Unit 4 : Water Quality

Chapter 1 : Water Quality and Criteria

Water quality

We have a glass of water in front of us. Can we say for sure if it is drinkable or not? The answer is 'no'. It may contain metals, salts, chemicals or some organic matter. Some of these are visible and some are invisible. Some of them change color, taste and smell of water. If it is visible to the eye, it is easy to estimate the quality of the water. But if they are not visible, then the quality cannot be checked by looking at the water alone.

What exactly is water quality?

Water quality depends on the percentage of dissolved physical and chemical substances in the water. Water quality is considered to be degraded when these substances are mixed in more than a certain amount of water. Water quality does not need to be the same for all uses (such as water used for agriculture, factory, drinking water). Since man is a sensitive animal, the quality of water he needs should be higher. Like that plants and land also needs pure water. Polluted water spreads the contamination to grains and vegetables, and as human use these, eventually humans will be harmed by it. Water supplied to the machines can be used even though it is of comparatively low quality. The wastewater from the city of Nagpur is purified and used to keep the machinery cool at the 'Koradi power plant' in Nagpur. This use is called water recycling. Reuse of the same water naturally reduces the demand for water.

Quality water is useful for the proper growth of human beings, animals and plants. It is unfortunate that approximately 29% of the world's population today does not have access to safe drinking water. Consumption of such water leads to various ailments. Water quality can be enhanced by natural and chemical action.

How does water get polluted?

Water is polluted both by nature and humans. We get water because of rain. We have already understood how it rains through the water cycle. Due to heat the sea water evaporate, forming clouds of vapor, which are turned to land due to the wind and rain falls. This rain water is pure. But when this water travels from the highlands to the plane grounds, it keeps coming in contact with various objects. Water keeps accepting good and equally bad things. This can lead to pollution. Not only that, when it seeps in the ground, it goes through soil, loam, rocks. They contain traces of minerals, salts and chemicals. In Bangladesh and in our country, some regions like Kokan, arsenic has found in large quantity in the soil. As arsenic is a toxic chemical. So when this water is taken out of the ground and used for drinking without purifying it, it goes into the human body and he has to suffer the consequences.

Like nature, human are also responsible for increasing water pollution. Water pollution has also been exacerbated by domestic sewage, water contaminated by chemical fertilizers and pesticides, and water containing a mixture of chemicals and minerals from factories. We get water from three sources namely rivers, lakes and ground. Of these, the river water flows and is oxygenated, and most of the water is pure, but the stagnant lake water and groundwater do not have such a process, so it is difficult to remove the pollution.

In our country, sewage generated in homes, farms and factories is discharged into the drains without being treated. These runnels flow into the river. As a result, all the rivers in our country are polluted. Bathing in the

water of some rivers can have adverse effects on your body. Water resources are already limited and if there is pollution, the availability of water is further reduced. For example, Powai Lake in Mumbai- despite having such a large reservoir in the center of the city, its water is polluted and cannot be used for drinking. So we have to fetch water from a distance of more than 100 km.

Water is always classified into surface water and groundwater. If surface water is to be purified, it can be easily purified. But if unclean/polluted water seeps into the ground, it is extremely difficult to purify it. So seepage of this unclean/polluted water into the ground must not be there. We always have to be aware of that.

Water quality Important concepts

pH (Potential of Hydrogen) of water :

Depending on the amount of acidic or alkaline substances mixed in the water, we have a measure of pH. Universal indicator is use for measurement of pH.

The numbers of 0 to 14 on the given scale are indicated by different coloured marks. It indicate the amount of acidic substances decreases from 0 to 7 and increases alkaline substances from 7 to 14 and 7 number indicates neutral pH e.g. Rainwater. Running water pH levels are generally 6.5 to 8.5.

Groundwater pH levels, however, range from 6.0 to 8.5. The higher the level of ions of iron, manganese, copper, lead, zinc in the water, that water is more acidic in nature. Such water causes rust on metals, stains on clothes, its consumption harms human health. Conversely, an increase in calcium carbonate leads to an increase in salinity.

pH of some substances are as follows :

Apple Juice : 3
Orange Juice : 3.5
Coffee : 5.5
Milk : 6.2
Soap Water : 10
Solution of bleaching powder : 12

Disolved Oxygen :

The most important factor in water quality is the dissolved oxygen in the water. Fish and other living things in water need oxygen to survive. Due to the movement of air, oxygen enters from the surface of the water and exists in a dissolved state. Oxygen formed during the photosynthesis process of aquatic plants, in wetlands or in mud is also soluble in water. This oxygen is useful for fish and other living things to breathe. The amount of oxygen in flowing and turbulent water of streams or rivers is higher than that of stagnant lake water. This dissolution continues until saturation occurs.

