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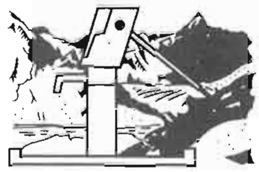
WATER, ENVIRONMENT AND MANAGEMENT



Low cost wastewater treatment for Pakistan

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ABSTRACT

A comparative study for the efficiency of wastewater treatment was carried out for the three options available in Karachi i.e. trickling filter, aerated lagoon and oxidation pond. The analysis of influent and effluent samples was carried out on weekly basis for twelve months. Sewage influent indicates that it is fairly strong and concentrated. The oxidation pond has an edge over the other two system on the basis of effluent quality, economics, operational and maintenance considerations. For developing countries where capital costs, operation and maintenance are the main constraints, oxidation pond seems to be the choice. Chlorine treatment is recommended for disinfection.

INTRODUCTION

There is acute and chronical shortage of potable water in Karachi and it is time to utilize secondary treated wastewater for landscape and irrigation. There is an extensive sewerage system involving 220 MGD of sewage, out of which about 175 MGD is drained untreated into the coastal waters creating environmental problems.

The two trickling filter plants treat 20 MGD each, an aerated lagoon treats 5 MGD and an oxidation pond located in the Karachi University Campus on a pilot plant scale treats 52500 gallon/day.

Karachi is supplied about 35gcd against who standards of 60gcd. Ten percent of this supply is used for lawns and greenery of residential and office buildings and another 10% is wasted through leakage in the system. The present research is aimed to investigate the three existing treatment options, from the recycling view point.

METHODOLOGY

The samples of the raw sewage (influent) were collected at the inlet to the treatment plants and the effluent samples at outlet points of the three systems on a weekly basis over a period of twelve months.

All parameters were determined according to the procedure laid down in (APHA,1980. EPA, 1976), during the months of November to October, 1987-88.

RESULTS & DISCUSSIONS

For the three types of the treatment under investigation the best choice shall be based on the comparative treatment efficiency of suspended solids, BOD, ammonia nitrogen, phosphate phosphorus and fecal coliform combined with the capital, operationaal and maintenance costs, as discussed in subsequent paras. Other parameters like toxic elements etc. are also important in agriculture reuse, but not discussed here since the above treatment methods hardly contribute to their removal.

The removal efficiencies for the three treatments for suspended solids, BOD, ammonia nitrogen, phosphate phosphorus and fecal coliform are presented in Table 1. The yearly average value provided in the table is estimated as average of weekly data.

Figure 1 and 2 present the seasonal varia-

TABLE 1: Comparative performance efficiency of the three systems (yearly average)

Parameter	Trickling Filter		Aerated Lagoon		Oxidation Pond	
Suspended Solids	(88-98)	93	(77-91)	85	(77-97)	92
Biochemical Oxygen Demand	(64-81)	72	(65-92)	80	(60-96)	79.3
Ammonia Nitrogen	(13-23)	17.3	(3.6-50)	22	(19-60)	37
Phosphate Phosphorus	(7-20)	13	(4-50)	22	(6-82)	41
Fecal Coliform	(76-93)	85	(96-99.99)	99.96	(91-99.80)	97.6

Paranthesis shows the range.

tion based on the monthly averages, for BOD and fecal coliform removals. As expected the performance of the oxidation pond (without mechanicaal aerators) is lowest for the two winter months but comparable and even better during rest of the year, (95% removal for BOD in July). The effluent quality from the oxidation pond and aerated lagoons meet the standards for irrigation reuse as far as suspended solids, ammonia nitrogen and BOD are concerned. The performance of the trickling filters was less than expected due to operational and maintenance problems, so typical with developing countries. The performance of oxidation pond during the 10 months of the year is excellent keeping in view that the hydraulic retention time was of very short duration of 3.4 days and at a depth of 1.04m. None of the effluents meets the reuse bacteriological criterion with fecal coliform as high as in the range of 10^6MPN/100ml. In Pakistan untreated and primary treated wastewater is used in agriculture since decades. While there is no data available for Pakistan, Shuval etal (Shuval, 1986) has reviewed all the available epedemiological studies of wastewater agriculture.

