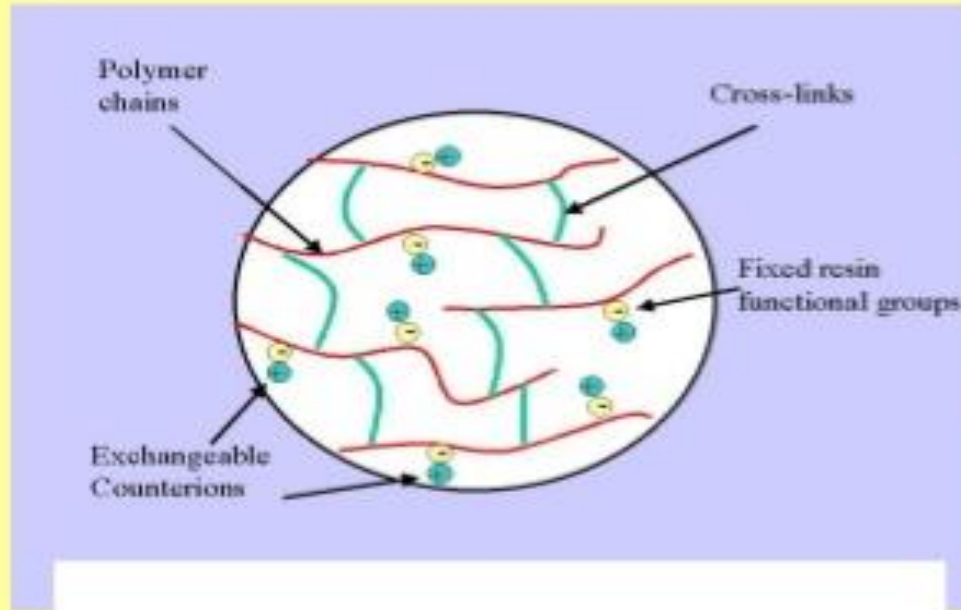
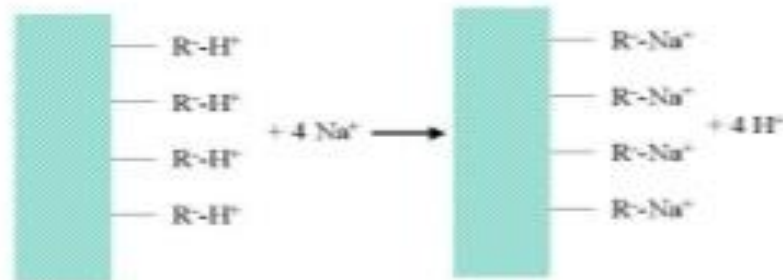


