FOUNDATION MICROBIOLOGY BI25M3

This lecture introduces the role of microorganisms in wastewater treatment.

Brock Biology of Microorganisms – Section 28.2

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BBC2 Metropolis Documentary ‘A Big Stink’

This programme adopts an often amusing, historical perspective on the problems of sewage disposal and pollution in London and the River Thames. The issues raised encompass some of the central themes of wastewater treatment and should provide a general introduction to this lecture.

The video largely aims to describe key historical events in the story of London’s struggle with sewage. Try to take notes around the following list of key dates and/or topics.

- Surfers Against Sewage
- Dick Whittington’s action as Lord Mayor in 15thC
- Middle Ages and attitude to human waste
- 1594 and Sir John Harrington
- 1775 and Alexander Cummings
- Paul Johnston (University of Exeter) - modern attitude to waste, the WC as a technical solution?
- Covering of watercourses
- 1846 and the River Fleet explosion
- 1849 - contaminated water and the arrival of cholera
- 1858 - the year of the big stink, Parliamentary action
- 1865 Sir Joseph Bazalgette, construction of sewage system: piston effect, location of outfalls, nature of tunnels
- 1870s London ‘transformed’ by new technology?
- 1878 sinking of paddle steamer, Parliamentary action again, rudimentary sewage treatment
- 1887 - all well again?
- Population growth of Greater London
- Post-war condition of River Thames - Thames ‘dies’ in 1947
- Restoring the Thames - sophisticated sewage treatment
- Culture of disposability
- Link between wastewater disposal and water quantity
- Sanitary insanity

FOUR STAGES IN THE TREATMENT OF SEWAGE

Preliminary treatment

Involves screening for large objects, maceration and the separation of storm flows.

Primary treatment (sedimentation)

Suspended solids are separated out as sludge.

Secondary (biological) treatment

Dissolved and colloidal organics are oxidised in the presence of microorganisms.

Tertiary treatment

When a high quality effluent is required. It may involve the removal of further BOD, bacteria, suspended solids, specific toxic compounds or nutrients.

BIOCHEMICAL OXYGEN DEMAND (BOD)

Definition:

A measure of the biodegradable organic matter in a water sample.

Measure O_2 consumed per unit volume of a water sample during a 5 day incubation at 20^oC.

A Typical Sewage Treatment Works

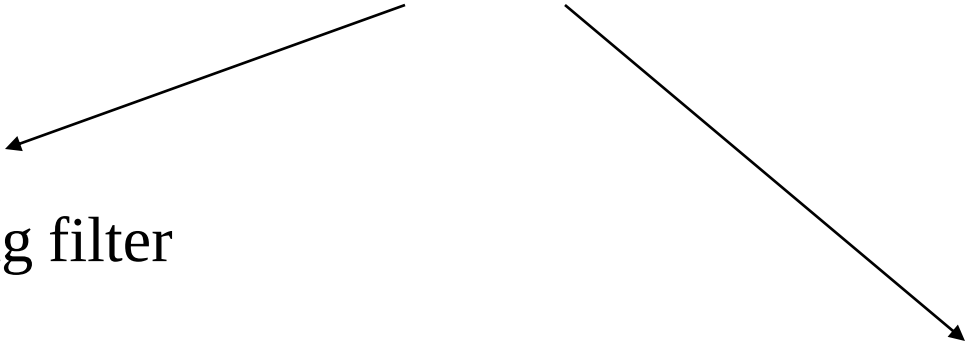
PRELIMINARY TREATMENT

- Screening – physical removal of relatively large or heavy solids e.g. rags.
- Achieved by passing through 75-100 mm screens.
- No real reduction in BOD.

PRIMARY TREATMENT

- Slowing the sewage flow down.
- Sewage is ‘kept’ in a chamber.
- ~ 90 % SS removed and 30-50 % of BOD removed.

SECONDARY TREATMENT



Trickling filter

Activated Sludge

Both biological treatments as they depend on microbes breaking down organic material to CO_2 and H_2O.

TRICKLING FILTERS

•Beds consist of circular tanks 1-3 m high.

•Bed packed with rocks, clinkers or plastics, diameter (~5.0 cm) – to which microbes attach.

• A wide range of heterotrophic bacteria and fungi are responsible for the primary oxidation of the effluent.

•Chemolithotrophic nitrifying bacteria tend to be dominant in the lower layers of the filter.

• Ecology of filter bed important – microbial biofilms on rocks grazed by protozoa and macroinvertebrates.

• Aerobic Gram –ve bacteria dominant, e.g. *Zoogloea*, *Pseuodomonas*, *Alcaligenes*.

•Fungi also present e.g. *Fusarium*, *Geotrichium*

Pros/cons

Low running cost but very temperature sensitive and a large acreage required.

ACTIVATED SLUDGE PROCESS

•Primary effluent is mixed with a flocculent suspension of microbes and aerated in a tank (5-10 hours).

•Slime-forming bacteria including *Zoogloea ramigera* form flocs. Associated with the flocs protozoa and invertebrates.

•Secondary effluent then settled in a tank.

•Fungi are not dominant microbes and may cause bulking.

SLUDGE

•Sludge is generated at both primary and secondary stages – decomposed anaerobically.

•Sludge consists of protein, fats and polysaccharides.

•Two stages:

First stage – digestion in closed tanks at 27 – 35 ^{o}C for 7-30 days, methane and CO_2 produced.

Second stage – sludge settles and thickens in open tanks for 20-60 days.

SLUDGE DISPOSAL

- Dumping at sea banned in 1998 in the UK.

- Land use – fertilizer, restricted by heavy metal content and transport costs.

- Landfill – holes are running out/cost rising.

- Incineration - a popular option!

TERTIARY TREATMENT

Refers to any or all of the following:

Further removal of BOD and SS.

Further removal of nitrates and phosphates.

Further removal of pathogenic microbes.

SEWAGE TREATMENT - SUMMARY

Three objectives in the treatment of sewage:

- To convert sewage into suitable end products.
- To produce a satisfactory effluent which can be discharged into a local watercourse.
- To produce sludge which can be disposed.