rate of 1.14 m^3/day/bed.

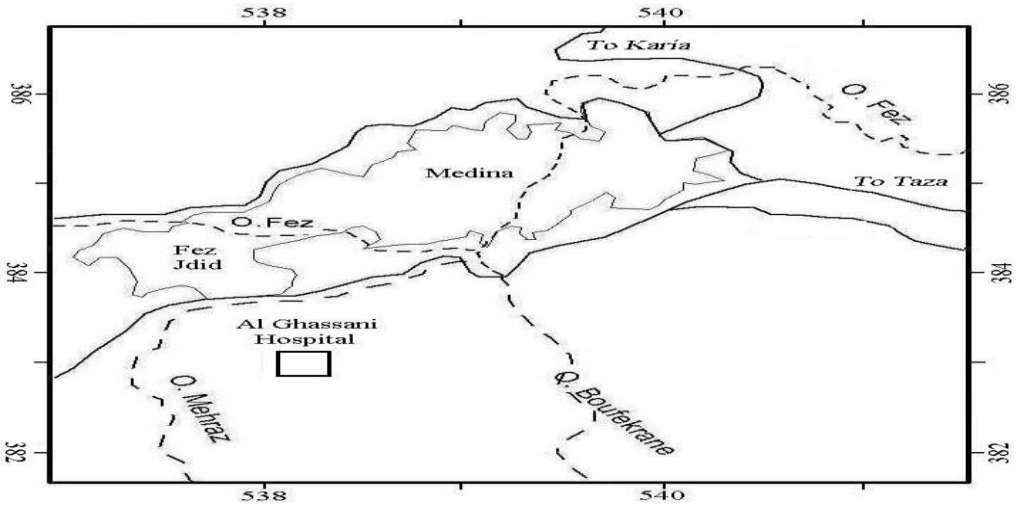

Figure 1: Situation of Al Ghassani Hospital in Fez

2. Physicochemical parameters

Method of analysis

The samples have been taken in the purification network inside the hospital both at the main outlet of the global purification network and at the internal sewers of the hospital. Studied parameters covered temperatures (°C), saltiness (‰), conductivity (ms/cm) and TDS (g/l) have been measured in situ with a conductimeter type ORION model 125. The pH indicatory strips of pH, immersed until there is no modification of color anymore, then we refers to the charter of pH measure while making a comparison with the color gotten on strip to determine the pH from 0 to 14.

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For other physicochemical parameters and heavy metals the analysis has been achieved from samples of the sewages in the hospital, within the unit of biometry at the faculty of medicine and pharmacy of Fez. The presence of matters in suspension in water reduces the brightness and lowers the productivity of the receiving environment. This is due, in particular, to a fall of dissolved oxygen content, consecutive to a reduction of the photosynthesis phenomena. This parameter has been measured by weighed after filtration or centrifugation and drying in a temperature of 105 °C.

The dosage of heavy metals contents (Fe, Cd, Cu, Pb, Nor, Hg, As, Cr, Zn) was done in the Faculty of Medicine and Pharmacy of Fez also within the unit of biometry. The analysis has been achieved on filtered samples to 0.45µm, by simple system of filtration, with an atomic absorption spectrophotometer AAS vario 6.

The BOD_5 represents the quantity of oxygen necessary to the destruction or to the deterioration of organic matters of water by the micro-organisms during 5 days in 20 °C and in the obscurity. This measure has been achieved by an Oxitop. The chemical demand in oxygen (COD) is the quantity of O_2 consumed by matters existing in water and oxidables in definite operative conditions.

The determination of COD has been done by the method of potassium dichromate. The principle of this dosage is an oxidization of the organic matters by an excess of potassium dichromate in acidic environment (H_2SO_4) in boiling and in presence of sulphate of silver and sulphate of mercury as catalyst.

The COD/BOD_5 ratio gives an indication on the biodegradability of sewages. For a report lower to 3, the sewage is easily biodegradable; beyond 5, the sewage is with difficulty biodegradable (presence of a "hard COD").

3. Biological parameters

The study is interested in a bacteriological analysis of the microorganisms existing in the sewages of Al Ghassani Hospital and the microbiological characterization of these sewages. Samples have been appropriated in a manual way in the sewers at the hospital's main outlet or inside the hospital following the accessibility. They are taken with the help of an agile where are fixed sterile bottles of ½ l. The bottles are filled until the 2/3, and kept in an icebox. The test of samples must be made as quickly as possible, in the hour that follows. We achieved of the numberings of the totals aerobes microorganisms, of total coliforms, fecal coliforms, and fecal streptococci. These analyses have been achieved in the laboratory of Biotechnology of the Faculty of Sciences and Technology of Fez.

