**Physical parameters of water quality /Physical characteristic of water**

* These are some physical aspects of water quality that helps to determine whether water is polluted or not.

**1. Color:**

* Pure water is colorless. Therefore any types of color appearance in water indicates water pollution.
* Natural water system is often colored by foreign material. If color is due to suspended material, it is called as apparent color. Color given by dissolved material that remains even after removal of suspended material is called true color or real color.
* The guideline value (maximum acceptable level) for color of drinking water is 15 TCU (True color unit).

**2. Turbidity:**

* Pure water is clear and do not absorb light. Therefore if turbidity appears in water, it indicates water pollution.
* Turbidity in water is given by various materials like suspended solid, dissolved materials and microbial loads. In general turbidity increases with increases in quantity of these materials in water. However different materials differ in their light absorption capacity.
* Some materials that give turbidity may be toxic to consumers. Therefore turbid water is not suitable for drinking purposes. Furthermore turbidity decrease efficiency of disinfection process.
* Materials that give turbidity provide attachment site for toxic chemicals.
* Turbidity prevents penetration of light into deeper layer of natural water system that directly affects photosynthetic organism in bottom.
* Drinking water should have turbidity less than 5 NTU (Naphthalometric turbidity unit)

**3. Taste and odor:**

* Pure water is always tasteless and odorless. Therefore if any types of taste and odor is present, it indicates water pollution.
* Water taste and odor may develops due to natural or artificial regions.
* Artificial region for taste and odor in water is due to disinfection process (chlorination). Some natural impurities dissolved in water can also give taste and odor.
* Inorganic salts such as NaCl, KCl etc dissolve in water give taste whereas compounds like H2S can give both taste and odor.
* Compounds giving taste and odor to water may be toxic to consumer, so drinking water should be taste less and odor less.

**4. Temperature:**

* Temperature is not directly used to evaluate whether water is potable (drinkable) or not.
* In natural water system like lake and river, temperature is very important physical factor that determines water quality. If temperature increase, solubility of Oxygen in water decreases.
* Furthermore rise in temperature increases the growth rate of aquatic microorganism, so they consume dissolved O2 faster and level of dissolved O2 decreases.
* Similarly, temperature affects disinfection process because efficiency of disinfection is lower at lower temperature.

**5. Foam:**

* Foam in water id due to foaming substances like detergents, soaps etc dissolve in water. Foam is regarded as dangerous in natural water system because it creates anaerobic condition.
* Some foaming substance is toxic to consumers. Therefore water with foam is not suitable for drinking purposes.

**6. Conductivity:**

* Conductivity of water is mainly due to presence of ionizable inorganic compounds.
* Pure water has very low conductance. For example 1µ mho for distilled water. Therefore conductivity measurement indicates amount of ionizable inorganic compounds in water.

**7. Total dissolved solid:**

* If water is filtered to remove suspended solid, the remaining solid in water indicates total dissolved solid.
* Dissolved solid may be organic (animal or plants waste) or inorganic compounds (carbonate, sulfate, bicarbonate etc). These compounds give variety of effects like hardness, taste, odor etc depending on nature of dissolved solid.
* If the dissolved solid in water exceeds 300 mg/ltr, it adversely affects living organisms as well as industrial products.

## **Physical Characteristics of Water**

### 1. Turbidity of Water

The turbidity is measured by a turbidity rod or by a turbidity meter with optical observations and is expressed as the amount of suspended matter in mg/l or parts per million (ppm).

For water, ppm and mg/l are approximately equal.

The standard unit is that which is produced by one milligram of finely divided silica (fuller’s earth) in one litre of distilled water.

#### Turbidity Meters

**Turbidity Rod:**

The turbidity can be easily measured in the field with the help of a turbidity rod. It consists of an aluminium rod which is graduated as to give turbidity directly in silica units (mg/l)

**Turbidimeter:**

The turbidity can be easily measured in the laboratory with the help of a instruments called turbidity meter. In general, a turbidity meter works on the principle of measuring the interference caused by the water sample to the passage of light rays.

**Jackson’s candle Turbidimeter:**

The height of water column will therefore be more for less turbid water and vice versa. Longer the light path lower the turbidity. Such a turbidimeter can not measure turbidites lower than 25 JTU.

It can be used for natural sources only and can not be used to measure the turbidity of treated water supplies, for which **Baylis turbidity meter**or **modern nephelometers** are used.

