WATER CONTINUED

DISINFECTION

The filtered water may normally contain some harmful disease producing bacteria in it. These bacteria must be killed in order to make the water safe for drinking. The process of killing these bacteria is known as Disinfection or Sterilization.

Disinfection Kinetics

When a single unit of microorganisms is exposed to a single unit of disinfectant, the reduction in microorganisms follows a first-order reaction.

$dN/dt=-kN$ $\qquad N=N_0e^{-kt}$

This equation is known as Chick's Law:-

N = number of microorganism (N_0 is initial number)
k = disinfection constant
t = contact time

Chlorine Chemistry

Chlorine is added to the water supply in two ways. It is most often added as a gas, $Cl_2(g)$. However, it also can be added as a salt, such as sodium hypochlorite (NaOCl) or bleach. Chlorine gas dissolves in water following Henry's Law.

$$Cl_{2(g)} \longrightarrow Cl_{2(aq)} \quad K_H = 6.2 \times 10^{-2}$$

Once dissolved, the following reaction occurs forming hypochlorous acid (HOCl):

$$Cl_{2(aq)} + H_2O \longrightarrow HOCl + H^+ + Cl^-$$

Hypochlorous acid is a weak acid that dissociates to form hypochlorite ion (OCl-).

$$HOCl \longrightarrow OCl^- + H^+ \quad Ka = 3.2 \times 10^{-8}$$

All forms of chlorine are measured as mg/L of Cl_2 (MW = 2 x 35.45 = 70.9 g/mol) Hypochlorous acid and hypochlorite ion compose what is called the free chlorine residual. These free chlorine compounds can react with many organic and inorganic compounds to form chlorinated compounds. If the products of these reactions posses oxidizing potential, they are considered the combined chlorine residual. A common compound in drinking water systems that reacts with chlorine to form combined residual is ammonia. Reactions between ammonia and chlorine form chloramines, which is mainly monochloramine (NH_2Cl), although some dichloramine ($NHCl_2$) and trichloramine (NCl_3) also can form. Many drinking water utilities use monochloramine as a disinfectant. If excess free chlorine exits once all ammonia nitrogen has been converted to monochloramine, chloramine species are oxidized through what is termed the breakpoint reactions. The overall reactions of free chlorine and nitrogen can be represented by two simplified reactions as follows:

Monochloramine Formation Reaction. This reaction occurs rapidly when ammonia nitrogen is combined with free chlorine up to a molar ratio of 1:1.

$$HOCl + NH_3 \longrightarrow NH_2Cl + HOCl$$

ENVIRONMENTAL PROTECTION

Environmental protection is a practice of protecting the natural environment on individual, organizational or governmental levels, for the benefit of both the environment and humans. Due to the pressures of overconsumption, population and technology, the biophysical environment is being degraded, sometimes permanently. This has been recognized, and governments have begun placing restraints on activities that cause environmental degradation. Since the 1960s, activity of environmental movements has created awareness of the various environmental issues. There is no agreement on the extent of the environmental impact of human activity and even scientific dishonesty occurs, so protection measures are occasionally debated.

Academic institutions now offer courses, such as environmental studies, environmental management and environmental engineering, that teach the history and methods of environment protection. Protection of the environment is needed due to various human activities.ref. Waste production, air pollution, and loss of biodiversity (resulting from the introduction of invasive species and species extinction) are some of the issues related to environmental protection. Environmental protection is influenced by three interwoven factors: environmental legislation, ethics and education. Each of these factors plays its part in influencing national-level environmental decisions and personal-level environmental values and behaviors. For environmental protection to become a reality, it is important for societies to develop each of these areas that, together, will inform and drive environmental decisions.