Results and discussion

1. Physicochemical parameters

In accordance with the norms of dismissals, the pH of Al Ghassani sewages is alkali (pH = 8) (Table 1). The value of pH alters the growth and the reproduction of the existing micro-organisms in water, most bacteria can grow in an included pH range between 5 and 9, and the optimum is situated between 6.5 and 8.5. Ph values, inferior to 5 or superior to 8.5, affect the growth and survival of the aquatic micro-organisms according to the World organization of Health.

Table 1: Measures taken inside (underlined) and outside at the outlet of the hospital

Parameters	12/06/06 8 am	12/11/06 10 am	12/14/06 12 am	12/21/06 11.30	22/12/06 11h	12/28/06 9h00	01/04/07 10h30	Mean
T (°C)	18.8	18.4	14.3	18.5	16.6	14.2	19	170.11
Cd (ms/cm)	2.01	2.47	1.319	2.97	1.544	1.395	2.09	1.97
Salinity (‰)	1	1.3	1.6	1.5	0.8	0.7	1.6	1.21
TDS (mg/l)	980	1240	1620	1490	751	680	1460	1174
pH	8	8	8	8	8	8	8	8

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The temperature has a very important role in the solubility of salts and especially of gases, and the determination of the pH. This parameter acts also as physiological factor acting on the metabolism of growth of the micro-organisms living in water. The results for every week are grouped in the following table, which gives the global measures of physical parameters inside and at the outlet of the hospital.

The temperature is a factor for the biologic activity. It varies, in average, from 15.03°C in the sewers of the internal purification network to 18.57 °C in the main outlet of hospital; however, it is always lower than 30°C in accordance with the norm of the hospital liquid dismissals. The values of conductivity that are very weak inside the hospital (about 1319 µs) it reaches 2.97 ms at the exit. All measured physical parameters show a difference between the values obtained inside and those measured to the main outlet of the hospital.

COD and BOD_5

For this study, the pollution analyse of Al Ghassani hospital sewages is based on the fluently used parameters; COD, BOD_5 and pH. For the assessment of sewages content in organic matter, COD and BOD_5 are analysed. Results (Table 2) showed a variation from 115.2 mg/l to 617.5 mg/l and from BOD_5 of 40 mg/l to 188.1mg/l respectively for COD and BOD_5 parameters.

The organic matters are oxidable matters that requires for their decomposition a certain quantity of oxygen and then, lead to impoverish the environment in oxygen, of this fact, they are considered like polluting matters. The COD/BOD_5 ratio is generally used to have a first evaluation of organic matters biodegradability of sewages.

Table 2: Analyses of COD and BOD_5

Parameters (mg/l)	12/06/2006 at 8h am	12/11/2006 at 10 am	12/21/2006 at 1 pm	12/22/2006 at 11h	12/28/2006 at 9h	01/04/2007 at 10h30	Mean	Normes[8]
COD	138.24	617.5	396.3	129.03	115.2	512.03	318.05	500
BOD_5	60	188.1	12.2	4503	40	-	76.56	100
COD /BOD_5	2.3	3.28	2.88	2.61	3.24	-		

The calculation of this COD/BOD_5 ratio that is, in average, equal to 2.83mg/l is consisted between 2 <DCO/DBO_5 <3, what allows to conclude that the sewages of the hospital are biodegradable with selected stumps. This ratio determines the possibility and the performance of deterioration for that we can hope by a biologic oxidation treatment.

This result leads to predict that that the sewage is easily biodegradable; a biologic treatment may be capable to eliminate the essential of pollution.

In accordance with the results of this study, [9] hold on Hyères hospital (France) gave also a ratio between 2 and 3, indicating a weaker biodegradability

[1] established that the hospital sewages are the more often considered as similar to the domestic sewages.

Other authors note that hospital sewages present for the global parameters (COD, BOD_5, NTK, total phosphor etc...) some features quite

similar to the average of those issued urban residuary waters with exception of detergents that present a concentration meaningfully more elevated.

Heavy metals

During this work on the sewages of Al Ghassani hospital, with the exception of mercury that is in very elevated concentration, in average of 0.75 mg/l (Fig.2), metals like iron, lead and zinc are with concentrations in conformity with the norms values. Other metals like cadmium, copper, chromium, arsenic and nickel don't present any trace in the studied sewages (Tab.3).

ISSN : 2028-2508
CODEN: JMESCN

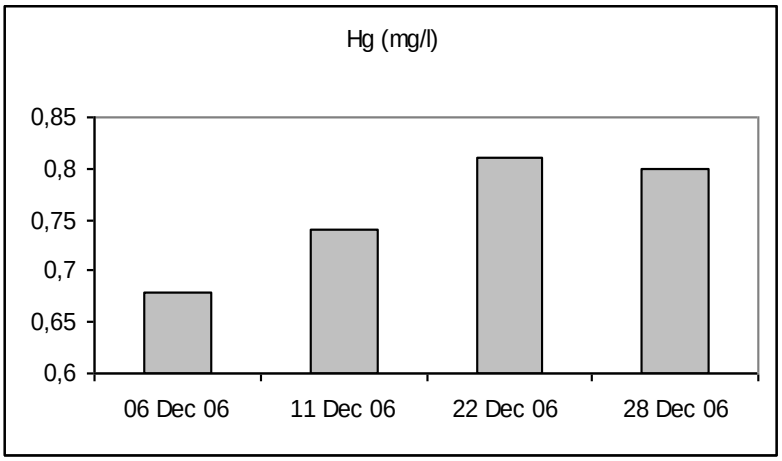

Figure 2: Temporal evolution of mercury

The mercury eliminated by the hospital purification network of purification may generate a considerable danger for environment.

