Water Systems

Among the most important distribution systems in the hospitality industry water is the most important amongst all and generally water provides a public utility similar to electrical energy. Hospitality industries are totally dependent on supply of potable water and sanitary drainage network system. The primary sources of fresh water are lakes, rivers and ground water. Due to pollution effects rivers and lakes are not considered as source and finally the only source remains as ground water. Again due to scarcity of ground water, there is also a need for recycling and conservation.

Water is classified as hard and soft depending upon its behaviour towards soap solution.

Soft water: Water that readily forms leather with soap is called soft water. Rain water, pond water, distilled water etc. are examples of soft water. Soft water is slightly acidic.

Hard water: Water that does not easily form leather with soap is called hard water. Sea water and groundwater from tube wells are sources of hard water. Hard water is alkaline in nature.

Advantages of soft water

1. Soft water consumes less soap for cleaning clothes.
2. It is good for cooking, imparting good taste to cooked food.
3. Soft water does not produce crust or deposit any scale in the pipe or other equipment that use water.

Disadvantages of soft water

1. Soft water is usually less palatable to drink due to lack of minerals.
2. Soft water does not provide vital minerals such as calcium and magnesium necessary for the body.

Advantages of hard water

1. Hard water provides good taste for drinking.
2. It provides vital minerals necessary for the body.

Disadvantages of hard water

1. Use of hard water causes wastage of soap and detergents. On an average, hard water will destroy about 3 lb of soap per gallons of water. This also shortens the life of clothing and textile materials in laundry.
2. Scale is precipitated out of such water, which forms thick white crust (called scaling) inside pipes that carry them. This crust or scale a) gradually reduces the internal diameter

and size of pipes, b) lowers the efficiency of the heating system by retarding the transmission of heat from furnace or heating coil to the water inside pipe and c) interferes

with the functioning of flow control valves in the pipeline.

3. Hard water is not suitable for paper, sugar, textile and pharmaceutical industries
4. Some people complain of dry skin after bathing in hard water.

Hardness of water

Total hardness is a test for overall water quality. There is no health concern associated with it. The degree of hardness is generally defined as calcium carbonate, equivalent of calcium and magnesium ions, present in water and is expressed in mg/L. In simple terms, hardness is a measure of how much calcium (and to a much lesser extent, magnesium) is in the water. Water hardness industry measures it in grains per litre, where 1 grain/litre = 64.72 mg/L.

pH value of water

The pH value of water is calculated as the logarithm of the reciprocal of hydrogen ion concentration (power of hydrogen and hence the term pH) present in water. It is, thus, an indicator of the acidity or the alkalinity of water. If pH of water is above 7, it will be alkaline and if it is less than 7, it will be acidic. The maximum acidity will be at zero value of pH and the maximum alkalinity will be at a value of pH equal to 14. Although pH value and hardness do not indicate the same property of water, the presence of carbonate ions in water (sometimes called 'carbonate hardness') pushes it towards alkalinity, and hence hard water is likely to have a high pH. A pH greater than 8.5 could indicate that the water is hard. Since measurement of pH is relatively simple, this could act as a reliable method to test the hardness of water.

Typical pH values of a few substances

Substance	Typical pH value
Battery acid	0.3
Stomach acid (gastric juices)	1.4
Lemon juice	2.1
Vinegar	3.0
Wine	3.5
Tomatoes	4.2
Pure rain water	5.5
Pure water	7.0 (neutral)
Blood or tears	7.4
Baking soda solution	8.5
Household bleach	12.5

Hardness of water

The hardness of water is mainly due to the presence of dissolved bicarbonate (HCO_3^-), chloride (Cl^-), and sulphate (SO_4^{2-}), salts of calcium (Ca), magnesium (Mg), and iron (Fe). Sodium (Na) salts do not cause any hardness. All these salts that causes hardness come from the rocks, get dissolved in the groundwater by way of rainwater percolating through the rock.

Ordinary soaps are mainly sodium and potassium salts of organic fatty acids such as stearic acid, palmitic acid, and oleic acid. When soap is added to hard water, calcium and magnesium salts dissolved in water reacts with the salts in the soap and form insoluble scum. The reaction occurs-

Na/K stearate/palmitate + Ca/Mg salt → Ca/Mg stearate/palmitate + Na salt

(soap salt) (hard water salt) (insoluble scum)

No soap in the mixture (mixture of hard water and soap) will form lather till all the salts present in the hard water are removed as scum. Thus soap is consumed without producing lather needed for cleaning clothes, resulting in a great wastage of costly soap. Synthetic detergents can overcome this problem as they form soluble salts of Ca and Mg and do not form a scum or soap curd.

