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USE OF SANDS OF THE DUNES LIKE BIOFILTER IN THE PURIFICATION OF WASTE WATER OF THE TOWN OF OUARGLA (ALGERIA)

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SUMMARY - In Algeria, on the 50 stations of purification carried out, nearly two third are out of order and the 15 stations, which are operational, encounter problems. Their operation is seldom in conformity with the posted performances. This established fact shows the gravity of the situation when it is known that more than 700 HM^3 of wastewater are evacuated annually.
Like the other towns of the country, the town of Ouargla (southern Algerian) knows serious problems of cleansing in particular since that the station of purification is out of order in 1980.
The alarming situation of the network of cleansing of the Ouargla town put in the obligation the authorities to create several outlets around the city. However, the rejection of urban effluents without any preliminary treatment it accentuated the enhancement and the contamination of the water table on one hand and on the other hand it generated the degradation of the closer palm plantations. This Oasis knows today a catastrophic ecological situation, which could be the origin of many epidemics.
Facing to cleansing and management of purification stations problems, it's recommended to involve other techniques of purification less expensive and simpler to manage in order to protect the public health and to safeguard the receiving backgrounds. The use of a local material, such as the sand of the dunes, as biological filter is a promising technique for the purification of the water used in the Algerian south.
Among many parameters, which condition the purification capacity of those natural techniques it's included: their physicochemical characteristics, the quality of water to be treated and the speed of filtration.
This study made it possible on one hand to determine of the physicochemical characteristics of sand's dunes (structure, texture and chemical composition) and to put forward their filtering capacity and on another hand to evaluate the purification performances of the designed prototype.

Key words: wastewater, Ouargla in Algeria, treatment and techniques of purification, biological filter

INTRODUCTION

In the town of Ouargla, the discharges of wastewater in an anarchistic way and without treatment, contribute considerably to the contamination of the ground water and the increase in its ascent. In addition, the state of degradation and out datedness of the station of purification is such as any rehabilitation is not economically possible. Thus the recourse to other techniques such as biological filtration, by using a local material, offers a very promising alternative for the cleansing in the area.

SAND FILTERS

The sand filters are natural environments, which can be used as mass filter in the purification of wastewater, by ensuring a double role**:** retention of MES and fixing of the biomass, which develops around the grains.

The choice of a filter support rests on the following criteria:

- Important specific Surface, favorable to the bacterial development.
- The granular support must be siliceous, and stable, at weak soluble matter rate.
- The granulometry must be selected in order to provide a sufficient surface to the development of the bio-film and to avoid the too fast filling of the filter.

BIOFILTRATION

The biological filtration of the wastewater, on granular support and at low speed became a particularly gravitational process of purification. In addition to the mechanical retention of MES, this technique allows the biological breakdown of organic, phosphorated and nitrogenized pollution.

On the microbiological level slow filtration constitutes a stage of disinfections, which moreover has the advantage of retaining well the protozoa and the flagellate unicellular, which can resist disinfections by chemical agents. In this process, one attends the development of a biological membrane around the sand grains, in which microscopic algae, bacteria and zooplankton are lodged.

They are extra cellular polymers, synthesized by the micro-organisms, which play the part of coagulant.

MATERIAL AND METHODS

Choice of the filter background

On the basis of a preliminary study, carried out on several grounds of the area it arises that:

1. The grounds of the palm plantation have a muddy sandy texture. These grounds have a good permeability and are slightly alkaline. As for salinity, it is very variable in space and the electric conductivity of the extract of the paste of ground varies between 0,60 and 15,43 mS/cm. Let us note that salinity is lower than the average for the majority of the intake points, however, 12% of the analyzed samples have a relatively strong salinity, this is due primarily to the bad drainage, leading to stagnations of water in the low areas, which receive the excess of irrigation water from high zones.

2. For sands of dune and rude sands, we can say that they are grounds with fine sand textures and rude sands, alkaline with a very low salinity and a soluble matter rate which is also weak; these two grounds which are primarily made up by quartz have a rate exceeding 87% of their composition. Sand of dunes and rude sands show favorable characteristics as filtering backgrounds. The results of the qualitative analysis of these two supports are consigned in *tables 1* and *2* and fig.1.

