EWCE 105
Environmental Chemistry

Lecture 9

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Lecture Outlines

Topics	Sub-Topics	References
Water Pollution and Pollutants	• Sources of water pollutants • Organic pollution – sources and effects • Elemental pollution – sources and effects of trace elements, heavy metals etc	**1.** Environmental Chemistry Author – Stanley E. Manahan 8th ed., CRC Press **2.** Environmental Engineering Authors: Howard S. Peavy, Donald R. Rowe and George Tchobanoglous McGraw Hill International Edition **3.** Water Pollution – Causes, Effects and Control Author: P. K. Goel New Age International publishers

Water Pollution

- Water pollution may be defined as the presence of impurities in water in such quantities and of such nature as to impair the use of water in a stated purpose.

- Major types of water pollution-

  ✓Surface water pollution

  ✓Ground water pollution

Types of Water Pollution Sources

1. Point sources –

- Entry of pollutants in the environment through single and readily identifiable points.
- Point sources tend to those directly identified as to their origins from human activities.
- Example includes sewage outflow.

2. Non-point sources –

- Pollutants coming from broader areas, relatively difficult to identify
- Usually associated with geosphere
- Example – water contaminated by fertilizer from agricultural land; water polluted by excess alkali leached from alkaline salts

Sources of Water Pollutants

Major sources of water pollutants:

(a) Natural sources – natural entry of pollutants in water bodies may occur through various agencies as follows:

- ✓ Rain water
- ✓ Atmosphere (dust storms, air pollution, volcanic dust, forest fires etc)
- ✓ Surrounding vegetation
- ✓ Underground rocks and volcanoes
- ✓ Natural run-off

Sources of Water Pollution

(b) Anthropogenic (manmade) sources –

- ✓ Mine drainage
- ✓ Municipal/ domestic wastewater
- ✓ Agricultural waste
- ✓ Urban and rural runoff
- ✓ Industrial wastewater

Organic Compounds

- Chemicals that contain carbon atoms
- Natural examples: sugars, amino acids, and oils
- Anthropogenic examples: pesticides, solvents, industrial chemicals, and plastics

Table 22.2 Some Synthetic Organic Compounds Found in Polluted Water

Compound	*Some Reported Health Effects*
Aldicarb (pesticide)	Attacks nervous system
Benzene (solvent)	Associated with blood disorders (bone marrow suppression); leukemia
Carbon tetrachloride (solvent)	Possibly causes cancer; liver damage; may also attack kidneys and vision
Chloroform (solvent)	Possibly causes cancer
Dioxins (TCDD) (chemical contaminants)	Some cause cancer; may harm reproductive, immune, and nervous systems
Ethylene dibromide (EDB) (fumigant)	Probably causes cancer; attacks liver and kidneys
Polychlorinated biphenyls (PCBs) (industrial chemicals)	Attack liver and kidneys; possibly cause cancer
Trichloroethylene (TCE) (solvent)	Probably causes cancer; induces liver cancer in mice
Vinyl chloride (plastics industry)	Causes cancer

Water Pollution by Organic Compounds

- Organic substances can serve as food for living organisms to obtain their energy needs and cell synthesis.

- These are mainly of two following types:

(a) Biodegradable organic matter –

✓ Basic organics, like carbohydrate, lipid, protein etc (most abundant in nature), which are readily utilized by microorganisms as their energy source and of major concern in water quality control