III. Ion-Exchange resin (or) deionization (or) demineralization process



Ion exchange resin



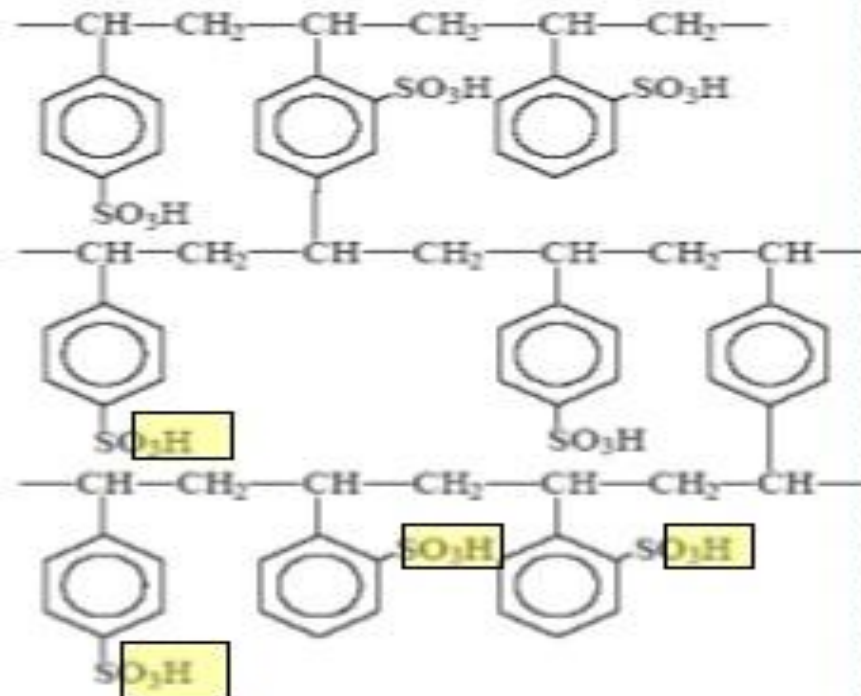
Cation exchange Resin

Resin after treatment

Ion exchange resins are insoluble, cross linked, long chain organic polymers with a microporous structure, and the functional groups attached to the chain is responsible for the "ion-exchange" properties.

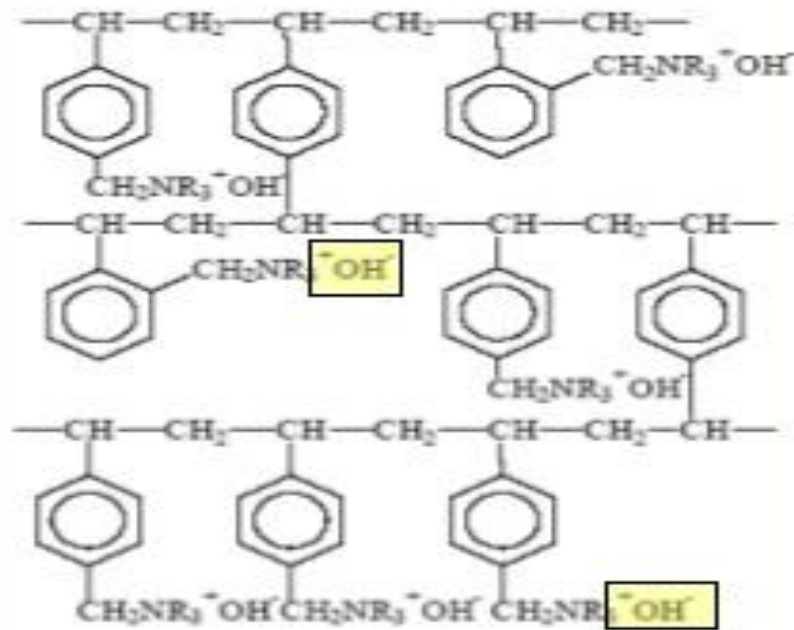
Structure of Cation and Anion exchange resins

