EWC 105
Environmental Chemistry

Lecture 11

Instructor
Maj Kazi Shamima Akter, Ph.D, Engrs
Department of EWCE, MIST

Lecture Outlines

Topics	Sub-Topics	References
Water Quality Monitoring	• Water quality parameters • Water quality standards • Elemental pollution – sources and effects of trace elements, heavy metals etc • Sources and impacts of acidity, alkalinity and salinity in water	**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 Quality Parameters

1. Physical water quality parameters
2. Chemical water quality parameters
3. Biological water quality parameters

Physical Water Quality Parameters

1. Suspended Solids (SS)

- Source –
  - ✓ inorganic solids, such as clay, silt, other soil constituents;
  - ✓ organic materials, like plant fibers and biological solids (algal cells, bacteria etc)
  - ✓ suspended solids from domestic and industrial wastewater

- Impacts –
  - ✓ Aesthetically objectionable
  - ✓ Biological degradation of organic solid cause objectionable by products

- Unit of measurement – mg/L

Physical Water Quality Parameters

2. Turbidity

- Source –
  - ✓ erosion of colloidal material such as clay, silt, rock fragments, metal oxides;
  - ✓ vegetable fibers, microorganisms
  - ✓ domestic and industrial material, like soap, detergents, emulsifying agents

- Impacts –
  - ✓Aesthetically objectionable
  - ✓ May interfere with light penetration and photosynthetic reactions in streams and lakes

- Unit of measurement – JTU (Jackson Turbidity unit), NTU (Nephelometry Turbidity Unit)

Physical Water Quality Parameters

3. Color

- Source –
  - ✓ organic debries such as leaves, weeds, tannins, humic acid, humates etc
  - ✓ iron oxide cause reddish color, manganese causes brown or blackish water
  - ✓ industrial dyeing

- Impacts –
  - ✓Aesthetically not acceptable
  - ✓ not acceptable in laundry and other industral process

- Unit of measurement – TCU (True Color unit)

Physical Water Quality Parameters

4. Taste and Odor

- Source –
  - ✓ minerals, metals, salts originated from soil, end products from biological reactions and constituents of wastewater.
  - ✓ Inorganic material produce taste only; alkaline matter imparts bitter taste while metallic salts give salty/ bitter taste
  - ✓ organic matters produce bad taste and odor

- Impacts –
  - ✓Aesthetically displeasing
  - ✓ some of these materials may be carcinogenic

- Unit of measurement – TON (Threshold Odor Number)

Physical Water Quality Parameters

5. Temperature

- Source –

✓ ambient/ atmospheric temperature

✓cooling water used in industrial process and discharged to water bodies

- Impacts –

✓Increased biological activity in elevated temperature cause depletion of dissolved O_2 in water

✓ Solubility of O_2 in water decreases with increased temperature

- Unit of measurement – ° C (degree Celsius)

Chemical Water Quality Parameters

1. Total Dissolved Solids (TDS)

- Source –
  - ✓ results from solvent action of water on solid, liquid and gas.
  - ✓ inorganics – minerals, metals, gas
  - ✓ organics – decay of vegetation, organic chemicals, organic gas

- Impacts –
  - ✓Cause color, taste and odor
  - ✓ some chemicals may be toxic

- Unit of measurement – mg/L

Chemical Water Quality Parameters

2. Alkalinity

- Source –

  ✓ CO_3^{2-}, HCO_3^-, OH^-, $HSiO_3^-$, $H_2BO_3^-$, HPO_4^{2-}, HS^-, NH_3, from dissolution of minerals in soil and atmosphere.

  ✓ HPO_4^{2-} from detergents, fertilizers, insecticides

- Impacts –

  ✓Bitter taste and odor

  ✓ precipitates cause fouling in pipes and appurtenances

- Unit of measurement – mg/L as $CaCO_3$

Chemical Water Quality Parameters

3. Hardness

- Source –

  ✓ multivalent metallic ions abundant in natural waters are Ca^{2+} and Mg^{2+}.

