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Research Article

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Anaerobic Reactor Element the Key to Integrated System

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ABSTRACT

This study is part of the adaptation and optimization of the operation of the integrated system Anaerobic Reactor Algal-Channel High Yield (RA-CAHR).

It is used to study the hydraulic behavior by numerical simulation.

These adjustments have led us to develop a new concept of Anaerobic reactor, which will improve the operation and the reactor.

Article consist to:

1. *The review of the current geometry of the reactor.*
2. *Present the reactor geometry defects.*
3. *Propose new geometries to remove dead or stagnant areas, preferential pathways.*

And the results obtained show that the hydrodynamic significantly influence the performance of the treatment process.

Keywords*: Optimization, system Anaerobic, Reactor Algal-Channel High Yield, Stagnant areas and Preferential pathways.*

INTRODUCTION

Fresh water is increasingly a rare resource, a fundamental aspect of life, it is also yhe development and the economic well-being[2]. This resource is already degraded by damage suffered in the past, the effects persist, now is the subject of ongoing attacks due to various human uses that compromise, sometimes irreversibly, its quality.

Moreover the unequal distribution of water resources and severe droughts, have forced officials of water resources to seek new supply innovative sources.

For many years, Morocco is developing a policy to improve people's access to safe drinking water and sanitation. Building on the reform of the institutional and legal context of the sector, considerable effort has been made though they are insufficient in the field of water to make available adequate resources. But unfortunately it is not always the same for all sanitation which appears as a poor relation of this mobilization.

Currently, the resource is under pressure, it is becoming rarer, more and more polluted, the cleaning sector seriously lags behind. Indeed, a significant difference was established between the pace of implementation of water supply networks and the investments earmarked for sanitation and waste water treatment.

So to meet the water needs while respecting human hygiene sewage; water has become a necessity that should not be overlooked[4], it should no longer be considered as a way to fight only against pollution but also as a means of waste water reuse after treatment[3], in order to reduce the water deficit which Morocco will face in the future.

Waste water treatment plant is an effective tool for reducing pollution of waste water and reuse for beneficial purposes[1]. This reduction depends primarily on the treatment solution selected as well as the design of designed structures[13].

1. Description of the station

The station used in our study is installed at the city of Rabat, which is located in the northwest of the Kingdom of Morocco and exactly at the Agricultural and Veterinary Institute Hassan II in Rabat[5]. The latter consists of a Anaerobic unit (Anaerobic Reactor) and other aerobic (Channel Algal High Yield and Maturation Basin). This station was fueled by domestic waste water comes from municipal sewage systems of Rabat, at the Takadoum sector.

The subject of our article is the anaerobic unit. These are covered rolls having a diameter of 3m and a variable depth comprised between 5 and 5.3m[6].

2. Principles and role of anaerobic reactor

Geometry considered is similar to the pilot station. The principle of operation of the reactor is based on the anaerobic metabolism[12].

The question is to present in many superior advantages to other conventional treatments such as aerobic. : A major clean-up performance, the amount of sludge formed is small compared to aerobic treatment with stabilization of this biomass[15], Elimination of bad odors and biogas as methane[10].

3. Conditions of work

- **PH**

PH adopted in the reactor is around neutrality. This setting encourages the cultivation of methanogenic bacterial stuffs[19].

- **Temperature**

The activity of the consortium is closely related to temperature. The bacterial stuff uses temperatures in the mesophilic environments. This range allows for more stable performance[11].

MATERIALS AND METHODS

Proposal of the problem

In this article, we will shed light on the technology development conditions in Morocco, and the characteristics of the processing constituting the system.

The hydrodynamics of a reactor performance influences as important as the kinetics of transformations that operates there[9]. For this hydrodynamics takes its place in the study of reactors in general and in particular our reactor subject of study.

The waste water is done by Anaerobic Reactor cover, it is empty inside that is to say in the form of a cylindrical tank.

