THE PLIGHT OF POTABLE AND USABLE WATER – POLLUTION, HEALTH HAZARDS, ENVIRONMENTAL THREATS AND ABATEMENT METHODS

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Summary

This chapter has attempted to provide a comprehensive outline of the importance, physical and chemical properties, sources, sources of contamination and their effect on health and environment, standards of quality and methods of treatment of waste water for the purpose of pollution control and water conservation. The methods outlined here are not without cost and are indicative of the complexity of the problem of combating pollution of potable water. It should also be remembered that these methods cannot solve our problem completely and what is left for us "intelligent humans" to realize when we open a tap to use water is that we cannot afford to waste valuable water. If we continue to pollute our water sources, the days are not far off when nations will fight wars, not for land but for safe, usable water. The chapter is addressed to the general reader who may not be a specialist in the field by avoiding depth and details with the main aim of creating an appreciation of the problems associated with potable and usable water on our planet.

1. Introduction

Water was one of the most abundant and easily available substances on our planet in the past. We say figuratively, even now, that money is spent like water by a spendthrift to undermine its value. Ironically, in our present-day world with heavy industrialization

and gross neglect of its side effects, we now realize that the converse is becoming true. Water is fast becoming a precious commodity. It has no substitute in our life support system. Human settlements and migrations throughout history have been influenced essentially by the availability of water.

Many cities have been built on the banks of rivers, lakes and similar water sources. Initially water was used mostly in the domestic sector and in the field of agriculture. This use had negligible adverse side effects on the water resources themselves. But with the advent of industrialization, the scenario has gradually changed. The acts of pollution which were marginal in the early days of industrial revolution have now assumed alarming proportions and if they continue unabated, are bound to cause irreparable damage to our life support system and the environment in future decades.

This chapter is concerned about water. It attempts to highlight the importance of water in our world of increasing population declining water quality and depletion usable water resources. Water is such a common and seemingly simple substance that we fail to realize that its properties are unique and often lie at the extreme end of the ranges of those of the other substances. It is the only substance of its kind capable of supporting life known in all forms on our planet.

2. Some Physical Properties of Water

For the sake of useful information certain important physical properties of water are given in Table 1.

Property	**Value**
Freezing point	0°C
Density of ice, 0°C	0.92 g
Density of water, 0°C	1.00 g cm^{-3}
Heat of fusion	80 cal g^{-1}
Boiling point	100°C at 760 mm
Heat of vaporization	540 cal g^{-1}
Critical temperature	347°C
Critical pressure	217 atm
Specific electrical conductivity at 25°C	1×10^{-7}/ohm-cm
Dielectric constant	78

Table 1. Some properties of water.

It is important to note that these properties are taken as reference to express the properties of all other matter on the earth. There are some special properties unique to water. These uncommon properties of this common substance render it supportive of life on our planet.

For instance, the density of water is at its maximum at 4°C unlike most liquids whose solid phases have greater density. This property enables survival of aquatic life even in frozen bodies of water. Its surface tension results in its retention in soil interstices and its ascent into plant tissues. Figure 1 shows the structure of the water molecule.

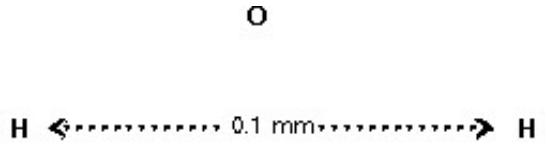

Figure 1. Structure of the water molecule.

3. Some Chemical Properties of Water

Water is not a strong oxidizing agent; it is even a poorer reducing agent. Water reacts with certain substances to form hydrates. In these, the water molecule is intact but becomes a part of the structure of the solid. In the formation of hydrates, generally heat is generated.

The large electronegetativity difference between its constituent atoms, namely hydrogen and oxygen, gives rise to an important intermolecular interaction – "hydrogen bonding." It is because of water's polar nature that it brings ions into solution and is an ideal medium for transporting nutrients in the bodies of organisms. Its unusual thermal properties allow storage and transport of heat and there are thermoregulation systems to maintain temperatures in a small range in the human body.

4. Sources of Water

Water covers two-thirds of the total surface area of the earth, the major sources being the oceans, ground water and surface water. A major portion of our water reserves are in the oceans. However, due to its high salt content, this is unfit for any use. Underground water reserves are estimated to be greater in magnitude than those of fresh water lakes and reservoirs combined. Underground water occurs in several geological formations known as aquifers at various depths. Under pressure this water is called artesian water. Underground water originates from precipitation over various ages which are determined by measurement of the decay of titrium, a radioactive isotope of hydrogen found in ground water. Water tables fluctuate depending upon the extent of recharge, rainfall, rate of extraction etc. Surface water is available in lakes, ponds, swamps, marshes, reservoirs etc.

The hydrological water cycle is a continuous circulation of the earth's moisture. This cycle is driven by solar energy in nature. Water flows away into the rivers and thereafter into the seas by run off which depends on the depth porosity, compactness of soil and the underlying material. Run off also depends on slope, surface configuration, character and density of vegetation.

The effect of run off is soil erosion. Land management is vital to soil and water conservation. The amount of water available on our planet has been nearly constant for several ages. There are several uses of water by human activity which hardly affects this amount although usable water is fast becoming a scarce commodity. Fish, wildlife and recreational use are nonconsumptive. Artificial impoundments unless properly located, designed and operated can destroy or depreciate priceless natural environment. Proper water management which includes recycling is essential to conserve usable water.

5. Degradation of Water Quality

Human activity, urbanization and industrialization result in large-scale contamination of water resources. We use our rivers, lakes and seas as dumping grounds for sewage and industrial waste. Any substance present in a greater quantity than that naturally occurring is a pollutant. Our desire and consequent attempt to develop and prosper have compelled us to nurture this destructive giant, namely, pollution.

Each day at least 25 000 people die from their everyday use of water, ironically, the very stuff of life itself. Dirty water is both the world's biggest killer and its biggest single pollution problem. In order to assess water quality, the following parameters are considered.

5.1. pH

pH is a measure of the acidity/alkalinity of the water sample. This parameter is a major controlling factor of metabolic activities in aquatic life because the chemical reactions taking place in organisms are pH-dependent.

5.2. Suspended Solids

The colloidal particles present in water give rise to suspensions which have the ability to absorb ions and positively charged species. Therefore insoluble materials can be transported large distances.

5.3. Potential

The potential is the capacity for oxidation or reduction. The factor used to measure the capacity to be oxidized is called Biochemical Oxygen Demand or BOD. It indicates the extent of pollution. When certain nutrients (pollutants) occur in larger quantities compared to their natural abundance, there is an explosion in algal population. The result is exhaustion of at least one of the nutrients which consequently leads to starvation and death of the entire algal population in the water body causing depletion in levels of dissolved oxygen. The fish in such waters suffer from asphyxia and perish. Finally what remains is a large deposition of the remains of the dead organisms.

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Bibliography and Suggestions for further study

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