

جلسه ۵:

پارامترهای شیمیایی و فیزیکی (۳)

درس: مهندسی تصفیه آب و فاضلاب

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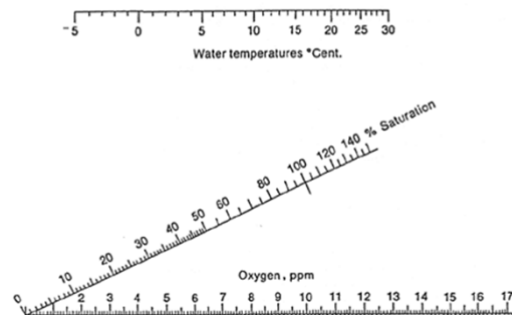
Dissolved oxygen

- Although each water molecule contains one oxygen atom, this oxygen is not what is needed by aquatic organisms living in natural waters.
- A small amount of oxygen, up to about ten molecules of oxygen per million of water, is actually dissolved in water. This dissolved oxygen is breathed by fish and shrimp and is needed by them to survive.
- Rapidly moving water, such as in a mountain stream or large river, tends to contain a lot of dissolved oxygen, whereas stagnant water contains less.

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DO nomogram

calibrated for fresh water @ sea level



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Dissolved oxygen

- Bacteria in water can consume oxygen. Since the presence of nutrients and the organic matter acts as food and increase bacteria growth, “eutrophic” conditions may form, which is an oxygen-deficient situation that can cause a water body “to die.”
- Aquatic life can have a hard time in stagnant water that has a lot of rotting, organic material in it, especially in summer when dissolved-oxygen levels are at a seasonal low (because the concentration of dissolved oxygen is inversely related to water temperature).

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Summertime fish kill

Video clip inserted

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Algae

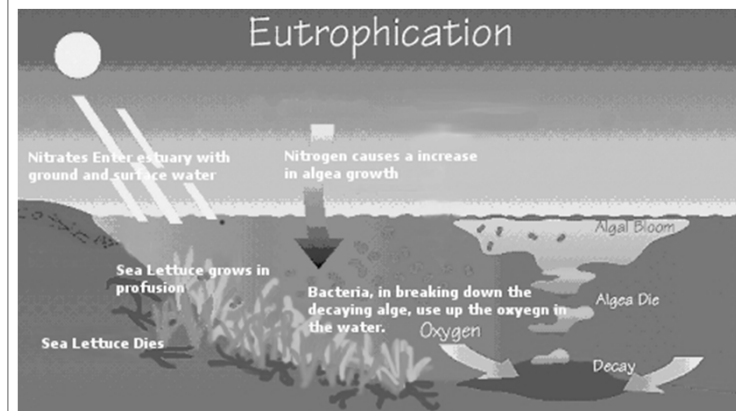
- Algae produce oxygen by photosynthesis during the day. In darkness they consume oxygen. Normally much more is produced than consumed.
- When the nutrients in the water are finished, the algae die. The resulting bacterial decomposition and loss of oxygen production can lead to oxygen depletion.
- Also, when a dense bloom produces a surplus of oxygen on a summer afternoon, much of the oxygen escapes into the atmosphere. During the night, the bloom attempts to take more oxygen out of the water than what remains from daytime photosynthesis.

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Algal bloom documentary



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noun: eutrophication

excessive richness of nutrients in a lake or other body of water, frequently due to runoff from the land, which causes a dense growth of plant life and death of animal life from lack of oxygen.

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Nutrients in water: Nitrogen

- In aquatic ecosystems, nitrogen and phosphorus are the most important chemical elements that are essential to the growth and survival of living organisms.
- Nitrogen is essential to all life. Nitrogen can go through many complex chemical and biological changes in a continuing cycle called the nitrogen cycle. Nitrogen is present in natural waters in different forms as nitrate (NO_3^-), nitrite (NO_2^-), and ammonia (NH_3).
- Organic Nitrogen can be in the form of a living organism, or in the intermediate products of organic matter decomposition. It usually occurs in only very small concentrations in most waters.

