Applied Chemistry

Water for Drinking and Cooking — Indian Standard Specification

1. Water for Human Consumption: Drinking and Cooking Purposes

Water intended for drinking and cooking purposes may be drawn from a variety of natural and man-made sources. However, whatever the source, water must be free from harmful microorganisms, toxic chemicals, and excessive dissolved or suspended impurities, and must meet defined quality standards before it can be considered safe and fit for human consumption.

The common sources from which water is obtained for drinking and cooking purposes are described below:

Source	Description
Surface Water	Water available on the surface of the Earth, including rivers, lakes, ponds, streams, and reservoirs; generally requires extensive treatment before use, since it is exposed to contamination from runoff, sewage, and atmospheric pollutants.
Groundwater	Water present beneath the Earth's surface, obtained through wells, tube wells, and springs; generally cleaner than surface water due to natural filtration through soil and rock layers, though it may contain dissolved minerals, salts, fluoride, iron, or arsenic depending on the local geology.
Rainwater	Water collected directly from rainfall, often through rooftop rainwater harvesting systems; relatively pure in its natural state, though it can dissolve atmospheric pollutants as it falls and may require simple filtration before use.
Municipal Supply	Treated water supplied through pipelines by municipal or public water supply authorities, sourced from rivers, reservoirs, or groundwater and subjected to systematic treatment (sedimentation, coagulation, filtration, and sterilization) before distribution.

Regardless of the source, water intended for human consumption must generally undergo appropriate treatment — such as sedimentation, coagulation, filtration, and sterilization (disinfection) — to remove suspended impurities, harmful microorganisms, and objectionable dissolved substances, before it can be considered potable (safe to drink).

Water used for cooking carries additional significance, since impurities present in the water can be concentrated during boiling and evaporation, or can chemically interact with the food being prepared, potentially affecting both the taste and the nutritional or hygienic

quality of the cooked food. For this reason, water used for cooking should meet the same quality standards required for drinking water.

2. Indian Standard Specification of Drinking Water

In India, the quality requirements for drinking water are laid down by the Bureau of Indian Standards (BIS) under the standard IS 10500, titled "Drinking Water — Specification". This standard was first published in 1983 and has since been revised to align with international water quality guidelines, including those of the World Health Organization (WHO). The current version, IS 10500:2012 (Second Revision), specifies the requirements and methods of sampling and testing for drinking water supplied for public consumption in India.

A distinctive feature of IS 10500:2012 is that it specifies two levels of limits for most parameters:

- Acceptable Limit: The preferred, desirable value up to which the water is considered safe and suitable for consumption without any adverse aesthetic or health effects; values in excess of this limit render the water unsuitable unless no alternative source is available.
- Permissible Limit (in the absence of an alternate source): A relaxed, higher limit that may be tolerated only when no better source of water is available; if a parameter exceeds even this permissible limit, the water source must be rejected as unfit for use.

IS 10500:2012 specifies requirements across several categories of parameters, including organoleptic and physical parameters (such as colour, odour, taste, and turbidity), general chemical parameters (such as pH, total dissolved solids, and hardness), parameters related to toxic substances (such as heavy metals and pesticide residues), and bacteriological, virological, and biological requirements, which together ensure that drinking water is both aesthetically acceptable and safe for health.

2.1 Selected Parameters and Their Acceptable / Permissible Limits (IS 10500:2012)

A selection of commonly referenced physical and chemical parameters, along with their acceptable and permissible limits as per IS 10500:2012, is given in the table below:

Parameter	Acceptable Limit	Permissible Limit (in absence of alternate source)
pH value	6.5 – 8.5	No relaxation
Colour (Hazen units), Max	5	15

Turbidity (NTU), Max	1	5
Total Dissolved Solids (mg/L), Max	500	2000
Total Hardness as $CaCO_3$ (mg/L), Max	200	600
Total Alkalinity as $CaCO_3$ (mg/L), Max	200	600
Chloride as Cl (mg/L), Max	250	1000
Sulphate as SO_4 (mg/L), Max	200	400
Nitrate as NO_3 (mg/L), Max	45	No relaxation
Fluoride as F (mg/L), Max	1.0	1.5
Iron as Fe (mg/L), Max	0.3	1.0 (commonly cited)
Residual Free Chlorine (mg/L), Min	0.2 (at consumer end, when chlorination is practised)	—
Total Coliform / E. coli	Shall not be detectable in any 100 mL sample	No relaxation (mandatory)

Note: The values above reflect commonly cited figures for IS 10500:2012 (Second Revision) as compiled from standard references and BIS-based summaries; for statutory or laboratory compliance purposes, the original IS 10500:2012 document (and any subsequent amendments) published by the Bureau of Indian Standards should be consulted.

Some of the key health and aesthetic considerations associated with these parameters include:

- pH: Water that is too acidic (low pH) can cause corrosion of pipes and fittings, while water that is too alkaline (high pH) can impart a bitter or soda-like taste.
- Total Dissolved Solids (TDS): High TDS affects the taste of water, and can cause scaling, gastrointestinal discomfort, and corrosion of pipes and fittings.
- Total Hardness: Excess hardness causes poor lathering with soap, scale formation in pipes and heating appliances, and can affect the taste of water and food prepared with it.
- Fluoride: While a small, controlled amount of fluoride is beneficial for dental health, excess fluoride in drinking water over a prolonged period can cause fluorosis, a condition affecting teeth and bones.
- Nitrate: Excess nitrate in drinking water is particularly dangerous for infants, since it can cause methemoglobinemia (commonly known as “blue baby syndrome”), a condition that reduces the oxygen-carrying capacity of the blood.