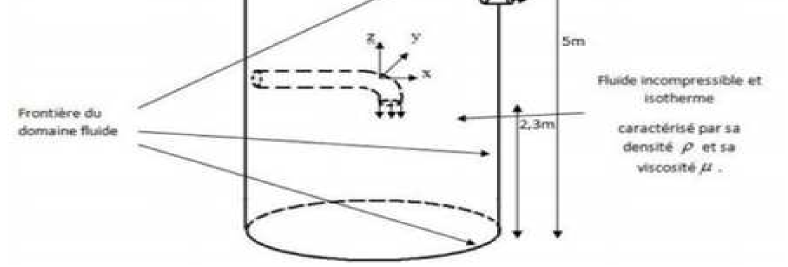
The purpose of this study is to present the geometry defects station reactor installed at the Agronomic and Veterinary Institute and propose of a geometry that enhances hydrodynamic reactor operation.

Theoretical approach flow

Statement of the problem

The figure below outlines the boundaries of the domain, the configuration of the input as well as output.

Fig. 1: Anaerobic reactor of the IAV station



Geometrical data

The characteristics of the reactor R are shown in the following table (the data are taken from the IAV station):

Table 1: geometrical data of the reactor R2

Depth (m)	5
Diameter (m)	3
Volume (m3)	31

Hydraulic Data

The data flow is summarized in the following table

Table 2: the flow of data

Travel time (j)	Flow rates (l / s)	Flow rates (l / s)
1,5	0,24	0,03
2	0,18	0,023
3	0,12	0,015

The properties of the mixture are summarized in the following table:

Table 3: the disregard of the mixture

property	waste water
Density (kg / m3)	998
Kinematic viscosity (m2 s-1)	10-6

Character turbulent flow

Reynold's number determines the ratio of inertial forces to viscous forces and thus characterizes the behavior of the fluid for a given geometry is given by:

$$Re = L / \mu$$

With: V: The speed of the flow at infinity (exit velocity); L: The length characteristic of RA (diameter); ρ: The volume density of the fluid; μ: The dynamic viscosity of the fluid.

Under the conditions of the flow, the values of the Reynolds number corresponding to different residence times are shown in the table below:

Table 4: Reynolds number for different residence times

Retention time (j)	Sore average speed (m / s)	Re
1,5	0,03	1210
2	0,023	928
3	0,015	606

These values give the flow laminar character remains to verify that there is no vortex phenomenon using the following formula:

$$Re = nD2 / \vartheta$$

D: The characteristic length of the RA (diameter of reactor (m) θ: Kinematic viscosity m^3 / s (1.0087 10-6 m3 / s) n: medium speed (rev / s)

From the values previously obtained on the Reynolds number, we deduce the speed of the fluid for different residence times. The values are summarized in the following table; they clearly show that there is no vortex phenomenon:

Table 5: medium speed for different retention time

Retention time (j)	Re	n (tr/s)	n (tr/min)
1,5	1210	0,00021	0,0127
2	928	0,00016	0,0097
3	606	0,00011	0,0063

Digital Approach flow

The software used

To achieve our simulations, we used the FLUENT CFD code by following the steps above:

1. The definition of the problem is done using the preprocessor GAMBIT[8]. It is covered with a cylinder height of 3m and 5m in diameter, with a supply pipe installed radially in the middle of the geometry of 0.1m diameter, the pipe will be connected to 4 other lines located in the middle of the reactor each conduit diameter 7 cm is related to a bend at its end.
2. Given our domain configuration. It defines a refined mesh to have good accuracy in the calculation of the flow.
3. The boundary conditions are chosen in a completed manner. These conditions concern the entry, exit, the walls and the bottom of RA. Input in an imposed speed ('velocity-inlet), output "Out flow" and the walls and bottom are identified as "Wall".

