WATER QUALITY

Water is usually tasteless, odorless, colorless and, a liquid in its pure state. But, water is one of the best naturally occurring solvents on earth and almost any substance will dissolve in it to some degree. This is why it is seldom found in its "pure" state and it usually contains several impurities (gases, solids, color). Water falling to earth as rain dissolves some of the gases in the atmosphere and when it falls on the earth and percolates through it, it dissolves the minerals present in the earth.

Water Sources:

Surface waters are those that come from rivers, streams, ponds, lakes and reservoirs, while ground waters come from wells, mines and springs. Ground water usually contains large amounts of dissolved substances (minerals) because it percolates(slowly filters) through rock and soil formations. The greater the depth below ground from which the ground water comes, the higher the level of dissolved minerals in the water. However, since it percolates through the earth, ground water contains relatively small quantities of suspended impurities and very little color. In contrast, surface waters contain lower levels of dissolved minerals , but higher suspended impurities , color and industrial pollutants.

Physical Impurities:

These are usually in the form of suspended impurities and color which can be separated from the water by filtration. Suspended impurities are usually due to soil erosion and this silt gives the water a hazy appearance. This is referred to as 'turbidity' and will often settle out slowly in reservoirs or tanks when this water is retained in these for some time. Odor and taste in water are due to the presence of dissolved gases such as sulfides, micro organisms, natural organic contaminants such as lignins, tannins and humic acids, and, increasingly now, due to industrial contaminants. Color and turbidity are usually measured by instruments available for these purposes and are expressed in "Hazen units" for color and in "Nephlometric Turbidity Units (Ntu)" for turbidity.

Mineral impurities:

Water dissolves the minerals present in the strata of soil it filers through in the case of ground water and, in the case of surface water, the minerals present in the soil over which it flows (rivers/streams) or over which it stands (lakes, ponds, reservoirs).The dissolved minerals in water are commonly referred to as Total Dissolved Solids (TDS). The TDS content of any water is expressed in milligrams /litre (mg/l) or in parts per million (ppm). The minerals are basically compounds (salts) of Calcium(Ca), Magnesium(Mg) and Sodium(Na) What is commonly called as 'hardness in water' is due to the compounds/salts of Ca and Mg such as Calcium or Magnesium Chloride, Calcium or Magnesium Sulphate (CaSo4, MgCl, etc).In some areas of India, there are ground waters which contain fluoride salts of Ca and Mg. Fluoride in water above 1.5 mg/l is dangerous and causes a disease called 'Fluorosis' which affects the teeth and the bones of humans who consume water with high levels of fluoride. Iron is another contaminant/impurity which is not safe for human consumption if it is present in water in excess of 0.3 mg/l. In several parts of eastern India, Arsenic is an impurity which has been found in ground water and needs to be removed as it is a slow poison.

Organic Impurities:

The upper layer of the earth's crust contain residual vegetable and animal matter along with bacteria and other micro-organisms. Surface waters therefore usually contain some

organic matter (tannins, lignins, humic acid, fulvic acid) and are more readily exposed to biological contamination. Surface waters are subject to seasonal changes because of rainfall and also due to domestic as well as industrial pollution. Agricultural run offs which bring with it pesticides and fertilizer residues are starting to cause serious problems with the use of surface waters. The constituent nutrients of fertilizers such as phosphorus and nitrogen can cause rapid, wide spread growths called “algal blooms” in lakes, ponds and reservoirs

Ground waters were relatively free from such contamination because of the filtering effect of the strata of soil through which the water percolates, but, over the decades industrial contaminants have begun to show up even in ground waters. This is because of the laxity in implementing/enforcing pollution control laws as a result of which untreated domestic and industrial effluents which has been discharged into open land has over the years percolated down to the water table and contaminated the ground water. This shows up in water in the form of BOD (biodegradable/biochemical oxygen demand) and COD (combined oxygen demand).These are two important parameters normally associated with effluents which are an indication of the extent of contamination which have now begun to show up in ground water and to a greater extent in surface water.

Standards of Water for Human Consumption:

Drinking water for human beings should contain some level of minerals(TDS), but these levels should not be excessive. The standard that applies to India is the BIS 10500-1991 standard (refer to attached table for the important parameters).This standard used the WHO standard as the basis and has been amended subsequently to take into account the fact that over exploitation of ground water which has the largest share of water supplied for human use has deteriorated to such an extent that the crucial parameters such as TDS, hardness, Chlorides, etc usually exceed the desirable levels substantially. Consequently, a higher permissible limit has been specified. Water used for drinking becomes unpalatable when the TDS level is above 500 mg/l, but lack of any better source enables people consuming such water to get used to its taste.

The BIS standard applies to the purity level acceptable for human beings to drink. For practically all industrial and some commercial uses, the purity levels required are very much higher and in most cases demand water with virtually no residual dissolved solids at all.

Water Testing:

The one certainty about ground water today is that its quality will continue to deteriorate over a period of time. The rate of deterioration will depend on the rate at which the water is extracted from the source and the levels of pollution that enter the source from time to time. Testing water samples regularly is advisable to keep track of the changes (deterioration).Water testing facilities are available with most Boards/Authorities that are responsible for supplying water to cities and towns as well as industrial estates. Increasingly stringent enforcement of pollution control laws have resulted in a substantial demand for laboratory facilities for water and effluent testing. There are numerous private water testing agencies in the field who, if they are assured of a steady flow of samples, will provide service that includes their personnel visiting the place for collection of samples to be taken for analysis.

