Chemical Parameter Analysis for Water, Waste Water and Ground Water

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Abstract

Water is the most essential commodity for the sustenance of life. Water is a chemical substance with the formula H2O.It is found in 3 states liquid, solid and gases. 97% earth surface covered by water. Animals & plants have 60-65 % water in their body. The availability of water on earth are immense in which mostly sea water which is unfit for drinking or irrigation purpose. The amount of fresh water is huge as well, but its distribution over the globe is uneven. The demands for drinking, other domestic needs are increases from 135 to 500 liters a day per person. Water plays an important role in making human life for survive. As man uses water he pollutes it and when the waste water is returned to open bodies it contaminates the natural waters. So, the quality of water and waste water plays an important role for experts in all over the world. Water keeps on cycling endlessly through environment "Hydrological cycle". The paper includes the Chemical quality parameter examined in water and waste waters.

Keywords: Water, Waste Water, Ground Water, Total Solids, Hardness, Chlorides, Chlorine, Iron & Manganese, Ph, Lead & Arsenic, Nitrogen & Its Compounds, Dissolved Gases, Metals

I. INTRODUCTION

As we all know water is the most important requirement for human life to survive. Depending upon the intended use of water certain quality parameters are established and based on this criteria quality standard is specified. Chemical parameters play an important role for quality of water and waste water. The quality of water depends on the location of sources and environment3al protection in given area.

A. Goals for examination of water and waste water

1) *Water*
- Determination of physical, chemical, biological characteristics of water.
- Determination of pollution sources.
- Suitability of water for various purposes like drinking, domestic use, industrial use, irrigation use etc.
- The treatment given to the water to bring the quality of water to the required standard as per IS IS-10500:1991 before supplying it to the public or for use of any purpose.
- Size & capacity of various treatment units of water treatment plant.
- Preparation of step by step process of water treatment plants.

2) *Waste Water*
- Estimation of pollution loads and their damage caused by introduction into the water bodies and use of Irrigation purpose.
- Estimation of potential damage to sewers and sewage treatment plants.
- Preliminary & secondary assessment for planning and operation of waste water treatment plants.
- Testing of selected parameter for calculation of discharge by regulating authorities.
- To find out toxic compound such as total solids, chlorides ,hardness, pH, nitrogen and its compounds
- Evaluate the degree of toxicity in the treatment system.
- To find out the solids & various gases that causes difficulties in treatment.

3) *Ground Water*
- Has a suitable composition in most cases is free from turbidity, objectionable colours, pathogenic organisms and almost overall absence of oxygen and require not much treatment.
- Is relatively much safer from hazards of chemical, radiogenic biological pollution to which surface water bodies are exposed.
- Circulating groundwater can have extreme variation in the composition with the appearance of pollutants and various contaminants. Furthermore, groundwater is often very pure microbiologically.

II. CHEMICAL PARAMETERS

Following are the Chemical parameters:

A. Total Solids

These include the solids in suspension, colloidal and in dissolved form. The quantity of suspended solids is determined by filtering the sample of water through a fine filter, drying and weighing. The quantity of dissolved and colloidal solids is determined by evaporating the filtered water (obtained from the suspended solid test) and weighing the residue. The total solids in a water sample can be directly determined by evaporating the water and weighing the residue. If the residue of total solids is fused in a muffle-furnace the organic solids will decompose whereas only inorganic solids will remain. By weighing we can determine the inorganic solids and deducting it from total solids, we can calculate organic solids.

Table – 1
Total Solids

Level of TDS (milligrams per litre)	*Rating*
Less than 300	*Excellent*
300 - 600	*Good*
600 - 900	*Fair*
900 - 1,200	*Poor*
Above 1,200	*Unacceptable*
As per Drinking water by WHO	*≤500 mg/L*
For Industrial purpose	*≤1000 mg/L*
For Ground Water –IS 10500-2012	*500 to 2000 mg/L*
For Irrigation purpose	*200 to 4000 mg/L*

B. Hardness

It is the property of water which prevents the lathering of the soap. It is caused due to presence of carbonates and sulphates of calcium and magnesium in the water. Sometimes the presence of chlorides and nitrates of calcium and magnesium also cause hardness in the water.

Hardness is usually expressed in mg/litre or p.p.m. of calcium carbonate in water. Hardness is generally determined by Versenate method. In this method, the water is titrated against EDTA salt solution using Erio chrome Black T as indicator solution. While titrating the colour changes from wine red to blue.