The simulation of the first non-improved geometry

The flow in the reactor is governed by the Navier-stored in cylindrical coordinates[7]. The resolution of the mass conservation equation mathematically and numerically can graphically plot the profiles of radial and axial velocities as follows:

Fig. 2: Graphical representation of the UZ function (r, Z)

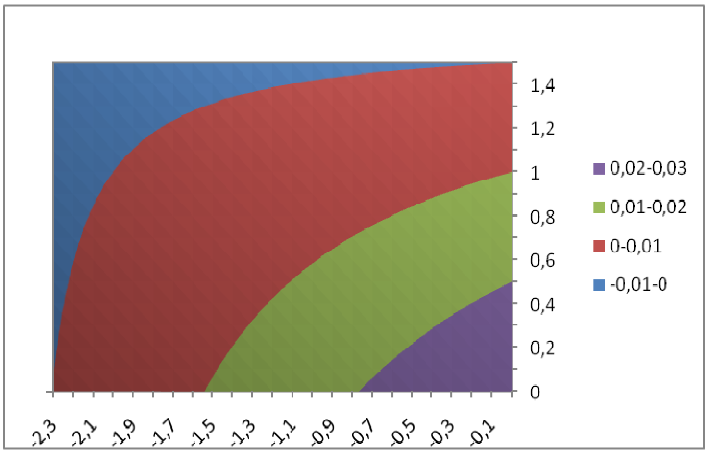


Fig. 3: speed profiles

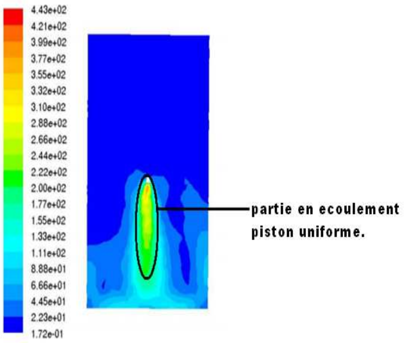


Fig. 4: Profiles of the core radial speed (r, Z)

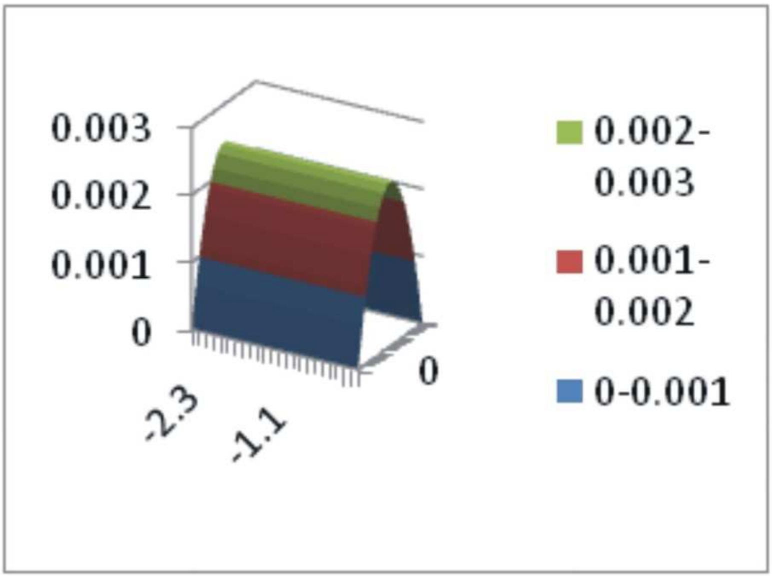
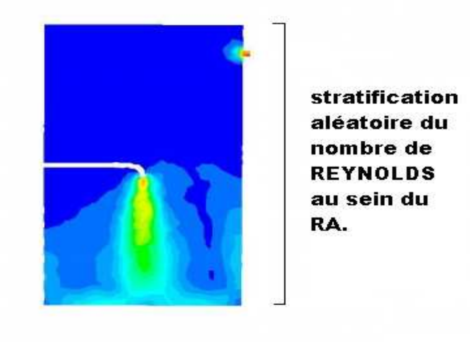