✓ ranging from simple hydrocarbons to complex biomolecules

Organic Water Pollution

(b) Non-biodegradable organic matter –

- ✓ Synthetic compounds, which are biologically inert to degradation

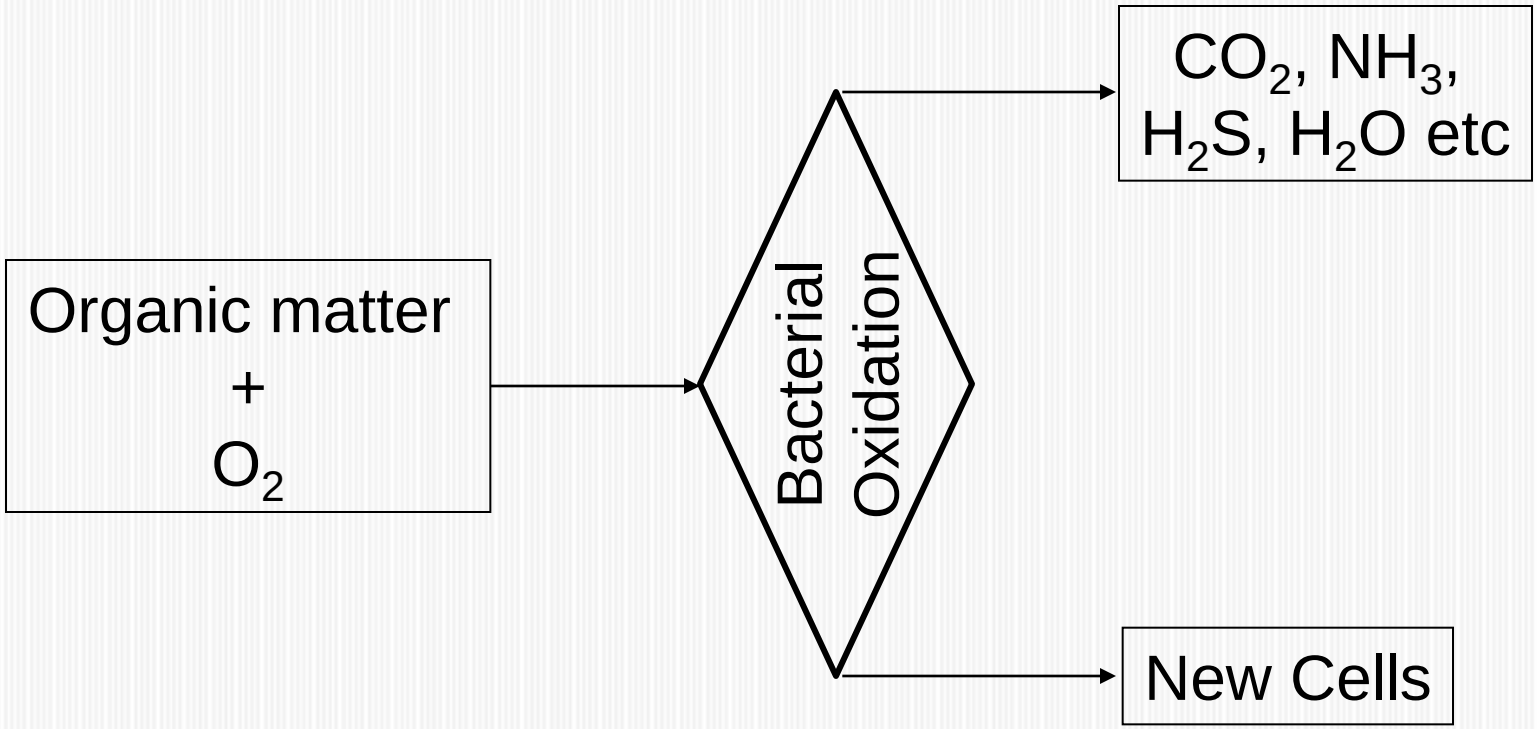
- ✓ Example includes detergents, pesticides, PCBs etc

Sources of Organic Matter in Water

- Disposal of municipal sewage (mainly of human excreta and other household organic wastes)
- Industrial wastewater (from food processing, dairy, paper and pulp, sugar, tanneries, textiles etc)
- Urban and rural runoff
- Detritus

