NEC license Exam Preparation

Chapter 6: Water Supply, Sanitation and Environment

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Chapter Outline

6.1 Water sources, water quality and water demand:

- sources of water (surface and groundwater) and their selection;
- impurities in water (suspended, colloidal, dissolved);
- hardness and alkalinity;
- living organisms in water;
- water-related diseases and prevention measures;
- drinking water quality standards;
- water demand estimation.

Average daily water consumption:

- It is based on complete one year supply of water.
- It is the total consumption during one year, divided by the population.

Base period and design period

- For, water supply system, base period is 2-3 years.

- *Design period;*

  Rural:15-20 yrs

  Urban: up to 30 yrs.

Variations in Water Demand

1. Seasonal variation
   - Generally neglected for Nepal.
   - So, seasonal peak factor =1

2. Daily variations
   - Daily peak factor for Nepal= 1.1.
   - Maximum Daily demand = 1 * Average Daily Demand

3. Hourly variation
   - Hourly peak factor for Nepal is 3.
   - Maximum hourly consumption = 3 * avg. hourly demand

*Overall peak factor= seasonal*daily*hourly peak factor*

India
- Seasonal variation= 1.4
- Daily variation= 1.8
- Hourly variation=1.5

Transmission system is designed for
a) Average flow
b) Peak flow
c) Both
d) none

In Nepal,
- P.F= 2-4 for continuous system & 4-6 for intermittent system.

Hardness and Alkalinity

Hardness:

- Hardness is the characteristics of water due to which sufficient lather is not formed with soap.
- It is due to the presence of bicarbonates, sulphates, chlorides and nitrates of calcium, magnesium, and strontium.

Types of hardness:

1. Temporary hardness: Due to bicarbonates of calcium, magnesium and strontium. It is also known as carbonate hardness.

2. Permanent hardness: Due to sulphates, chlorides, and nitrates of calcium, magnesium and strontium. It is also known as non-carbonate hardness.

- Total Hardness = CH + NCH.

Determination of hardness:

- Hardness in mg/l as CaCO3 = ion concentration in mg/l $* \frac{\text{Equivalent wt of CaCO3}}{\text{Eq wt of ion}}$

Note:

Equivalent wt of CaCO3, Ca++, Mg++ and Sr++ are 50, 20, 12 and 43.8 respectively.

Q.

For a water sample, Ca++ =65 ppm& Mg+ =51 ppm, then total hardness in terms of CaCO3 is?

Q. Pseudo-hardness in water is caused due to?

a) calcium
b) Strontium
c) Chlorine
d) sodium

Q. One degree of hardness of water means a content of salts of

a) 10.3 mg/litre
b) 12.3 mg/litre
c) 14.3 mg/litre
d) 16.3 mg/litre.

- *As per Clarke's one grains of CaCO3 dissolved in one gallon of water will produce 1o of hardness. ∴ 1o of hardness will be equivalent to 64.8/4.546 = 14.254 mg/litres of CaCO3.*
- *1 grain=64.8 mg & 1 gallon=4.55 litre*

Alkalinity:

- Capacity to neutralize a standard solution of acid.
- Waste water is normally alkaline in nature.
- Three species are responsible for alkalinity:

HCO3 -, CO3 – and OH-

- The major form of alkalinity is the bicarbonate alkalinity.
- HCO3- and OH- do not exist together.

Total alkalinity = Carbonate alkalinity + Bicarbonate alkalinity

OR,

Total alkalinity = Carbonate alkalinity + Hydroxide alkalinity

Determination of alkalinity:

- Carbonate alkalinity in mg/l as $CaCO_3$ = CO_3-- concentration/0.6
- Bicarbonate alkalinity in mg/l as $CaCO_3$ = HCO_3 - concentration/1.22
- Hydroxide alkalinity in mg/l as $CaCO_3$ = OH^- concentration/0.34

Relation between Hardness and alkalinity:

- When Alkalinity < TH,

  CH = Alkalinity

  &

  NCH = TH – CH

- When, Alkalinity >= TH

  CH = TH & NCH = 0

Which is not unit of hardness

a) Ppm
b) Degree centigrade
c) Degree clark
d) Degree French

1 ° F (French degree)= 10 mg/l of calcium carbonate

Q. If TH& TA of water sample are: 300 ppm and 100 ppm, CH and NCH are:

a) 100,200 ppm
b) 200,100 ppm
c) 300, 0 ppm
d) 100, 0 ppm

Living Organisms in Water

- Algae, Bacteria, Viruses, and Worms exist in the water as living organisms.

