Environmental Engineering

For

Civil Engineering

By

www.thegateacademy.com

✆ 080-40611000

Syllabus for Environmental Engineering

Quality Standards, Basic Unit Processes and Operations for Water Treatment. Drinking Water Standards, Water Requirements, Basic Unit Operations and Unit Processes for Surface Water Treatment, Distribution Of Water. Sewage and Sewerage Treatment, Quantity and Characteristics of Wastewater Primary, Secondary and Tertiary Treatment of Wastewater, Sludge Disposal, Effluent Discharge Standards. Domestic Wastewater Treatment, Quantity and Characteristics of Domestic Wastewater, Primary and Secondary Treatment Unit Operations and Unit Processes of Domestic Wastewater, Sludge Disposal.

Types of Pollutants, Their Sources and Impacts, Air Pollution Meteorology, Air Pollution Control, Air Quality Standards and Limits.

Characteristics, Generation, Collection and Transportation of Solid Wastes, Engineered Systems for Solid Waste Management (Reuse/ Recycle, Energy Recovery, Treatment and Disposal)

Impacts of Noise, Permissible Limits of Noise Pollution, Measurement of Noise and Control of Noise Pollution.

Previous Year GATE Papers and Analysis

GATE Papers with answer key

thegateacademy.com/gate-papers

Subject wise Weightage Analysis

thegateacademy.com/gate-syllabus

Contents

"Picture yourself vividly as winning and that alone will contribute immeasurably to success."

...Harry Fosdick

CHAPTER 1

Quality Standards of Water

Learning Objectives

After reading this chapter, you will know:

1. Sources of Water
2. Quality Standards of Water
3. Basic Unit Process and Operation for Water Treatment
4. Hardness of Water

Sources of Water

Introduction

To supply the required amount of water demand the planners of the scheme must go in to the search of nearby water sources.

The various sources of water can be classified into two categories

1. **Surface Sources**
   - Ponds and lakes
   - Stream and rivers
   - Storage reservoir
   - Ocean, (generally not used for water supplies at present technologies are available)

2. **Sub Surface Water Sources or Underground Sources**
   - Springs
   - Infiltration wells
   - Wells and tube wells
   - Infiltration galleries

Quality Standards of Water

Quality standards of water are defined on the basis of analyzing the raw water on their physical, chemical and biological characteristics.

Physical Characteristics

- Turbidity
- Colour
- Taste and odour
- Temperature
- Specific conductance

Turbidity: It is the measure of the amount of suspended matter present in water.

Light can pass through water in straight line. If some impurities present in water then light ray will deviate from its original path. Turbidity is actually the process of measuring the deviated path of light through water, which will also imply the amount of suspended matter present in water.

Effectively turbidity is measured by turbidity rod or by a turbidity meter with optical observation, and is expressed as the amount of suspended matter in mg/ltr.

The standard unit is that which is produced by 1 mg of finely divided silica in 1 litre of distilled water.

Measurement

(a) For field – Turbidity rod
(b) For Lab
- Jackson's turbidity meter is used to measure high turbidity
- Nephlometer is used for treated water. Nephlometer can measure turbidity less than 1 ppm
NTU – Nephlometer Turbidity Unit

The IS value for drinking water is 10 – 25 NTU.
Turbidity is mainly used for astheatism and the preferable value will be 0 NTU.

Colour: Dissolved organic material from decaying vegetation or inorganic materials may import colour to the water.
The standard unit of colour is that which is produce by "one mg of platinum cobalt" dissolved in one liter of distilled water.
The IS value for treated water is 5 to 25 cobalt unit, measured by using Tintometer.

Taste and Odour: Mostly organic and inorganic material originating from municipal or industrial waste cont ribute taste and odour to the water. Taste and odour can be expressed in terms of odour intensity and threshold values.