Cation exchange resin



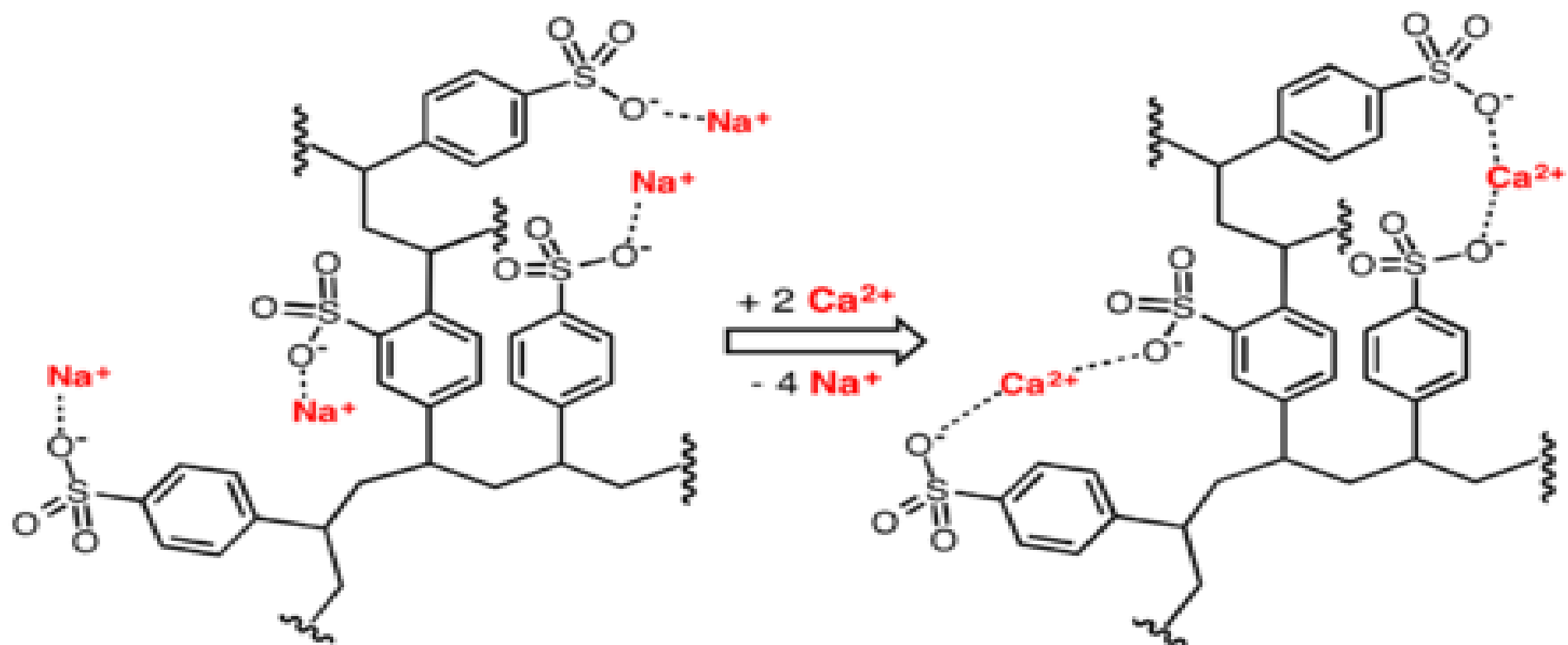
A strongly acidic sulphonated polystyrene cation exchange resin