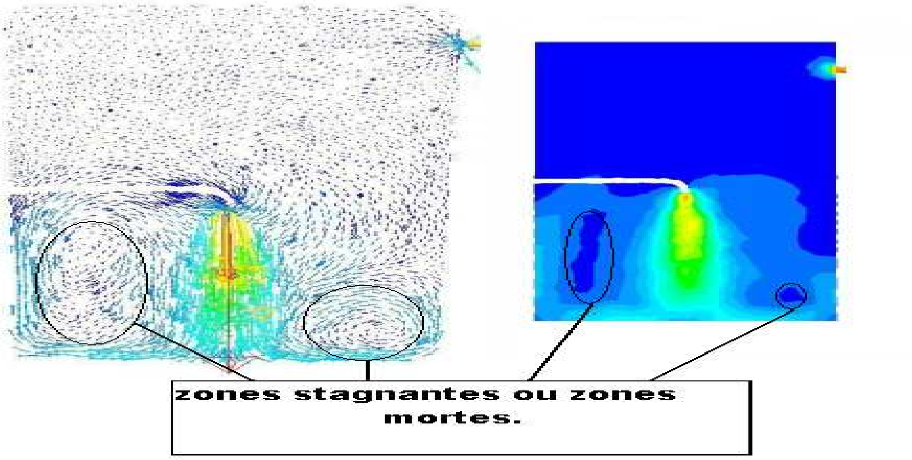
Fig 5: stratification of the Reynolds number



The simulation shows that we have a plug flow above the outlet bends, as well as turbulence in the output level which is manifested in a peak Reynolds number. Greater velocities are observed at the bottom wall of the reactor, is the region where sludge which causes a peeling phenomenon of the boundary layer near the bottom wall, so we have a risk of bubbling mud.

The simulation of the reactor does not conclude a hydraulic system for the entire reactor (random stratification of the Reynolds number). The flow regulating in the present reactor dead areas is more or less important.

Fig. 6: position dead zones



Improvement of the hydrodynamic operation of the reactor

Objectives to be achieved

To address these problems we think of making changes to the geometry of the reactor, such changes should give the following results:

- Decrease speed below the inlet elbow to avoid bubbling mud.
- Provide stratification number of fairly simple to conclude REYNOLDS hydrodynamics of the new geometry shown.
- We want a piston flow model which gives a good hydrodynamic performance but it can not provide this type of flow if the stratification of the Reynolds number is fairly simple (variation along the height of RA).
- Eliminate existing dead zones in the reactor, which involves little to the concentration changes occurring on the main flow.

Solution Overview

To solve the problem stated above, we aimed to reduce the speed below .So we think to make multiple entries in the form of a shower at 4 outputs. The main duct section inlet radius (10 cm) will be divided into 4 bends with a radius of each section (7 cm).

This provision will allow mixing the different fluids nets between them and eliminating dead zones. Indeed, each entry of 4 bends will give a profile configuration number of REYNOLD as configuring a single entry the different configurations will be grouped with each other which allow you to merge a dead zone.

Laminating Reynolds number strongly depends on the effluent entry position. Indeed, the speed of each point in the inside area of the reactor depends on the distance to the entrance and the point which results in a dependence between the Reynolds number and the entry position. So if we vary the input position of the main bend we go to actually change the stratification of the Reynolds number in the reactor.

It remains to make a flow simulation (CFD simulation by the FLUENT software) as proposed by the geometry and conclusion to the relevance of our choice.

Study of variants

We opted for 4 geometries which we will present the characteristics and simulation results

Geometry 1: it is a reactor with a cylindrical geometry height 5m and 3m diameter, with an installed supply line radially in the middle of the geometry of 0.1m diameter line will be linked to four other pipelines located in the middle of the reactor, each conduit diameter 7 cm is associated with a bend at its end.

