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A Contribution to the development of certain treatment processes of waste water And its re-use in the irrigation for small communities

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Abstract

Considering the socio-economic, the strong demographic and urban pressures, pollution sources, both multiples and diverse increase, thus threatening water resources, which are already limited.

To the urban effluents are added the industrial effluents and to the people water needs are added the industrial and agricultural needs.

Water treatment must first protect health and contribute to the improvement of the quality of life. It is noticed that the diseases that are caused by waste waters kill annually 25 millions of people, especially in developing countries. 80% of these diseases are due to a lack of water improvement. The object of waste waters purification is to protect environment from a pollution whose consequences are extremely expensive at short term.

Indeed, Moroccan people are now aware of the economic and social value of water. They know that water purification is no longer a social welfare but an economic investment for the whole of their country.

Besides the classical purification methods that exist in Morocco for more than 20 years and which are energetically and financially expensive, natural purification solutions that have been used for more than a century, are nowadays used and technologically adapted to the present needs.

Therefore, it is in this context that we present two experimental studies:

The first one concerns the development of a wastewater treatment plant for a small community. Wastewater treatment plants techniques present the advantage to be rustic (low cost technology with reduced management and the use of local materials like sand or gravel)

Treatment efficiency and drawback reduction can be obtained by using selected media for filtration.

The second study is based on the building up of a station for the treatment of waste waters, with a capacity of 750 m^3, the equivalent of 10.000 per inhabitant.

The station of purification is composed of a clarifying and anaerobic basin and five sand filters. The capacity of this station increases with the establishment of an aerobic system (bacterial bed) between the tank and the sand filters.

I- Waste water in Morocco

I- 1-Urban waste water

Urban waste water in Morocco is formed by domestic discharges and as there are few separate networks and often unitarian networks, rain water is added to domestic waste water. So, industrial waste, such as heavy metals, organic compounds (cleaners, hydrocarbons) and salts, increases the organic polluting load as well as the toxicity of effluents.

In big cities of Morocco, the average volume of discharges is 93,5 liters/d/inhab*.

- for the cities of more than 500 000 inhabitants, the average is 127 liters/d/inhab.

- for the cities from 100 000 to 500 000 inhabitants, the average is of 87 liters/d/inhab.

The volume of urban waste water thrown back in nature without treatment is considered at 400 millions m^3 / year (60 % in sea, 40 % in the river system or spread on the ground).

A study on the quantity of domestic waste water, realized by the ministry of the environment on fifteen big cities in Morocco has allowed to establish the following parameters of pollution:

Parameters	Average rate in Moroccan cities	Average rate in French cities
S.S. (mg/l)	423.5	330
BOD_5 (mg/l)	368	460
COD (mg/l)	855.5	1000
N total (mg/l)	69	119
P total (mg/l)	15	19
faecal Streptocoques		4.10^3-4.10^6

Tab1: pollution parameters according to city size .

The report $\frac{COD}{BOD_5}$ is lower than 2.5 marking thus the importance of the effluent of biodegradability. Domestic waste water is strongly organic.

The Nitrogen is essentially under mineral shape (NH4 +, NO3-, NO2-) and organic (Amino acids). Its main origin in domestic waters is Urine.

* In France, the average rate of discharges is 150 l/d/Inh and in the USA, it is 170/d/Inh.

Table 2: pollution per Inhabitants

Parameters	Size of the cities	
	Lower than 100.000 Inhab.	Superior to 100.000 Inhab.
S.S. (g/hab/j)	31.8	38
BOD_5 (g/hab/j)	23.1	27
COD (g/hab/j)	75.5	77
N total (g/hab/j)	12	6.5
P total (g/hab/j)	2.1	1.25

The liquid purification is deficient in certain districts. The corking and the breaking down of the purification network are due to the lack of maintenance.

Besides, the wastewater disposals without preliminary treatment in rivers or in sea degrade sites with tourist vocation and are considerably prejudicial to the health of the population. It is due to the difficulties of treatment and to management problems in particular, the insufficient covering of the costs towards the investments is to be realized.

I-2 The industrial liquid discharges

The industrial tissue in Morocco consists of more than 7000 production units among which approximately half is localized in the region of Casablanca. The farm-produce industry represents approximately 25 % of these units.

The industry consumes more than a billion m^3 a year. The chemical and the para-chemical industries use 97 % of the total used volume (80 % results from the sea). The farm-produce industries use 24 million m^3 of water that is 2.2 % of the total volume.

The total output of the discharges is estimated at 964 millions of m^3 that is 89 % of the used volume of water. In the following table, we represent the annual mean values and parameter indicators of pollution.

Table 3: annual total pollution

Parameters	Annual quantity
BOD_5	58.000 Tonnes
COD	100.000 Tonnes
M.S.	6.6 millions Tonnes
N total	3.300 Tonnes
P total	200 Tonnes
Cr	110 Tonnes
Hg	15 Tonnes
Sulphur	140 Tonnes

These liquid discharges are poured in natural circles of production units in the sea constituting the main discharge with 98,4 % of the thrown back total volume followed by streams in 1.4 % and the rest is 0,2 % for sewage farms and septic pits.

Example:

- city of Mohammadia 300 kg /day of heavy metals thrown back in the Atlantic Ocean
- City of Fez: 341 kg /day poured in Oued Fez
- City of Casablanca 2208 Kg/day thrown back mainly in the Atlantic Ocean.