  ✓ also includes Fe^{2+}, Mn^{2+}, Sr^{2+}, Al^{3+} etc

- Impacts –

  ✓Soap consumption by hard water represents an economic loss to water users

  ✓ precipitates cause scaling in boilers using hard water

- Unit of measurement – mg/L as $CaCO_3$

Chemical Water Quality Parameters

3. Fluoride

4. Metals – non-toxic and toxic

5. Organics – biodegradable and non-biodegradable

6. Nutrients – N, P

Biological Water Quality Parameters

1. Pathogens

- Bacteria, virus, protozoa, helminths
- Pathogen indicators – Total Coliform (TC), Faecal Coliform (FC)

- Impacts –
  - ✓Cause infections
  - ✓ Transmit dieseases

- Unit of measurement – MPN (Most Probable Number)

Drinking Water Quality Standards (WHO)

Table 2-9 Drinking-water standards of the World Health Organization

Chemical constituent	Concentrations in milligrams per liter				
	WHO International (1958)			WHO European (1961)	
	Permissible limit	Excessive limit	Maximum limit	Recommended limit	Tolerance limit
Ammonia (NH_4)	—	—	—	0.5	—
As — Arsenic	—	—	0.2	—	0.2
Cadmium	—	—	—	—	0.05
Calcium	75	200	—	—	—
Chloride	200	600	—	350	—
Chromium (hexavalent)	—	—	0.05	—	0.05
Copper	1.0	1.5	—	3.0*	—
Cyanide	—	—	0.01	—	0.01
Fluoride	—	—	—	1.5	—
Fe — Iron	0.3	1.0	—	0.1	—
Pb — Lead	—	—	0.1	—	0.1
Magnesium	50	150	—	125†	—
Magnesium + sodium sulfates	500	1000	—	—	—
Manganese	0.1	0.5	—	0.1	—
Nitrate (as NO_3)	—	—	—	50	—
DO — Oxygen, dissolved (minimum)	—	—	—	5.0	—
Phenolic compounds (as phenols)	0.001	0.002	—	0.001	—
Selenium	—	—	0.05	—	0.05
Sulfate	200	400	—	250	—
TS — Total solids	500	1500	—	—	—
Zn — Zinc	5.0	15	—	5.0	—

* After 16 h contact with new pipes; but water entering a distribution system should have less than 0.05 mg/L of copper.

† If there is 250 mg/L of sulfate present, magnesium should not exceed 30 mg/L.

Source: Adapted from Todd. [2-17]

Water Quality Standards (Bangladesh)

Table 17.6: Bangladesh water quality standards for surface water for water supply

		Values for water supply by	
Water quality parameters	Unit	Disinfection only	Conventional treatment
PH	--	6.5 – 8.5	6.5 – 8.5
Biochemical oxygen demand	mg/l	2 or less	3 or less
Dissolved oxygen	mg/l	6 or more	6 or more
Total coliform	number/100ml	50 or less	5,000 or less

Water Quality Standards (Bangladesh)

Table 17.7: Drinking water standards

Water quality parameters	Unit	Bangladesh standards	WHO guideline values, 1993
1. Aluminum	mg/l	0.2	0.2
Ammonia (NH_3)	mg/l	0.5	.5
Arsenic	mg/l	0.05	.01
Barium	mg/l	0.01	0.7
e	mg/l	0.01	.01
°C	mg/l	0.2	
	mg/l	1.0	0.3
8. Cadmium	mg/l	0.005	0.003
Calcium	mg/l	75	
Chloride	mg/l	150-60	
Chlorinated alkenes			
Carbon tetrachloride	mg/l	0.01	.002
1,1 Dichloroethylene	mg/l	0.001	
1,2 Dichloroethane	mg/l	0.03	0.03
Tetrachloroehylene	mg/l	0.03	
Trichloroethylene	mg/l	0.09	
12. Chlorinated phenols			
Pentachlorophenol	mg/l	0.03	
henol	mg/l	0.03	0.02
ual)	mg/l	0.2	0.6-1.0
	mg/l	0.09	0.2
15. Chromium (hexavalent)	mg/l	0.05	
16. Chromium (total)	mg/l	0.05	
Chemical oxygen demand)	mg/l	4	
Coliform (faecal)	N/100ml	0	
Coliform (total)	N/100ml	0	
Colour	Hazen Unit	15	
per	mg/l	1	
nide	mg/l	0.1	
Detergents	mg/l	0.2	
Dissolved oxygen	mg/l	6	
Fluoride	mg/l	1	
	mg/l	200-500	