Types of hardness

Depending upon the nature of the dissolved salts, hardness may be

i) Temporary or carbonate hardness

ii) Permanent or noncarbonate hardness

Temporary hardness- It is caused by the presence of dissolved bi-carbonates of calcium [$Ca(HCO_3)_2$].

Permanent hardness- It is caused by the presence of chloride and sulphate salts of calcium and magnesium like, calcium chloride ($CaCl_2$), calcium sulphate ($CaSO_4$), magnesium chloride ($MgCl_2$) and magnesium sulphate ($MgSO_4$)

The reduction or removal of hardness from water is known as water softening. It is done mainly for the reduction in soap consumption, lowering the maintenance cost of plumbing fixture, boiler tubes, and to improve the taste of food, etc. and saving energy.

The permissible hardness for public supplies normally ranges 75 to 115 mg/L (14.25 mg/L is equivalent to one degree of hardness. Different methods for removal of hardness are shown below:-

Removal of hardness

- Temporary hardness
  - Boiling
  - Clarke's process
- Both temporary and permanent hardness
  - Zeolite or Permutit (base exchange) Process
  - Lime soda
  - Caustic soda
  - Ion exchange by resin
  - Calgon process
- Permanent hardness
  - Washing soda

The temporary hardness of water can be removed either by boiling or by adding lime to the water. The chemical reaction takes place (in boiling process) as

$Ca(HCO_3)_2 + Heat \rightarrow CaCO_3 \downarrow + CO_2 \downarrow + H_2O$

(Calcium bicarbonate) (Calcium carbonate, insoluble)

$Mg(HCO_3)_2 + Heat \rightarrow MgCO_3 \downarrow + CO_2 \downarrow + H_2O$

(Magnesium

bicarbonate, insoluble)

The chemical reaction takes place (in addition of lime or Clarke's process) as

$Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow 2CaCO_3 \downarrow + 2H_2O$

(Calcium bicarbonate) (Hydrated lime) (Calcium carbonate, insoluble)

$Mg(HCO_3)_2 + 2Ca(OH)_2 \rightarrow Mg(OH)_2 \downarrow + 2CaCO_3 \downarrow + 2H_2O$

There are six methods for removing permanent hardness like,

1. Washing soda process
2. Base exchange process (or Zeolite process)
3. Lime soda process
4. Caustic soda process
5. Ion-exchange process or demineralization(DM) process
6. Calgon process

1. The chemical formula of washing soda is Na_2CO_3. The reaction takes place when washing soda is added to hard water is

   $Na_2CO_3 + CaSO_4 \rightarrow CaCO_3 \downarrow + Na_2SO_4$

   $Na_2CO_3 + MgCl_2 \rightarrow MgCO_3 \downarrow + 2NaCl$

2. Hardness can be very effectively and economically removed by using a chemical called zeolite. A zeolite softener resembles a sand filter. The hard water enters the softener from top react with the zeolite and the softened water is collected through the strainer at the base. The reaction takes place as

Na_2Z	+	Ca or Mg salt	→	Na_2 salt	+	Ca or Mg zeolite
(Sodium zeolite/ Or active zeolite)		(Hard water salt)				(Exchanged or used zeolite)

After a few days of operation, all the active sodium zeolite changes to used calcium and magnesium zeolite. These can be converted back to the active sodium zeolite by reacting it with 10 per cent solution of sodium chloride (common table salt solution). This process is known as regeneration. The reaction takes place as

CaZ / MgZ	+	2NaCl	→	Na_2Z	+	$CaCl_2$ / $MgCl_2$
(used zeolite)		(sodium chloride Solution)		(regenerated zeolite)		(dissolved salt removed by flushing water)

Advantages of zeolite process- * Zero hardness can be obtained and have specific uses in textile industries, boilers, etc. * The plants are compact, automatic, and easy to operate. * The running ,maintenance and operation (RMO) cost is quite less. * It also removes iron and manganese from water. * There is no problem in treating water of varying quality.

3. In lime soda process, in addition to washing soda lime is added to remove temporary hardness. Hydrated lime reacts with bicarbonates of Ca and Mg.