Current microbiological standards for wastewater reuse for crop irrigation vary from country to country and even from state to state in U.S., on the whole they are very strict(CSDPH,1968. Ducan & Cairncross 1989. WRFA,1977). However Engelbege guidelines given by WHO (WHO, World Bank, IRCWD,1985), are opposed to such stringent limits and conclude that risks of irrigations with well treated (secondary) wastewater were minimal and

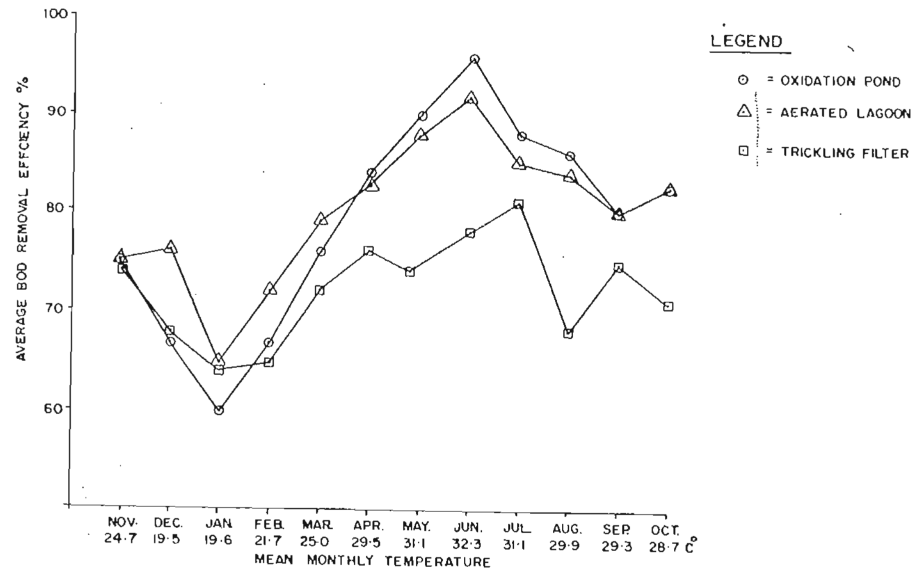

FIG. I SEASONAL VARIATION OF BOD REMOVAL EFFICIENCY

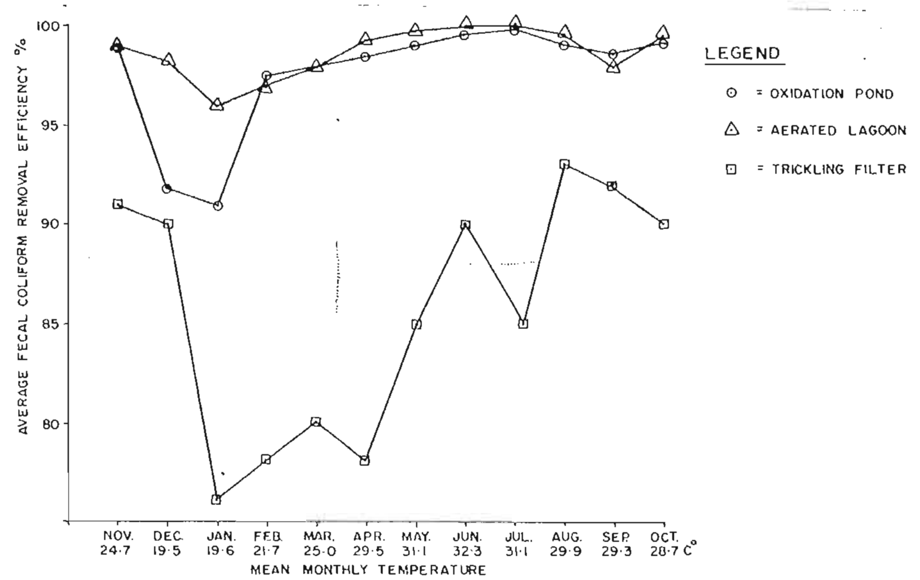

FIG. 2 SEASONAL VARIATION OF FECAL COLIFORM REMOVAL EFFICIENCY

that current bacterial standards are unjustifiably strict. The experience in Pakistan of Wastewater reuse for irrigation justifies and supports Engelberge guidelines.

In oxidation ponds and aerated lagoons, mosquito breeding, scum formation and odour problem was non existant for most of the months. However in winter months with cloudy weather odour problem was noted. Therefore the effluent quality from oxidation pond and aerated lagoon is positively better than the trickling filter except for few cloudy winter days in the whole year.