- Bacteriological requirements: The presence of total coliform bacteria or E. coli in drinking water indicates faecal contamination and the possible presence of disease-causing pathogens; IS 10500:2012 requires that these organisms must not be detectable in any 100 mL sample of drinking water, with no relaxation permitted under any circumstances.

Compliance with these standards is essential to ensure that water supplied for drinking and cooking purposes, whether by municipal authorities, private suppliers, or individual households drawing water from wells or other sources, remains safe, palatable, and free from significant health risks to consumers.

3. Multiple Choice Questions (MCQs)

Answer the following questions by selecting the most appropriate option.

1. Which of the following is generally considered the purest natural source of drinking water before atmospheric contamination?

A) River water
B) Rainwater
C) Pond water
D) Sea water

2. Groundwater is generally cleaner than surface water mainly because it undergoes:

A) Chemical treatment before reaching the ground
B) Natural filtration through soil and rock layers
C) Boiling underground
D) No contact with any minerals

3. The Indian standard specification for drinking water is published by:

A) World Health Organization (WHO)
B) Bureau of Indian Standards (BIS)
C) Ministry of Water Resources
D) Central Pollution Control Board (CPCB)

4. The current (second revision) Indian standard specification for drinking water is designated as:

A) IS 456:2000
B) IS 10500:2012
C) IS 3025:1991
D) IS 12345:2012

5. As per IS 10500:2012, the acceptable pH range for drinking water is:

A) 5.0 – 7.0
B) 6.5 – 8.5

C) 7.5 – 9.5

D) 4.5 – 6.5

6. As per IS 10500:2012, the acceptable limit of total dissolved solids (TDS) in drinking water is:

A) 100 mg/L

B) 500 mg/L

C) 1000 mg/L

D) 5000 mg/L

7. As per IS 10500:2012, the acceptable limit of total hardness (as $CaCO_3$) in drinking water is:

A) 100 mg/L

B) 200 mg/L

C) 600 mg/L

D) 2000 mg/L

8. As per IS 10500:2012, the acceptable limit of fluoride in drinking water is:

A) 0.5 mg/L

B) 1.0 mg/L

C) 2.0 mg/L

D) 5.0 mg/L

9. As per IS 10500:2012, the acceptable limit of chloride in drinking water is:

A) 100 mg/L

B) 250 mg/L

C) 500 mg/L

D) 1500 mg/L

10. As per IS 10500:2012, the acceptable limit of nitrate in drinking water is:

A) 10 mg/L

B) 45 mg/L

C) 100 mg/L

D) 250 mg/L

11. According to IS 10500:2012, the presence of total coliform or E. coli in a 100 mL sample of drinking water is:

A) Permissible up to a small limit

B) Not detectable, with no relaxation allowed

C) Allowed if chlorine is added later

D) Not tested for at all

12. Excess fluoride in drinking water, beyond the permissible limit, is mainly associated with the health condition known as:

A) Methemoglobinemia

B) Fluorosis
C) Typhoid
D) Cholera

13. Excess nitrate in drinking water is particularly associated with a health risk in infants known as:

A) Fluorosis
B) Methemoglobinemia (blue baby syndrome)
C) Arsenicosis
D) Jaundice

14. The minimum residual free chlorine required at the consumer end of a treated water supply, as commonly specified, is:

A) 0.02 mg/L
B) 0.2 mg/L
C) 2.0 mg/L
D) 20 mg/L

15. The 'permissible limit in the absence of an alternate source' in IS 10500:2012 means that:

A) The water is completely unfit for any use
B) This higher limit may be tolerated only when no better source of water is available
C) This is the preferred, most desirable value
D) This limit applies only to industrial water

Answer Key

1. B) Rainwater | 2. B) Natural filtration through soil and rock layers | 3. B) Bureau of Indian Standards (BIS) | 4. B) IS 10500:2012 | 5. B) 6.5 – 8.5 | 6. B) 500 mg/L | 7. B) 200 mg/L | 8. B) 1.0 mg/L | 9. B) 250 mg/L | 10. B) 45 mg/L | 11. B) Not detectable, with no relaxation allowed | 12. B) Fluorosis | 13. B) Methemoglobinemia (blue baby syndrome) | 14. B) 0.2 mg/L | 15. B) This higher limit may be tolerated only when no better source of water is available

4. Broad / Long Answer Questions

1. Describe the different natural and man-made sources from which water may be obtained for human consumption, for drinking and cooking purposes.

2. Explain why groundwater is generally considered cleaner than surface water, and mention the impurities that may still be present in groundwater depending on local geological conditions.

3. Explain the two-tier system of 'Acceptable Limit' and 'Permissible Limit in the absence of an alternate source' used in IS 10500:2012, and explain the significance of each.

4. State the Indian standard specification governing drinking water quality, mentioning the organisation responsible for publishing it and the year of its most recent (second) revision.

5. List the acceptable and permissible limits, as per IS 10500:2012, for pH, turbidity, and total dissolved solids in drinking water.

6. List the acceptable and permissible limits, as per IS 10500:2012, for total hardness, chloride, and sulphate in drinking water.

7. Explain the significance of fluoride and nitrate limits in drinking water, referring to the specific health conditions associated with excess levels of each.

8. Explain why bacteriological requirements (total coliform and E. coli) in IS 10500:2012 have no permissible relaxation, unlike most chemical parameters.

9. Explain the importance of maintaining a minimum residual free chlorine level in treated drinking water supplied to consumers.

10. Discuss the overall importance of adhering to Indian standard specifications for drinking water quality, referring to the health and aesthetic considerations involved.