Fig. 7: Representation of the geometry 1

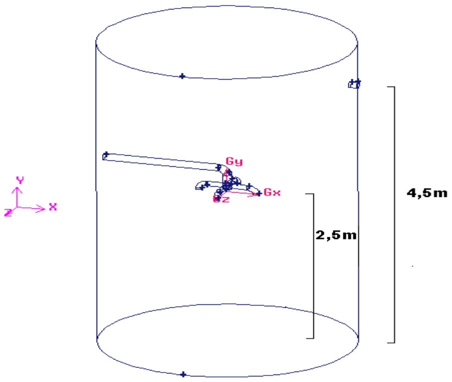


Fig. 8: geometry of the inlet elbows

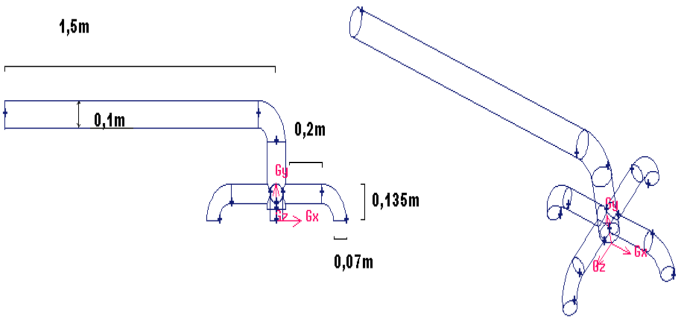
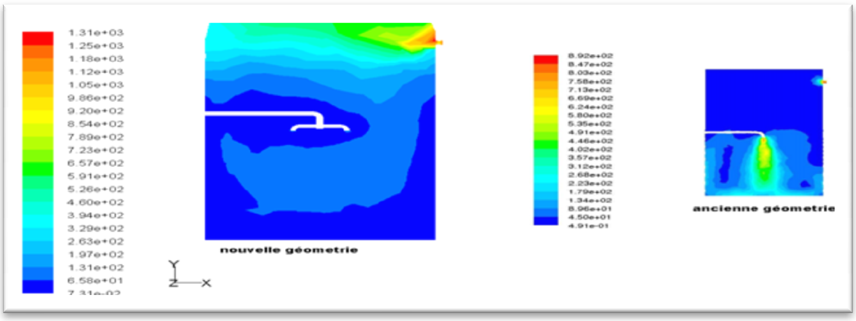
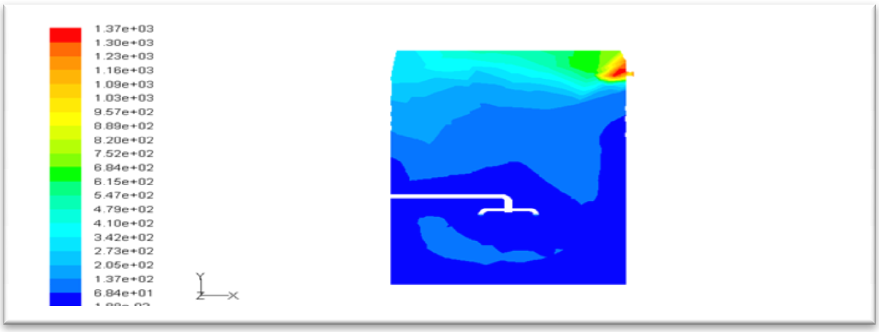


Figure 9: Simulation of Reynolds number for the new and the old geometry



Geometry 2: we will vary the position of the entrance to the main line, moving the 1m down. Which gives a distance of 1.5 m between the input and reactor bottom?

Figure 10: simulation of the Reynolds number for the second geometry



Geometry 3: We moved the main line down from 0.5m. This gives a distance of 1m between the bends 4 of the input and the reactor bottom.

Figure 11: simulation of the Reynolds number for the third geometry

Geometry 4: Geometry^4 is the same as the geometry^3 except replacing 4 bends input by a shower.