**Baylis Turbidimeters**

One of the two glass tubes is filled with water sample (whose turbidity I to be measured) and the other is filled with standard water solution of known turbidity. The electric bulb is lighted and the blue colour in both the tubes is observed from the top of the instrument.

**Modern Nephelometer:** for low turbidity less than 1 unit.

NTU – Nephelometric Turbidity Units

FTU – Formazin Turbidity Units

**Ratio turbidimeter:** River water has maximum amount of turbidity.

### 2. Colour

The presence of colour in water is not objectionable from health point of view, but may spoil the colour of the clothes being washed. The standard unit of colour is that which is produced by one milligram of platinum cobalt dissolved in one litre of distilled water.

For public supplies, the colour number on cobalt scale should not exceed 20 and should be preferably less than 10.

Colour determined by an instrument is known as **tintometer.**

### 3. Taste and Odour

The extent of taste or odour present in a particular sample of water is measured by a term called **odour** **intensity**, which is related with the **threshold odour** or **threshold odour number.**

Water to be tested is therefore gradually diluted with odour free water, and the mixture at which the detection of odour by human observation is just lost, is determined. The number of times the sample is diluted represents the threshold odour number.

For public supplies, the water should generally free from odour, i.e. the threshold number should be 1 and should never exceed 3.

### 4. Temperature of Water

For potable water, temperature of about about clip_image002C is desirable. It should not be more than clip_image004C.

### 5. Specific Conductivity

The total amount of dissolved salts present in water can be easily estimated by measuring the specific conductivity of water.

## **Chemical Characteristics of Water**

### 1. Total Solids and Suspended Solids

Total solids (suspended solids + dissolved solids) can be obtained by evaporating a sample of water and weighing the dry residue left and weighing the residue left on the filter paper.

The suspended solid can be found by filtering the water sample. Total permissible amount of solids in water is generally limited to 500 ppm.

### 2. pH value of Water

clip_image006

If clip_image008concentration increases, pH decreases and then it will be acidic.

If clip_image008[1]concentration decreases, pH increases and then it will be alkaline.

clip_image010

pH + pOH = 14

if the pH of water is more than 7, it will be alkaline and if it is less than 7, it will be acidic.

The alkalinity is caused by the presence of bicarbonate of calcium and magnesium or by the carbonates of hydroxides of sodium, potassium, calcium and magnesium.

Some, but not all of the compounds that cause alkalinity also cause hardness.

**pH Measurement:**

the pH value of water can be measured quickly and automatically with the help of a **Potentiometer.**

The pH can also be measured by indicators as given below:

|  |  |  |  |
| --- | --- | --- | --- |
| **Indicator** | **pH range of indicator dye** | **Original color** | **Final color produced** |
| **Methyl orange** | 2.8 – 4.4 | Red | Yellow |
| **Methyl red** | 4.4 – 6.2 | Red | Yellow |
| **Phenol red** | 6.8 – 8.4 | Yellow | Red |
| **Phenolphthalein** | 8.6 – 10.3 | Yellow | Red |

Permissible pH value for public supplies may range between 6.6 to 8.4.

The lower value of pH may cause incrustation, sediment deposits, difficulty in chlorination.

### 3. Hardness of Water

Hard waters are undesirable because they may lead to greater soap consumption, scaling of boilers, causing corrosion and incrustation of pipes, making food tasteless etc.

**Temporary Hardness**: If bicarbonates and carbonates of calcium and magnesium are present in water, the water is render hard temporarily as this hardness can be removed to some extent by simple boiling or to full extent by adding lime to water. Such a hardness is known as temporary hardness or carbonate hardness.

**Permanent Hardness:** If sulphates, chlorides and nitrates of calcium or magnesium are present in water, they can not be removed at al by simple boiling and therefore, such water require special treatment for softening. Such a hardness is known as permanent hardness or non-carbonate hardness.

It is caused by sulphates, chlorides, nitrates of Ca and Mg.

**Carbonate hardness** = Total hardness or Alkalinity (which ever is less)

Non-carbonate hardness = Total hardness – Alkalinity

* Carbonate hardness is equal to the total hardness or alkalinity which ever is less
* Non-carbonate hardness is the total hardness in excess of the alkalinity. If the alkalinity is equal to or greater than the total hardness, there is no non-carbonate hardness.
* One French degree of hardness is equal to 10mg/l of CaCO3.
* One British degree of hardness is equal to a hardness of 14.25mg/l.
* Water with hardness upto 75 ppm are considered soft and above 200 ppm are considered hard and in between is considered as moderately hard.
* Underground waters are generally harder than surface waters.
* The prescribed hardness limit for public supplies range between 75 to 115 ppm.