Drinking water supply and sanitation in India continue to be inadequate, despite longstanding efforts by the various levels of government and communities at improving coverage. The level of investment in water and sanitation, albeit low by international standards, has increased in size during the 2000s. Access has also increased significantly. For example, in 1980 rural sanitation coverage was estimated at 1% and reached 21% in 2008. Also, the share of Indians with access to improved sources of water has increased significantly from 72% in 1990 to 88% in 2008.[7] At the same time, local government institutions in charge of operating and maintaining the infrastructure are seen as weak and lack the financial resources to carry out their functions. In addition, only two Indian cities have continuous water supply and according to an estimate from 2008 about 69% of Indians still lack access to improved sanitation facilities.

A number of innovative approaches to improve water supply and sanitation have been tested in India, in particular in the early 2000s. These include demand-driven approaches in rural water supply since 1999, community-led total sanitation, a public-private partnerships to improve the continuity of urban water supply in Karnataka, and the use of microcredits for water supply and sanitation in order to improve access to water and sanitation.

Policy and regulation

The responsibility for water supply and sanitation at the central and state level is shared by various Ministries. At the central level three Ministries have responsibilities in the sector: The Ministry of Drinking Water and Sanitation (until 2011 the Department of Drinking Water Supply in the Ministry of Rural Development) is responsible for rural water supply and sanitation; the Ministry of Housing and Urban Poverty Alleviation and the Ministry of Urban Development share the responsibility for urban water supply and sanitation. Except for the National Capital Territory of Delhi and other Union Territories, the central Ministries only have an advisory capacity and a limited role in funding. Sector policy thus is a prerogative of state governments.

National Urban Sanitation Policy. In November 2008 the government of India launched a national urban sanitation policy with the goal of creating what it calls "totally sanitized cities" that are open-defecation free, safely collect and treat all their wastewater, eliminate manual scavenging and collect and dispose solid waste safely. As of 2010, 12 states were in the process of elaborating or had completed state sanitation strategies on the basis of the policy. 120 cities are in the process of preparing city sanitation plans. Furthermore, 436 cities rated themselves in terms of their achievements and processes concerning sanitation in an effort supported by the Ministry of Urban Development with the assistance of several donors. About 40% of the cities were in the "red category" (in need of immediate remedial action), more than 50% were in the "black category" (needing considerable improvement) and only a handful of cities were in the "blue category" (recovering). Not a single city was included in the "green category" (healthy and clean city). The rating serves as a baseline to measure improvements in the future and to prioritize actions. The government intends to award a prize called Nirmal Shahar Puraskar to the best sanitation performers.

WATER QUALITY

The raw or treated water is analysed by testing their physical, chemical and bacteriological characteristics:

Physical Characteristics:

Turbidity
Colour
Taste and Odour
Temperature

Chemical Characteristics:

pH
Acidity

Alkalinity
Hardness
Chlorides
Sulphates
Iron
Solids
Nitrates

Bacteriological Characteristics:

Bacterial examination of water is very important, since it indicates the degree of pollution. Water polluted by sewage contain one or more species of disease producing pathogenic bacteria. Pathogenic organisms cause water borne diseases, and many non pathogenic bacteria such as *E.Coli*, a member of coliform group, also live in the intestinal tract of human beings. *Coliform* itself is not a harmful group but it has more resistance to adverse condition than any other group. So, if it is ensured to minimize the number of coliforms, the harmful species will be very less. So, coliform group serves as indicator of contamination of water with sewage and presence of pathogens.

WATER DISTRIBUTION SYSTEMS

The purpose of distribution system is to deliver water to consumer with appropriate quality, quantity and pressure. Distribution system is used to describe collectively the facilities used to supply water from its source to the point of usage.

Requirements of Good Distribution System

1. Water quality should not get deteriorated in the distribution pipes.
2. It should be capable of supplying water at all the intended places with sufficient pressure head.
3. It should be capable of supplying the requisite amount of water during fire fighting.
4. The layout should be such that no consumer would be without water supply, during the repair of any section of the system.
5. All the distribution pipes should be preferably laid one metre away or above the sewer lines.
6. It should be fairly water-tight as to keep losses due to leakage to the minimum.

