EWC 333
Wastewater Engineering and Sanitation

Lecture 12

Instructor

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Lecture Outline

Topics	Reference
• Role of bacteria in sewage treatment • Bacterial growth pattern in biological treatment • Relation between Food/Microorganism (F/M) ratio and biomass settling characteristics	Water Supply and Sanitation - Feroz Ahmed and Mujibur Rahman ITN -BUET

Role of Bacteria in Sewage Treatment

- Bacteria are capable of solubilizing food particles outside their cell wall by means of extracellular enzymes, and hence can remove soluble, colloidal and solid organic matter from wastewater.
- The bacteria important in the aerobic treatment of sewage are rod-shaped, facultative and mesophilic.
- They are excellent oxidizers of dead organic matter and grow extremely well in sewage.

Role of Bacteria in Sewage Treatment

- They are all capable of exuding a slimy flocculant layer which in some treatment units (e.g. activated sludge) in an important mechanism in the treatment process.

- Coliforms and other intestinal bacteria do not play any significant role in the sewage treatment processes. They are merely passengers in the system.

Role of Bacteria in Sewage Treatment

- Aerobic bacteria utilize free oxygen as an electron acceptor. The end products of aerobic activity are CO_2, H_2O, SO_4^{-2}, NO_3^-, NH_3 and more bacteria.

- The bulk of the available energy is converted into either cell mass or heat, yielding a stable effluent, which will not undergo further decomposition. And this indicates the completion of treatment.

Favorable Environment for Bacterial Growth

Bacteria can grow in an environment only if –

- There are sufficient nutrients available. Bacteria require relatively large amounts of carbon, nitrogen, hydrogen and oxygen; smaller amounts of phosphorus, sulphur, potassium, calcium, iron and magnesium; and trace quantities of several other elements (e.g. zinc, molybdenum).

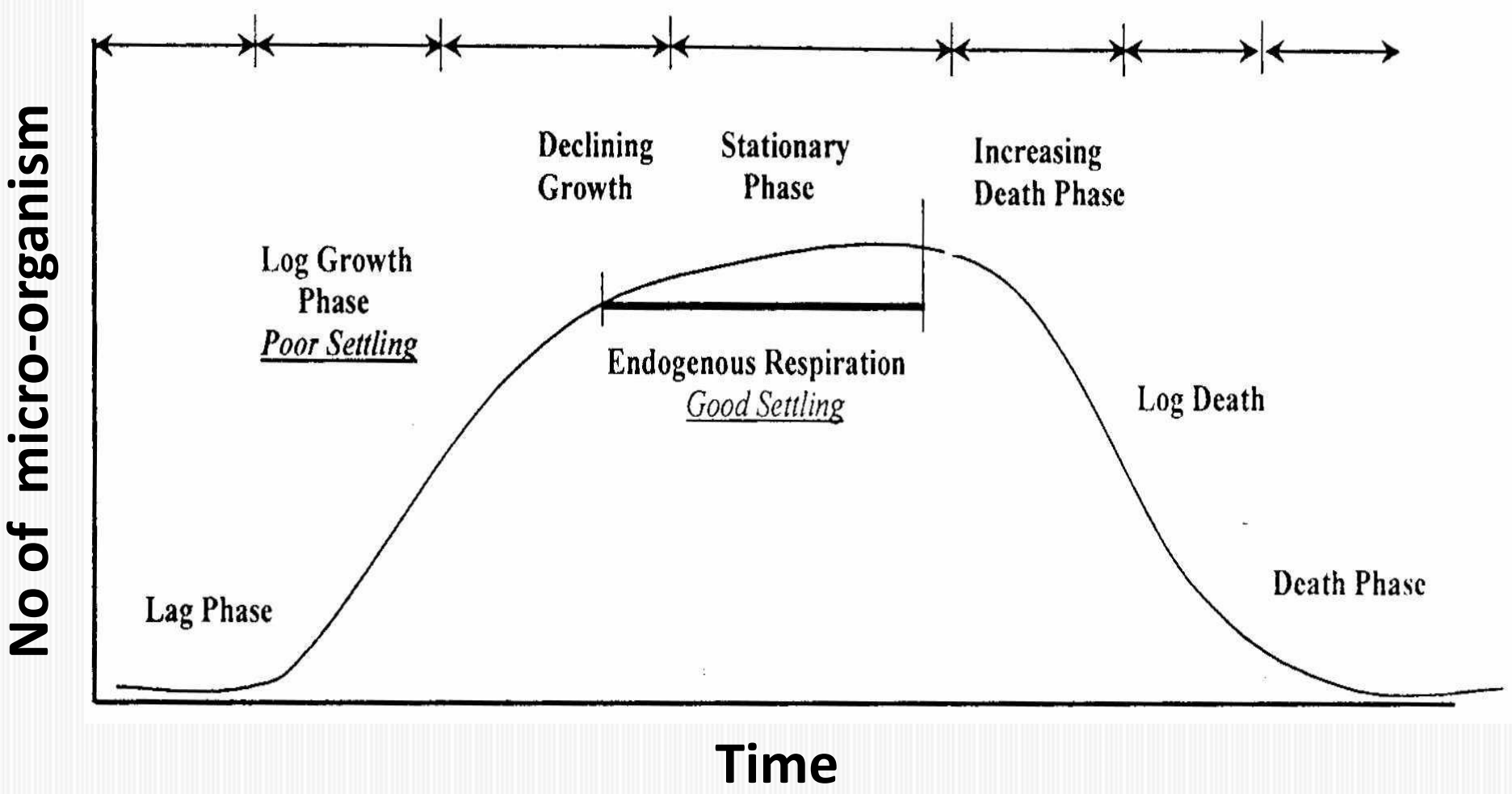
- There is an absence of toxic compounds (Chlorine compounds, Cr, Pb, Hg, Ag etc)