Among these heavy metals, we find: the chromium, the mercury, the cadmium, the lead, the arsenic, the bore and even the cyanide.

In Morocco, there is still no demanding rule that the industries throw back in the sewerage system of the domestic quality effluents.

Environmental impact

In spite of the fact that Atlantic Ocean is quantitatively the natural receiving circle with about 99 % of the total output of the discharges, the pollution impact is more important in streams.

The Sebou River which conveys the discharges of oil-works, tanneries and sweets which are concentrated there, as well as all the domestic discharges of the city of Fez which entails a net degradation of the quality of the Sebou River wateru. This deterioration affected a critical threshold during the active period of oil-works by the discharge of margins generate important polluting loads.

On account of these important discharges, the regime of dissolved oxygen in the river of Sebou remains overdrawn on more than 70 km downstream to the city of Fez. Anoxic states (0 mg 0_2/L) are registered regularly during the period of oil-works activity (from October to March) in the course of which, the load in oxidizable material expressed in DCO reaches values of the order of 600 mg 0_2 per liter.

The degradation of the quality of waters of Sebou sometimes reaches levels such as the processing capacities of both existing stations which are widely exceeded. It engenders stops of these stations and treatment cost in reagent and in raised energy which moves from \$0.14/m^3, during a raised period normal to 0, \$7/m^3.

I-3 Natural Parameters

Morocco has a semi dry climate characterized by spatial disparities of water resources. More than 70 % of superficial and subterranean waters is concentrated in less than 25 % of the national territory. The following table gives an outline onto the pluviometer in the main regions.

The annual average drainage in Morocco is of the order of 30 billions m ^{3}. If we deduct the losses, by evaporation and in the sea, there are only more than 9 billions of m^3 a year.

Tab. 4: annual Precipitation per region

`	Mean value	Maximum
North-west mountain of Atlas	600-1000 mm	2000 mm (in the mountains of Rif)
South of Atlas	100-200 mm	500 mm
deserts regions	50 mm	120 mm

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The potential of mobilizable water is about 21 billions of m³ among which 16 billions of m³ of surface water and 5 billions m ³ of groundwater.

In 1994, 88 % of mobilized waters were used in the irrigation while the domestic consumption and the manufacturers has disposed of only 9 %

The hydraulic policy led by Morocco since 1967 drove to the realization until our days of 80 dams and to the good mastery of the engineering and the know-how in studies and in realizations. These dams allow to cover about 950.000 hectares of agricultural lands with a capacity of 12 billions of m ³, to potabilize an annual volume of a billion of m ³ of water and to produce an electrical energy of the order of 1,6 Gwh a year. Besides, we have recorded an increase of the consumption in drinking water from 85 to 116 liters per inhabitant and a day between 1972 and 1992.

Regrettably the hydrous resources are more and more soiled and natural waters more and more mixed with waste water. In certain continental cities a thrown back part of waste water is reused in irrigation neither without treatment nor any precaution. We consider that about 70 millions of m³ of used water are reused every year to irrigate approximately 7000 hectares of agricultural plots of land with all the risks of epidemics which it contains.

II- The treatment Technologies used in Morocco

Since the independence of Morocco, about fifty stations of treatment of waste water were built. Stations managed by the private sector or Para public work suitably, while those run by the municipalities are abandoned. So, there are no more treatment stations in big cities.

The processes used in main plants of operational purge in Morocco are shown in the table below:

A study realized by the National Office of Drinkable water in 1993 on 21 stations revealed the following problems:

- Non-adaptability of the field in the means and in the local needs
- Conceptual deficiency of the works.
- Lack of maintenance.
- Absence of budget appropriate for the purification
- Lack of training of the engineers and the local technicians

Tab. 5 : example of operational water-treatment plants in Morocco

Kind of station	Locality	Year of build	Condition
lagunage	Benslimane	1997	Experimental Site
	Bouznika	1981	In fonction
	Boujaad	1992	In fonction
	Rissani-ONEP	1993	Experimental Site
	Boufekrane	1987	In fonction
Filtres à sables	Agadir	1989	Site expérimental
Boues activées	Alhoceima	1997	In fonction
	Benimellal	1992	inconnected
	Nador	1991	In fonction
	Khouribga	1984	In fonction
	Benguérir-OCP		In fonction
	Marrakech	1991	In fonction

Besides, the social side has its importance. The populations is again made a bit sensitive in the environment problems . So, the collectors of sewers also serve for draining several tons of domestic garbage and sometimes end up eventually to be totally blocked which creates the flood of sewers especially during the rainy season.

Almost all the littoral cities throw back their waste water to the raw state in the sea (approximately 200.000 m^3/day which often exceeds the capacity of absorption and dilution that the natural maritime environment can assure.

Whatever is the process of used treatment, the operations of pretreatment are indispensable. The major role of pretreatments and that to remove from the effluent, the biggest particles susceptible to bother the later treatments. So, the pretreatment is a preliminary necessity for any purge process.

According to the quality of the effluent to be treated and the importance of the station, we use the set or a part of the system constituted by ware-netting, by Dilacerations, the Sieving for industrial waters, by the desanding and the rundown.

Pretreatments also have as a role to optimize the functioning of water-treatment plants.

