

Microbial Quality Control in Food and Pharmaceutical Industries (SEC – A - 1)

BIS Standards for Drinking Water
(Unit - 4)

- Water is usually tasteless, odourless, colourless and, a liquid in its pure state.
- 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
- It usually contains several impurities (gases, solids, colour).
- 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
- 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.
- Ground water contains relatively small quantities of suspended impurities and very little colour.
- In contrast, surface waters contain lower levels of dissolved minerals, but higher suspended impurities, colour and industrial pollutants.

Physical Impurities

- These are usually in the form of suspended impurities and colour 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.

- Odour 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.
- Colour and turbidity are usually measured by instruments available for these purposes and are expressed in “Hazen units” for colour and in “Nephelometric Turbidity Units (Ntu)” for turbidity.

Mineral impurities

- 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)
- Presence of Calcium or Magnesium Chloride, Calcium or Magnesium Sulphate (CaSO_4 , MgCl_2 , etc) in water causes 'hardness in water'

- 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) and are more readily exposed to biological contamination.
- 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

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
- 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
- The [Central Water Commission](#) provides a classification of the tolerance limits for inland surface waters for the various classes of water use.
- As per ISI-IS: 2296-1982, the tolerance limits of parameters are specified as per classified use of water depending on various uses of water.

- The following classifications have been adopted in India-
- Class A: Drinking water source without conventional treatment but after disinfection
- Class B: Outdoor bathing
- Class C: Drinking water source with conventional treatment followed by disinfection.
- Class D: Fish culture and wild life propagation
- Class E: Irrigation, industrial cooling or controlled waste disposal

BIS Standard

- BIS is a statutory institution established under the *Bureau of Indian Standards Act, 1986* to promote harmonious development of the activities of standardization, marking and quality certification of goods & attending to connected matters in the country
- The BIS standard applies to the purity level acceptable for human beings to drink
- Bureau of Indian Standards has the following objectives -
 - i. To assess the quality of water resources, and
 - ii. To check the effectiveness of water treatment and supply by the concerned authorities

- This standard specifies the acceptable limits and the permissible limits in the absence of alternate source
- It is recommended that the acceptable limit is to be implemented as values in excess of those mentioned under 'Acceptable' render the water not suitable.
- Such a value may, however, be tolerated in the absence of an alternative source. However, if the value exceeds the limits indicated under 'permissible limit in the absence of alternate source' the sources will have to be rejected.

Organoleptic and physical parameters

Colour, Hazen Units	
IS 10500-2012	Acceptable: 5 Hz., Permissible: 15 Hz
Risks or effects	Visible tint, acceptance decreases
Sources	Tannins, Iron, Copper, Manganese, Natural deposits, organic waste
Treatment	Filtration, Distillation, Reverse osmosis, Ozonisation

Odour	
IS 10500: 2012	Agreeable
Risks or Effects	Rotten egg, musty, chemical smell
Sources	Chlorine, Hydrogen sulfide, Organic matter, Septic contamination, Methane gas
Treatment	Activated carbon, Air stripping, oxidation, Filtration

pH	
IS 10500-2012	Acceptable limit: 6.5-8.5, Permissible: No relaxation
Risks or effects	Low pH - corrosion, metallic taste High pH - bitter/soda taste, deposits
Sources	Natural
Treatment	Increase pH by soda ash Decrease pH with white vinegar / citric acid

Total dissolved solids, mg/l, Max	
IS 10500: 2012	Acceptable limit: 500 mg/l Permissible: 2000 mg/l
Risks or effects	Hardness, scaly deposits, sediment, cloudy coloured water, staining, salty or bitter taste, corrosion of pipes and fittings
Sources	Livestock waste, septic system Landfills, nature of soil Hazardous waste landfills Dissolved minerals, iron and manganese
Treatment	Reverse Osmosis, Distillation, deionization by ion exchange

Turbidity NTU Max

IS 10500: 2012

Acceptable unit: 1 NTU
Permissible limit: 5 NTU

Risks or effects

Cloudiness or haziness

Sources

High sediment deposition due to pollution and industrial activities like construction, mining, quarrying, agriculture, due to presence of organic matter such as phytoplankton

Treatment

Settling or filtration processes using sand filtration, settling tanks, and clarifiers.

