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Study of the Biodegradability of the Drugs in the Urban Wastewater Using the Activated Sludge Process

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There are a large number of treatment plants that treat urban wastewater activated sludge process. Present study deals, a municipal wastewater activated sludge process. This plant is located in Boumerdes (Algeria). The study aimed to assess the effectiveness of the sewage treatment plant. The objectives of the study were: (i) monitoring and characterization sewage treatment plant (ii) to follow and to examine the efficiency of the biodegradation of the drugs (antibiotic, antifungal, antistamine) during the treatment of wastewaters. Physico-chemical parameters characterisation of wastewaters inlet to the treatment plant and outlet to treatment plant was conducted. Different parameters like COD, BOD_5, biodegradability ratio, pressure of the surface, production of activated sludge and rheological aspect were analyzed and compared to the other actived sludge process.

1. Introduction

The presence of the drugs residues in the aqueous environmental matrixes become an international concern in the domains of environment and public health. According to ONU and programs of the NUPE, the water pollution is considered the first reason of death worldwide (Barrier, 2010)
The phyto-sanitary products, the corporal care and the chemical substances that are designed for our well being and our health put in great danger the access of water and to the biodiversity, thus the water which is so essential for life becomes a source of diseases.
In recent years, scientific data indicate the presence of drugs in the environment (Halling-Sorenson et *al.,* 1998 ; Kummerer, 2004; Dietrich et *al.,* 2005 ; Aga, 2008)
According to numerous international scientific studies (Mullot, 2009) a vast range of the chemical and pharmaceutical products, antibiotics, anticonvulsants, antidepressants, antiseptics, antihistamine, and also the waste radioactive are found in the wastewater, irrigation and potable water. In fact all these products resist to the various treatment processes of the potable and the wastewater. However it has been revealed in laboratories that the smallest quantities of drugs, on a continuous basis, affected the development of the embryonic renal cells, blood cells as it helps the multiplication of the cancer cells (Barrier, 2010).The major parts of the pharmaceutical products that arrive to the stations of purification came from either domestic or hospital wastewater and from the industrial discharges (pharmaceutical laboratories) (Luis, 2009).
According to Matamoros et *al*., 2009, these water treatment stations behave as a source of introduction of drug residues in the environment. However, even after passage of effluent treatment plant, it is established that the efficiency of these plants for the treatment of drug residues is variable but not absolute (Khan et Ongerth, 2002; Yu et *al*, 2006; Santos et *al*, 2008)
It is now established that pharmaceuticals are aquatic pollutants (Kummerer, 2000; Jones, 2001)
In this context, objective of this study is to survey the biodegradability of a collection of pharmaceutical substances (Antibiotic, doxyline 100mg "capsules", antifungal: ketoconazole 2% "dermal cream" and an antihistamine: loratadine 10 mg "tablet" that are discharged in a station of purification of wastewater. The

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survey is done according to the method of experience plans (factorial plan 2^3). The survey will reveal the reasons behind the non-biodegradability of these drugs.

2. Materials and methods

Wastewater samples were collected from station of purification situated in Boumerdes one to two times per week from April 2011 until June 2011. Sample collections were done at 11:00am. The analysis of the samples concerned the physico-chemical parameters as, pH, temperature, chemical oxygen demand (COD), biochemical oxygen demand (BOD_5), organic matter (MO) and biodegradability ratio, pressure of the surface and production of the activated sludge.

Parameters COD and BOD_5, have been analyzed by COD-meter, BOD_5 –meter. The following methods were used: for COD measurement, the K2CrO4 boiling method, for BOD5, the 20°C incubation method (Rodier) . These parameters (BOD_5, COD, OM, biodegradability report, surface tension and production of the activated sludge). The surface pressure has been measured by the stalagmometer. These parameters were analyzed according to the Standard Methods AFNOR.

The experimental device used in the laboratory is composed of a cylindrical-conical whose maximum volume is of 5 litters. For this purpose several series of tests were realized using one litter of activated sludge and two litters of wastewater. The aeration has been insured by using a porous disc disposed on the bottom of a cone. The input of the oxygen is insured by the use of an air pump. In addition the tests of purifications have been done within a period of five hours.

The rheological measures have been made with one cell, a coaxial cylinder with a viscometer of type **"**VTT555"**.**

3. The Used Drugs and their Domain of Study

The experiences have been realized with three types of drugs following an experience factorial plan (2^3). The table 3.1 presents the studied factors (drugs) and their domain of study.