III- Treatment by monitoring infiltration

The station of treatment is located at 5 Km South-east of Agadir. This city has a semi-arid climate in sweet winter and an annual average rain of 250 mm, very irregular. The temperatures are moderate with an annual average of 19°C (average of maxima 27°C, average minima 11°C).

The treatment station of waste water of Ben Sergao village (20.000 Inhabitants) was realized in 1988. Its conception and its follow-up were secured by the

French cooperation, urban community of Agadir and the regional direction of the hydraulics.

III-1 Description of the waste-water station

The BenSergao station was conceived to filter by percolation, an output of $750m^3$ (10.000 inhab) let be half of the waste water of the current population of the municipality.

The drainage is made by gravity of the amont towards the approval (represent:4).

This field of purge includes:

1- An overflow of thunderstorm which works when the output overtakes 50l/s.
2- A starting pretreatment (ware-netting of 3 cm diameter)
3- A primary treatment by anaerobic decanting
4- A pond of temporary stocking
5- Five ponds of infiltration-percolation

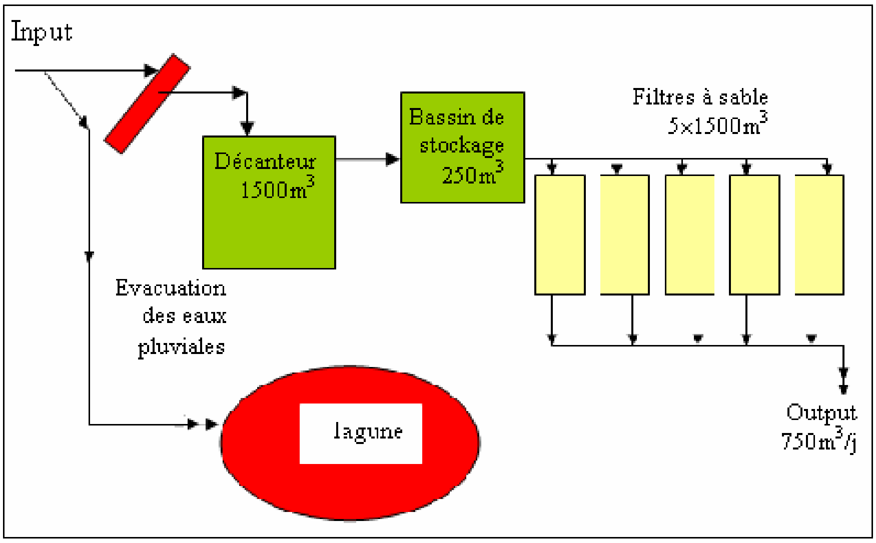

Fig. 4: plans of the station of treatment of Agadir

. □ wire-netting : is placed at the exit of the storm waste-weir. The wire-netting is inclined in the same direction of the flow

□The Pond of anaerobic decantation: has a useful volume of 1500 m^3.

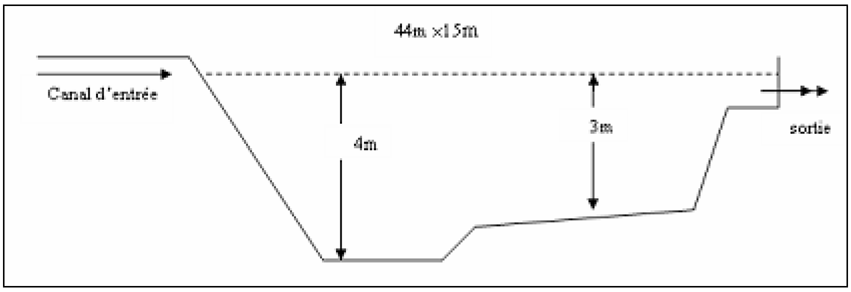

Fig. 5: plans of the pond of decantation

The bottom of this dock wasn't proofed. It was warped by settled mud.

This process is concerned with a decantation of waste water during 2 days of retaining time in enough deep pond to permit an anaerobic digestion. The mud extraction is necessary all 15 months. The mean pH of the liquid is 6,8 and its mean Temperature is 21°C.

The storage Pond : was sized for a capacity of 250 m^3 of the waste water arising from the anaerobic decantation pond. This dock is not deep but has an extended surface.

The evacuation of waters towards filters is accomplished by steeps, three times a day. The maximal output is limited to 150 L/s.

Sand filters: for a daily volume of 750 m^3, we take into consideration the following parameters:

- Daily volume: 3 outputs a day of 250 m^3 each one.
- Height of blade of infiltrated water: 0,17 m a day
- Surface of infiltration: 5x 1500 = 7500 m^2
- Nature of the sand: local sand
- Height of the filtering sand: 2m

The settled water is introduced into these ponds in 45 minutes (debit max : 150L/).

Every day, three ponds of infiltration on a total of five, receive each one covered.

A pond receives during three consecutive days one covered a day, then it is put in the rest two consecutive days. The processes of chemical and Bactrian oxydation are reactivated by the reoxygenating the granular set.

To increase the aeration of the sandy massif by its base, an air shaft was placed in the superior extremity of every drain, in the continuation of these drains (figure : 6).