There is a correlation between the temperature of water and the dissolved oxygen. It is lower in hot water and higher in cold water. The amount of dissolved oxygen can be increased by creating artificial turbulence in the water or by exposing the oxygen to the water. In short, the amount of dissolved oxygen depends on temperature, air pressure, and salinity of the water. The oxygen level is higher on the surface of the water, it lowers as you go deep into the water. The reason for this is that the amount of oxygen naturally decreases as the aquatic life uses it.

Biological Oxygen Demand (B.O.D.) :

The bacteria that maintain the quality of the water must get the required amount of oxygen dissolved in water. If it is reduced, the bacteria will not be able to survive. Nature is constantly supplying oxygen to the flowing water. When water and oxygen come in contact, the oxygen dissolves in it. Standards have been set for how much it should be.

If this amount is 1 to 2 mg per liter, then water is considered to be very good.

It is considered satisfactory if it is 3 to 5 mg. If it is 6 to 9 mg, it is considered to contain polluting organic matter. As the proportion increases, so does the pollution.

BOD levels of water required for agriculture and industry are also higher.

Chemical Oxygen Demand (C.O.D.) :

The chemical oxygen requirement of water is examined from the point of view of checking the efficiency of the sewage treatment plant. If the COD of water is high, it is considered to be harmful to aquatic organisms. If more organic matter is dissolved in water, then COD is higher. A mechanism is set up to reduce it. With the help of this system, it is beneficial to reduce the COD in the wastewater and then dump it in the river. Most cities do not have such systems. That is why the rivers of our country are found to be in the grip of pollution. COD in water should not exceed 250 mg per liter.

Is it must the Rainwater Be Pure?

Rainwater is pure because the water evaporates due to heat, creating clouds and water droplets. In the past, distilled water was needed for injections. For fulfilling this need of water they collect the rain water in rainy days and consider that the water is pure.

But one thing is not taken into consideration. When it starts to rain, the water droplets travel from the clouds to the ground. It is also important to consider how clean is the air in the atmosphere. Soil particles in the air, microscopic chemicals contained in the smoke are polluting these raindrops and when this drop falls on the ground, there is no guarantee that the water in it will be pure. In Dombivali, an industrial estate in Mumbai's suburbs, has received green rain. When this was studied, it was found that there were some chemical industries in this colony, the chemicals were released in the form of vapor in the air. It affected the rain and the raindrops turned green.

When there is first rainfall in Pune, it's pH is 4 to 6. For this reason, when the roof water is used for recharge, it is said that the first rain water should not seep into the ground.

Do you know

Experiment of New Water in Singapore :

Singapore is considered to be one of the most advanced nations in the world. The water problem of this country is very acute. Despite the good rains, the problem is compounded by the fact that there are very few dams, rivers and streams in the country and there is not enough space to store water. Therefore, this country imports water from Malaysia to solve the water problem. Water is imported through a long-term agreement with that country. But the country is in a crisis of high demand and limited supply. With a lot of research, this country has come up with the right answer to the question. For this, they used two ways. The first way is to desalinate seawater. Seawater is made potable by setting up big factories. In this way they complete country's 35 % need of water.

In spite of this, unable to fulfill the demand, they did another experiment. The wastewater generated in the cities is purified to such an extent, that it is also used for drinking. For this 47 different tests are done and only then the water is used. This water is called New Water. Initially, the public strongly opposed to use this water. But through government efforts and with the help of media, they were convinced that the water was pure. Now the fears in the minds of the people have completely disappeared and it is being used for drinking water. In this way 35% need completed. Gradually, the water supply will be increased to such an extent that the country will not even have to import water from Malaysia.

Let's Tell

If you decide to reuse wastewater from your town or village, write down the plan for uses of that water.

When considering water quality, one has to consider the purpose for which the water will be used. Water is used for various purposes like drinking, domestic use, swimming, agriculture, industries etc. Accordingly the required quality of water changes. The amount of physical, chemical and biological elements in water is the quality of water. Water is a universal solvent. Water has the capacity to absorb and dissolve as many components as possible. According to the standards set by the Indian Standards Organization (ISO) for drinking water quality, water is said to be contaminated if one or more components are found to exceed the ceiling. This contaminated water is detrimental to the proper growth of living organisms i.e. humans, animals and plants. Groundwater quality is being affected by the increase in total population, changing lifestyles, increasing use of groundwater in rural and urban areas, as well as the use of factories and their wastewater, agriculture and its fertilizers and pesticides.