- Excessive growth of algae in water may be controlled by the application of *copper sulphate or chlorine.*

- *Eutrophication?*

Bacteria Types

(i) According to oxygen need

(a) ***Aerobic bacteria:*** Bacteria that need oxygen to live are called *aerobic bacteria.*

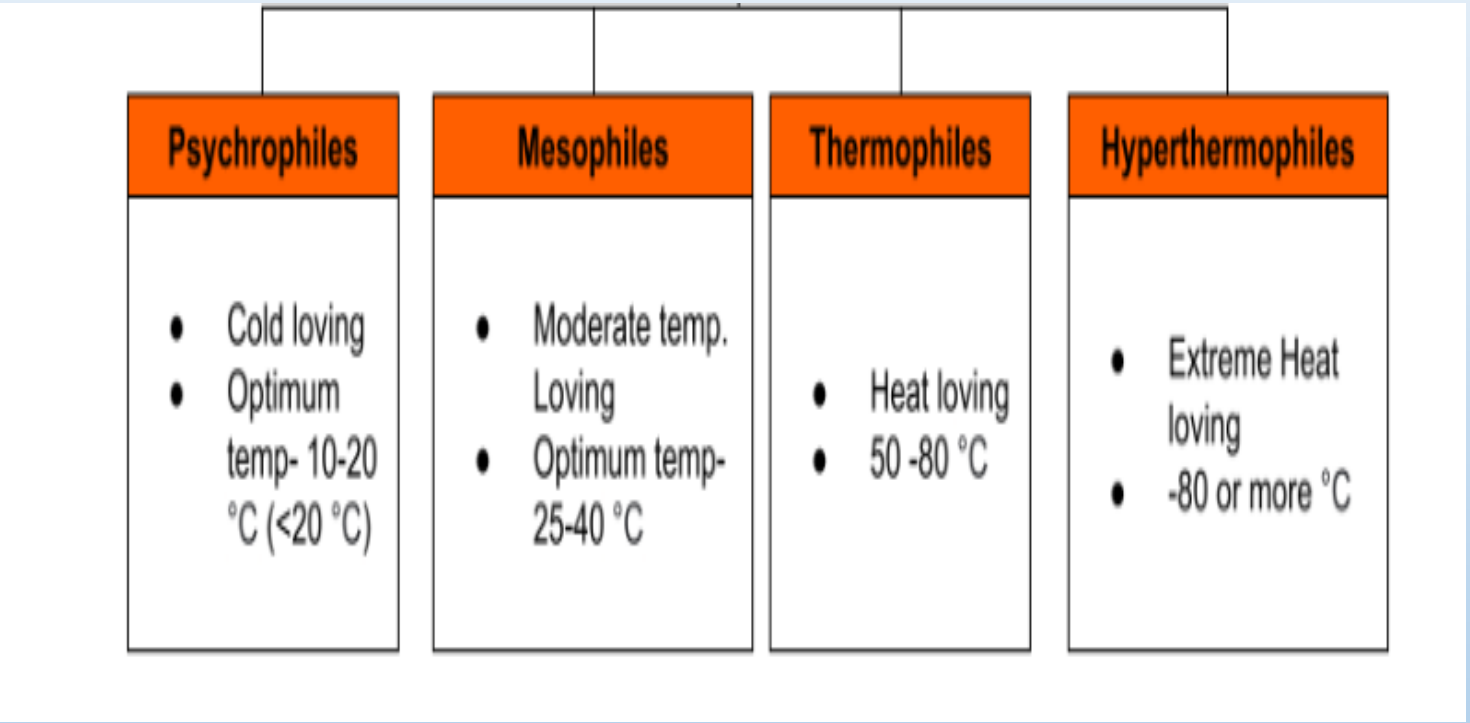
(b) ***Anaerobic bacteria:*** Bacteria that survive in the absence of oxygen are called *anaerobic bacteria.*

(c) ***Facultative bacteria:*** Bacteria that can live and multiply with or without oxygen are called *facultative bacteria.*

On the basis of life process:

1. Saprophytic: Bacteria that depends upon dead or decaying organic matter.
2. Parasitic: Bacteria that lives and multiplies within the body of living organism.

- **On the basis of temperature**



MCQ.

E-coli falls in …… range

a) Mesophilic

b) Thermophilic

c) Hyperthermophilic

d) Any of the above

Note: Mesophiles survive at normal temperature. Eg.: E. coli.