The measurement of Hardness can be done by the following formula:

1) *Hardness in ppm or mg/l (H_w)*

$$= Ca^{++} \text{ ions in ppm or mg/l} \times \frac{\text{combination wt. of } CaCO_3}{\text{combination wt. of } Ca^{++}}$$

$$= +Mg^{++} \text{ ions in ppm or mg/l} \times \frac{\text{combination wt. of } CaCO_3}{\text{combination wt. of } Mg^{++}}$$

Table - 2
WHO: World Health Organization

Level of Hardness (milligrams per litre or ppm)	*Rating or value of Hardness*
British Degree of Hardness	*14.25 mg/l or ppm*
French Degree of Hardness	*10 ppm*
Hardness upto 60 mg/l (as per WHO)	*Soft water*
Hardness range from 60 to 120 mg/l(as per WHO)	*Moderately Hard water*
Hardness range from 120 to 180 mg/l(as per WHO)	*Hard water*
Hardness range more than 180 mg/l(as per WHO)	*Very Hard water*

Underground water are generally harder than surface water, as they do have more opportunity to come in contact with minerals. For Boiler feed waters and for efficient cloth washing in laundaries,etc. the water muse be soft with hardness less than 75 ppm. Generally prescribed limit for public supplies ranges between 75 ppm to 150 ppm.

C. Chlorides

Sodium chloride is the main substance in chloride water. The natural water near the mines and sea have dissolve sodium chloride. Similarly the presence of chlorides $_{may}$ be due to the mixing of saline water and sewage in water. Excess of chlorides is dangerous and unfit for use. The Chlorides can be reduced by diluting the water. Chlorides above 250 p.p.m. are not permissible in water. The chloride can be determined by titrating the water with silver nitrate and potassium chromate. In this titration process reddish colours will be formed if chlorides are present.

1) *As per IS 10500-1991*

Table – 3
As per IS 10500-1991 Sodium chloride

Sr. No	*Substance*	*Requirement (Desirable Limit) mg/l*	*Permissible Limit mg/l*
1	*Chlorides (as Cl) mg/L, Max.*	*250*	*1000*

D. Chorine

Dissolved free chorine is never found in natural waters. It is present in the treated water resulting from disinfection with chlorine. The chlorine remains as residual in treated water for the sake of safety against pathogenic bacterias.Residual chlorine is determined by the starch-iodide test or Orthotolodin test. In Starch-Iodide test, potassium iodide and starch solutions are added to the sample of water due to which blue colour is formed. This blue colour is then removed by titrating with N/100 sodium thiosulphate solution, and the quantity of chloride is calculated.

The amount of chloride can be easily ascertained by using the simplified titration equation

$$\begin{bmatrix}\text{Quantity of chlorine}\\ \text{In mg/l in the original}\\ \text{Sample of water}\end{bmatrix} = 0.355 \begin{bmatrix}\text{No. of ml of thiosulphate}\\ \text{required to remove the blue}\\ \text{colour}\end{bmatrix}$$

1) As per IS 10500-1991

Table – 4
As per IS 10500-1991

Sr. No	*Substance*	*Requirement(Desirable Limit) mg/l*	*Permissible Limit mg/l*
1	*Residual, free chlorine, mg/L, Min*	*0.2*	*No Relaxation*

E. Iron and Manganese

These are generally found in ground water. If these are present less than 0.3 p.p.m., it is not objectionable, but if exceeds 0.3 p.p.m. the water is not suitable for domestic, bleaching, dyeing and laundering purposes. The presence of Iron & Manganese in water makes brownish red colour in it, leads to the growth of microorganisms and corrodes the water pipes. The quantity of Iron & Manganese is determined by colorimetric methods. In these methods some colouring agents are added in the water and colour so formed is compared with standard colour solutions.

F. pH Value

Depending upon the nature of dissolved salts and minerals, the water found in natural sources may be acidic or alkaline. The acidity or alkalinity is usually measured in p.p.m. of the dissolved salts and is expressed in terms of equivalent weight of calcium carbonate.

When acids or alkalies are dissolved in water they dissociate into electrically charged ions of Hydrogen and Hydroxyl respectively. Hydrogen ions are charged with positive charge whereas Hydroxyl ions are charged with negative charge. The following equations show the dissociation of some of the acids and alkalies in the water.

$$\left.\begin{array}{l} HOCL = H^+ + OCL \\ H_2CO_3 = 2H^+ + CO_3^- \\ H_2SO_4 = 2H^+ + SO_4^- \end{array}\right\} \text{ACIDS}$$

$$\left.\begin{array}{l} NH_3 + H_2O = NH^+_4 + OH^- \\ Mg(OH)_2 = Mg^{++} + 2\,OH^- \\ NaOH = Na^+ + OH^- \end{array}\right\} \text{ALKALIES}$$

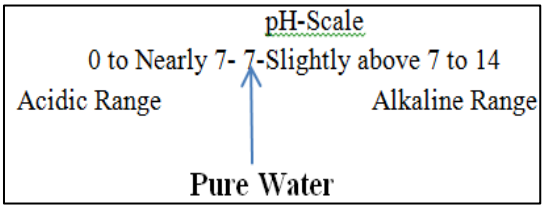
The net concentration of hydrogen ion H^+ will exceed that of hydroxyl ions and will be more than the hydrogen ion concentration of neutral water (i.e. 10^{-7})and thus decreasing the pH value to less than 7 and thus making the water acidic.

The net amount of OH^- ions present in the alkaline water will be more than that present in the neutral water. Thus, it will reduce the hydrogen ions concentration to less than 10^{-7} and thereby increasing the pH above 7.