4. Caustic soda can be used to remove both carbonate (temporary) and non-carbonate (permanent) hardness. This process is very efficient for low alkalinity water. Calcium and magnesium hydrogen carbonates react with caustic soda to produce insoluble calcium carbonate and magnesium hydroxide. The reactions are-

   $2NaOH + MgSO_4 \rightarrow Mg(OH)_2 \downarrow + Na_2SO_4$

   $2NaOH + CaCl_2 \rightarrow Ca(OH)_2 \downarrow + 2NaCl$

   $4NaOH + Mg(HCO_3)_2 \rightarrow Mg(OH)_2 \downarrow + 2Na_2CO_3 + 2H_2O$

   $2NaOH + Ca(HCO_3)_2 \rightarrow CaCO_3 \downarrow + 2Na_2CO_3 + H_2O$

5. There are many types of equipment in industry like water boiler, other process equipment and scientific apparatus which need water free of minerals. The process by which the minerals are removed is known as demineralization (DM) and the plant is known as DM plant. It is very suitable for producing water of any desired hardness or even mineral free

water. The demineralized water is sometimes called deionized water and is as pure as distilled water.

The process consists of passing the water through cat ion exchange resins, which produce almost similar effects as are produced in the zeolite process, except that hydrogen (instead of sodium) is exchanged for the basic metallic ions. The cat ion exchange resins

in fact are phenol aldehyde condensation products whose chemical formula is H_2R (H represents hydrogen ion and R represents the organic part of the substance). The reaction takes place as below:-

$$Ca(HCO_3)_2 + \underset{\text{(fresh cation exchange resin)}}{H_2R} \rightarrow \underset{\text{(exchanged or used resin)}}{CaR} + 2H_2O + 2CO2 \uparrow$$

$$Na_2CO_3 + H_2R \rightarrow Na_2R + H_2O + CO_2 \uparrow$$

6. Calgon is the trade name of a complex salt, sodium hexametaphosphate $(NaPO3)_6$. Calgon ionizes to give a complex anion, which subsequently combines with Ca and Mg ions in hard water.

$$(NaPO_3)_6 \text{ or } Na_2(Na_4P_6O_{18}) \rightarrow 2Na^+ + \underset{\text{(complex anion)}}{Na_4P_6O_{18}^{2}}$$

In addition of Calgon to hard water causes the calcium and magnesium ions of hard water to displace sodium ions from the anion of Calgon according to the following reaction:

$$CaSO_4 + Na_2(Na_4P_6O_{18}) \rightarrow Na_2SO_4 + Ca(Na_4P_6O_{18})$$

This result in the removal of calcium and magnesium ions from hard water in the form of a complex compound with Calgon and thus the water softened. Sodium salts are released into water without causing any hardness. It is being dosed into water used for washing machine, dyeing work, etc.

<u>Water distribution system</u>

In cities and towns normally water is supplied by civic bodies through public water lines. It is required to have a storage reservoir on top of the building. The civic body charges the establishment for water consumption either lump-sum or through recording of consumption by water meters. However, many hotel units particularly in isolated areas find it economical and convenient to have their own bore well pumps within the premises that provide raw water which is further treated for consumption. But now a days lifting of groundwater through digging of wells needs permission from government departments. A hotel establishment needs a lot of water for various essential functions. An average figure will be 200 litres (about 50 gallons) per person per day. Cold water is used for diverse functions in a hotel like:-

* Drinking * Cooking in the kitchen * Kitchen, restaurant, and lavatory wash sinks and washbasins * Lavatory flush * Laundry * Estate and floor cleaning purposes * Fire-sprinkler system * Cooling the diesel generating set, refrigeration plant, etc. * Hot water and boiler make up water * Gardening etc. * In swimming pool and other water bodies, if any.

In India central-room heating is not required and hotels normally do not use such systems. Hot water is used for laundry purpose and kitchen, throughout the year and for personal use of the guests, particularly during winter season in hotels in plains and throughout the year for hill station hotels.

Water quality requirements are different for different uses in the hotel industry. For example, water lines for drinking, kitchen, and wash basins/sink must be supplied with bacteria-free soft water, while laundry and other functions can work with plain soft water. In modern establishments, laundry line is connected with drinking water line. Lavatory wash basin and water closets (WCS) may be provided with only soft water. In many modern units, waste water is collected, treated and recycled. Rain-water harvesting has assumed great importance and in many establishments this may supplement the main water supply system.