Table 1. Physical analysis of the soil

Ground	point of sample	Permeability K (cm/h)	Density in (kg/l)	The coefficient of uniformity	The representative diameter
Ground of Palm plantation	Mekhadma	15.29 – 42.89	1.57 – 1.60	1.70 – 1.74	-
	Ksar	3.52 – 30.80	1.40 – 1.70	1.68 – 1.72	-
	Ain Beida	7.16 – 81.13	1.31 – 1.60	2.22 – 2.40	-
	Rouissat	6.28 – 18.49	1.45 – 1.60	1.80 – 1.88	-
Sand dune	Ain Beida	7.2 – 12.8	1.56 – 1.60	1.69	0.18
Rude sand	Ain Beida	78.0	1.60 – 1.62	2.40	0.25

Table 2.Chemical analysis of the soil

Ground	Sampling point	pH	EC (mS/cm)	Insoluble (%)	CaCO3(%)
Ground of Palm plantation	Mekhadma	8,16 – 6,23	1,45 – 6,00	86,2 – 84,0	0.03 – 0.16
	Ksar	7,53 – 6,27	2,12 –15,43	85,2 – 80,25	0.03 – 0.18
	Ain Beida	7,96 – 6,12	0,60 – 5,92	83,2 – 78,9	0.13 – 0.46
	Rouissat	7,77 – 6.25	2,59 –11,12	80,2 – 79,0	0.13 – 0.24
Sand dune	Ain Beida	8,53	0,52	87,94	0.87
Coarse sand	Ain Beida	7,80	0,82	94,65	0.87

The curves of the granulometric analysis, corresponding to the three types of grounds (sand of the palm plantation, sands dunes and rude sands), are represented in fig. 1.

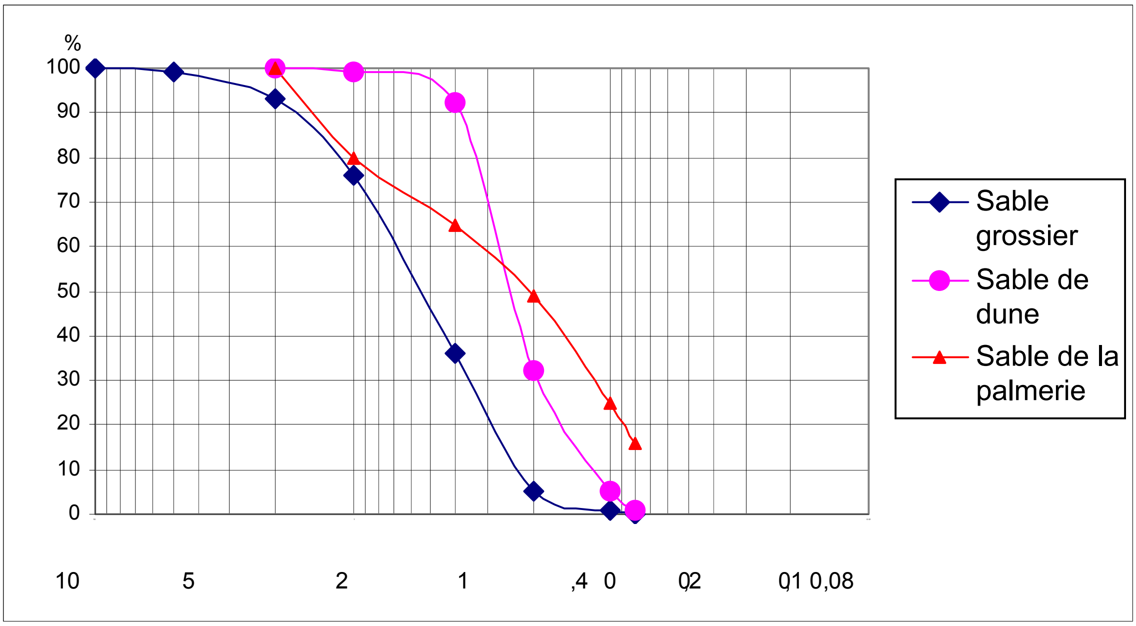

Fig. 1. Granulometric analysis of soils of the area of Ouargla

For our study we chose the sand of the dunes, which in addition to its availability, presents very favorable characteristics for its use as filters: its permeability is 7.2 to 12 cm/H, its salinity is very low (electric conductivity is 0.52 mS/cm), the rate of the insoluble matters is approximately 87% (quartz compound primarily) and its organic matter is very low (less than 1%). The granulometric analysis show that it is about a very uniform ground (the dimension of the aggregates varies between 0.3 and 2 mm).

Experimental device

With an aim of studying the performances of sands of the dunes in purification of pre-treated wastewater, we set up an experimental device consisting of:

1. A water container and flow regulator having a volume of 250 ml.
2. A Plexiglas septic tank, which ensures the anaerobic pre-treatment with the following dimensions**:** L1 = 250 mm, L2 = 125 mm H = 165 mm h1=79 mm and H2 =40 mm (Fig. 2).

