Sarnia • Lambton Environmental Association
Industries Working Together

Water Treatment - Biological

This monograph, one in a series of single issue documents dealing with Lambton County environment, has been prepared by the Sarnia-Lambton Environmental Association in co-operation with the School Boards of Lambton Kent.

Introduction

Micro organisms in aquatic systems feed on dissolved/suspended organic matter; their digestion processes decompose organic wastes. Oxygen is consumed during these decomposition processes thus decreasing the supply of dissolved oxygen in the water. If the rate of decomposition is excessive, the resultant oxygen depletion produces stresses on aquatic organisms. Biological (secondary) treatment systems address problems associated with biochemical oxygen demand. Break-down of wastes is transferred from natural waterways to lagoons and/or vessels where conditions can be controlled so that decomposition occurs efficiently. **Biological treatment is simply a concentrated, controlled, application of a natural process.** Wastewaters often require physical and/or chemical treatment as well; these processes are introduced in Monograph W3.

Facts

An Activated Sludge System	*Biological Treatment Is Effective For These Wastes*
	**Wastewater Sources** and **Examples** • Municipalities - domestic and storm* waters * combined sanitary and storm sewers • Food Processing - meat and vegetable trimmings; caustic soda - used to peel vegitables • Petroleum Refining - phenol, oil and grease • Petrochemical Production - phenol, styrene, benzene

Key Words

activated sludge - a semi-liquid mass that is highly populated by microorganisms; through controlled aeration, oxygen is maintained at a high level thoughout the mixture

acclimatization - adaptation to environmental change, the population of a specific strain of bacteria increases over successive generations in response to its environment; other bacteria for which the environment is not particularly suitable remain in the system but their numbers are small until possible changes favour their increase

aerobic bacteria - require oxygen; *anaerobic bacteria* function in the absence of oxygen

Biochemical Oxygen - the amount of oxygen utilized when the organic matter in a given volume of water breaks downbiologically

microorganisms - microscopic organisms (microbes); included are bacteria, protozoa, yeasts, viruses, algae

Biological Oxidation (Biox) Treatments Break Down Wastes

Microorganisms (bacteria, fungi, algae) feed on wastes

Treatment Systems - Some Examples

Lagoon - Shallow excavation (1.5 metres in depth) - designed to receive domestic sewage and/or some industrial wastes; purification is dependent upon the combined action of air, sunlight, sedimentation and microorganisms.

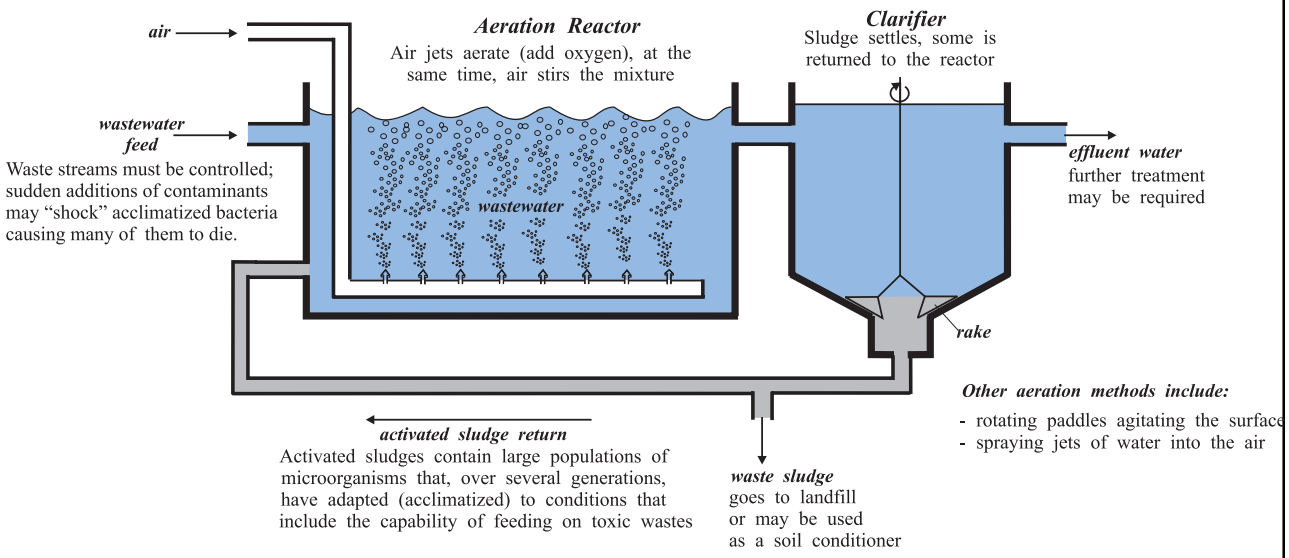
Wetland - Natural treatment occurs as water contacts vegetation, air, plant litter and sediments.