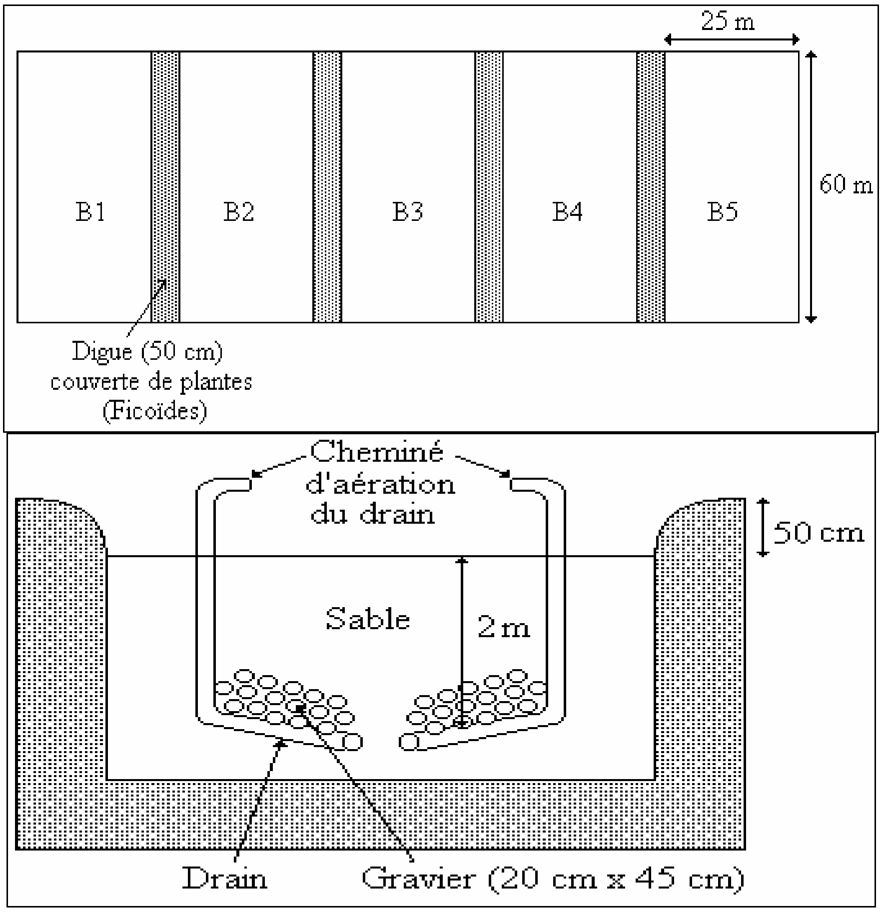

Fig. 6: plans of the filter with sand

Infiltrated waters are collected in depth (under 2m of sand) by a network of drainage and a collector common to five ponds. This network is constituted by two tablecloths of drains PVC. Every tablecloth of drains is granted to a collector who ends in a tub of taking The characteristics of filters with sands are summarized in the following table:

Table : 6 The mean infiltration velocity is 1.85m a day

Paramètre	valeur
Output (m^3/day)	750
Surface (m^2) x 5	5x1500
Volume of sand (m^3)	13000
Organic load (mg BOD_5/J)	142.5

III-2 Purification produce of the station

The physico-chemical analysis of water of the station is monthly made by the regional direction of hydraulics of Agadir. The following table summarizes the characteristics of raw waste water at the input.

Table : 7

Parameter	value
Capacity (inhabitant)	10.000
Output (m3 / day)	750
Individual discharge of water (l/ Inhab/J)	75
BOD_5(mg/l)	374
COD (mg/l)	1.189
Organic load (g BOD_5/hab.day)	28,5

The physico-chimiques performances of the station are summarized on the following table:

Table : 8

Parameter	Untreated water	Decanted water	Filtred water	Purification produce
S.S. (mg/l)	431	139	2,8	99%
COD (mg/l)	1189	505	52	95.6%
BOD_5 (mg/l)	374	190	10	97%
Nitrate (mg/l)	0	-	56,7	
N total (mg/l)	116	-	73,7	36%
P Total (mg/l)	26	24,5	15,8	40%
K^+ (mg/l)	37	-	37	
Ca^{++} (mg/l)	143	-	238	

- The pond of anaeroby settling eliminates 49.2 % of BOD_5 and 58 % of COD.
- The whole station eliminates 99.3 % of suspension matter, 95,6 % of COD and 97,3 % of BOD5.

The microbiologic analyses are made every month by the laboratory of the ministry of health of Agadir.

The parasites are eliminated and coliformes is effectively reduced. Purified waters can be used without limitation for the irrigation of all the cultures (plants, lawns and vegetable farming). The following table gives the values of the microbiologic average measures (Ministry of health):

Micro-organisme	Untreated water	Decanted water	Filtred water	Purification produce
Coliformes fécaux (nb/100ml)	$6,156.10^{6}$	$4.96.10^{5}$	327	4.27 Ulog
streptocoques fécaux (nb/100ml)	$2,09.10^{7}$	$1,603.\ 10^{6}$	346	4.78 Ulog
Œufs Nématodes (nb/l)	139	32	0	100%
Oeufs Cestodes (nb/l)	75	18	0	100%
Oeufs Helmintes (nb/l)	214	47	0	100%

Financial aspect:

The cost of exploitation of the station, the maintenance, analyzes renewal and overheads of management is 0,084 € / m3 of treated effluent (on the basis of 750m3 / j). Filters with sand occupies important surfaces 7500m^{2} to treat waters of 10.000 inhabitants only.