Fig. 12: Image of the entrance shower

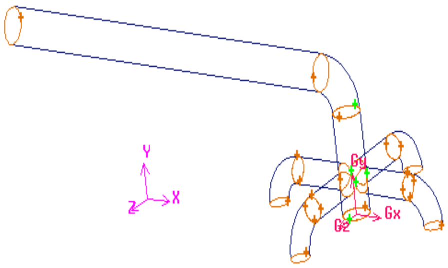


Fig. 13: entry shower: flow simulation results

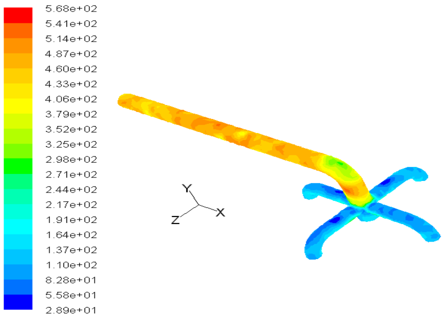
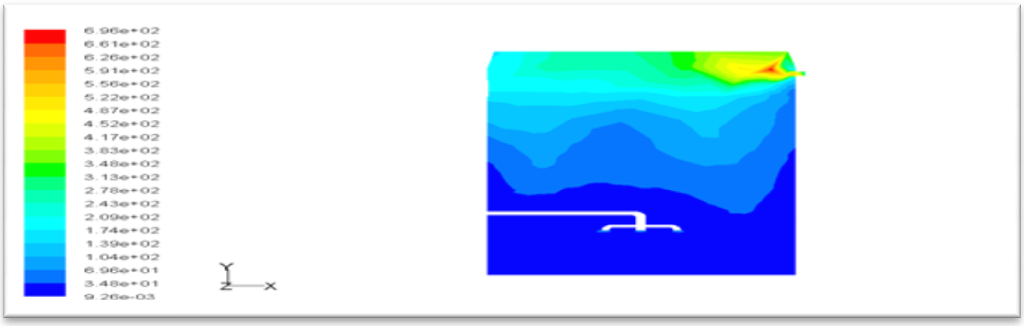


Fig. 14: simulation of the Reynolds number for the fourth geometry



RESULTS AND DISCUSSION

The analysis of the simulations allows progress that geometry 1 avoids the risk of bubbling mud located in the reactor bottom (low REYNOLDS at the bottom of the reactor unlike the old geometry). This provides a simple lamination of the Reynolds number, therefore there is a piston flow, which allows a small dead area in the upper part of the reactor and eliminates the zones created by the old geometry. This, also, gives a strong turbulence at re-output (new geometry) = 1310, Re (old geometry) = 892

The 2nd geometry Give a simple stratification of Reynolds number, better than the 1st, we can conclude that we have a plug flow. This eliminates the dead zone produced in the first geometry, but produces another dead zone below the input elbows. And it t gives strong turbulence at the outlet than the geometry 1ér.

The 3rd geometry gives a simple stratification of the Reynolds number, better than the 1st. We can conclude that we have a plug flow, which eliminates dead zones produced in the 1st and 2nd geometry and gives no dead zone. High turbulence at the outlet for the 3rd geometry, rather than the 2nd.

Besides, follows that the 3rd geometry can be considered as the best of the 3 obtained geometries. We also want to improve the stratification profile Reynolds number to converge plug flow, the more stratification profile Reynolds number is better the closer you get this type of flow.

For this reason we think to add an inlet pipe in the middle of the 4 elbows (like a shower), this behavior will help to mix the fluid streams together and standardize the Reynolds number in a given section.

But the problem that has arisen here is the determination of the speed in each of the shower output section. To do this we first simulate the flow in the shower to get the output speed, then simulate a new geometry of RA (geometry 4) with the shower at the entrance and exits insert rates obtained as conditions limitations in geometry[4].

The 4th geometry: Avoid the risk of bubbling mud located in the reactor bottom (low REYNOLDS at the bottom of the reactor unlike the old geometry), ives a simple stratification of Reynolds number, the better of the geometry[1,2,3]. we can say that in this case most likely the flow can be described piston, removes dead zones produced in the 1st and 2nd and the old geometry and gives no dead zone; and it does not give rise to turbulence at the outlet.