Layouts of Distribution Network

The distribution pipes are generally laid below the road pavements, and as such their layouts generally follow the layouts of roads. There are, in general, four different types of pipe networks; any one of which either singly or in combinations, can be used for a particular place. They are:

Dead End System
Grid Iron System
Ring System
Radial System

Distribution Reservoirs

Distribution reservoirs, also called service reservoirs, are the storage reservoirs, which store the treated water for supplying water during emergencies (such as during fires, repairs, etc.) and also to help in absorbing the hourly fluctuations in the normal water demand.

Functions of Distribution Reservoirs:

- to absorb the hourly variations in demand.
- to maintain constant pressure in the distribution mains.
- water stored can be supplied during emergencies.

Location and Height of Distribution Reservoirs:

- should be located as close as possible to the center of demand.
- water level in the reservoir must be at a sufficient elevation to permit gravity flow at an adequate pressure.

Types of Reservoirs

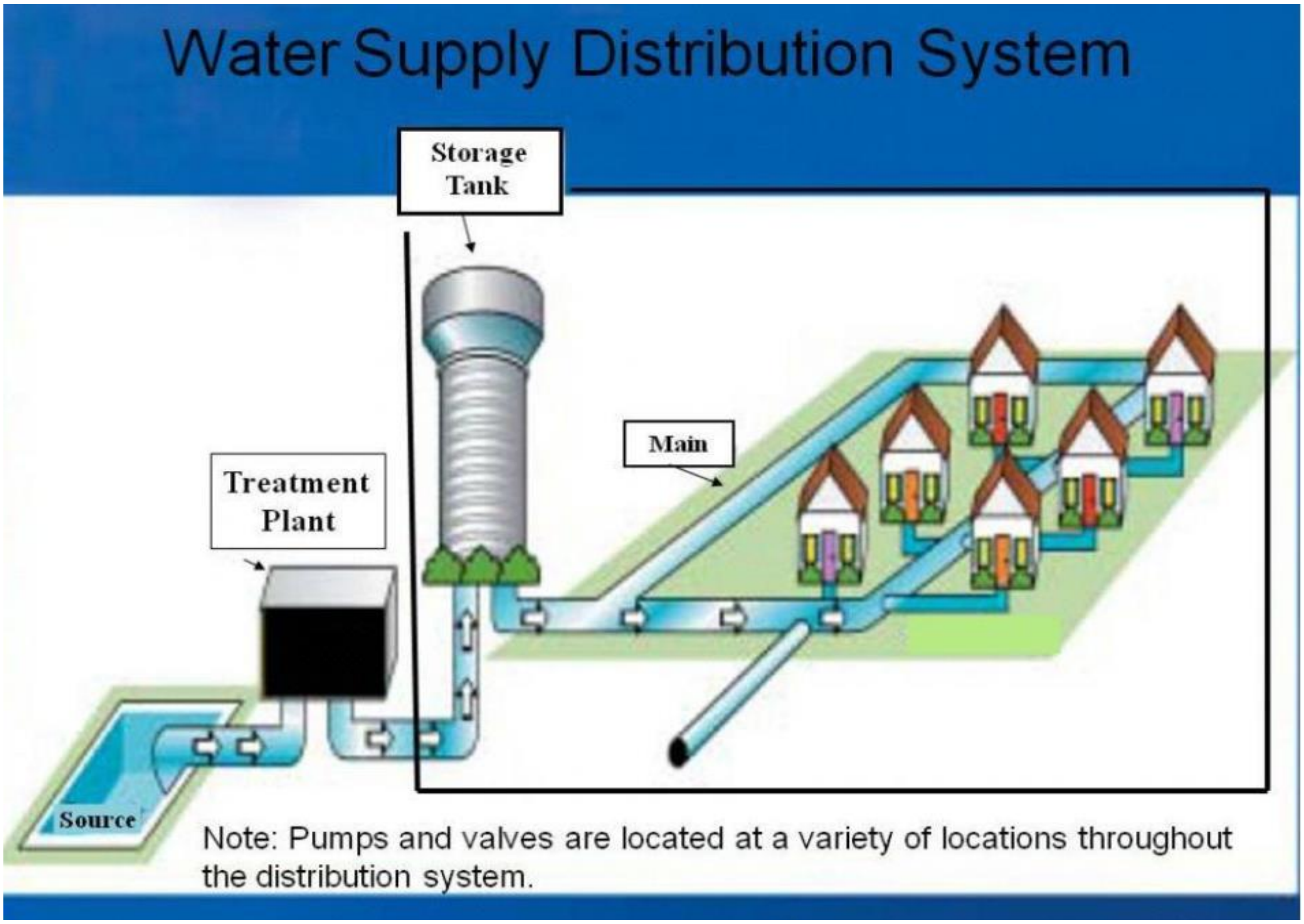
1. Underground reservoirs.
2. Small ground level reservoirs.
3. Large ground level reservoirs.
4. Overhead tanks.