Favorable Environment for Bacterial Growth

- The environment itself is suitable, having the following conditions-

  - ✓ Neutral pH (about 6.5-8.5 units)
  - ✓ Correct concentration of dissolved oxygen (zero for anaerobes; a minimum of 1-2 mg/l for aerobic growth)
  - ✓ Temperature around 35ºC.

Bacterial Growth Pattern



Bacterial Growth Pattern

(i) *Lag Phase*

- Cell numbers do not increase;
- The bacteria are however internally active, manufacturing if necessary any extra-cellular catalysts (enzymes) that they may require in order to be able to oxidize the waste.

Bacterial Growth Pattern

(ii) *Exponential or Log Phase*

- Logarithmic growth occurs during this phase
- The bacteria lay down food reserves within their cells which they may use when there is little or no food left in their environment.
- The bacteria arc now growing as fast as they are able to in the waste.
- Although the log growth phase coincides with the maximum rate of substrate (waste) removal, this is not the optimum zone of operation for waste treatment systems.

Bacterial Growth Pattern

(ii) *Exponential or Log Phase*

- In order to maintain log growth, the food must be in ample supply, but a low concentration is desired in the treated waste.

- Further, the maximum rate of utilization requires that other growth factors, such as oxygen, be supplied at a maximum rate and this may be difficult to do.

Bacterial Growth Pattern

(ii) ***Exponential or Log Phase***

- Finally, bacteria in the log growth phase of development have a great deal of energy available, have limited accumulation of waste products, and hence are likely to be motile, dispersed, and difficult to remove by sedimentation.

Bacterial Growth Pattern

(iii) *Declining Growth Phase*

- Available food supply has been largely depicted and. food becomes the limiting factor in further growth.
- The declining growth phase is generally used for biological treatment systems.

Bacterial Growth Pattern

(iv) *Stationary Phase*

- The number of new cells is approximately balanced by those that die, so that the population cell density does not change.

(v) *Death Phase*

- As the death rate exceeds the growth rate, the culture enters the dead phase.
- The population density steadily declines.

Bacterial Growth Pattern

- During both the *stationary* and *death phases* there are a substantial proportion of cells which neither die nor subdivide.

- They exist by utilizing the intracellular food reserves laid down during exponential growth; this process is known as *endogenous respiration.*

- When a cell has depleted its food reserves, it starts to oxidize itself, this process is known as autolysis (self-destruction), leads of course to *death.*

Relation between F/M ratio and Bio-mass Settling

Food : Micro-organisms (F/M)	Growth phase	Waste removal rate	Bio-mass settling characteristics
Very High	Log Phase	Maximum	**Dispersed, Poor**
Moderate	Declining Growth	Good	**Good**
Low	Stationary Phase	Moderate	**Very good**
Very low	**Death Phase**	**Negative**	**Autolysis**

Relation between F/M ratio and Bio-mass Settling