Trickling Filter - Wastewater is sprayed over rocks that are covered with microorganisms; spraying brings the wastewater into contact with air (oxygen) and also with the microorganisms.

Rotating Biological - Large discs on a rotating shaft are mounted in tanks containing waste water; one-half of each disc is out of the water (exposed to air); microorganisms on the rotating discs repeatedly contact air and then the organic substances in the water.

Activated Sludge - Microorganisms, nutrients and air are mixed with organic substances in a tank containing waste water. Over a period of time, several generations of microorganisms are produced. Species that can tolerate specific wastes within a system increase in numbers and consume those wastes.

Activated Sludge System - The Cornerstone of Wastewater Treatment



Eckenfelder, 1989, page 221

Biological Oxidation (Biox) Treatments Break Down Wastes

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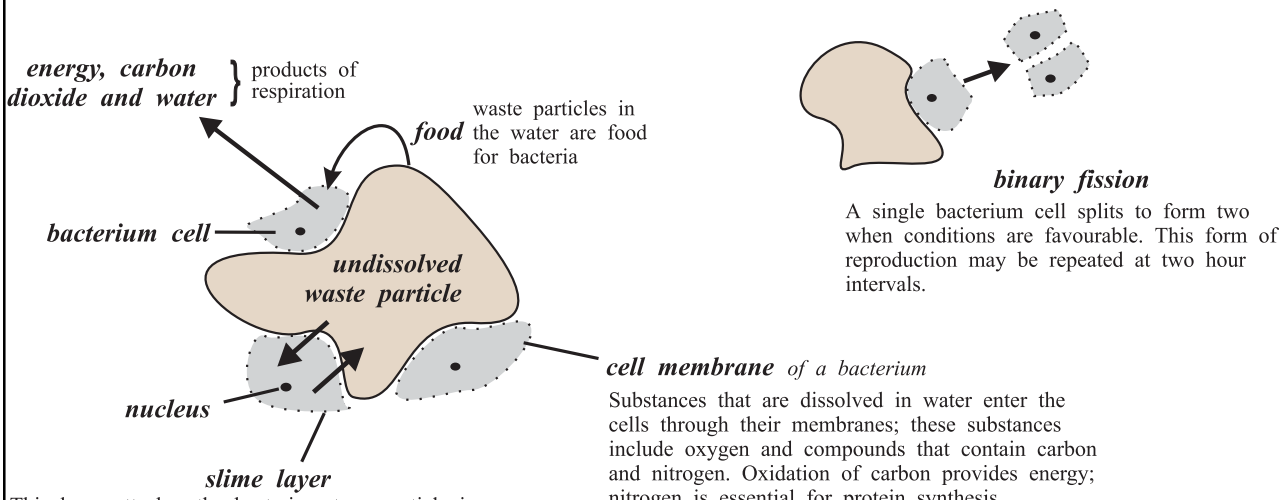
Waste Decomposition - at the Cellular Level



slime layer

This layer attaches the bacterium to a particle in the water; enzymes produced by the bacteria break down the particle, soluble products formed diffuse through the membrane and into the cell.