4th geometry allows therefore plug flow where it has not stagnant or dead zones, and eliminates turbulence at the outlet.

CONCLUSION

Through numerical simulation we developed geometry (geometry 4) that meets the criteria of a good hydrodynamic performance; this geometry provides the following results:

- The removal of dead or stagnant areas.
- Non bubbling mud located in the reactor bottom.
- A plug flow within the reactor.
- Low REYNOLDS at the reactor outlet (no turbulence).

These results can not be verified with a tracer test done on a model representing the geometry[4].

REFERENCES

1. Degrement, Technical memento of water. Ed and technical documentation. 8th Edition 1201pp (1978)
2. Degrement, Technical memento of water. Ed and technical documentation. (2004)
3. Eckenfelder, W., Management of urban and industrial wastewater American Translated by L.VENDEVENNE. Ed. And Technical Documentation. (1982)
4. Edeline, F. The biological waste water treatment theory and technology. Ed. Cebedoc, P 61. (1979)
5. El hamouri. B. Bouchebchoub, A. Rhallabi, N. Marchich, M. Ettalbi, M., Treatment of domestic wastewater in an algal pond high efficiency. *Acts Agronomy and Veterinary Institute*, **7**: pp 3-7 (1988)
6. El hamouri, B. Jellal, J.E. Belkhadir, R., Metabolic interactions entre algae and bacteria Pendant waste water treatment in high rate algal pond. first Asia Pacific Conference on Algal biotechnology University of Malaya Kuala eumpuer. (1992)
7. FLUENT GUIDE (2006) "CFD-guide on line"
8. GAMBIT GUIDE (2006) "CFD-guide on line"
9. Jellal, J., Contribution to the optimization of the performance of an algal channel high efficiency in removing organic matter. Thesis of state, University Sidi Med Ben Abdellah Morocco. (1994)
10. Jellal, J., Financial aspects of wastewater reuse in Morocco. Seminar on water management. (18-20 December 1996)
11. Jupsin, H. Paret, E. and Vasel, J.L., Dynamic mathematical model of high rate algal ponds (HRAP) Water Science and Technology, **48(2)**: P197-204 (2003)
12. Martin, G., Update on the treatment and effluent treatment. Ed. Technique and Documentation, Lavoisier, Paris. **3**: 298p. (1987)
13. Metcalf and Eddy. Wastewater Engineering Treatment. **1**: TMH Ed. P 93. (1979)
14. Oron, G. Shelef, G. Levi, A. Meydan, A. Azov, Y., Algae / bacteria ratio in High-Rate Pond used for Waste Treatment. Environmental and Water Resources Engineering. Technion, Israel, **38**: pp.570-576 (1979)
15. Oswald, W.J. and Gootas, H.B., Photosynthesis in sewage treatment. Transaction of the American Society of Civil Engineers, **(122)**: pp 73-105 (1957)
16. Oswald, J.W. Gotaas, H.B., Algae in waste water treatment. *Sewage and ind. wastes*. 437-455 (1957)
17. Oswald, J.W., Microalgae and Wastwater treatment in Microalgae Biotechnology. ed. Ma. Borowifzca & L. J. borowifca cambridge university .press. (1988)
18. Oswald JW (1976) Syllabus on Waste pond design, Algae Project Repport. "Sanitary Engineering Research Laboratory U of California, Berkley.
19. Roques, H., Theoretical Basis of biological water treatment. Vol1 Ed. Technique et Documentation pp 292-339 (1979)
20. Rodier, J., in the analysis of water - waters, waste water, sea water Ed Dunod. (1987)
21. Shelef, G. and Azov, Y., High-rate oxidation ponds the Israeli experience. *Water.Sci.Tech.* **19(12)**: pp 245-255 (1987)
22. Vaillant, J.R., Improvements and new features for the purification of waste water. Urban sewage and industrial waste water. Collection BCEOM Eyrolles. (1974)