3. A column of PVC filtration of 90 cm height and 24.2 cm in diameter filled from bottom upwards by a gravel layer of 10 cm and a dune sand layer of 70 cm height. It is posed on an elevated steel support of 25 cm to allow the recovery of filtered water.
4. A water supply system made up of four pipes in the form of a cross provided with nine small slits (ф=1.4mm) in order to allow the water supply of the filter in a homogeneous way. The rate of water supply of the filter is 2.6 l/day.

During this study (138 days), we followed the purification performances of each work and determined the total output.

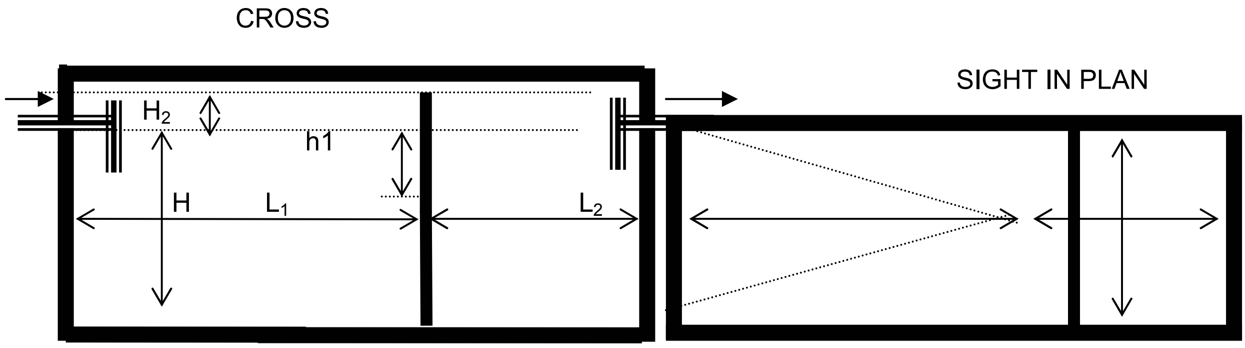

Fig. 2. Dimensions of a septic tank

RESULTS AND DISCUSSION

After four days of operation (lasted of maturation of the filter) we carried out analyses of raw water, pretreated water (entry of the filter) and water filtered (exit of the filter) at various periods. The results obtained are gathered in *Tables 3, 4* and *5*.

We note an increase in salinity at the exit of the septic tank, which could be attributed to the phenomena of re-releasing.

On the outlet side of the filter, the increase in salinity is very important during the first five days, which could be explained by the scrubbing of the salts contained in sand. This increase is stabilized and become less important for the other sampling campaigns.

The evolution of the pH on the outlet side of the filter shows a light fall during the first 4 samples then increases for all the other samples. This is explained by a more intense algal development, therefore a strong consumption of CO_2, which results in a rise in the pH.

The degradation of the organic matter was illustrated by the decrease rates of the DBO_5 and the DOC in septic tank. The sand filter and all the installation allowed us to release the following observations:

- The reduction in the DBO_5 was remarkable; it reaches a best performance in the septic tank after 38 days.
- The output knew stabilization with a value exceeding 50 %. The temperature of the study area and the quality of wastewater justifies this increase in the output.
- After filtration the rate of abatement varies from 47 to 88.5 % and reached its maximum after 65 days.
- The purification performances of the installation exceeds 62%, with a maximum of 97%, at the end of 65 days of operation.

The abatements obtained on the DOC were also very interesting: with a range varying from 24.3% to 75.6%, for the septic tank, 55.8% to 89.3% for the filter and 69.6% to 96.2% for all the installation.

The outputs obtained are very encouraging and seem justified by the temperature of the area and the quality of wastewater.