IV- Processes to autonomous purification with recycling.

The process of autonomous purification is established by a septic pit, of a denitrifying filter and of a nitrifying filter with recirculation allowing the elimination of the nitrogenous compounds.

This process is experimentally studied at the Faculty of Science of Fez (Morocco) and to the Scientific and technical Centre of the Building (CSTB) of Paris (France) within the framework of a project of realization of an experimental station of low-cost autonomous purification for a small community in Fez having 2000 inhabitants with the scientific and logistic support of the CSTB.

The purge system is established by a septic tank of rainy waters, of a denitrifying reactor and of a nitrifying reactor (represent: 7)

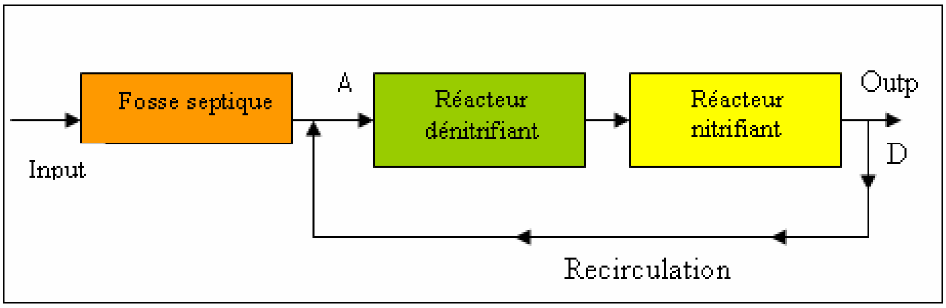

Fig. 7: plans of the system of purge with recirculation

In the process of elimination of the nitrogenous compounds, the system is fed by effluents stemming from the septic pit any waters. The stage of denitrification is placed upstream to that of nitrification so as to assure an elimination of the ions nitrates thanks to the source of carbon. The drainages in denitrifying and nitrifying filters are respectively in saturated and in unsaturated conditions.

a- The septic pit of rainy waters

The septic pit, assures two essential functions: the settling and the liquefaction of the solid materials

- The settling which is expressed by an accumulation of the denser particles in the bottom of the pit while those who are lighter (lipids in particular) climb up the surface from their admittance in the pit.

- The liquefaction of the solid materials held by settling and floatation is provoked by an anaerobia digestion of the degradable organic matters under a weak concentration of oxygen, what is translated by a decrease of the quantity of settled mud. This is made according to two successive phases: fermentation and Methanisation.

We present on figure 8 below, the stream of external carbon of DCO during the digestion anaerobia

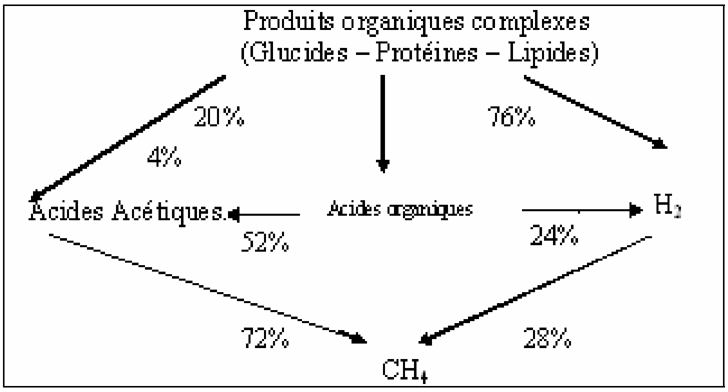

Fig. 8: stream of carbon (DCO) during the various stages

The anaerobia digestion (Mc. Carty on 1964)

The efficiency of the fermentation is conditioned by four essential factors:

- The capacity of the sufficient pit of a horizontal surface
- The time of stay of mud connected to the frequency of drainings: approximately 2 years)
- The hydraulic amortization can put back in suspension settled mud or dissolve partially fats.
- The environmental parameters such as Temperature, the pH (a temperature lower than 10 ° C and a pH lower than 4,5 blocks the process of fermentation.

b- Aerobic Reactor

The process can be summarized by the following stages:

- The infiltration percolation on a sand of chosen granulometer. The filtration on granular environment is used for the treatment of the septic effluents and assures essentially an important dejection of the COD and the suspension matter. These last ones establish the main vector of microbial pollution
- The purge on the filtering massif which is made by oxidation of the carbon material in CO_2 and the nitrogenous matter (aminus,NH_4^+) to ions NO_3^- (nitrification*). The complete oxidation of these substances is made thanks to the aerobic character of the environment purifier. This oxidation consumes the present oxygen in the gas phase of the filtering massif. It depends on the time of stay of effluents, on Temperature and on the Concentration in oxygen.
- The disinfection which is represented by the elimination of the pathogenic micro-organisms. It is a function of the speed of percolation, of the thickness of the filtering massif and of the nature of the system purifier.