As

0.05 mg/L

BOD_5 20°C

0.2 mg/L

Cl^-

150 – 600 mg/L

Cl (residual)

0.2mg/L

FC

0 N/ 100 mL

TC

0 N/ 100 mL

Color

15 Hazen Unit

DO

6 mg/L

Hardness as $CaCO_3$

200 – 500 mg/L

Water Quality Standards

Table 17.7: Drinking water standards

27.	Iron	mg/l	0.3-1.0	0.3
28.	Kjehldal nitrogen (total)	mg/l	1	
29.	Lead	mg/l	0.05	0.01
30.	Magnesium	mg/l	30-35	
31.	Manganese	mg/l	0.1	0.1
32.	Mercury	mg/l	0.001	0.001
33.	Nickel	mg/l	0.1	0.02
34.	Nitrate	mg/l	10	50
35.	Nitrite	mg/l	<1	3
36.	Odour	mg/l	Odourless	
	Oil and grease	mg/l	0.01	
	pH	–	6.5-8.5	
	Phenolic compounds	mg/l	0.002	
40.	Phosphate	mg/l	6	
41.	Phosphorus	mg/l	0	
42.	Potassium	mg/l	12	
43.	Radioactive substances			
	Total alfa radiation	Bq/l	0.01	
	Total beta radiation	Bq/l	0.1	
44.	Selenium	mg/l	0.01	0.01
45.	Silver	mg/l	0.02	
	Sodium	mg/l	200	200
	Suspended solids	mg/l	10	
	Sulphide	mg/l	0	
	Sulphate	mg/l	400	250
	Total dissolved solids	mg/l	1000	1000
	Temperature	°C	20-30	
	Tin	mg/l	2	
53.	Turbidity	JTU	10	5
	Zinc	mg/l	5	3

pH — 6.5 – 8.5

TSS — 10 mg/L

TDS — 1000 mg/L

Temp — 20 – 30 °C

Turbidity — 10 JTU

* for Coastal Areas of Bangladesh, in case of non-availability of alternative sources value is 1000.

Water Quality Standards (Bangladesh)

Source: Bangladesh Environment Conservation Act, 1997

(A) Standards for inland surface water

Best Practice based classification	Parameter			
	pH	BOD mg/l	DO mg/l	Total Coliform number/100
a. Source of drinking water for supply only after disinfecting:	6.5-8.5	2 or less	6 or above	50 or less
b. Water usable for recreational activity :	6.5 – 8.5	3 or less	5 of more	200 or less
c. Source of drinking water for supply after conventional treatment :	6.5 – 8.5	6 of less	6 or more	5000 or less
d. Water usable by fisheries:	6.5 – 8.5	6 of less	5 or more	---
e. Water usable by various process and cooling industries :	6.5 – 8.5	10 or less	5 or more	5000 or less
f. Water usable for irrigation:	6.5 – 8.5	10 or less	5 or more	1000 or less

Notes:

1. In water used for pisiculture, maximum limit of presence of ammonia as Nitrogen is 1.2 mg/l.
2. Electrical conductivity for irrigation water – 2250 µmhoms/cm (at a temperature of 25°C); Sodium less than 26%; boron less than 0.2%.

Water Quality Standards (Bangladesh)

Source: Bangladesh Environment Conservation Act, 1997

Standards for Sewage Discharge

Parameter	Unit	Standard Limit
BOD	miligram/l	40
Nitrate	„	250
Phosphate	„	35
Suspended Solids (SS)	„	100
Temperature	Degree Centigrade	30
Coliform	number per 100 ml	1000

Notes :

(1) This limit shall be applicable to discharges into surface and inland waters bodies.

(2) Sewage shall be chlorinated before final discharge.