Storage Capacity of Distribution Reservoirs

The total storage capacity of a distribution reservoir is the summation of:

1. ***Balancing Storage:*** The quantity of water required to be stored in the reservoir for equalising or balancing fluctuating demand against constant supply is known as the balancing storage (or equalising or operating storage). The balance storage can be worked out by *mass curve method*.
2. ***Breakdown Storage:*** The breakdown storage or often called emergency storage is the storage preserved in order to tide over the emergencies posed by the failure of pumps, electricity, or any othe mechanism driving the pumps. A value of about 25% of the total storage capacity of reservoirs, or 1.5 to 2 times of the average hourly supply, may be considered as enough provision for accounting this storage.
3. ***Fire Storage:*** The third component of the total reservoir storage is the fire storage. This provision takes care of the requirements of water for extinguishing fires. A provision of 1 to 4 per person per day is sufficient to meet the requirement.

The total reservoir storage can finally be worked out by adding all the three storages.



RE-USE AND CONSERVATION OF WATER

Conserving our water resources is important

Our ground water and surface water supplies are at risk of overuse in many areas. The demand can be greater than the amount supplied by rain and snowmelt. Water conservation, wastewater recycling, and reuse is becoming more important due to increases in:

- Demand on potable water resources,
- The cost of treating wastewater,
- Regulations requiring greater flows for streams and rivers, which reduces irrigation sources, and
- The demand for sustainable building options.

Keep in mind that it is often cheaper, easier, and safer to use less water in the first place than to recycle or reuse wastewater. However, there are many ways for homeowners and water system managers to conserve water.

Water recycling is also important

By design, on-site sewage systems, also known as septic systems, naturally recycle wastewater by recharging ground water with appropriately treated effluent. To ensure on-site sewage systems are treating waste effectively and not polluting the ground water, building and home owners must make sure their systems are working properly.

On-site sewage systems (OSS) with design flow of less than 3,500 gallons per day (individual homes and small buildings)

OSS Using Subsurface (Underground) Drip Irrigation

Description: A type of on-site sewage system designed to treat residential-strength wastewater so that the treated wastewater (effluent) can be used for subsurface irrigation of plants.
A subsurface drip system is an efficient pressurized wastewater distribution system that can deliver small, precise doses of effluent to shallow subsurface dispersal fields.

Benefits:

- Uses all the wastewater from a building.
- Produces healthy, fast-growing plants.
- Gives you the ability to put water exactly where it's needed and keep paths and areas between plants dry. This reduces both waste and weeding.
- The amount of wastewater used during irrigation can be controlled precisely so that nearly all of it remains in the root zone where the plant can use it the most.
- Delivers equal amounts of water to plants over a wide area.