Anion exchange resin



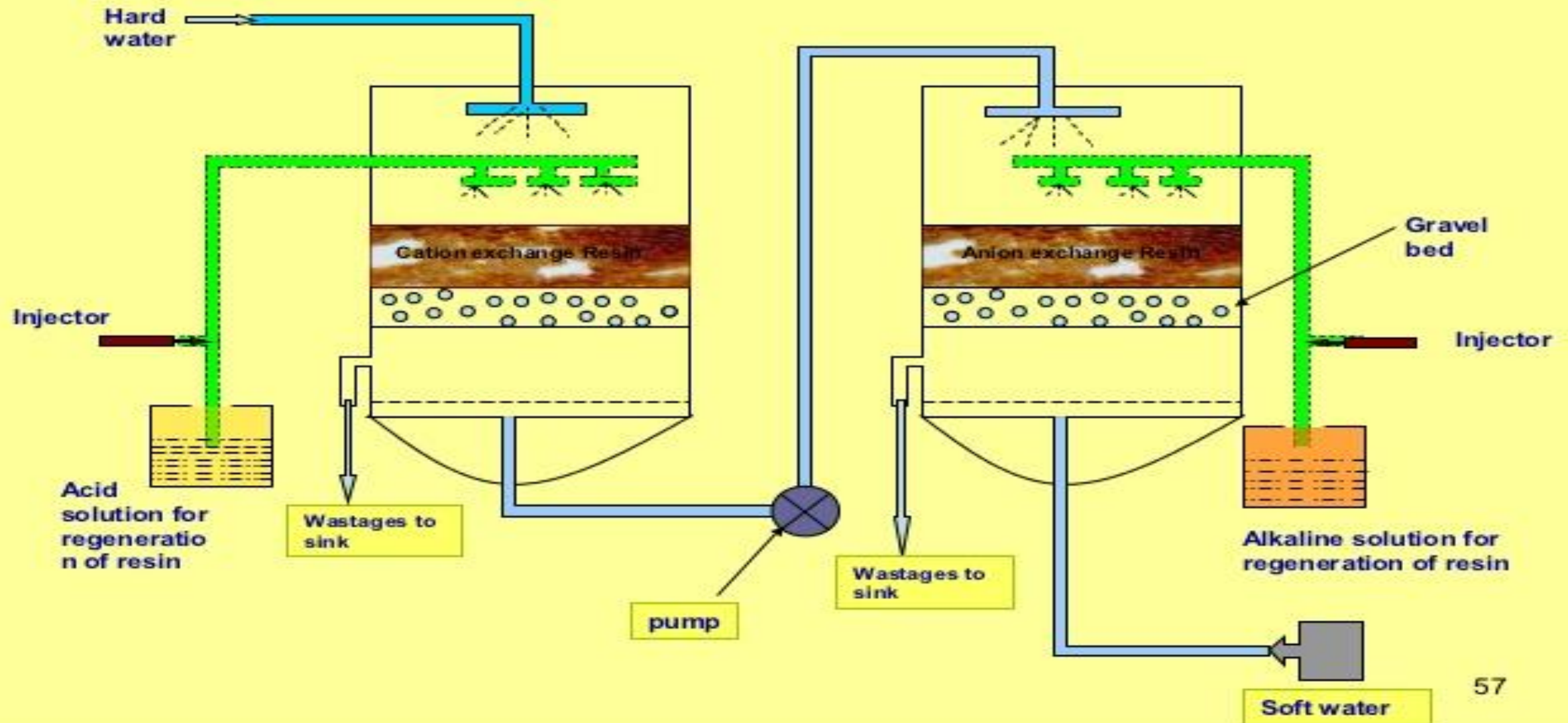
A strongly basic quaternary ammonium anion exchange resin

$\text{R} = \text{CH}_3$



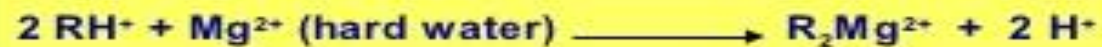
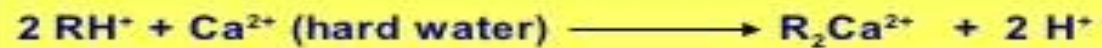
Cation Exchange Process

Ion exchange purifier or softener

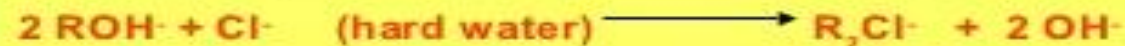
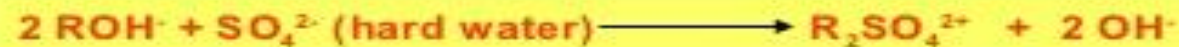


