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SEDIMENT ACCUMULATION IN A SERIES OF FOUR PILOT-SCALE STABILIZATION PONDS

A. Ghrabi and M. Ferchichi

Unité des Ressources Naturelles et Environnement, I.N.R.S.T. 43, Av. Charles Nicolle, 1082 Cité Mahrajène Tunis, Tunisia

ABSTRACT

Settling and accumulation of sediments have been measured on the bottom of the facultative and three maturation ponds of a series of pilot-scale stabilization ponds. The mean deposition rate in the facultative pond showed that the attempt to establish a short-term sedimentation by in situ measurements failed. The rates were largely overestimated and the values calculated from the sediment accumulated in a long-term are closer to the reality. The sediment depth increase rates are 5 cm/year for the facultative pond and 1.3 cm/year for second and third maturation ponds. In the last maturation pond it is 1.6 cm/year. The rate of sediments deposit (volatile solids) in the first pond can be estimated by an at^{-b} equation.

KEYWORDS

Accumulation; Sediments; Settling; Silting; Wastewater Stabilization Ponds (WSP).

INTRODUCTION

In several studies it was noticed that it is not possible to neglect the role of sediments in the wastewater treatment by stabilization ponds (Gloyna, 1972; Drakidès, 1983; Iwema et al., 1987; Beaumier, 1988; Carré et al., 1989; ...). The first pond of a system works by the settling and elimination of suspended organic matter and the more important part of dissolved organic matter. Indeed the working of a pond is closely bound to sediments and the behavior of these depends on the season. In Winter, the pond operates by storage of the sediments so between the end of spring and the beginning of the fall, when the temperature of sediments exceeds 20°C, fermentation resuspends soluble matter in the water phase increasing the overcharge of the pond. The aim of this paper is to study the evolution of sediments and to estimate the accumulation at the pond bottom.

MATERIALS AND METHODS

Pilot scale-stabilization ponds

The experimental study of domestic wastewater treatment by semi-industrial plant is conducted on pilot-scale stabilization ponds. The pilot include a series of four ponds: a faculative pond (F) and three maturation ponds (M1, M2 and M3). The ponds system studied has been described earlier by GHRABI et al. (1994).

Sedimentation

The sediments deposited have been collected in situ on the bottom of a facultative pond by traps. Three to five samples were taken by traps placed near the inlet and same number near the outlet. The traps consisted of 56.74 cm^2 circular glass with a 5 cm high wall. The deposition rates have been estimated from sediment quantities collected by traps, during 3 and 28 days on the facultative pond, and sediment quantities deposed on the bottom of each pond at the end of experimental studies (180, 750 and 930 days). The measurements of dry and volatile solids (DS, VS) have been determined respectively by drying at 105°C and calcination at 525 ± 25°C.

RESULTS AND DISCUSSION

The sediments collected by traps in the bottom of the facultative pond present a slight odour and they have pale colour near the outlet. The sediments collected in 28 days seemed more fermented than those collected in 3 days.

Settling and accumulation rates

The samples have been taken from march until the end of may 1991. The sediment temparature varied from 16 to 16.5°C. The deposition rates in the facultative pond are given in table 1.

Table 1 Deposition rates in the facultative pond.

	Sediment rate ml/(d. m^2)	cm / y	Dry Solids (g / l)	Volatile Solids (g / l)
Settling (3 days)	4880	183	50.6	33.0
Accumulation (28days)	1648	60	49.7	31.0

The digestion of sediments can explain the difference betwen the settling sediment rates in 3 days and the accumulation after 28 days. This indicates a strong fermentation of sediments (more than 33% in 28 days), conforming with the observations of Carré et al. (1987) and Beaumier (1988). The settling rate is very high and it indicates an apparent crowding in some months. The rates of observed accumulation are high compared with the values found by certain authors (some cm/year). The duration of 28 days is insufficient to obtain a total digestion of the sediments.

Profiles of the sediments in bottom of ponds

The thicknesses of the sediments are not regular and reflect for each pond the hydraulic conditions of the system: accumulation near the inlet, the outlet, in the corners and near the pond walls. This preferential zone is indicated by most of the authors. In ponds M1 and M3, this order is not respected: most accumulation is noted near the outlet. In these ponds, the sedimentation seems to be influenced by the dominant winds (North West/South East) contrarily to observations of Barron et al. (1987). When the meteorological conditions are favorable (sunny and no wind), the algae growth becomes very important and forms a layer floating at the surface of the water. This layer which invades all the surface of the pond in some days (2 to 3) finishes to being carried and condensed by the wind in the corners and then settles on the bottom this would explain the strong accumulation of the sediments near the outlet of the M1 and M3 and near the inlet of the M2. The fine organic particles, among them many algae -more than near the inlet as a result of direction of the prevailing winds- settle near the outlet, Carré et al. (1987).

The result of the measurements of the silting in the different ponds is presented in table 2.

Table 2 Deposition dry solids (moisture = 95%).

Pond	Volume of sediments m^3	Deposition rate cm/year
F	12.67	5.0
M1	3.78	1.3
M2	3.80	1.3
M3	4.53	1.6

The silting is limited to the first pond (F). The tank of the sediments permitted retention about 3/4 of the volume that would facilitate the desludging. The rate of the silting in the three maturation ponds is not high and it is comparable to the values given in the literature.

Relation between accumulation rate and time

The accumulation rate in the facultative pond was estimated from:

- volumes collected in the traps after 3 and 28 days,
- volumes accumulated in the bottom of the pond after 6, 25 and 31 working months. Evolution of sediments is given by the figure 2.

Figure 1 indicates that the values esitmated after 3, 28 and 180 days don't translate the real rate of accumulation. The values calculated at the long term is near of the reality. The evolution of the sediments seems be well fitted by a law of exponential type $\mathbf{at^{-b}}$ with a very good correlation ($VS = 360.5\ \theta^{-0.656}$; $R^2 = 0.994$).

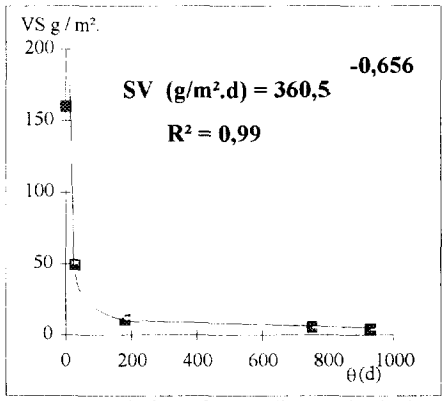

Figure 1: Evolution of the sediments in the bottom of the facultative pond (Ghrabi et al.1994).

CONCLUSION

This study confirm the role of the sediments in the treatment by stabilization ponds. The settling and accumulation rates obtained doesn't translate the real silting rates. However, the accumulation rates calculated from the deposed sediments in the bottom of the ponds at long term are much nearer the values cited by the literature for the first pond. The calculated rates of the sediments accumulation in the other ponds (M1, M2 and M3) really seem to translate the silting in the maturation ponds.

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