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WASTE STABILIZATION PONDS AS TEACHING AND RESEARCH TOOLS

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ABSTRACT

In any campus where there is an excess of land or where a decorative pond is available, it is often possible to establish a system of waste stabilization ponds (WSP) to be used as an open air research laboratory, as source of water for watering the campus grounds and as a demonstration unit for the community at large. One such system, comprising one photosynthetic and one macrophyte pond in parallel, followed by one fish and one irrigation pond in series, was built at the Faro Polythecnic in Portugal. The ponds are preceeded by an underground unit formed by three septic tanks in series followed by two upflow anaerobic filters in parallel. This system is expected to receive 120m^3/day of a mixed effluent coming from the sanitary facilities, the refectory and the fish processing laboratory, with concentrations of about 600mg/l in both BOD and SS.

KEYWORDS

Waste stabilization, demonstration units, water reuse, photosynthetic ponds, macrophyte ponds, fish ponds, anaerobic upflow filters.

PONDS IN THE CAMPUS: THE NEED AND THE FEASIBILITY

Institutions of higher education, such as universities and polytechnics, which offer courses suitable for the training of water scientists and engineers, are always faced with the difficulty of finding appropriate facilities for performing experiments that may be comparable to real world situations. Such a problem comes to the fore when dealing with wastewater treatment processes which require large expanses of land. This is often circumvented by resorting to bench scale experiments and leaving aside the processes that are less amenable to miniaturization. In such cases ponds are always at a disadvantage.

However, this does not need to be so. Many campuses have decorative or landscaping ponds or pools that can easily be converted to stabilization ponds which, alone or in association with compact or underground units, may be organized into effective wastewater treatment systems.

THE EXPERIMENTAL DIMENSION

A large number of experiments of varying complexity can be carried out in such a WSP system. They are ideal to determine the rate constants for BOD and coliform decay, to study inhibitory effects to treatment processes caused by metals, pesticides or other industrially originated toxic materials, to test the efficiency of fixed or floating macrophytes on the removal of contaminants and to study the adaptation of fish and molluscs to pond environments and to measure their rate of growth, their most convenient population densities and their suitability for the uptake of nutrients.

Another set of experiments can also be performed outside the pond environment using the pond water, either before or after the treatment is completed. Examples of such experiments are studies on hydroponics, using both recirculating and "once through" flow arrangements, the measurement of biomass buildup by irrigated plants, the efficiency of nutrient removal by plant roots, the use of unsaturated soil as a wastewater treatment media and the modelling of groundwater contamination.

THE DEMONSTRATION DIMENSION

Wastewater from the pond system may be distributed by an underground pipe network and used for watering the grass, flower beds and trees existing on the campus and peripheral fields, which may bring in considerable savings in water bills and pumping costs from alternative boreholes. This is particularly important in climates of low and erratic rainfall where the peak demand for water by other users coincides with the dry periods. Wastewater treated by a pond system, with its normally excelent coliform quality, is well suited to be used for satisfying local irrigation needs, so leaving the groundwater resources to meet other needs.

In the course of their professional lives, students who have been exposed to the merits of pond systems while at college, will tend to adopt it whenever suitable, thus transfering the technology into the community at large. Besides, the system may be used as a direct demonstration facility for the benefit of water managers and the general public.

THE FARO POLYTECHNIC EXPERIMENT

The System

A sewerage network serving the academic buildings, the catering block and the sports centre empties into the sump of the pumping station that feeds the wastewater to an underground three-compartment septic tank; from there on the flow is gravity driven. The upstream compartment has 2/3 of the total capacity to accommodate the build up of sludge. The anaerobic effluent from the tank enters two parallel anaerobic, fixed film, upflow filters packed with high specific area plastic media.

The effluent from the filters may be split between two aerobic ponds and fed near their bottom; one of them is a photosynthetic pond and the other will be populated with a choice of fixed or floating macrophytes, as required by the experiments. These two ponds empty into a fish pond where selected populations of both fish and shellfish will be tested. Recirculation water is pumped from this pond to a manhole some 10m upstream from the pond system where it joins the effluent from the anaerobic filter and satisfies its immediate oxygen demand. The effluent from this pond runs into a retaining tank from where it is pumped into a pressurized underground grass irrigation network. Excess water is wasted into the town sewer.

The water level in the system may be varied by adjustable weirs which allow the fish free movement. Shallow wells dug into the ponds bottom provide shelter for the fish when the ponds need emptying for cleaning or for mosquito control.

The Design Criteria

The fish processing laboratory will discharge $60m^3$/day with 1000mg/l of both BOD and SS. Full capacity student and staff population is 1200 and wastewater discharge is taken as 50ℓ/hd.day. A mixed effluent of $120m^3$/day and 650mg/l of both BOD and SS was assumed. A coliform count of less than 10/100ml was taken as the limiting design parameter.

A septic tank hydraulic retention time (HRT) of 18 hours was chosen in order to achieve a removal of 40% BOD, 60% SS and 60% coliform count. Allowing for the long night and weekend stoppages the HRT based criteria was dropped in favour of a BOD based one to design the anaerobic filter and a conservative value of $1.3kg/m^3$day was assumed. A removal of 85% BOD and 60%coliform count is expected in the filter. The depth of all ponds is 0.75m. The macrophyte pond, with an area of 0.14ha, an HRT of 14 days at full flow and an organic load of 50kg BOD/ha day, is expected to give removals of 80% BOD and 96% coliform count. The aquaculture pond has an area of 0.05ha and receives 1.4kg BOD/day. It should give removals of 95% BOD and 99.9% coliform count. Therefore the final effluent should have $\simeq$1mg/l BOD and $\simeq$6 colif./100ml.

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