### 4. Chloride Content

The chloride content of treated water to be supplied to the public should not exceed a value of about 250 ppm.

The chloride content of water can be measured by titrating the water with standard silver nitrate solution using potassium chromate as indicator.

### (5) Nitrogen Content

The presence of nitrogen in water may occur in one or more of the following reasons:

1. **Free ammonia:** It indicates very first stage of decomposition of organic matter. It should not exceed 0.15mg/l
2. **Albuminous or Organic Matter:** It indicates the quantity of nitrogen present in water before the decomposition of organic molten has started. It should not exceed 0.3mg/l
3. **Nitrites:** Not fully oxidized organic matter in water.
4. **Nitrates:** It indicates fully oxidized organic matter in water (representing old pollution).

* Nitrites is highly dangerous and therefore the permissible amount of nitrites in water should be nil.
* Ammonia nitrogen + organic nitrogen = kjeldahl nitrogen
* Nitrates in water is not harmful. However the presence of too much of nitrates in water may adversely affect the health of infants causing a disease called **methemoglobinemia**commonly called **blue baby disease.**
* The nitrate concentration in domestic water supplies is limited to 45 mg/l.

### 6. Metal and other chemical substances in water:

Iron – 0.3ppm, excess of these cause discolouration of clothes.

Manganese – 0.05ppm

Copper – 1.3ppm

Sulphate – 250 ppm

Fluoride – 1.5 ppm, excess of this effects human lungs and other respiratory organs.

Fluoride concentration of less than 0.8 – 1.0 ppm cause dental cavity (tooth decay). If fluoride concentration is greater than 1.5ppm, causing spotting and discolouration of teeth (a disease called fluorosis).

### 7. Dissolved gases

Oxygen gas is generally absorbed by water from the atmosphere but it being consumed by unstable organic matter for their oxidation. Hence, if the oxygen present in water is found o be less than its saturation level, it indicates presence of organic matter and consequently making the waters suspicious.

### Biological Oxygen Demand (BOD):

The extent of organic matter present in water sample can be estimated by supplying oxygen to this sample and finding the oxygen consumed by the organic matter present in water. This oxygen demand is known as Biological oxygen demand (BOD).

It is not practically possible to determine ultimate oxygen demand. Hence, BOD of water during the first five days at clip_image012C is generally taken as the standard demand.

clip_image014= Loss of oxygen in mg/l x dilution factor.

The BOD of safe drinking water must be nil.

## **Bacterial and Microscopic Characteristics of Water**

Five types of parasitic organisms (i.e. bacteria, protozoa, viruses, worms and fungi) are generally known to be infective to main and are found in water.

### 1. Bacteria

These are the minute single cell organisms possessing no defined nucleus and having no green material to help them manufacture their own food. They are reproduced by binary fusion and may of various shapes and sizes are 1 to 4 microns, examined by microscope.

a) Non-disease causing bacteria – Non pathogenic bacteria.

b) Disease causing bacteria – Pathogenic bacteria.

### 2. Protozoa

These are single cell animals and are the lowest and the simplest form of animal life. They are bacteria eaters and thus destroy Pathogens. They are counted by microscope.

### Classification of bacteria based on oxygen requirement:

1. **Aerobic bacteria:** Those which require oxygen for their survival.
2. **Anaerobic bacteria:** Those which flourish in the absence of free oxygen.
3. **Facultative bacteria:** Those which can survive with or without free oxygen.

**Pathogenic bacteria**

These can be tested and counted in the laboratories but with great difficulty. These tests are therefore, generally not performed in routine to check up of the water quality. The usual routine tests are generally conducted to detect and count the presence of coliforms which in themselves harmless organisms, but their presence or absence indicates the presence or absence of pathogenic bacteria.

**Coliform index**

It may be defined as the reciprocal of the smallest quantity of a sample which would give a positive portion. Coliform sometimes called bacteria coli (B-coli) or Escherichia (E-coli) are harmless aerobic micro-organisms.

If not more than 1 coliform is present per 100ml of water, then water is said to be safe for drinking.

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