Like the ISO-9000 quality system, an NABL accredited laboratory’s results are acceptable to any government authority(particularly Pollution Control boards).NABL is

the National Accreditation Board for Laboratories and is a very stringent quality system involving regular surveillance audits to retain the NABL certification or for renewing it. This quality system involves testing methods which are clearly specified and standardized for consistent, accurate results.

Laboratories run by the water supply boards/authorities usually carry out tests only for a few important parameters relevant for water used for human consumption. Laboratories other than these offer the full spectrum of service and offer to test a select few or all the parameters for which they charge accordingly. Where bacteriological tests are involved to check if the water is safe for drinking, specially sterilized bottles are to be used(provided by the lab), sampling procedures are to be followed and the sample is to be returned to the lab within a fixed period of time, as the tests have to be carried out within a specific period of time to ensure accurate results are obtained. Somewhat similar procedures are necessary for getting the BOD/COD figures for a sample of water or effluent.

If neither of the above two types of tests are to be carried out, a sample of water can be given to the laboratory in a PET/Polythene bottle of at least 2 litres volume. The bottle should be thoroughly rinsed in the water/effluent which has to be tested before filling it, properly sealed and labeled with date of collection, source and type of sample, name of the person/agency that requires the test report and then given to the laboratory.

Purification Processes:

Depending on the end use of a water, the analyses report of a sample of that water gives a clear indication of the type of purification that is required. In brief, the following are the purification processes available in India.

a) Water with turbidity in excess of limit specified in BIS 105000:

-Pressure filtration with addition of a coagulant.

-Pressure filtration with chlorination/ozonisation if bacteria is present.

b) Water with total hardness in excess of limit specified by BIS 105000:

-Sodium base exchange water softening or nano filtration.

c)Water with TDS level in excess of limit specified in BIS 105000:

- Reverse Osmosis desalination or electrodialysis depending on the level of TDS present.

d) Water with iron content in excess of limit specified by BIS 105000.

-If iron is in the dissolved form, aeration of water to oxidize and precipitate the iron, coagulant dosage followed by pressure filtration. OR

-Using an iron removal filter containing iron removal media.

e)Water with Fluoride content in excess of the limit specified by BIS 105000:

- Using a Deflouridation unit containing fluoride removal media.

f) Water with only bacteriological contamination (for domestic use):

- Boiling for 20 minutes, exposure to ultra violet light, iodination, ultrafiltration.

There are companies with substantial and proven expertise in water purification using all the above purification processes who can assess the user’s requirement accurately and select appropriate treatment systems which they can supply, install and service.

BIS 105000 STANDARD FOR DRINKING WATER

Essential Characteristics

Sr.no	Characteristic	Requirement.(desirable)	Permissible limit in the absence of an alternative source
1.	Color-Hazen units, maximum	5	25
2.	Odor	Unobjectionable	Unobjectionable
3.	Taste	Agreeable	Agreeable
4.	Turbidity,Ntu,Max	5	10
5.	pH value	6.5 to 8.5	No relaxation
6.	Total Hardness as CaCo3,max mg/l	300	600
7.	Iron as Fe,max mg/l	0.3	1.0
8.	Chlorides as Cl,max mg/l	250	1000
9.	Residual free Chlorine as Cl, min	0.2	- -

Desirable Characteristics

10.	Dissolved Solids, mg/l, max	500	2000
11.	Calcium as Ca, mg/l,max	75	200
12.	Copper as Cu, mg/l,max	0.05	1.5
13.	Manganese as Mn, mg/l,max	0.10	0.3
14.	Sulphate as So4,mg/l,max	200	400
15.	Nitrate as No3,mg/l,max	45	100
16.	Fluoride as F, mg/l,max	1.5	1.9
17.	Phenolic compounds, mg/lit, max	0.001	0.002
18.	Mercury as Hg, mg/lit max	0.001	No relaxation
19.	Cadmium as Cd, mg/lit , max	0.01	No relaxation
20.	Selenium as Se, mg/lit, max	0.01	No relaxation
21.	Arsenic as As, mg/lit, max	0.01	No relaxation
22.	Cyanide as Cn, mg/lit, max	0.05	No relaxation
23.	Lead as Pb, mg/lit, max	0.05	No relaxation
24.	Zinc as Zn, mg/lit, max	5.0	No relaxation
25.	Anionic detergents, mg/lit, max	0.2	1.0
26.	Chromium as Cr, mg/lit, max	0.05	No relaxation
27.	Polynuclear Hydro carbons	--	--
28.	Mineral oil, mg/lit ,max	0.01	0.03
29.	Pesticides, mg/lit, max	Absent	0.001
30.	Alkalinity, mg/lit ,max	200	600
31.	Aluminum as Al, mg/lit, max	0.03	0.2
32.	Boron as B, mg/lit, max	1.0	5.0

Bacteriological Standards:

a) For water entering a distribution system- Coliform count in any sample of 100 ml should be zero(0).
b) For water in a distribution system – (i) E Coli count in 100 ml of any sample must be zero (0). (ii)Coliform organisms should not be more than 10 per 100 ml in any sample. (iii) Coliform organisms should not be present in 100 ml of any two consecutive samples or more than 5% of the samples collected for the year.