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Nutrients in water: Nitrogen

- Ammonia is a toxic pollutant (NH_3), but the dose needs to be high to harm humans (rare in drinking water).
- Nitrate (NO_3^-) is less toxic to people than ammonia or nitrite and the primary health hazard from drinking water with nitrate occurs when nitrate is transformed to nitrite in the digestive system (especially in infants).
- Septic tanks, animal feedlots, and fertilizer use may be the source of high levels of nitrate.
- Nitrite (NO_2^-) is extremely toxic. Fortunately, since it is rapidly oxidized to nitrate it is usually present only in trace amounts in aerobic freshwater systems.

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Total Kjeldahl Nitrogen (TKN)

$$\text{Total Nitrogen} = \text{TKN} + (\text{Nitrate} + \text{Nitrite})$$

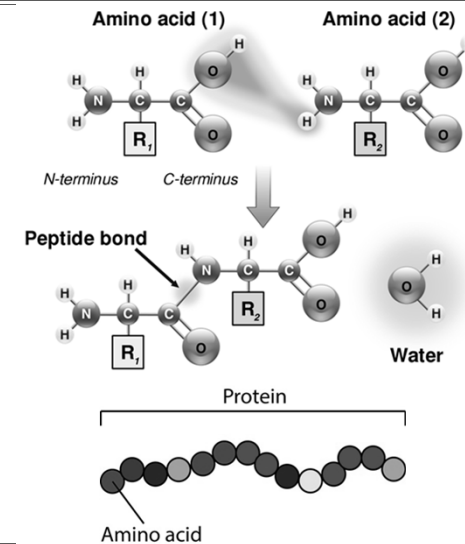
$$\text{Total Organic Nitrogen} = \text{TKN} - \text{Total Ammonia}$$

$$\text{Total Inorganic Nitrogen} = (\text{Nitrate} + \text{Nitrite}) + \text{Total Ammonia}$$

$$\text{TKN} = \text{Total Organic Nitrogen} + \text{Total Ammonia}$$

- TKN is a widespread method for determining protein content in food. But it can have errors, as it measures nonprotein nitrogen as well. This is evidenced by the 2007 pet food incident nitrogen-rich chemicals were added to raw materials to fake high protein contents.

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Nitrogen and Phosphorous cycles

Video clip inserted

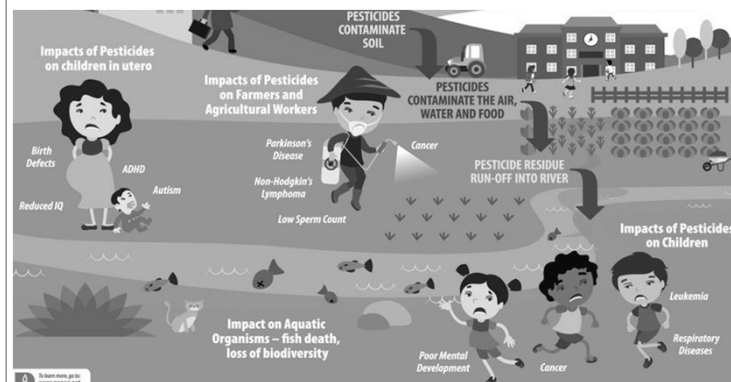
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Pesticides

- Pesticides are chemicals used to kill or control pests. This can include herbicides (weeds), insecticides (insects), fungicides (fungi), etc.
- Farm workers have special risks associated with inhalation and skin contact during preparation and application of pesticides to crops.
- However, for the majority of the population, a principal vector is through ingestion of food that is contaminated by pesticides. Water contaminated with pesticide runoff can affect humans directly (consumption) or indirectly (consumption by fish and accumulation in the food chain).

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Pesticides



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Heavy metals

- The term heavy metal refers to any metallic chemical element that has a relatively high density and is toxic and/or carcinogenic at low concentrations.
- Heavy metals can not be degraded or destroyed!

