WORLD HEALTH ORGANIZATION

ORGANISATION MONDIALE DE LA SANTÉ

COURSE ON WASTE STABILIZATION PONDS - DESIGN AND OPERATION

EM/CRS.WST.STB.PDS./5

Alexandria, 12 - 21 September 1981

1 July 1981

WASTEWATER TREATMENT PRACTICES

By

Mr K.V. Ellis
WHO Short Term Consultant*

* Lecturer in Environmental Health Engineering, University of Technology, Loughborough, UK

Wastewater Treatment Practices

Surface water pollution

This mainly results from the addition of either municipal wastewater (from towns and cities) or industrial wastewater to streams, rivers and lakes.

By pollution we usually mean the addition of harmful (disease producing) organisms to the water or the addition of 'biodegradable' organic material to the water. Wastewater treatment processes greatly reduce the numbers of harmful organisms discharged to rivers, but wastewater treatment is mainly concerned with reducing the quantity of 'biodegradable' material that is discharged.

Biodegradable organic compounds are those which can act as the food (or substrate) for bacteria and other microorganisms in the water. The bacteria break down these organic materials into simple, stable inorganic compounds such as water, carbon dioxide, sulphates, phosphates and nitrates, and at the same time produce fresh bacterial cells. These bacteria involved in the stabilization (purification or breakdown) of the organic compounds are mainly 'aerobic' bacteria. 'Aerobic' bacteria require oxygen disssolved in the water in order to be able to stabilize the organic compounds. They can use up a great deal of oxygen in stabilizing these compounds.

The main purpose of wastewater treatment is that the bacterial stabilization processes should take place in wastewater treatment works in a rapid concentrated process, rather than more slowly in the river. If the process of stabilization takes place in the river all the oxygen which is normally dissolved in the river water can be used up and then all the normal life in the river (including fish) will die. This must be avoided.

Wastewater treament processes

Most wastewater treatment processes are 'aerobic' in that they make use of the same types of aerobic bacteria that exist naturally in the rivers. However, the aerobic processes in the wastewater treatment processes are usually far faster and more concentrated than in the river, and artificial means must be employed (mechanical aeration) to add a lot of oxygen to the wastewater being treated.

Some wastewater treatment processes are 'anaerobic'. This means the bacteria used in these processes only live and operate (metabolize) in the absence of oxygen in the water. In rivers and lakes these 'anaerobic' processes occur at the bottom of deep rivers and lakes. In wastewater processes they are operated either in closed tanks (sealed off from the air) or in deep lagoons.

The processes of wastewater treatment can be listed as

- Stabilization ponds - anaerobic ponds
  - facultative ponds
  - aerobic (maturation) ponds
- Aerated lagoons
- Oxidation ditches
- Percolating (trickling, biological) filters
- Rotating disc treament units
- Activated sludge
- Anaerobic digestion

Approximately, these processes are listed in an order of increasing sophistication or complexity. They progress from low technology (ponds) to high technology (activated sludge etc). Percolating filters, rotating disc units and activated sludge processes are called secondary, biological treatment processes as they require the prior removal of the suspended-solids from the wastewater by separate, settlement processes (primary treatment). Most of the processes also require the removal of grit and the screening of the wastewaters (preliminary treatment processes).

Oxidation ditches are a simpler form of the activated-sludge process. Percolating filters and rotating disc treatment units are called 'fixed-film' treatment processes as the aerobic bacteria are held in a fixed position as the wastewater flows past.

Stabilization ponds are the simplest form of treatment and require no skilled maintenance, but use a large area of land. The treated water discharged at the end of the process (the effluent) can be of a high quality but is often contaminated by the presence of large numbers of 'algae'. All the oxygen required by stabilization ponds is provided either by the 'photosynthetic' action of algae or by direct absorption of atmospheric oxygen from the air.

Often the large land area required by stabilization ponds forces designers to use aerated-lagoons which are a lot like the ponds but use mechanical means for dissolving the atmospheric oxygen unto the wastewater. Aerated-lagoons require much less land area than stabilization ponds but require power and mechanical equipment and some skilled maintenance.

The activated sludge process requires the development of a large, active mass of aerobic bacteria and other microorganisms (the activated-sludge), which is mixed with the wastewater being treated and later separated from the treated effluent and then used again and again. Activated sludge units need little land area and produce a very high-quality effluent, but require properly constructed concrete channels and tanks, a lot of electrical power, the use of complex and costly equipment and a lot of skilled maintenance.

Most anaerobic 'digestion' units are also costly, complex and require skilled maintenance. They are usually employed to reduce the 'biodegradable' content of very strong wastes to a level at which normal aerobic process can be employed. These anaerobic processes are also often used for 'stabilizing' the sludges produced during conventional wastewater treatment processes. However, 'anaerobic' stabilization ponds are a simple and effective means of employing an anaerobic process without using costly and sophisticated equipment.

'Polishing' processes

Following normal wastewater treatment processes it is sometimes necessary to improve even further the quality of the effluent. This is achieved by one or more of a number of processes which include

Sand filtration - rapid gravity
upward flow
slow sand
Microstrainers
Upflow pebble filters
Maturation ponds
Grass plots

These processes normally reduce further the amount of biodegradable organic material in the effluent and reduce considerably the number of remaining bacteria.