Table 3. Physicochemical parameters' analysis

N°	Dates	Number of days	T °C	pH			EC (mS/cm)		
				Raw water	Pretreated water	Filtered water	Raw water	Pretreated water	Filtered water
01	10.08.99	5	30	7.48	7.80	8.07	2.60	5.40	13.40
02	17.08.99	12	33	7.11	7.50	7.42	2.80	4.30	5.20
03	29.08.99	24	32	7.37	7.77	7.65	2.70	3.00	4.20
04	05.09.99	31	30	7.43	7.93	7.44	2.80	3.10	3.90
05	12.09.99	38	30	6.31	7.72	7.76	2.70	3.10	4.00
06	19.09.99	45	29	7.42	7.91	8.10	2.70	2.80	3.80
07	26.09.99	52	27	7.44	8.00	7.98	2.80	2.90	3.80
08	09.10.99	65	26	6.93	7.80	8.10	2.70	2.70	3.60
09	17.10.99	72	28	7.23	7.50	8.21	2.70	2.70	3.40
10	30.10.99	86	26	7.11	7.40	8.10	2.60	2.70	3.30
11	13.11.99	100	25	6.44	6.71	8.14	2.50	2.80	3.30
12	20.11.99	107	23	6.81	7.31	8.16	2.70	2.80	3.60
13	29.11.99	116	19	7.22	7.43	8.31	2.30	2.30	3.20
14	04.12.99	121	18	6.88	6.99	8.36	2.80	2.60	3.30
15	12.12.99	129	20	7.38	7.30	8.34	2.60	2.70	3.40
16	21.12.99	138	16	6.72	7.38	8.30	2.50	2.60	3.10

Table 4. Results of analysis of the DBO_5

N°	Number of days	DBO_5 Mg/L			Output %		
		Raw water	Pretreated water	Filtered water	Septic tank Output	Filtration Output	Total output
1	5	430.00	360.00	160.00	16.28	55.56	62.79
2	12	450.00	320.00	170.00	28.89	46.88	62.22
3	24	410.00	240.00	120.00	41.46	50.00	70.73
4	31	330.00	180.00	80.00	45.45	55.56	75.76
5	38	580.00	160.00	40.00	72.41	75.00	93.10
6	45	460.00	140.00	30.00	69.57	78.57	93.48
7	52	260.00	70.00	15.00	73.08	78.57	94.23
8	65	500.00	130.00	15.00	74.00	88.46	97.00
9	86	580.00	260.00	50.00	55.17	80.77	91.38
10	100	580.00	270.00	65.00	53.45	75.93	88.79
11	116	480.00	220.00	60.00	54.17	72.73	87.50
12	121	260.00	110.00	30.00	57.69	72.73	88.46
13	129	400.00	180.00	55.00	55.00	69.44	86.25
14	138	300.00	140.00	45.00	53.33	67.86	85.00

Table 5.Results of analysis of the DCO

N°	Number of days	DCO Mg/L			Outputs %		
		Rough water	Pretreated water	Filtered water	Septic tank Output	Filtration Output	Total output
1	5	826.00	538.00	230.00	34.87	57.25	72.15
2	12	1200.00	826.00	365.00	31.17	55.81	69.58
3	24	1104.00	836.00	288.00	24.28	65.55	73.91
4	31	768.00	442.00	154.00	42.45	65.16	79.95
5	38	998.00	394.00	67.00	60.52	82.99	93.29
6	45	1286.00	538.00	86.00	58.16	84.01	93.31
7	52	739.00	259.00	29.00	64.95	88.80	96.08
9	65	989.00	355.00	38.00	64.11	89.30	96.16
10	72	952.00	307.00	58.00	67.75	81.11	93.91
11	86	749.00	346.00	86.00	53.81	75.14	88.52
12	100	768.00	365.00	106.00	52.47	70.96	86.20
13	107	624.00	260.00	77.00	58.33	70.38	87.66
14	116	1536.00	614.40	192.00	60.00	68.75	87.50
15	121	634.00	211.00	76.80	66.72	63.60	87.89
16	129	1498.00	365.00	144.00	75.63	60.55	90.39
17	138	1382.00	461.00	154.00	66.64	66.59	88.86