Substances undesirable in excessive amounts

Aluminium (as Al), mg/l, Max	
IS 10500: 2012	Acceptable limit: 0.03 mg/l Permissible limit: 0.2 mg/l
Risks or effects	High risk associated with dialysis patients
Sources	Rock and soil leaching
Treatment	Portable Cation Exchange*** Distillation, Reverse Osmosis

Ammonia (as total ammonia-N), mg/l, Max	
IS 10500: 2012	Acceptable limit: 0.5 mg/l Permissible limit: No relaxation
Risks or effects	None proposed for human, but toxic for aquatic life
Sources	Disinfection with chloramines, wastes, fertilizers & natural processes
Treatment	Ion Exchange with zeolite Sodium aluminosilicate zeolites Distillation

Barium (as Ba), mg/l, Max	
IS 10500:2012	Acceptable limits: 0.7 mg/l Permissible limits: No relaxation
Risks or effects	Difficulties in breathing, increased blood pressure, changes in heart rhythm, stomach irritation, brain swelling, muscle weakness, and damage to the liver, kidney, heart, and spleen.
Source	Mineral deposits Disposal of drilling wastes Smelting of copper Motor vehicle parts manufacturing
Treatment Point-of-Entry (POE) Point-of-Use (POU)	Cation Exchange Reverse Osmosis Distillation

Iron (as Fe), mg/l, Max	
IS 10500: 2012	Acceptable limit: 0.3 mg/l Permissible limit: No relaxation
Risks or effects	Brackish color, rusty sediment, bitter or metallic taste, brown-green stains, iron bacteria, discolored beverages
Sources	Leaching of cast iron pipes in water distribution systems Natural
Treatment	Oxidizing Filter , Green-sand Mechanical Filter

Manganese (as Mn), mg/l, Max	
IS 10500: 2012	Acceptable limit: 0.1 mg/l Permissible limit: 0.3 mg/l
Risks or effects	Brownish color, black stains on laundry and fixtures at .2 mg/l, bitter taste, altered taste of water-mixed beverages
Sources	Landfills Deposits in rock and soil
Treatment	Ion Exchange , Chlorination, Oxidizing Filter , Green-sand Mechanical Filter

Sulphate (as SO ₄), mg/l, Max	
IS 10500: 2012	Acceptable limit: 200 mg/l Permissible limit: 400 mg/l
Risks or effects	Bitter, medicinal taste, scaly deposits, corrosion, laxative effects, "rotten-egg" odor from hydrogen sulfide gas formation
Sources	Animal sewage, septic system, sewage By-product of coal mining, industrial waste Natural deposits or salt
Treatment	Ion Exchange , Distillation , Reverse Osmosis

Nitrate (as NO ₃), mg/l, Max	
IS 10500: 2012	Acceptable limit: 45 mg/l Permissible limit: No relaxation
Risks or effects	Methemoglobinemia or blue baby disease in infants
Sources	Livestock facilities, septic systems, manure lagoons, fertilizers Household waste water, fertilizers Fertilizers Natural Deposits
Treatment	Ion Exchange, Distillation, Reverse Osmosis

Chloride (as Cl), mg/l, Max	
IS 10500: 2012	Acceptable limit: 250 mg/l Permissible limit: 1000 mg/l
Risks or effects	High blood pressure, salty taste, corroded pipes, fixtures and appliances, blackening and pitting of stainless steel
Sources	Fertilizers, Industrial wastes Minerals, seawater
Treatment	Reverse Osmosis , Distillation, Activated Carbon

Fluoride (as F), mg/l, Max	
IS 10500: 2012	Acceptable limit: 1.0 mg/l Permissible limit: 1.5 mg/l
Risks or effects	Brownish discoloration of teeth, bone damage, skeletal damage
Sources	Industrial waste Geological
Treatment	Activated Alumina, Distillation, Reverse Osmosis, Ion Exchange

Total arsenic (as As), mg/l, Max	
IS 10500: 2012	Acceptable limit: 0.01 mg/l Permissible limit: 0.05 mg/l
Risks or effects	Weight loss; Depression; Lack of energy; Skin and nervous system toxicity
Sources	Previously used in pesticides (orchards) Improper waste disposal or product storage of glass or electronics, Mining Rocks
Treatment	Activated Alumina Filtration, Reverse Osmosis, Distillation, Chemical Precipitation, Ion exchange, lime softening

Total chromium (as Cr), mg/l, Max	
IS 10500: 2012	Acceptable limit: 0.05 Permissible limit: No relaxation
Risks or effects	Skin irritation, skin and nasal ulcers, lung tumors, gastrointestinal effects, damage to the nervous system and circulatory system, accumulates in the spleen, bones, kidney and liver
Sources	Septic systems Industrial discharge, mining sites Geological
Treatment	Ion Exchange, Reverse Osmosis, Distillation

Copper (as Cu), mg/l, Max	
IS 10500: 2012	Acceptable limit: 0.05 Permissible limit: 1.5
Risks or effects	Anaemia, digestive disturbances, liver and kidney damage, gastrointestinal irritations, bitter or metallic taste; Blue-green stains on plumbing fixtures
Sources	Leaching from copper water pipes and tubing, algae treatment Industrial and mining waste, wood preservatives Natural deposits
Treatment	Ion Exchange, Reverse Osmosis, Distillation