Process or Ion-exchange mechanism involved in water softening

Reactions occurring at Cation exchange resin



Reactions occurring at Anion exchange resin



At the end of the process



Regeneration of ion exchange resins

Regeneration of Cation exchange resin



Regeneration of Anion exchange resin



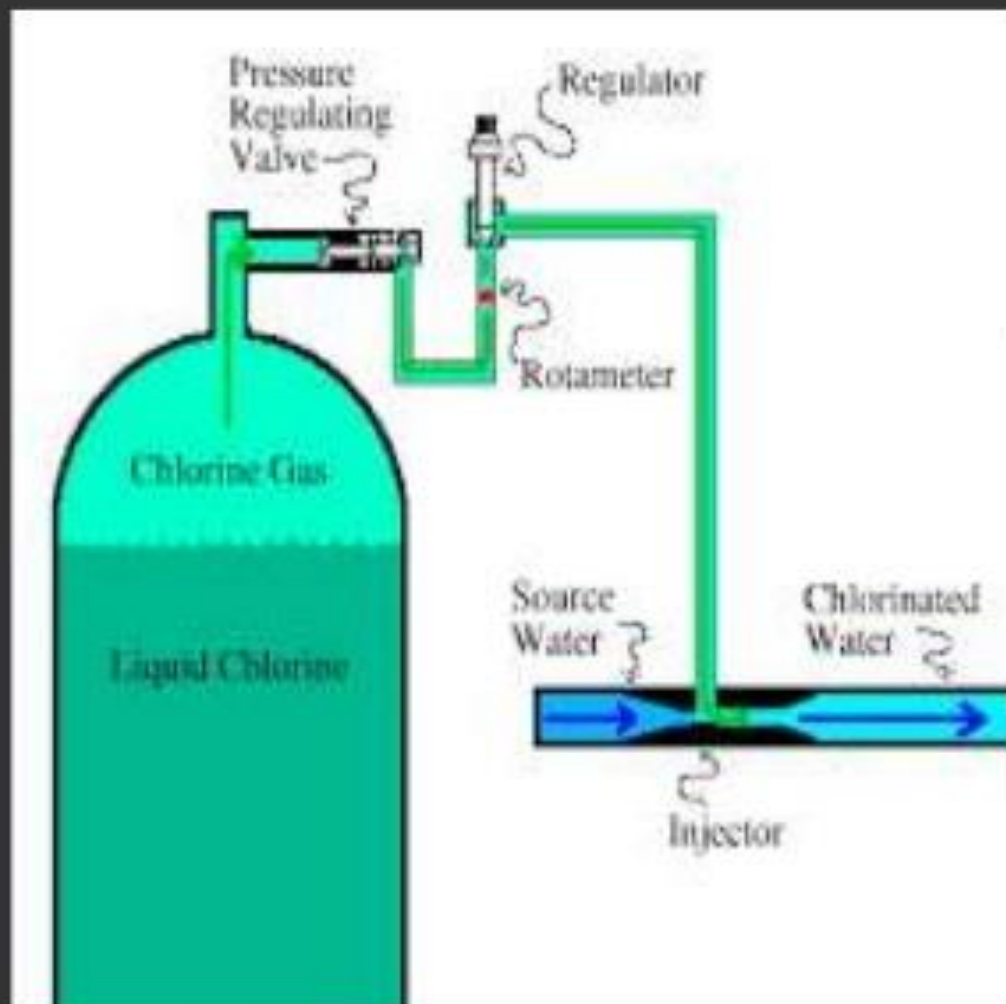
Advantages

1. The process can be used to soften highly acidic or alkaline waters
2. It produces water of very low hardness of 1-2ppm. So the treated waters by this method can be used in high pressure boilers

Disadvantages

1. The setup is costly and it uses costly chemicals
2. The water should not be turbid and the turbidity level should not be more than 10ppm

METHODS OF CHLORINATION



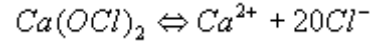
PREFLUSHING OF SOURCE WATER

The source water used for disinfection and pressure testing shall be flushed prior to its use to ensure that contaminants or debris are not introduced into the new pipe. Adequate drainage must be provided during flushing. Drainage should take place away from the construction area. During the contact period, it is recommended that the valve isolating the new main from this system (if applicable) be tagged to prevent unintentional release of the elevated chlorine residual water into the system.