The economics of the above three systems for Karachi is present in Table 2. Thus based on the effluent quality, (except for few days in winter months) capital, operational and maintenance cost, oxidation ponds as a systems of treatment holds an edge over more sophisticated conventional methods particularly in arid and semiarid zones where inexpensive land is available. The oxidation pond are technologically simple and so cost effective that even developed countries like USA have more than 4000 oxidation pond, even though it can afford more expensive treatment methods and are planning to have more (Glyona, 1971. EPA-600/9-79-011, 1979. EPA-600/2-77-109, 1977. EPA-600/2-77-086, 1977). To provide conventional wastewater treatment for 2 billion people, in the developing countries will cost more than $600 billion (Dale, 1979) and therefore search for low cost treatment methods has assumed and rightly received much importance and attention. Obviously the capital cost for oxidation pond would be high enough for cities located in the expensive agricultural lands.

However cities and towns with arid inexpensive lands around, offer the most suitable site for oxidation ponds and with feasibility to develop green belts. Large cities like Karachi has to be divided in sectors and each sector to be provided with an oxidation pond on the ouskirts along with the green belt. The decentralization of the system will minimize management problems, enhance community participation, reduce massive diggings along the road side for sewer lines and equally distribute wastewater along the periphery for irrigation.

A conceptual plan for Karachi is presented in which a number of oxidation pond receive the water from respective sectors and deliver the effluent to the green belt. The idea of green belt around Karachi has the following benefits:

a) Minimize dust problem
b) Reuse precious water now being drained into the sea
c) Produced vegetable, not only making Karachi self sufficient but leave enough for export
d) Provide jobs to the unemployed
e) Once built the oxidation pond can be operated and maintained, involving community participation on self help basis.

CONCLUSION

a) Stabilization ponds coupled with vegetable and fodder growing belts are best solution to medium size and small towns in arid zones where inexpensive land is available.
b) A number of stabilization ponds on sectorwise distribution with vegetable and fodder growing belts are recommended for large cities like Karachi.
c) Aerated lagoon are recommended for large and small towns located in the irrigated and expensive agricultural lands.
d) The use of conventional type of treatment plants should be discouraged in the light of experience gained from the existing ones. Sophisticated operational problems, maintenance and spares are major factors against the conventional type of treatment plants i.e. trickling filter, activated sludge, biofilters etc.

TABLE 2: Estimated cost comparision per MGD for the three systems (Alam 1989) (BOD removal efficiency 75%)

Costs (million US $)	Conventional Treatment (Trickling filter)	Aerated lagoon System	Oxidation Pond System
Capital	0.16	.092	.070
Operation & maintenance (per year)	.0034	.007	.0024
Land area (ha)	.020	.042	.112

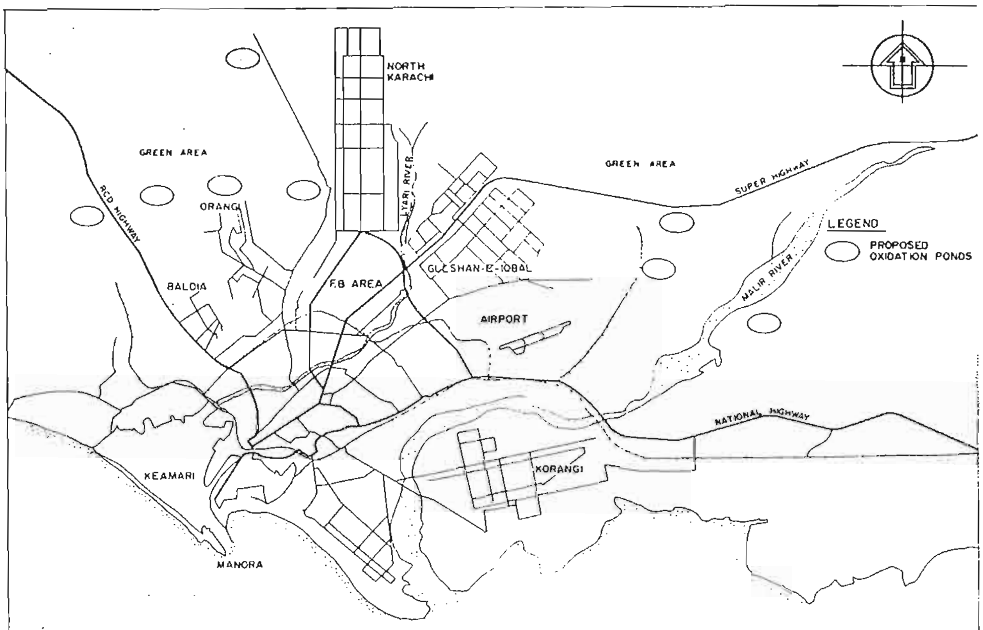

FIG. 3 A CONCEPTUAL PLAN SHOWING LOCATION OF OXIDATION PONDS AROUND KARACHI

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