4.1.1 Water Testing

Although the taste, smell, color and cleanliness of water are all indicators of water quality, to determine its safety for drinking, it is necessary to carry out physical, chemical and biological testing of drinking water. Turbidity caused by small sand or mud particles in the water and odor caused by substances like hydrogen sulfide can affect the acceptability of water. All these offensive elements are reduced when water is filtered properly. When water comes in contact with clean air and sunlight the odor is reduced

Following things are necessary to make water drinkable :

1. The water should be good in taste. It should not be brackish, salty or oily.
2. It should be crystal clear, colorless and transparent (showing bottom).
3. The water should not have odor, no algae or oily layer.
4. Harmful chemicals should not be overdosed or not at all.
5. It should not contain harmful bacteria or viruses.
6. The pH of water should be 6.5 to 8.5.
7. Water should be stored in a clean, covered and convenient container.

4.1.2 Water quality testing machine

Our body definitely needs certain amounts of elements like iron, calcium, magnesium. But if their amount in water increases, they can be dangerous to all living organisms including human beings. In addition, metals like arsenic, barium, cadmium, chromium, and lead from man-made substances can be dissolved in water .

Maximum limits of vital properties (or proportion of constituents) of water taken as per Indian standards (Central Public Health Engineering Code of Practice) given in chart.

Water Quality Standards

Water Components	Standards	Permisibile Value
pH of Water	6.5-8.5	8.5
Hardness of water ($CaCO_3$)	300 mg/liter	600 mg/liter
Chloride (Cl^-)	250 mg/liter	1000 mg/liter
Sulphate (SO_4^{2-})	200 mg/liter	400 mg/liter
Florides (F^-)	1.0 mg/liter	1.5 mg/liter
Nitrates (NO_3^-)	45 mg/liter	45 mg/liter
Calcium (Ca^{2+})	75 mg/liter	200 mg/liter
Iron (Fe^{2+})	0.3 mg/liter	0.3 mg/liter
Mangenese (Mn^{2+})	0.1 mg/liter	0.3 mg/liter
Copper (Cu^{2+})	0.05 mg/liter	1.5 mg/liter
Zink (Zn^{2+})	5.0 mg/liter	15 mg/liter
Arcenic (As^{3+}), Chromium (Cr^{2+}), Lead (Pb^{2+})	0.05 mg/liter	Not more than 0.05 mg/liter
Cadmium (Cd^{2+})	0.01 mg/liter	Not more than 0.01 mg/liter
Mercury (Hg^{2+})	0.001 mg/liter	Not more than 0.001 mg/liter
TDS	500 mg/liter	2000 mg/liter

Microbes - The highest probability index of Coliform species should be zero or less than one in 100 ml. Also the highest probability index of the total number of microorganisms in any sample should not be more than 10 in 100 ml. The maximum limits of these substances are mentioned. In addition, these standards should include maximum limits on the amount of viruses, asbestos and chlorinated carbonaceous substances.

The effects of harmful substances in water

Sr.No.	Substances	Consequences of crossing the limits
1.	Turbidity	Due to turbidity, there is room for growth of pathogens in the water. People will not use muddy water for drinking as it does not look attractive or clean.
2.	pH	If the concentration is less than 7 or more than 8.5, the biochemical activities/processes in the body are not carried out properly.
3.	Heaviness (due to salts)	It takes time to cook food, soap does not foam, stains on clothes and utensils, etc.
4.	Iron and manganese	In rare cases it can cause gastric ulcer.
5.	Chloride	More than 1000 mg per liter of chloride makes water salty and people do not use it for drinking. Also, chloride in water is an indicator of fecal contamination.
6.	Fluoride	If the fluoride level is less than 1 mg per liter, spots will appear on the teeth. Fluoride levels greater than 1.5 mg per liter cause bone diseases.
7.	Phosphate	Helps to grow of algae and other aquatic plants and water quality deteriorates.
8.	Nitrate	A life-threatening circulatory disease like 'Blue Baby'
9.	Arsenic	Arsenic poisoning can cause skin damage, muscle weakness, and prolonged drinking of this water can lead to skin or lung cancer.
10.	Bacteria and viruses	Diseases like typhoid, dysentery, diarrhea, cholera, jaundice, polio, scabies are caused by pathogenic bacteria and viruses in the water.
11.	Worms and germs	Diseases like stomach worms, malaria, filariasis etc. can be caused.

In short, water quality is a very important factor in water use. That is, water quality is also an important factor in determining water type associated with use. Roughly speaking, there are various types of water quality such as for drinking water for domestic use, water suitable for agriculture as well as water that can be used for factories. Of course, the quality of drinking water must be highest in all these.

Exercise

1. Explain the concept of : BOD and COD.
2. Get more information about the New Water experiment and present it to the class.
3. Write any four criteria for drinking water quality.
4. Briefly describe the consequences of exceeding the quality limit.
5. Write a definition of contaminated water.
6. With the help of elders in the house, check the quality of water coming into your house from the inspection center provided by the water supply department.
7. Inspect the pH of various water sources in the village or surrounding area.