جلسه ۴:

پارامترهای شیمیایی و فیزیکی (۲)

درس: مهندسی تصفیه آب و فاضلاب

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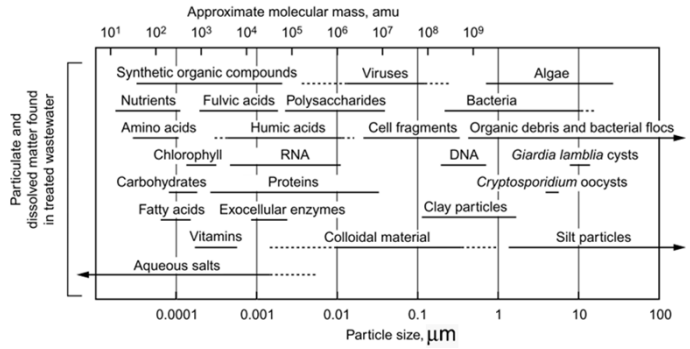
Particulate Matter (PM) in water

- (1) increases turbidity
- (2) can cause disease (pathogens)
- (3) impacts disinfection by shielding organisms
- (4) can clog sprinklers and drip irrigation tubing
- (5) can become a carrier of absorbed toxic constituents
- (6) can block sunlight thereby reducing photosynthesis by aquatic plants and thus reducing dissolved oxygen. The plants could die, decompose, cause bad smells etc.
- (7) can cause an increase in surface water temp by absorbing heat from sunlight

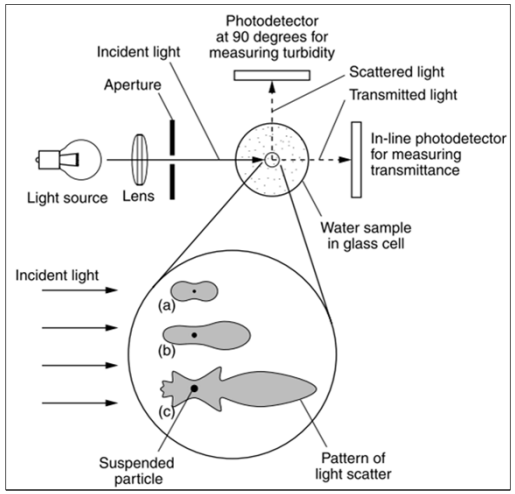
Size



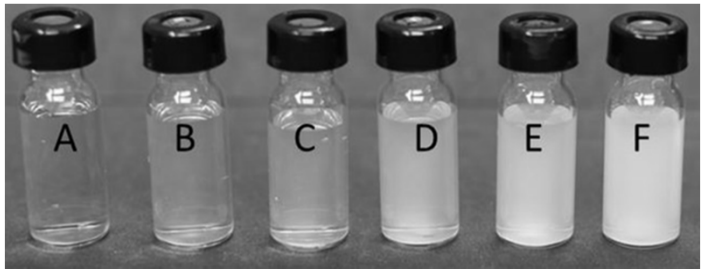
Turbidity

Nephelometric Turbidity Unit (NTU) and Formazin Neph. Unit (FNU) are common.

* The Jackson Turbidity Unit (JTU) is old.



Turbidity



0 NTU 50 NTU 100 NTU 250 NTU 500 NTU 1000 NTU

Turbidity issues

- Some particles might block others. Also, light reflected from different parts of a particle can create interference.
- Some particles will adsorb most of the light, and only scatter a minimal amount
- Intensity of the scattered light varies with the wavelength of the incident light. So, turbidity measurements tend to be more sensitive to particles in the size range of the incident light wavelength (0.3 to 0.7 um for visible light).
- Wastewater samples with nearly identical turbidity values could have very different particle size distributions.

TSS and NTU relationship?

Filter effluent

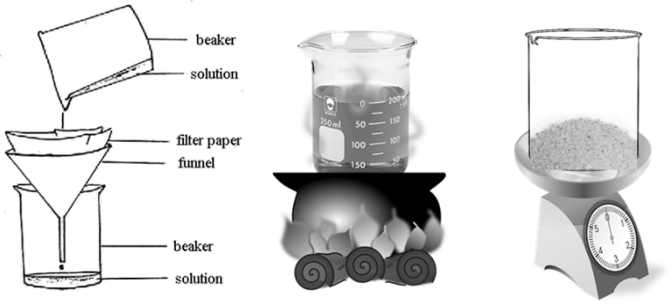
$$\text{TSS, mg/L} = (1.3 \text{ to } 1.6) \times (\text{turbidity, NTU})$$