The more the speeds of percolation are weak and the more the thickness of the massif is big, better is the disinfection.

c- anaerobic Reactor

The elimination of the nitrogen by the dénitrification is made by heterotrophic bacteria in anoxic conditions, either under weak concentration in oxygen, or in absence of this last one. These conditions provoke an induction of the enzymatic systems which use the oxygen connected to the nitrate ions and nitrite for the respiratory needs. The nitrate ion is so reduced to nitrite ion and the ion nitrite is reduced to molecular nitrogen. The presence of a source of carbon is necessary for bacteria. The domestic effluent is often used as source of carbon thanks to its cheap cost and a satisfactory quickness of reaction. The methanol is sometimes used because it is easily degraded.

The takings analyzed in the site of purge of waters of the CSTB (city Nantes) show the good return épuratoire at the release of the nitrifying reactor as shown in the following table:

Tab. 9: return épuratoire of the water-treatment plant with recirculation

Parameters	Effluent in the entry	filtered Effluent	Return on elimination
pH	7.3	7.9	
COD (mg 0_2/L)	381	36	91%
BOD_5 (mg 0_2/L)	200	3.6	98%
	64	3.2	95%
S.S. (mg 0_2/L)	0.1	42	
NH4+	12	2.8	77%
PO4			
Faecal Coliformes (/100ml)	2.10^5	$\leq 10^2$	98%
Escherichia coli (/100ml)			

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The shape below shows the evolution of DCO at the output of reactor with number (R) of recirculation water (figure 9)

The concentration of nitrates ions with adimensional = deep of denitrifying reactor $\frac{l}{L}$ is presented below: (figure10)

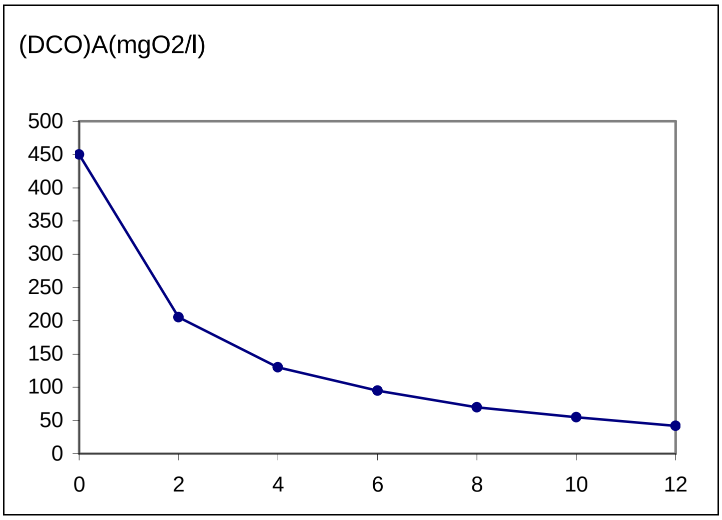

fig. 9: Evolution of COD at the output of reactor with number of recirculation water

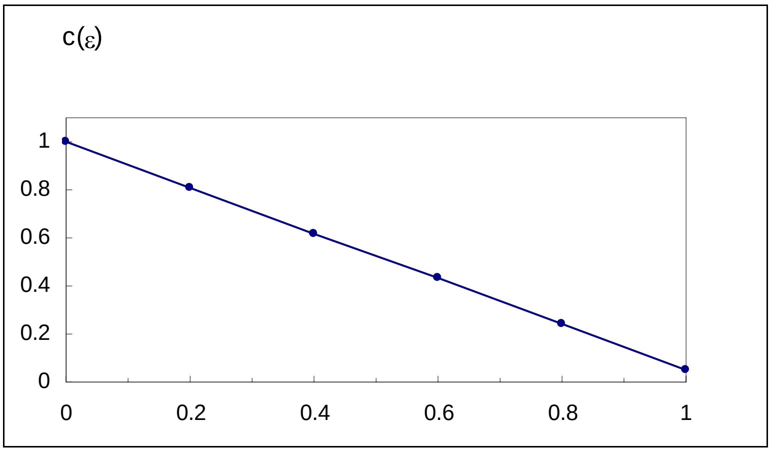

fig. 10: concentration of nitrates ions with adimensional deep of denitrifying reactor $= \frac{l}{L}$

Conclusion

The various studies realized on the quality of waters and their purification in Morocco lead to specific characteristics, which must be taken into account in future programs of liquid purification.

Among the principal specificities, it is necessary to retain the following:

- the absence of the industrial effluents treatment
- the frequent plugging of the existing sewers systems.
- The bad management of the local communities of purification (80% of water treatments plants realized by the communities are now out of order.

The natural purification experiments carried out in Morocco show that the treatment systems by controlled infiltration are efficient and constitute an alternative to waste stabilisation ponds for a small community. The process of autonomous purification with recirculation was successfully experimented and it is under study for pour the for the realization of an experimental station.