Water-Related Diseases

a. Water borne diseases
b. Water-washed diseases
c. Water-based diseases
d. Water vector diseases

Water borne diseases

By drinking contaminated water.

Eg.: Diarrhoea, dysentery, Typhoid

Water Washed Diseases

- Due to insufficient quantity of water for hygiene.
- Affects mainly the intestinal tract and the skin.
- Eg.: Ascariasis, Conjunctivitis, shigellosis.

MCQ.

Mathamoglobinemia, or blue baby syndrome is caused due to excess

a) chlorides
b) nitrites
c) nitrates
d) sulphides.

Water Based Diseases

- All these diseases are due to infections by parasitic worms.

Eg.; Schistosomiasis (Bilharziasis)

Water Vector Diseases:

- These diseases are caused by insects that either breed in water or bite near water.

Eg.: Yellow Fever and Dengue, Malaria, Filariasis

Examination of water/analysis of water:

1. Physical examination:

i. Temperature:

- The desirable temperature is 10 to 15.6°C.
- The temperature above 25°C is considered objectionable and
- the temperature above 35°C is considered to be unsuitable for water supply.

ii. **Color:**

- The color is measured by platinum cobalt scale (tintometer or colorimeter.)
- The permissible color unit is 5 TCU .
- True and apparent colour?

iii. Turbidity:

- Turbidity is defined as the measure of the resistance of the passage of light through it.
- The units of turbidity are Nephelometric Turbidity Unit (NTU), Jackson Turbidity Unit (JTU), Formazyn Turbidity Unit (FTU).
- Permissible turbidity is 5NTU

2. Chemical Examination

i. pH:

- The pH of drinking water should be between 6.5 and 8.5.

ii. Total solids:

- Residue obtained when the water sample is kept into the oven for evaporation at 103ºC -105ºC for 24 hrs.

- When ignited in muffle furnace at 600ºC for 15-20 minutes, volatile solids escape out and obtained fixed solid.

Q. How many times A is acidic than B if pH of A and B is 4.4 & 6.4.

a. 1.45 b. 1 c. 10 d. 100

Q. For maximum alkalinity of water, pH value should be

a) zero

b) less than 7

c) more than 7

d) 14

3. Biological Examination:

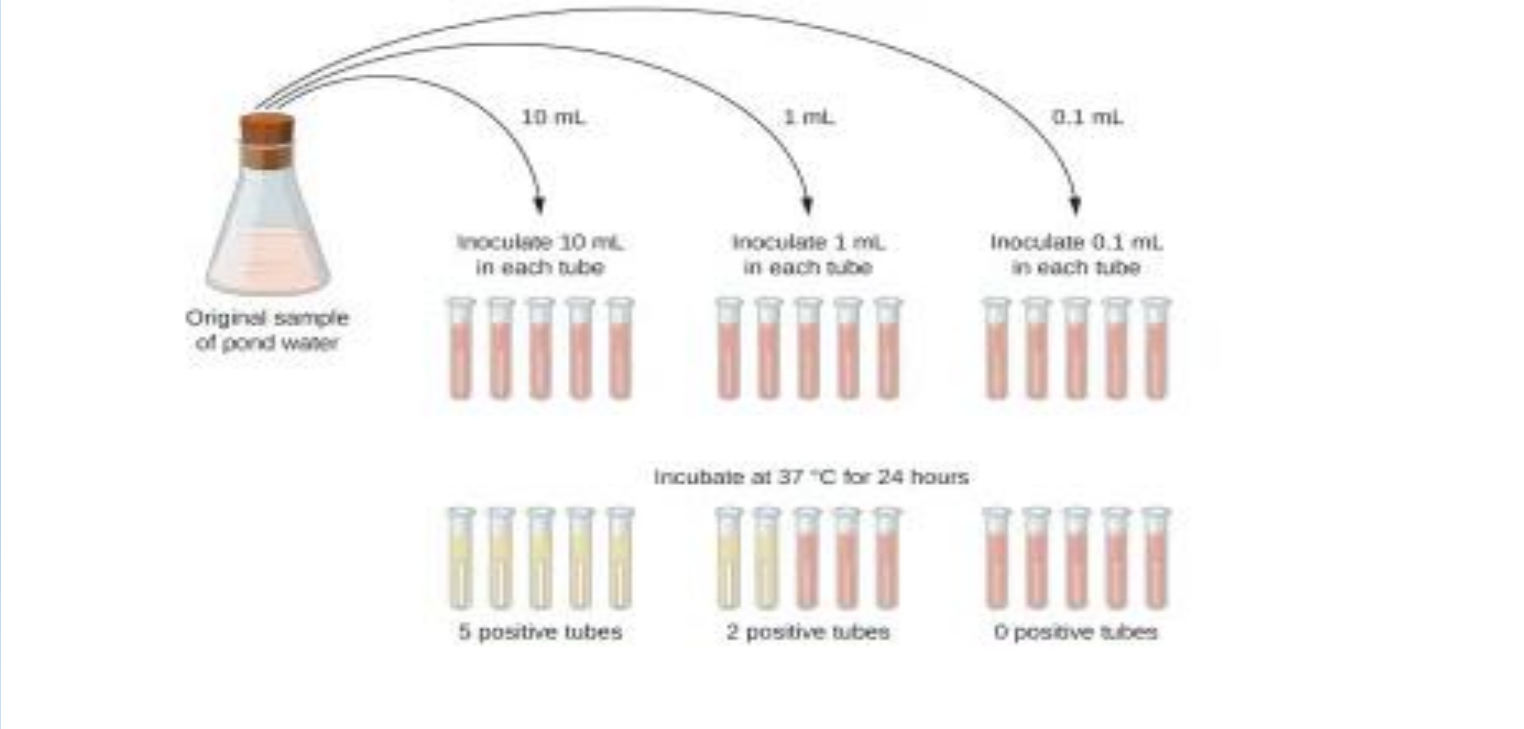
- to determine the presence of microorganisms in the water sample.
- The concentration of E-coli are tested to determine the presence of pathogens.
- The two methods are: Multiple tube fermentation technique &Membrane filter technique.