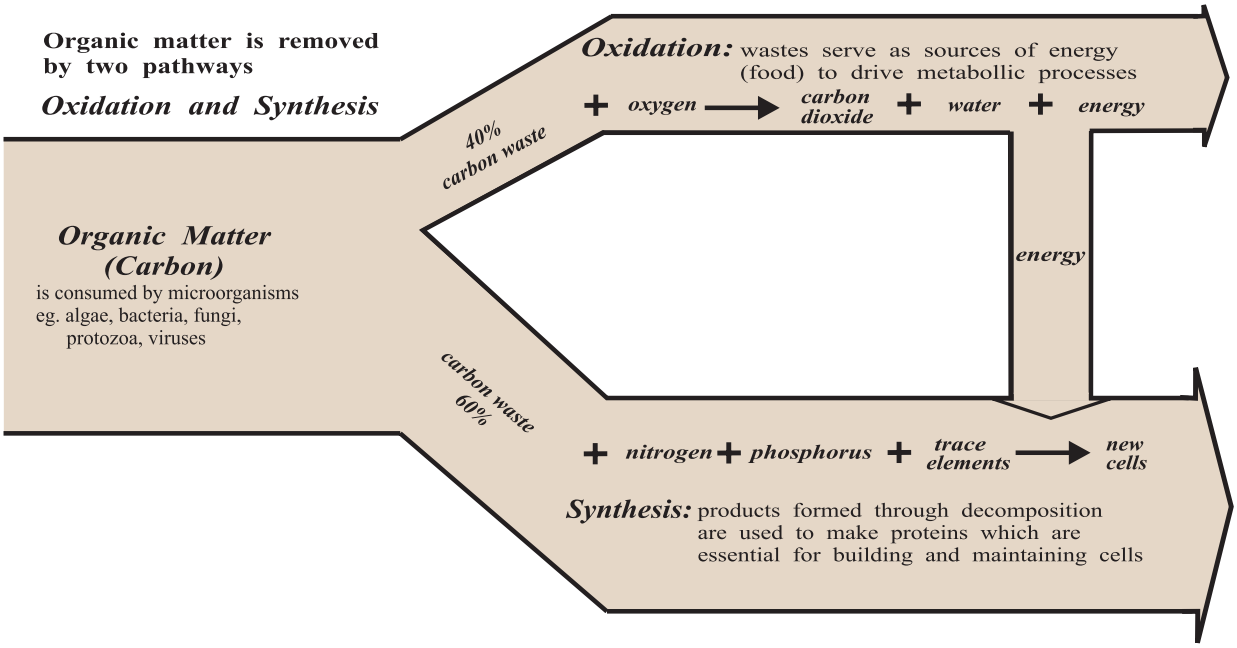
cell membrane *of a bacterium*

Substances that are dissolved in water enter the cells through their membranes; these substances include oxygen and compounds that contain carbon and nitrogen. Oxidation of carbon provides energy; nitrogen is essential for protein synthesis.

binary fission

A single bacterium cell splits to form two when conditions are favourable. This form of reproduction may be repeated at two hour intervals.

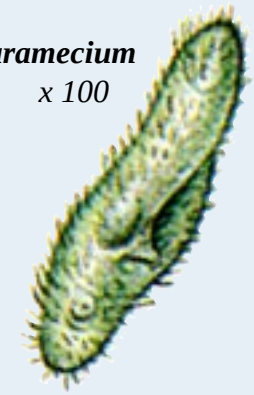
Waste Decomposition - Some Chemistry



Manahan, 1991, page 188

Examples of Important Microorganisms Found in Activated Sludge

Paramecium
x 100

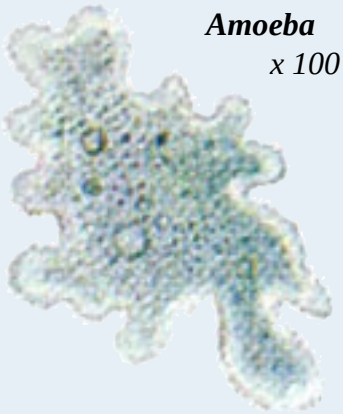


Paramecium
- short hair-like structures (cilia) wave in an undulating fashion, this allows the paramecium to move and also to direct food into a mouth-like opening.

Bacteria
- most obtain their energy from dead plants and animals and thus are the principal agents of decay.

Bacteria
x 1000

Amoeba
x 100



Amoeba
- moves by means of streaming movements and temporary extensions of the cell called pseudopodia. Pseudopodia surround minute food particles.

Conclusion

If conditions are inadequate to maintain healthy populations of microorganisms, potentially harmful wastes may remain in partially treated wastewaters.

Bioaccumulation of harmful substances and their progression up through the food web can result in harmful concentrations in higher forms of life.

Resources

American Chemical Society, Environmental Science & Technology, Feb. 1993

Eckenfelder, W. Wesley 1989, Industrial Water Pollution Control

Lambton College 1992, Refinery Wastewater Effluent Treatment Systems Operations Training Manual

Manahan Stanley, 1991and 2000, Environmental Chemistry

ORTECH 1995 to present, Annual Report, Water Quality Assessment

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** materials from this monograph may be reprinted*

** references available in our resource centre*

** additional copies of this monograph are available from the Sarnia-Lambton Environmental Association or on-line at http:\\www.sarniaenvironment.com*

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