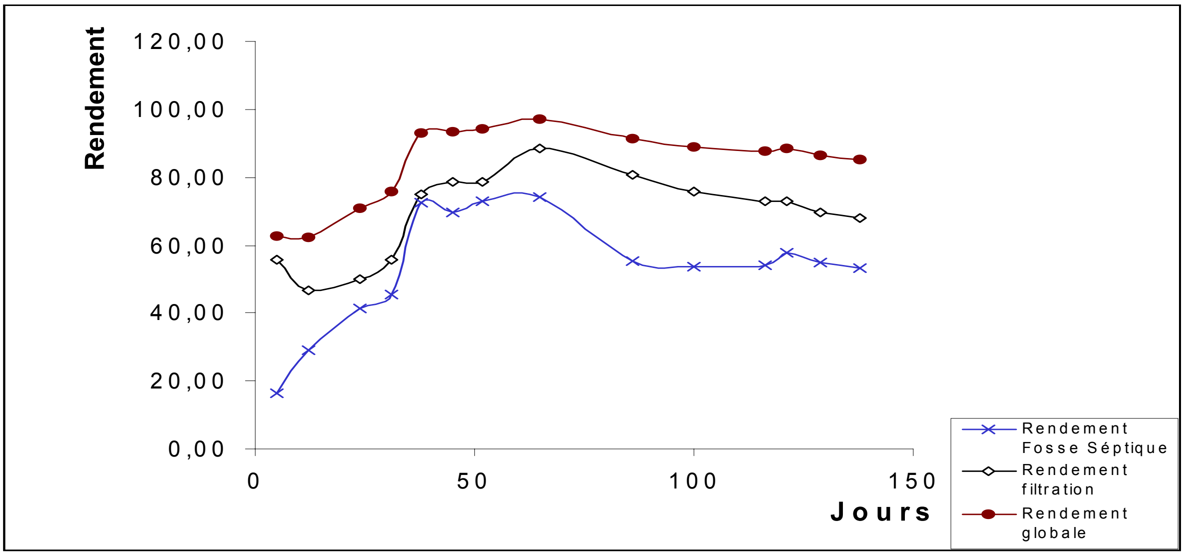

Fig. 3. Evolution of the abatement of the DBO_5 according to the time at the exit of each work.

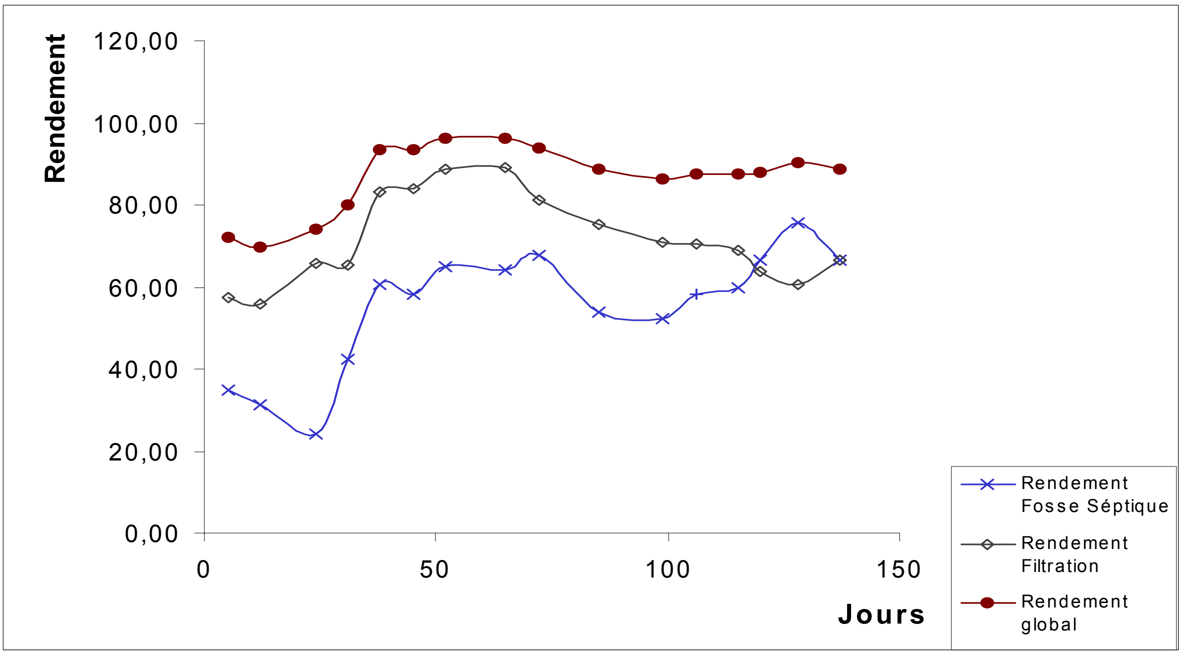

Fig. 4. Evolution of the abatement of the DOC according to the time at the exit of each work.

CONCLUSION

It comes out from this study that the use of sands of dune makes it possible to solve the problem of the water used without recourse to very expensive techniques, which require very important means of management.

The physicochemical and granulometric characterization showed that they are very uniform grounds, with sandy texture, primarily of quartz; they are not very saline and at weak rate of limestone and organic matter.

Results obtained on the abatement of the DBO_5 and DOC show the effectiveness of this technique in the degradation of the organic matter. However, to justify the choice of this technique, it is necessary to carry out an experimental site to reduce the errors of scale and to take into account the other parameters of pollution that was not studied in this work (MES, nitrogenized, phosphorated Pollution and bacteriological quality).

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