Indicator organisms:

- The presence of pathogenic bacteria can be indirectly checked by testing the water for coliforms or E-coli.
- The presence of E-coli in water indicates the pollution of water.
- So, coliforms are known as indicator organisms as their presence indicate probable pollution from excreta.

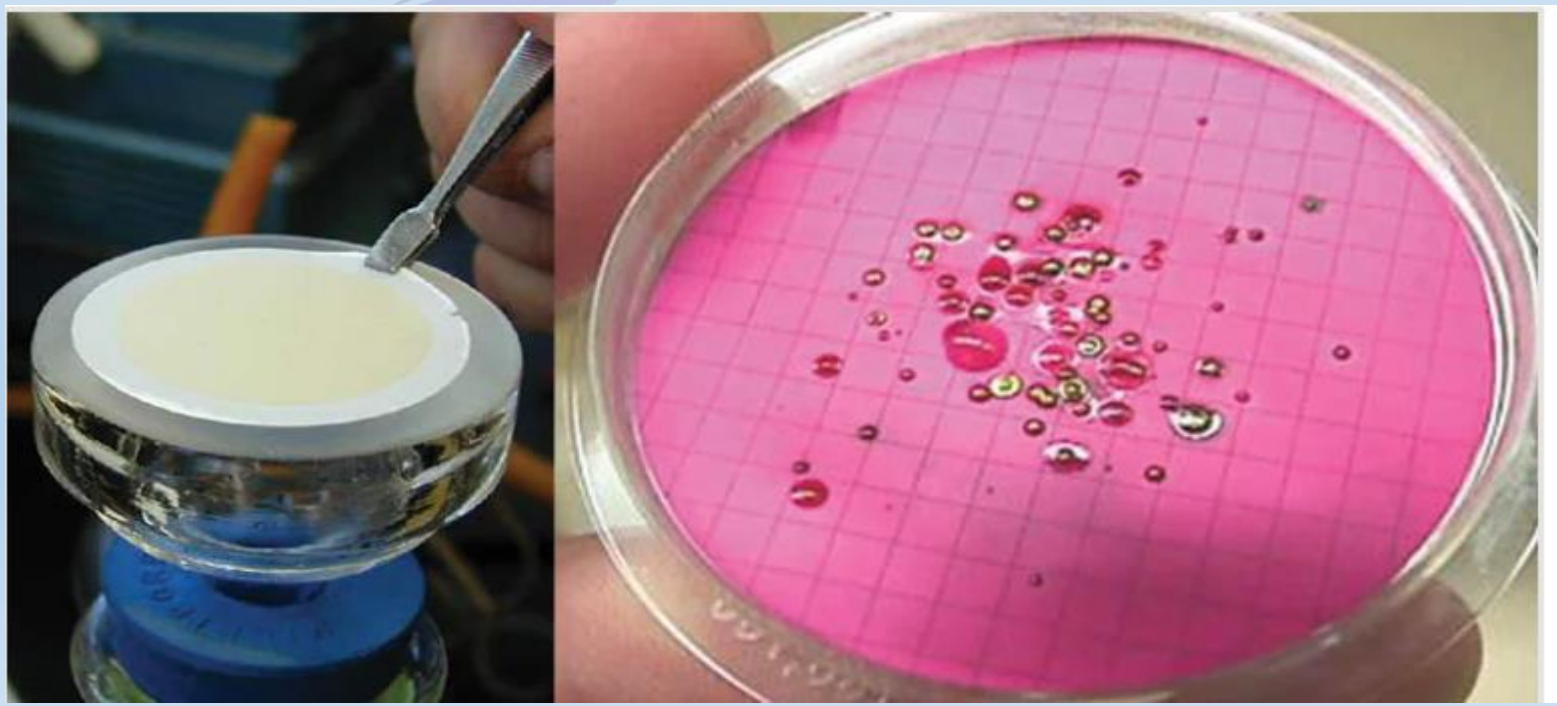
Multiple tube fermentation technique:

- Durham tubes are used for the determination of the coliform group of bacteria.
- Three stages: Presumptive test, Confirmed test, Completed test.
- Most Probable Number (MPN) is defined as that bacterial density which is most likely to be present in the water.
- MPN/100ml = 100*Number of positive tubes / √(ml in negative tubes * ml in all tubes)



Membrane filter technique:

- *M-Endo Agar is used as a nutrient* which inhibits the growth of bacteria other than the coliform group.
- M-*endo agar is selective culture media.*
- The plate is then incubated at a temperature of 37 ° C for 20 hours.
- The number of visible colonies was counted with the help of the microscope.



Parameter	Maximum Limit
Physical	
Turbidity	5 NTU
pH	6.5-8.5
Color	5 TCU
Taste and Odor	Non-objectionable
Electrical Conductivity	1500 µS/cm
Chemical	
Total Hardness	500 mg/l
Residual Chlorine	0.1-0.5 mg/l
Total Dissolved Solids	1000 mg/l
calcium	200 mg/l
Ammonia	1.5 mg/l
Nitrate	50 mg/l
Iron	0.3-3 mg/l

NDWQS 2079
Published on Nepal Gazette
2079/03/02

https://mows.gov.np/en/detail/post/2447

MCQ.

Biochemical Oxygen Demand (B.O.D.) of safe drinking water must be

a) nil
b) 5
c) 10
d) 15

MCQ.

E. Coli bacteria die in water having pH greater than

a) 6.5
b) 7.5
c) 8.5
d) 9.5

MCQ.

Maximum threshold number permitted for indicating the odour of public water supplies, is

a) 1

b) 2

c) 3

d) 4

What is the Threshold Odor Number (TON), if 180 mL of odor-free distilled water is required to produce a 200 mL mixture from a 20 mL odor?

a) 1
b) 10
c) 9
d) 0.9

For public water supplies, the threshold odour number should be 1 and should never exceeds 3

Odour and taste:

It is one of the parameters which define the **physical property of water**

The odour in water is measured by a device known as **osmoscope** and exp in terms of Threshold Odour Number (TON)

TON is a **dilution ratio** at which odour is just detectable

$$\mathrm{TON} = \frac{A+B}{A}$$

Where,

A = Volume of water sample tested in 'ml'

B = Volume of distilled water used in dilution in 'ml'

Capacity of osmoscope = A + B = 200 ml

Alkalinity Relationships

Result of P/M or P/T Alkalinity Test*	Hydrate Alkalinity (OH) Equals:	Carbonate Alkalinity (CO_3) Equals:	Bicarbonate Alkalinity (HCO_3) Equals:
P = 0	0	0	M
P = M	M	0	0
P = ½ M	0	M	0
P < ½ M	0	2P	M–2P
P > ½ M	2P–M	2(M–P)	0

*Note: Because the endpoints for methyl orange and total alkalinity indicator are nearly identical (pH 4.6 and pH 4.5, respectively) the industry uses both indicators interchangeably for reading total alkalinity. **Therefore, the values for M and T can be interchanged in the table above.**

If p-end point is at 4.2 ml and m-end point is 101 ml. Find three species of alkalinity.

THANK YOU!