Cyanide (as CN), mg/l, Max	
IS 10500: 2012	Acceptable limit: 0.05 mg/l Permissible limit: No relaxation
Risks or effects	Thyroid, nervous system damage
Sources	Fertiliser, Electronics, steel, plastics mining
Treatment	Ion Exchange, Reverse Osmosis, Chlorination

Lead (as Pb), mg/l, Max	
IS 10500-2012	Acceptable limit: 0.01 mg/l Permissible: No relaxation
Risks or effects	Reduces mental capacity (mental retardation), interference with kidney and neurological functions, hearing loss, blood disorders, hypertension, death at high levels
Sources	Paint, diesel fuel combustion Pipes and solder, discarded batteries, paint, leaded gasoline Natural deposits
Treatment	Ion Exchange, Activated Carbon , Reverse Osmosis, Distillation

Mercury (as Hg), mg/l, Max	
IS 10500-2012	Acceptable limit: 0.001 mg/l Permissible: No relaxation
Risks or effects	Loss of vision and hearing, intellectual deterioration, kidney and nervous system disorders, death at high levels
Sources	Fungicides Batteries, fungicides Mining, electrical equipment, plant, paper and vinyl chloride Natural deposits
Treatment	Reverse Osmosis, Distillation

Zinc (as Zn), mg/l, Max	
IS 10500-2012	Acceptable limit: 5 mg/l Permissible: 15 mg/l
Risks or effects	Metallic taste
Sources	Leaching of galvanized pipes and fittings, paints, dyes Natural deposits
Treatment	Ion Exchange Water Softeners, Reverse Osmosis, Distillation

Total coliform bacteria

IS 10500-2012

Nil/100ml

Risks or effects

Gastrointestinal illness

Sources

Livestock facilities, septic systems, manure lagoons Household waste water Naturally occurring

Treatment

Chlorination , Ultraviolet, Distillation, Iodination

E coliform bacteria	
IS 10500-2012	Nil/100ml
Risks or effects	Gastrointestinal illness
Sources	Livestock facilities, septic systems, manure lagoons Household waste water Naturally occurring
Treatment	Chlorination , Ultraviolet, Distillation, Iodination

Health effects of chemical parameters

Parameter	BIS Guideline value (maximum allowable)	General and health effect
Total dissolved solids	2000 mg/l	Undesirable taste; gastro intestinal irritations; corrosion or incrustation
pH	6.5-8.5	Affects mucous membrane; bitter taste; corrosion; affects aquatic life
Alkalinity	600	Boiled rice turns yellowish
Hardness	600	Poor lathering with soap; deterioration of the quality of clothes; scale forming; skin irritation; boiled meat and food become poor in quality

Parameter	BIS Guideline value (maximum allowable)	General and health effect
Calcium	200 mg/l	Poor lathering and deterioration of the quality of clothes; incrustation in pipes; scale formation
Magnesium	100 mg/l	Poor lathering and deterioration of clothes; with sulfate laxative
Iron	0.3 mg/l	Poor or sometimes bitter taste, color and turbidity; staining of clothes materials; iron bacteria causing slime
Manganese	0.3 mg/l	Poor lathering and deterioration of clothes; with sulfate laxative
Aluminium	0.2 mg/l	Neurological disorders; Alzheimer's disease
Copper	1.5 mg/l	Liver damage; mucosal irritation, renal damage and depression; restricts growth of aquatic plants
Zinc	15 mg/l	Astringent taste; opalescence in water; gastro intestinal irritation; vomiting, dehydration, abdominal pain, nausea and dizziness

Parameter	BIS Guideline value (maximum allowable)	General and health effect
Ammonia	0.5 mg/l	Indicates pollution; growth of algae
Nitrite		Forms nitrosoamines which are carcinogenic
Nitrate		Blue baby disease (methemoglobineamia); algal growth
Sulfate		Taste affected; laxative effect; gastro intestinal irritation
Chloride		Taste affected; corrosive
Fluoride		Dental and skeletal fluorosis; non-skeletal
Phosphate		Algal growth

Parameter	BIS Guideline value (maximum allowable)	General and health effect
Arsenic	0.05 mg/l	Toxic; bio-accumulation; central nervous system affected; carcinogenic
Mercury	0.001 mg/l	Highly toxic; causes 'minamata' disease-neurological impairment and renal disturbances; mutagenic
Cadmium	0.003 mg/l	Highly toxic; causes 'itai-itai' disease-painful rheumatic condition; cardio vascular system affected; gastro intestinal upsets and hypertension
Lead	0.01 mg/l	Causes plumbism-tiredness, lassitudes, abdominal discomfort, irritability, anaemia; bio-accumulation; impaired neurological and motor development, and damage to kidneys

Parameter	BIS guideline value (Maximum allowable)	General and health effects
Chromium	0.05 mg/l	Carcinogenic; ulcerations, respiratory problems and skin complaints
Pesticide		Affects central nervous system
Detergent		Undesirable foaming