Taste: FTN (Flavour Threshold Number)

Odour: TON (Threshold Odour Number)

Temperature: The increase in temperature decreases palatability (pleasant in taste), because at high temperature CO_2 and some other volatile gases are expelled.
The ideal temperature of water for drinking purpose is 5 to12°C. For Indian condition 25°C.

Specific Conductivity of Water:
Pure water is a poor conductor of electricity. If electricity is passing through it then it is implied that particles are present in water. Here particles means Suspended solids (SS) and Total dissolved solids (TDS) both. In another sentence specific conductivity of water will imply the presence of total solids (TS) in water.
$\therefore TS = TDS + SS$

Where, TS = Measured in specific conductivity
Unit: μho

$$1\ \mu\text{ho} = \frac{1\ \text{Amp}}{1\ \text{Volt}}$$

Impurities in Water

(a) Suspended impurities
(b) Colloidal impurities
(c) Dissolved impurities

Chemical Characteristics: Chemical analysis of water is carried out in order to determine the chemical characteristics of water.

- pH
- Acidity
- Alkalinity
- Hardness
- Chlorides
- Iron solids
- Nitrates

pH: pH value denoted about the alkalinity and acidity of the water. It is the logarithm of reciprocal of the hydrogen ion concentration $pH = \log\left[\frac{1}{H^+}\right]$

The value of pH for drinking water must lies between 6.5 to 8.5.
pH value is measured directly by using 'Potentiometer'.

Acidity: It is caused by the presence of uncombined CO_2 mineral acids or salts of strong acids and weak bases. It also the salts of strong acids and weak bases. It also determines the measures of capacity of water to neutralizes the measures the base.

- It is expressed as mg/l in terms of $CaCO_3$
- Desirable 200 mg/l $CaCO_3$ permissible limit 600 mg/l

Chlorides Content

- In the form of NaCl
- Permissible limit – 250 mg/l
- Chloride concentration is detected by titrating water with standard silver nitrate solution using $KMnO_4$ as indicator

Sulphates: Sulphates occur in water due to leaching from sulphate mineral and oxidation of sulphides

- Sulphates desirable limit = 150 mg/l
  Permissible limit = 400 mg/l

Iron: When ferric oxide comes in contact with water it converts into ferrous bicarbonate and further it oxidises to ferric hydroxide ppt under favorable conditions.
Desirable limit – 0.3 mg/l
Permissible limit – 1.0 mg/l

Fluoride: The excess fluoride content in water causes fluorosis

Fluoride	Effect
< 1 ppm	Fever cavities in teeth
> 1.5 ppm	Fluorosis (Discoloration of teeth and deformation of bones)

Nitrogen Content:

The presence of nitrogen in water is an indication of the presence of the organic matter.
It may occur in the following forms:

(a) Free ammonia
(b) Albuminoid nitrogen
(c) Nitrites
(d) Nitrates

(a) **Free Ammonia:** It represents first stage of decomposition of organic matter, its value should not exceed 0.15 mg/l.
(b) **Albuminoid Nitrogen/Organic Nitrogen:** Quantity of nitrogen present in water in the form of undecomposed organic matter. Decomposition of organic matter started.
(c) **Nitrites:** Presence of party decomposed organic matter
(d) **Nitrates:** Presence of fully oxydised organic matter in water, limit < 45 mg/l

- The presence of too much of nitrate in water causes the disease called methemoglobinemia disease (Blue baby syndrome).
- Kjeldahl nitrogen = Free ammonia + Albuminoid nitrogen (Organic nitrogen)

Dissolved Gases

Methane – Explosive
H_2S – Bad smell
CO_2 – Indicates biological level then it indicates presence of organic matter oxygen deficiency
5 – 8 ppm
Nitrogen – Indicates presence of organic matter
Minimum dissolved oxygen for survival fishes etc = 4 mg/l
BOD, COD, TOC, etc: BOD_5 = Loss of oxygen (mg/l) × Dilution factor BOD of safe drinking water
Permissible limit = 0 for safe drinking water

Bacterial and Microscopic Characteristics

Bacteria's are the minute single cell organisms

(a) Aerobic Bacteria → Required oxygen for survival
(b) Anaerobic Bacteria → Do not required dissolve O_2
(c) Facultative Bacteria → Can survive with or without O_2

- Through some species of bacteria may be helpful in cleaning of water but other pathogenic bacteria are harmful.
- The presence of pathogenic bacteria can be tested by counting presence of coli forms.