The reuse of waste waters after their treatment is necessary for two reasons:

- To meet the irrigation needs of the peri-urban green zones.
- To ovoid the globe contagion by eutrophisant agents by using the complementary process of cleaning up

Bibliography

1. Y. BENJELLOUN
‘‘Experimental and analytical approach of treatment of effluent liquid methods’’ Application to olives margin methods. Arab conference for environmental studies , Damar University, Yemen 8-10 October 2001
2. direction générale des collectivités locales: l’épuration des eaux usées au Maroc – Synthèse des études expérimentales.
3. Y. BENJELLOUN, A. LAKEL
Waste water treatment an its reuse for a small community synthesis of report of European project (inco-Med submitted)
4. Y. BENJELLOUN
‘’Impact des rejets des déchets liquids sur la pollution de la rivière de Sebou. Quelques solutions dans le cas des rejets oléicoles’’
Séminaire sur le rôle de la région dans le développement économique et social, Ecole Mohammadia des Ingénieurs , 13-15 Mai 98, Rabat -Maroc

Annex

An example of the purge systems experimented in Morocco

Treatment by waste stabilisation ponds The lagunage is one of the natural techniques of effective and reliable purge which allows an almost total elimination of germs witnessed in faecal contagion, indicating the sanitary quality of waters

The lagunage allows a separation of the solid elements of the liquid phase by sedimentation and a biologic purge owed essentially to the action of bacteria. The process consists in making residuary stay waters in stabilization ponds.

According to the depth of the pond, we shall distinguish:

The pond of aerobic stabilization the depth of which is lower than 1,5 m: all the aqueous phase is oxygenated.

the optional pond of stabilization the depth of which varies 1,5 m in 2,5m: the water is oxygenated in surface and the bottom is deprived of oxygen (zone anoxique)

the pond of stabilization anaerobia whose depth is superior to 3 meters and in which the processes of fermentation occupy all the volume.

The functioning of the aerobic pond is based on the symbiosis between algae producers of oxygen in the presence of light and the aerobic bacteria which degrade the complex organic molecules. On the other hand in the aqueous phase ponds anoxique anaerobia, anaerobes bacteria are responsible for the fermentation.

The ecosystem is in fact very complex because the activity of the human beings is there dependent of numerous not controllable factors among which temperature figures.

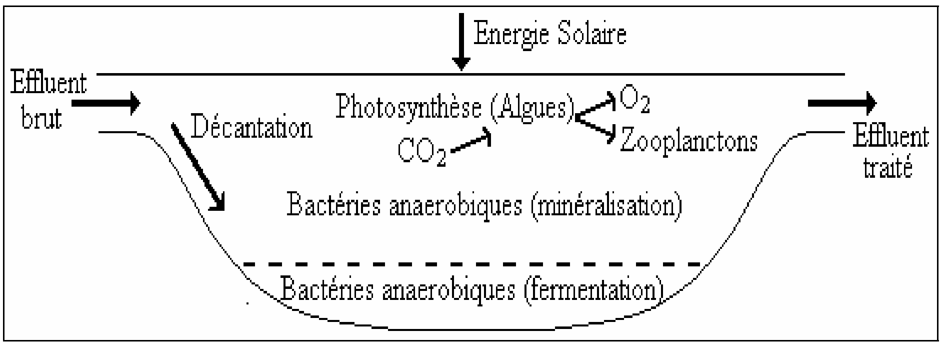

Fig.1: functioning of a pond of lagunage aerobe

The end result depends on the size, on the shape and on the number of ponds. It is a function of the time of stay and of the local climatic conditions (Temperature, Humidity, Pluviometer)

A complete field of lagunage includes:

1- A first pond of fermentation (anaerobia)
2- The second optional pond (aerobe)
3- The third pond of maturation (aerobe)

A field of treatment must be adapted according to needs

Example:

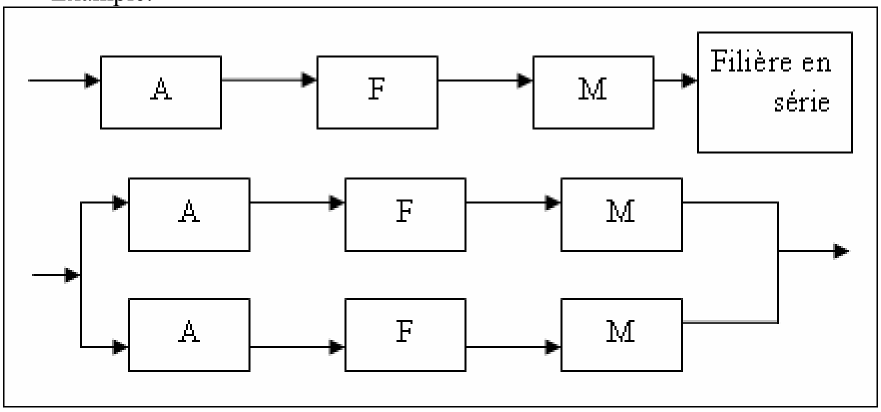

Fig.2: some possible arrangement of the mass ponds or in parallels A=Anaérobie, F=Facultatif, M=Maturation

The pond of anaerobia stabilization is used for the settling and the degradation of organic matters by fermentation. This fermentation produces a gas (H_2S or CH_4). This pond is always placed upstream in a field of treatment. With a depth superior to 3 meters, he can receive organic loads from 100 to 500 grams of DB05 by m^3 and a day with a short time of keeping back (from 1 to 5 days). For a tropical climate, with 1 in 2 days time of keeping back, the elimination of the DBO_5 of domestic waste water can reach 70 to 80 % while it is only 45 % for a climate moderated even in summer.The settling of the solid materials contained in waste water forms a coat of mud which lowers gradually the useful volume of the pond.

The optional pond, of a volume identical to that of the pond anaerobia has to have one more large surface because of its weakest depth. Its functioning is based on the symbiosis between algae and bacteria. It is more dependent on climatic conditions than the pond anaeroby.