Disorders Linked to Heavy Metal Toxicity

Attention Deficit Disorder	Parkinson's disease	Asthma
Autism Spectrum disorders	Thyroid disorders	Arthritis
Auto-immune disorders	Multiple Sclerosis	Candidiasis
Chronic Fatigue Syndrome	Kidney disease	Epilepsy
Lou Gehrig's disease (ALS)	Schizophrenia	Fibromyalgia
Gulf War Syndrome	Hypertension	Insomnia
Alzheimer's disease	Liver disease	Infertility

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5 heavy metals in drinking water

- 1. Arsenic Provisional guideline value 0.01 mg/l (10 µg/l)
- 2. Cadmium Guideline value 0.003 mg/l (3 µg/l)
- 3. Chromium Provisional guideline value *Total chromium*: 0.05 mg/l (50 µg/l)
- 4. Lead Provisional guideline value 0.01 mg/l (10 µg/l)
- 5. Mercury Guideline value 0.006 mg/l (6 µg/l) for inorganic mercury

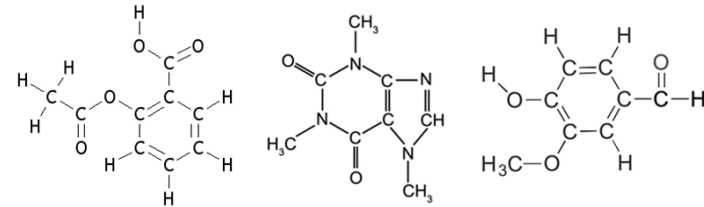
- For comparison

Pesticides previously used for public health purposes	Guideline value	
	µg/l	mg/l
DDT and metabolites	1	0.001

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Organic pollution

- There is an infinite number of combinations of organic molecules which makes their individual identification time consuming and difficult. Therefore some methods are required to make general judgement regarding organic pollutants.



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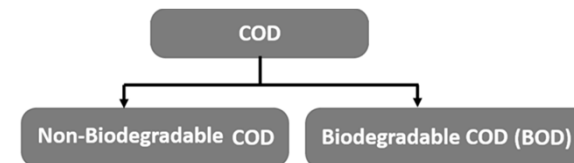
Biochemical Oxygen Demand (BOD)

- BOD is a measure of the amount of oxygen that bacteria will consume while decomposing organic matter under aerobic conditions. This can give a general understanding of the amount of compounds present.
- Biochemical oxygen demand is determined by incubating a sealed sample of water for a specific duration (e.g. BOD₅) and measuring the loss of oxygen from the beginning to the end of the test.
- Samples often must be diluted prior to incubation or the bacteria will prematurely deplete all of the oxygen in the bottle before the test is complete.

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Chemical Oxygen Demand (COD)

- Since there are many compounds which are hard or not possible to decompose biologically, a parameter has been defined indicating the amount of oxygen needed to oxidize all compounds completely.
- COD measurements can be made in a few hours while BOD measurements take (at least) five days.
- COD values are always greater than BOD values.

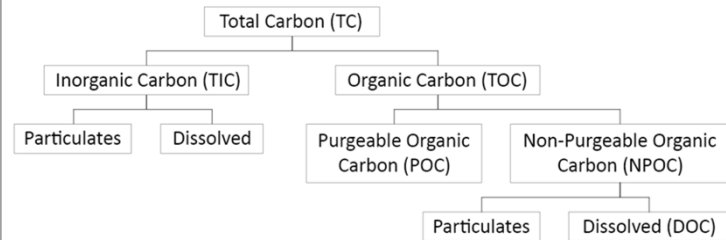


Total Organic Carbon (TOC)

- TOC is another parameter that can give a general view of water quality. It is a measure of carbon in organic molecules, thus excluding inorganic carbon, literally carbon dioxide dissolved in water and its dissolved species (bicarbonate, carbonate, etc.).
- Purgeable carbon is organic carbon that can be removed from a sample by purging with an inert gas. This is also sometimes called Volatile Organic Carbon (VOC) which is not an exact definition. For example The EU defines a VOC as any organic compound with an initial boiling point less than 250°C

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Total Organic Carbon



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