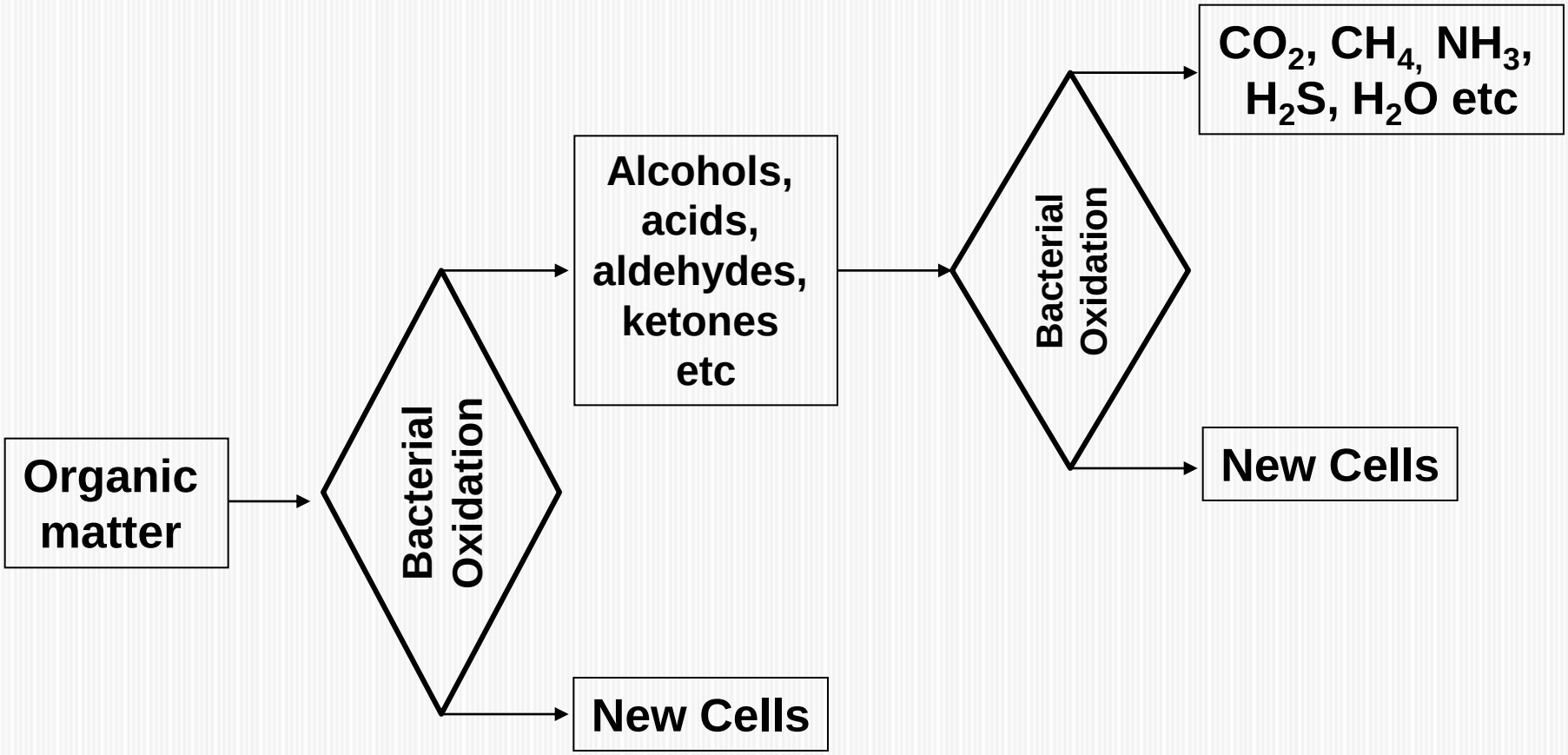
Degradation of Organic Matter

(a) Aerobic decomposition/ oxidation



Degradation of Organic Matter

(b) Anaerobic decomposition/ digestion



Major Effects of Organic Pollution in Water

- **Aesthetic effects –**

✓ Accumulation of degradation products in water, like H_2S

✓ Produce odors and disagreeable taste

- **Effect on O_2 balance in water–**

✓ Degradation of organic matter causes depletion of O_2 from water.

✓ O_2 depletion adversely affect the aquatic life.

Major Effects of Organic Pollution in Water

- **Eutrophication–**

✓ Excessive algal growth due to nutrient enrichment

✓ Causes increase in turbidity and decrease in dissolved O_2 concentration

Parameters for Measuring Organic Pollution

1. Biochemical Oxygen Demand (BOD) –

- ✓ The respiratory demand for O_2 exerted by microorganisms, while stabilizing the organic matter under aerobic condition is called BOD.
- ✓ Oxidation is carried out by bacteria.

2. Chemical Oxygen Demand (COD) –

- ✓ Total O_2 demand by organic material present in the water sample.
- ✓ Oxidation is carried out by strong oxidizing agents.

Parameters for Measuring Organic Pollution

3. Dissolved Oxygen (DO)

4. Total Oxygen Demand (TOD)

5.Organic carbon

6. Ammonical Nitrogen

7.Total Organic Phosphorus

8. Biological Indices (Algal index, Diversity index, Species deficit index etc)

Elemental Pollution in Water

Trace element –

- refers to elements occurring at very low levels of a few parts per million (ppm) or less in a given system.

- Example: As, Be, B, Cr, Cu, Fe, Pb, Mn, Mb, Hg, Se, Zn etc.

Heavy metals

- causes toxicities to humans

- Includes essential elements, like Fe

- Includes toxic elements, like Cd and Hg

- Having strong affinity for S and disrupt enzyme function by forming bonds with S-groups in enzymes.

Elemental Pollution

Important trace elements in water and wastewater:

Element	Sources	Effects and significance
Arsenic (As)	Mining by-product, chemical waste	Toxic (possibly carcinogenic)
Chromium (Cr)	Metal plating, tanning industries	Cr(III) as essential, Cr (VI) as toxic
Copper (Cu)	Metal plating, mining, industrial wastes	Toxic to waste plants and algae at higher levels
Iron (Fe)	Industrial waste, corrosion, acid mine water, microbial action	Essential nutrient, damages fixtures by staining

Elemental Pollution

Important trace elements in water and wastewater:

Element	Sources	Effects and significance
Lead (Pb)	Industrial wastes, mining, fuels	Toxic, harmful to wildlife.
Manganese (Mn)	Industrial waste, acid mine water, microbial action	Toxic to plants, damages fixtures by staining
Mercury (Hg)	Industrial wastes, mining, coal	Toxic, mobilized by anaerobic bacteria
Zinc (Zn)	Industrial waste, metal plating, plumbing	Essential element, Toxic to plants at higher levels