Settled secondary effluent

$$\text{TSS, mg/L} = (2.0 \text{ to } 2.4) \times (\text{turbidity, NTU})$$

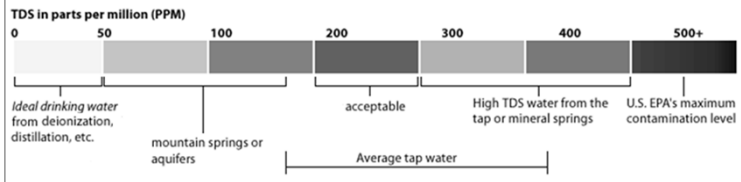
Settleable solids

Total dissolved solids



TDS limits

- The WHO is more lenient, stating that TDS<600 mg/L is good and TDS<1000 mg/L is acceptable.
- As per the US EPA:



What are salts?

Salinity

- Salinity affects dissolved oxygen solubility in water body. In high salinity levels, dissolved oxygen concentration lowers. That's why sea water has a lower dissolved oxygen concentration than freshwater sources.
- Salinity influences organisms that can live in that area. In general, aquatic organisms can tolerate a specific salinity range.
- Salinity also affects water density. One of the driving forces behind ocean circulation is the increase in density with salt levels.

Dissolved oxygen vs. Salinity

- The values in the table are the saturated concentration of dissolved oxygen, mg/L

Temp °C	Salinity (parts per thousand)				
	10	20	30	40	50
0	14.6	13.6	12.7	11.9	11.1
20	9.1	8.6	8.1	7.6	7.2
25	8.2	7.8	7.4	7.0	6.6

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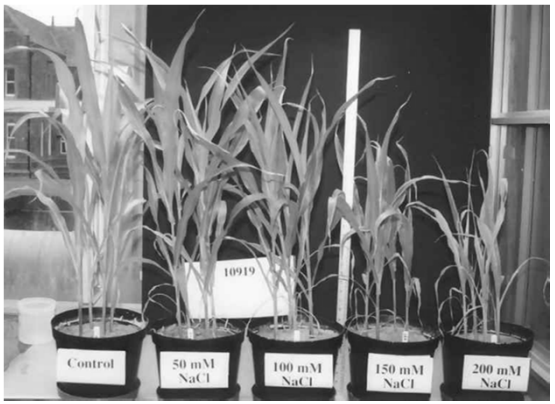
Salinity tolerance



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Conductivity

- Conductivity is a measure of water's capability to pass electrical flow. This is related to the ion concentrations in the water (electrolytes).
- The more ions present in water, the higher the conductivity. Therefore, we can say that sea water has a very high conductivity.
- The standard is to report conductivity at 25°C, since the higher the water temperature, the higher the conductivity level will be.
- Conductivity is usually reported in micro- or millisiemens per centimeter (uS/cm or mS/cm).

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Calculation of TDS

$$TDS = K * EC_{25}$$

$$EC_{25} = EC_t[1 + 0.022(25 - t)]$$

Water type	Typical EC_{25} (μS/cm)	K factor
Distillate	1–10	0.50
RO permeate	300–800	0.55
Seawater	45,000–60,000	0.70
Reject brines	65,000–85,000	0.75

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Homework

- Assuming we have a water sample for which conductivity measurements show 60,000 uS/cm, what is the estimated total dissolved solids content?
- Assume the temperature of the water sample to be the last 2 digits of your student number.

Ionic strength

- Ionic compounds, when dissolved in water, dissociate into ions. The total electrolyte concentration in solution will affect important properties such as the solubility of different salts.

$$I = \frac{1}{2}\sum_{i=1}^{n} c_i z_i^2$$

- where one half is because we are including both cations and anions, c_i is the molar concentration of ion i (M, mol/L), z_i is the charge number of that ion, and the sum is taken over all ions in the solution.

Ionic strength

- For a 1:1 electrolyte such as NaCl, where each ion is singly-charged, the ionic strength is equal to the concentration.
- For the electrolyte MgSO4, however, each ion is doubly-charged, leading to an ionic strength that is four times higher than an equivalent concentration of sodium chloride. Generally multivalent ions contribute strongly to the ionic strength.
- **Homework:** what is the ionic strength of a solution containing 0.0X M of Na_2SO_4 and 0.02 M of KCl? Assume X to be the last digit of your student number.

Total solids