[2] notes that this liquid heavy metal used mostly in hospitals via thermometers, has a considering toxic risk and its use has the tendency to decrease strongly with average of six thermometers/bed/year which is about 2g of mercury. The dismissals of mercury accidentally eliminated by wastewaters network contribute to the diffuse contamination of the atmosphere and the aquatic environment. It's transformed then in the sediments of rivers to organic metal by the bacteria.

Table 3: Analyses of heavy metals in the sewages of Al Ghassani hospital

Days	Fe (mg/l)	Pb (mg/l)	Hg (mg/l)	Zn (mg/l)
12/06/2006 at 10h30 am	0.084	0.29	0.68	0.04
12/11/2006 at 12am	0.088	0.27	0.74	0.022
12/22/2006 at 8am	0.006	0.27	0.81	0
12/28/2006 at 9 am	0.088	0.273	0.8	0.01
Mean	0.,066	0.28	0.75	0.018

Bacteriological analyses

The results of bacteriological analysis of the different samples are illustrated in table 4. These results show that the number of microorganisms in Unit forming a colony per ml (UFC/ml) is in the order of 102 to 106 germs / ml. It proves to be as well as, the concentration of the fecal coliforms is lower that of total coliforms. In the same way, the concentrations of coliforms and streptococci are lower to the concentrations of the total germs aerobes.

Table 4: Numberings of microorganisms in the sewages of Al Ghassani hospital

	12/16/06	12/25/06		12/25/06		12/25/06
Concentration	Outlet	Inside	Outlet	Inside	Outlet	Inside
Total aerobes Microorganisms (UFC/ml)	$4{,}2\ 10^4$	$2{,}8\ 10^5$	$7{,}9\ 10^4$	$2{,}9\ 10^5$	$1{,}5\ 10^5$	$4{,}3\ 10^6$
Total Coliforms (TC/ml)	$2{,}6\ 10^3$	$3{,}6\ 10^3$	nd	$5{,}2\ 10^3$	$4{,}6\ 10^3$	$5{,}2\ 10^4$
Fecal Coliforms (FC/ml)	nd	$2{,}1\ 10^3$	nd	$1{,}9\ 10^3$	$7\ 10^2$	$6\ 10^2$
Fecal Streptococci (FS/ml)	$1{,}2\ 10^3$	$1{,}1\ 10^3$	nd	$2{,}1\ 10^4$	$4{,}8\ 10^3$	$2{,}1\ 10^4$

nd: not determined

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It seems obvious because these 2 types of microorganisms (coliforms and streptococci) are optional anaerobic aerobes, and make integral part of the totals germs aerobes totals. Otherwise, the concentration of the different studied germs decreases slight lythe from inside to the outside of the hospital. These germs are with pathogenic characters notably Escherichia Colis, Klebsiella, Salmonella, Shigella, Enterococcus.

Conclusion

The liquid dismissals of Al Ghassani hospital are a major vector of pollution and deterioration. The study revealed that the COD/BOD_5 is about 2.83 mg/l, the mean concentration of mercury is elevated (Hg=0.75µg/l), an important concentration of microorganisms. The cOD/BOD_5 remains between 2 and 3 with allows predicting that sewage is easily biodegradable, a biologic treatment should be capable to eliminate the essential of pollution.

These products daily rejected in the sewers are used either to subjective use in favour of the patient and personal, to assure a remarkable hygiene (soap...). Either to objective use concerning the quality of the cares; medicines, antibiotics, antiseptics, treatments (detergent, disinfectants…).

In laboratories, in addition to disinfectants and detergents, we find other special products, intended solely to the analyses. The dismissals of this service have a particularity according to the diversity of reagents and products used:

The biologic sewages: blood, spits, urines, remaining after the analyses and can be the source of a risk of contamination of environment since they are rejected in sewages of the hospital.

The chemical sewages: products of specific use in laboratories, serving for the analyses (enter in the experimental protocols). These include expired chemical liquid products, acids, bases, various reagents, formalin, solvents and stains.

The hospital also uses the Cedex which is a drifted aldehyde serving for the sterilization of some medical tools. The elimination of those chemicals and biologic products is made directly in sewers without any previous treatment. They are always the cause of a pollution that can generate different risks for human and environment.

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(2012) www.jmaterenvironsci.com