During the stay of waste water in an optional pond, the biodegradable organic matter is transformed into alive organic matter (algae, bacteria, protozoon). This pond is generally sized by taking into account the maximum load in $DB0_5$ by unity of surface and a day for which the pond will still have an important enough aerobic zone.

The pond of maturation is used to improve the dejection of germs witnesses of faecal contagion to assure a strong decrease of the load in pathogenic germs. It is conceived for a while by keeping back for 5 days when there is only a single pond and from 3 to 10 days for 2 or several mass ponds. Its dimensionnement becomes established according to the bacteriological quality of effluents wished the release.

Because of the weak depth of this pond (lower than 1,5m), algae are plentiful in all the column of water. A pond of maturation is aerobic in all its volume and the photosynthetic activity creates a pH there entailing an important bactericidal effect.

An example of treatment system by lagunage experimented in Morocco at Aboujaad is presented in the annex

Example of waste stabilisation ponds

The site Aboujaad is situated in the southeast of the city of Jadida. It has a semi-arid climate in moderate winter. The water-treatment plant of Aboujaad has as an objective, the protection of the tablecloth of this region (Tadla) which is polluted by nitrates and re-use of effluents after treatment for an irrigation without limitation. This station was conceived of a population of 15.000 Inhabitants with a debit of 2500m^3 a day or approximately 30L/s. It is constituted of: Two anaerobia ponds arranged in parallels, each having a surface of 940m^2 and a depth of 2.5m. The time of stay of effluents in this pond is of 1.5 days. optional ponds arranged in parallels, each Two having a surface of 11.250m^2 and a depth of 2 m. The time of stay of effluents in this pond is of 13 days. ponds of maturation arranged in series, each Two having a surface of 5.780m^2 and a depth of 1.5m. The time of stay of waters in this pond is of 7 days. 6 ponds represent a total surface of 3.6 ha (figure:3), their bottom are waterproofed thanks to a sealing by the compacted clay. The control and the follow-up of this work is assured by the direction of the research and the economic planning of the water (DRPE) as well as the public Laboratory of studies and attempts (LPEE).

The outgoing effluents of the ponds of maturation are reused in its integrity for vegetable framing in the approval of the station because, they contain less of 1000CF / mL.

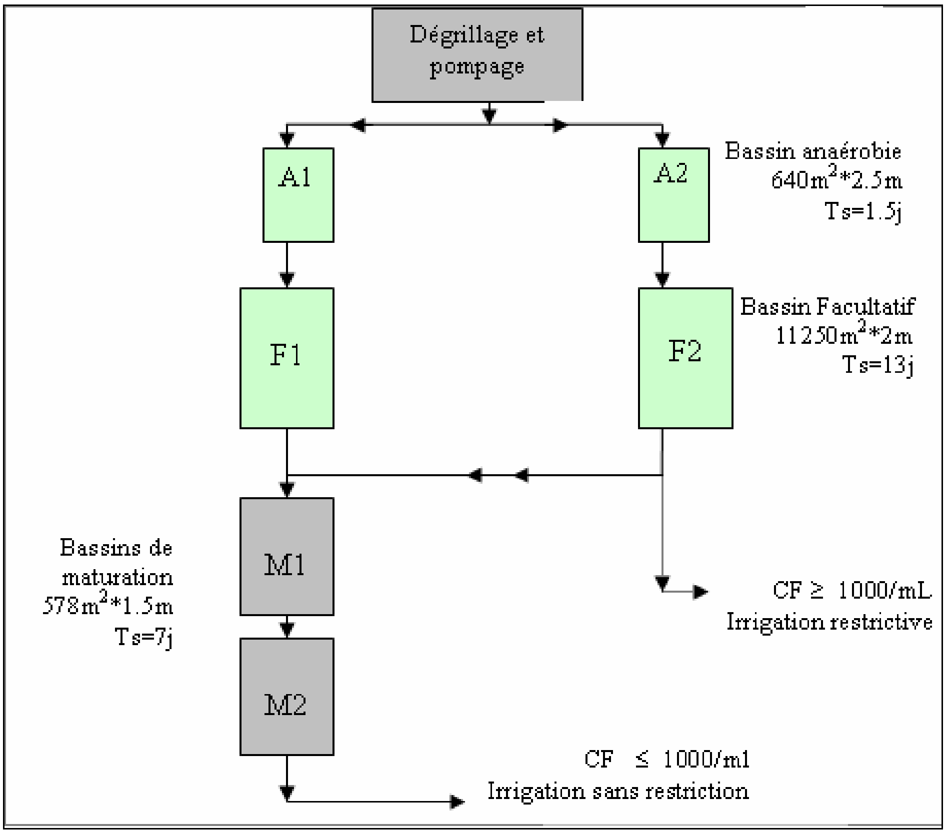

Fig. 3: plans of the Aboujaad station

The following table gives the purifying performances of this station:

Paramètres	DBO_5 (mg/L)	DCO (mg/L)	MES	NTK (mg/L)	P_T (mg/L)	CF (nb/mL)	O.Hem (nb/mL)
Input	360	620		62	18	5.10^6	14.2
Output	302.5	496		40.3	14.5	$2. 10^3$	0
Prostration	84%	80%		65%	80%	96%	100%