The pH value of neutral water will be equal to

$$pH = \log_{10}\frac{1}{H^+} = \log_{10}\frac{1}{10^{-7}} = \log_{10} 10^7 = 7$$

The pH Value can be represented by:



For determination of pH value:- The pH valule of a water is generally determined by colorimetric method or Electrometric method. In Colorimetric method some indicator is added in the sample of water and colour so formed is compared with standard colour discs or solutions.

Table - 5
Acidic water causes corrosion, alkaline causes sedimentation deposits.

Indicator	pH Range	Acid	Base
Thymol Blue	1.2-2.8	red	yellow
2,4-Dinitrophenol	2.4-4.0	colorless	yellow
Methyl yellow	2.9-4.0	red	yellow
Methyl orange	3.1-4.4	red	orange
Bromphenol blue	3.0-4.6	yellow	blue-violet
Methyl red	4.4-6.2	red	yellow
p-Nitrophenol	5.0-7.0	colorless	yellow
Phenol red	6.4-8.0	yellow	red
Thymol blue	8.0-9.6	yellow	blue
Phenolphthalein	8.0-10.0	colorless	red
Alizarin yellow	10.0-12.0	yellow	lilac
Salicyl yellow	10.0-12.0	yellow	orange-brown
Trinitrobenzoic acid	12.0-13.4	colorless	orange-red

Acidic water causes corrosion, alkaline causes sedimentation deposits.

G. Lead and Arsenic

These are not usually found in natural waters. But sometimes lead is mixed up in water from lead pipes or form tanks lined with lead paint when water moves through them. These are poisonous and dangerous to the health of public. The presence of lead and arsenic is detected by means of chemical tests for it.

1) As per IS 10500-1991

Table – 6
As per IS 10500-1991

Sr No	*Substance*	*Requirement(Desirable Limit) mg/l*	*Permissible Limit mg/l*
1	*Lead (as Pb) mg/L, Max*	*0.05*	*No Relaxation*
2	*Arsenic (as As) mg/L, Max*	*0.01*	*No Relaxation*

H. Dissolved Gases

1) DO

From atmosphere or due to activity of algae. DO relate to temp. High temp. low DO. Minimum 4mg/L necessary for fish. At 20 ˚c 9.2 mg/L and at 30˚c 7.6 mg/L. More DO increase corrosivity.

2) CO_2

Dissolved from atmosphere, from decomposing organic matter. Higher CO_2 makes water acidic so corrosivity increases. Higher CO_2 imparts taste and odour.

3) H_2S

Found in ground water, produced by reduction of sulphate, or by decomposition of organic matter. If present gives rotten egg smell.

I. Nitrogen and its compounds

Presence of Nitrogen indicates presence of organic matter. Occur as- free ammonia, organic nitrogen, nitrites, nitrates. Free ammonia first stage of decomposition, organic nitrogen before decomposition, nitrites partly decomposed and nitrates fully oxidized. For potable water free ammonia limit 0.15 mg/L, organic nitrogen 0.3 mg/L, nitrates very dangerous so limit is zero.Nitrate conc. in domestic water supply limit 45mg/L. Mathemoglobinemia- more nitrate conc.

J. Metals and other chemical substances

Water contains various types of minerals or metals such as iron, manganese, copper, lead, barium, cadmium, selenium, fluoride, arsenic etc. Following table gives the maximum permissible quantity of these metals which can be allowed in the water.

Table – 7
Metals and other chemical substances

Name of Metal	*Max. Permissible limit in p.p.m.*	*Name of Metal*	*Max. Permissible limit in p.p.m.*
Magnesium	*125.0*	*Chromium*	*0.05*
Zinc	*15.0*	*Sulphate*	*2.50*
Silver	*0.05*	*Phenol*	*0.001*
Fluoride	*0.05 to 0.1*	*Cyanide*	*0.2*
Copper	*1.0 to 3.0*	*Iron*	*0.3*
Barium	*1.0*	*Manganese*	*0.05*
Cadmium	*0.01*	*Selenium*	*0.05*

The concentration of iron and manganese should not be allowed more than 0.3 p.p.m. otherwise they will cause discoloration of clothes during washing. They may also cause incrustation in water mains due to deposition of ferric hydroxide and manganese

oxide. As lead and barium are very toxic, a low p.p.m. of these are allowed. Arsenic, Selenium are poisonous and may cause fatality, therefore they must be removed totally. Human lungs are effected by presence of high quality of copper in the water.A laxative effect is caused in the human body due to presence of sulphates in the water. Fewer cavities in the teeth will be formed due to excessive presence of fluoride in water more than 1 p.p.m.

III. CONCLUSION

The Chemical parameters of water, waste water & ground water explain in this paper is helpful to ensure safety to public health. It becomes essential that the water to be supplied to public through public water supply scheme should be thoroughly examined. This paper is very useful to all Central & State Water supply -sewerage bodies, Municipal corporations & Taluka level water supply schemes.

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