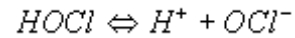
1.The Action of Chloride and its Range of Application

Chlorination is known as the addition of chlorine gas or some other oxidizing chlorine compound (sodium or calcium hypochlorite, chlorinated lime, chlorine dioxide) to the water to be treated. The actual agent is hypochlorous acid (HOCl) which forms when chlorine is added to water: $Cl_2 + H_2O \rightleftharpoons HOCl + H^+ + Cl^-$

Hypochlorous acid also forms subsequent to dissociation, when chlorinated lime or hypochlorites are added



Following chemical equilibrium



depends on pH and temperature. At pH levels between 3 and 6, hypochlorous acid dissociates poorly. Chlorination is most effective in that range of pH 7-8. At pH levels greater than 8, hypochlorite ions predominate or exist almost exclusively. Hence the disinfecting effect drops off rapidly as the pH level increases.

Simultaneously with the dissociation, hypochlorous acid partly breaks up, forming monatomic oxygen, which contributes to the oxidizing effect:



The fraction that becomes effective as an oxidizing agent when chlorine or some of its compounds is added to raw water is called "free available" or "active" chlorine.

Small amounts of chlorine, due to its ability to penetrate cells of microorganisms, are sufficient to destroy many different strains of bacteria. Similarly, many types of viruses and macro-organisms such as schistosoma larvae can be killed. A contact time of at least 30 minutes is required, at the end of which the residual chlorine concentration in the water must still be between 0.1 and 0.5 mg/l (= ppm). Amoebic cysts and spores with resistant cell membranes require higher doses and longer contact times.

Chlorine also reacts with many other oxidizable water constituents such as iron and manganese compounds, ammonia, and compounds thereof (forming chloramines), as well as numerous types of organic particles. The presence of these substances reduces the germicidal effect considerably. Sufficient chlorine must be added to the water to make sure that there is a residual concentration to prevent recontamination.

It is advisable to remove or reduce prior to chlorination, those substances by means of sedimentation and/or filtration which would impede disinfection.

Through such pretreatment, helminth eggs (parasitic worms) can be removed which are insensitive to chlorination. In recent times, it was found that through chlorination, certain undesirable side effects may occur. Particularly in industrialized areas, synthetic organic compounds may enter the hydrologic cycle in high concentrations. The presence of chlorine enhances the danger of the formation of carcinogenic compounds (e.g., chloroform and other trihalomethanes)

2. Chlorinated Lime or Bleaching Powder ($\text{CaO} \cdot 3 \text{CaOCl}_2 \cdot 3 \text{H}_2\text{O}$)

- In general, the powder is readily available and inexpensive. It is stored in corrosion resistant cans. When fresh, it contains 35% active chlorine. Exposed to air, it quickly loses its effectiveness. It is usually applied in solution form which is prepared by adding the powder to a small amount of water to form a soft cream. Stirring prevents lumping when more water is added. When the desired volume of the solution has been prepared, it is allowed to settle before decanting. Solutions should have concentrations between 5 and 1% of free chlorine, the latter being the most stable solution. Some 10% of the chlorine remains in the settled sludge. The same precautions for the NaOCl solution pertain also to the storage of dissolved chlorinated lime.



- **3 Ozonation**

- Ozone (O₃) is one of the most effective disinfectants. As a powerful oxidant, it reduces the contents of iron, manganese, and lead, and eliminates most of the objectionable taste and odor present in water. Its effectiveness does not depend on the pH value, temperature or ammonia content of the water. Since ozone is relatively unstable, it is generated almost invariably at the point of use. Ozone is obtained by passing a current of dried and filtered air (or oxygen) through between two electrodes (plates or tubes) subjected to an alternating current potential difference. A portion of the oxygen is then converted into ozone.
- This principle of ozone production has been used in Europe for a long time, since it has the advantage of being applicable under a wide range of conditions. It leaves no chemical residuals behind in the treated water. On the other hand, no lasting protection against recontamination is provided either. Capital costs for the instrumentation of ozone production and feeding, as well as operating costs due to the electrical energy requirements, are very high. Moreover, operation of ozonizers requires continuous and skilled monitoring. The operational requirements therefore exceed the resources available in rural areas of most developing countries