Table 1: The studied factors (drugs) and their domain of study

Factor (mg/L)	Low level	High level
Doxycycline	1	50
Ketoconazole	2	20
Loratadine	1	5

Experiments were performed according to the following matrix of experience (table 2)

Table 2: matrix of experience

	Doxycycline	Ketoconazole	Loratadine
1	-1	-1	-1
2	+1	-1	-1
3	-1	+1	-1
4	+1	+1	-1
5	-1	-1	+1
6	+1	-1	+1
7	-1	+1	+1
8	+1	+1	+1

The results of the parameters of the pollution obtained are reported in table (3 and 4).

The values of the surface pressure of all the tests are greater than that of pure water (72 mN / m), none of which exceeds the value 61, 83 mN / m.

We have observed the manifestation of a yellow moss in the tests 5 and 8. This is due to the fact that the used drugs act as cleanser or detergent or as the tensioactive and harm the bacterial cytoplasm membrane (Prescott, 2003)

The surface tension in the seventh test does not change (the concentration of the ketokonazole and of the loratadine are in a high level) and it can be due to the fact that dermal cream (ketoconazole) is not dissolute or is partial dissolute as it shows that the loratadine cannot decrease the surfaces pressure

It has been said that lowering the superficial pressure increases the solubility of a specific hydrophobic substances. These variations have been analyzed using the method of the plans of experiences.

The other characteristics of the parameters of the pollution before and after purification are presented in tables (4, and 5).

Table 3: Results of the parameters of the pollution before purification.

number	COD (mg) O_2/L)	BOD_5 (mgO_2/L)	OM(mgO_2/L)	k	γ(mN/m)
1	341.00	153.00	266.67	2.23	58.82
2	141.00	108.00	155.00	1.31	52.88
3	400.00	198.00	331.33	2.02	59.73
4	877.00	260.00	552.33	3.37	57.34
5	274.00	126.00	217.33	2.17	57.17
6	1132.00	190.00	567.33	5.96	51.72
7	425.00	175.00	316.67	2.43	60.11
8	1081.00	260.00	620.33	4.16	56.99

Table .4: Results of the parameters of the pollution after purification.

	COD (mg O_2/l)	BOD_5 (mgO_2/l)	OM (mg O_2/l)	K	γ(mN/m)
1	58,00	5.00	22.67	11.60	57.69
2	34,00	27.00	29.33	1,26	57.60
3	71,00	8.00	29.00	8.88	60.27
4	90,00	14.00	39.33	6.43	58.94
5	67,00	11.00	29.67	6.09	59.45
6	75,00	4.00	27.67	18.75	60.15
7	38,00	13.00	21.33	2.92	61.83
8	73,00	80.00	77.67	0.91	60.03

These variations have been analyzed using the method of the plans of experiences. The results obtained following the experimental design are given in Table 5. The table represents the percentage of COD, BOD_5 OM and γ. Some parameters decreased. This decrease was represented by negative values .

The drugs have an effect on the organic matter, the microorganisms and an effect on the solubility and hence the bioavailability of the organic and inorganic matter.

We noticed that the drugs have an effect on activated sludge for this purpose we carried out a study on mud rheology

Table 5: Results of the plans experiences.

Coefficients	A0	A1	A2	A3	A12	A13	A23	A123
Coefficients	4.90	3.44	-1.92	2.21	-2.35	0.258	-1.093	-0.10
γ (%)	-86.63	-3.67	-4.68	-1.67	-0.99	-1.32	0.84	4.90
COD (%)	-89.15	4.97	1.06	1.41	1.1962	-0.7938	5.7762	6.29
BOD_5 (%)	-89.86	0.725	-1.3525	-0.68	0.3125	-1.4725	1.535	3.325
OM (%)	147.99	-92.06	-54.94	-63.712	5.2825	76.12	-58.18	-38.54

In order to determine the rheological parameters (τ_0, k and n) and the characteristic of the curve of the flow that has been obtained we propose to adjust these rheograms (figures 1 and 2) by a group of models (Bingham, Herschel-bulkley, Casson, Oswald). All the activated sludge presented a non Newtonian flow (Chhabra ,2008; Alexandrou et *al, 2003*)