Coliforms

Used to measure the coliform bacteria present in water sample
"It may be defined as the reciprocal of the smallest quantity of a sample which would give a positive E.Coli test"

Coliforms (Also Called E.Coli)

- Coliforms are important harmless aerobic micro-organism which are found residing in the intestines of all warm blooded animals including human being.
- Since these harmless organism live longer in water than the pathogenic bacteria it is generally presumed that the water will be safe (or) free from pathogens if no coliform bacteria are present in it.

Measurement of Coliform

- Widely used
- Filter the water through a sterile membrane of special design porosity = 80 pore size (5 to 10 μm) and the membrane is put in contact with nutrients (M – Endo's medium) that will permit the growth of only coliform colonies. This process is called culturing.
- After an incubation period of 20 hrs, the coliform organs are developed into visible colonies which can be easily counted E Coli ferment lactose with gas formation with 48 hours incubation at 35°C. Based on this E.coli density is estimated by multiple fermentation procedure in different test. Which consist of identification of E.coli in different dilution combinations.
- MPN value is calculation as follows:
- Five 10 ml (five dilution combinations) tube is tested for E.coli and if out 5 only one given positive test for E.coli and all other are negative.
- E.Coli from the table we can find out the MPN value for one (+ve) and other (−ve), which is equal to 2.2 in present case.

Water Borne Diseases and their Control

(a) Disease caused by bacterial infections
- Typhoid Fever – Salmonella typhi
- Cholera – Vibro cholera
- Bacillary Dysentery – Shiga bacillus or Flexner bacillus
- Diarrhea

(b) Disease cause by viral infections
- Hepatitis – Hepatist virus
- Poliomyelitis – Polio virus

(c) Disease caused by protozoal infections
- Amoebic Dysentry – Entamoeba hystolystic germ.

Quality Standard for Industrial Water Supply

It depends upon requirements of particular industry.
The cooling water required in industries may not be of high standards.
The water required for processing for boiler feed purposes must be very higher quality.

(a) **Boiler Feed Water:**
- It should be soft
- High pressure boilers should contain very low amount of dissolved oxygen and dissolved solids.

(b) **Pulp and Paper:**
- Water should be free from iron, Mn(Manganese) and hardness.

(c) Water required for distilleries backeries should preferably be hard.

Quality Standard for Municipal Water Supply

Municipal water required for domestic uses, particularly the water required for drinking, must be colourless odourless and tasteless. It should be free from turbidity and excessive toxic chemical and bacteriological characteristics of water must be in between the desirable and permissible limit.

Basic Unit Process and Operation for Water Treatment

Unit Process Aeration	Function (Removal) Colour, Odour, Taste
Screening	Floating Matter
Chemical Methods	Iron, Manganese
Softening	Hardness
Sedimentation	Suspended Matter
Coagulation	Suspended matter, a part of colloidal water and bacteria
Filtration	Remaining colloidal, dissolved matter, bacteria
Disinfecting	Pathogenic bacteria, organic and reducing substances

Source	Treatment Required
1. Ground water and spring water fairly free from contamination	No treatment or chlorination
2. Ground water with chemical, mineral and gases	Aeration, coagulation (if necessary, filtration and disinfection)
3. Lakes, surface water reservoir, with less amount of pollution	Disinfection
4. Other surface water such as river, canals and impounded reservoir with a considerable amount of pollution	Complete treatment