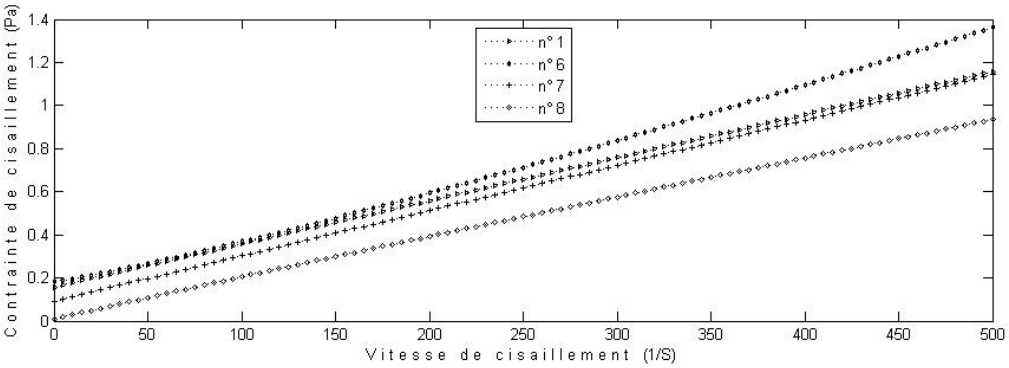

Figure 1: Rheograms of the activated sludges

The presence of a constrained threshold is an important characteristic of the rheology of all the activated sludge .This represents the required effort for the beginning of the flow.

The activated sludge of the experience number 6 has a flow index of (n = 1. 1549 > 1) which shows a shear thickening conduct. The interpretation of this is: in rest the free volume between the particles is minimal and it is occupied by the aqueous phase. Every particle is coated of one pellicle of water (in which other liquids exist in the raw water) which has the role of lubricant.

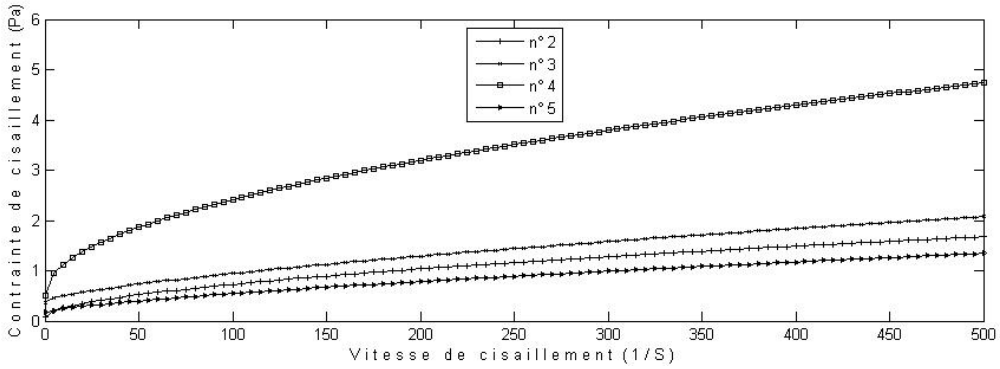

Figure 2: Rheograms of the activated sludges

4. Conclusions

The results of the experimental designs show that the elimination of the COD, BOD_5 and OM were not very affected in the presence of the three drugs with various concentrations.

Nevertheless the values of the answers average “a0” showed an important elimination of these parameters, that is due to the fact that the majority of these matters are to eliminate and/or they were remained in mud (a significant amount of mud is produced), from where the effect of the drugs studied on these parameters with the phenomena of flocculation, coagulation and joining against the walls of engine.

The presence of the drugs in water worn urban influences considerably the rheology of the activated sludge that it is for the modification of the critical stress of shearing or for the rheological behavior, which strongly influences biodegradability and separation water-mud.

The results of this study showed that the presence of the drugs have an impact on the activated sludge process and thus on the biodegradation of the drugs after purification what would require another research task which should be carried out to examine and quantify the conditions and effects generated on the plans organizational and structural, material, financial and of the human stock management on the level of the purification plants. The study of mechanical properties (rheology) of activated sludge from a biological treatment of drug residues can help us to know the evolution of the mobility of bacteria and microorganisms as well as the efficiency of the activated sludge process. Water and sludge from biological treatment should not be used in agriculture and especially if these waters contain antibiotics

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