There are several water distribution systems used in hospitality and catering industries, like

a) Upfeed system
b) Upfeed system with circulating pumps
c) Downfeed system (cold water only)
d) Downfeed circulating system
e) Combination system

a) It is the most commonly used water distribution system where the pressure of water is sufficient to force water throughout a hotel building of six floors or less in height. The

maximum number of floors which can be fed with this system depends on pressure, resistance of pipe and the height of the building.

b) This system is used when the water pressure is inadequate and a circulating pump along with a return pipe is installed to increase water pressure and water to flow constantly throughout the system. This is frequently used on hot water lines to provide an adequate supply of hot water by making a provision of water heater.
c) Here water is forced or pumped to a storage tank (overhead) located on the top floor of the building. When water is required, it flows by gravity from the storage tank to the tap. This system is used in very tall buildings.

d) It is very similar to the circulating puffed system. This technique is frequently used with hot water to ensure adequate amount of hot water at each fixtures.
e) It is a combination of upfeed and downfeed system. The upfeed system is used for the lower building levels and the downfeed system for the upper building levels. This system is probably the most efficient distribution system for multiple-floor hotel building because main water supply pressure is utilized to the full extent and additional pressure is generated by pumps to reach water on water storage tank located on the top floor of the building.

The normal hot-water temperature requirements in the hospitality industry are:-

110 degree Fahrenheit or 43.3 degree Celsius for domestic use.

- Normal personal washing: 140 degree Fahrenheit or 60.0 degree Celsius.
- Food production sinks: 160 degree Fahrenheit or 71.1degree Celsius.
- Dish washing: 180 degree Fahrenheit or 82.2 degree Celsius.
- Pools and spas: 80-100 degree Fahrenheit or 26.7 – 37.8 degree Celsius.
- It is highly recommended to label fixtures supplied with water above 120 degree Fahrenheit or 48.9 degree Celsius with a warning that the water is hot and dangerous.

<u>Swimming Pool Maintenance</u>

Swimming pool design, construction and maintenance are controlled by local development authorities in coordination with public health department. The equipment and their utility connections are frequently tested by these departments.

The fundamental pool device is the filter. The filter removes impurities from water and keeps clear and sparkling. The true test of adequate filtering is to toss a small coin into the pool at its

average depth and to be able to distinguish one side of the coin from the one it rests on at the bottom of the pool. The filter must cycle pool water every six to eight hours. Water turnover cycle consists of forcing all the pool water through the filter in a specified time period. In a normal operation, one water cycle is required each day. If swimming activity increases, more than one water turnover cycle may be required. Normally, pool water is used for cleaning the filter and filters are cleaned by back washing. The instructions given by the manufacturer of the filter should be followed, as there is no set schedule of cleaning of filters.

Swimming pool should be cleaned from time to time from debris, leaves, insects and soil by using various types of nets. The pH level of pool water should be between 7.2 and 7.6 or slightly alkaline. If pH exceeds 7.6 then there is a chance of developing water algae which may cause

skin and mucous-membrane irritations to swimmers. If pH level falls below 6.8 metal equipment may corrode. Shock treatments are used to kill algae. Shock treatment means increasing the level of disinfectant from 1 part per million of bromine to 5 parts per million (in case of chlorine it is 2 parts per million to 10 parts per million). In case of excessive growth of algae the pool must be cleaned after draining the water with acid chemicals known as acid washing.

<u>Fittings in water distribution line</u>

There are some important water line fittings such as valves, taps, cocks, tee, socket, nipple, bend and flushing cistern which are always present in any water-distribution line of a hotel. Valves and cocks are kept to a minimum in hot water line.

Valves, taps and cocks are fittings in water lines to regulate flow through the lines and are integral parts of any water-distribution system. The function of a valve is the same as a tap, i.e. to open and close or control flow of water through a line. The word tap is used when the valve is small in size and fitted just before any service utility such as basin, sink, shower etc. The flow of water in large pipelines is controlled by valves.

A tap is what we see at the draw-off end of water service line. They are normally screw-down type valves. Depending upon the directions of water entering the tap and coming out of tap they may be categorized as Bib tap, Pillar tap, Globe tap etc. Bib tap has a horizontal inlet and free outlet in the form of a bent tube called bib which prevents dust from entering into the free end and contaminating water when it comes out. Pillar tap has a vertical inlet and horizontal outlet through a bib. These are used in lavatory basins and baths. Globe tap has a horizontal inlet and vertical outlet, were used in baths and now replaced by pillar taps.

Cocks are normally plug-type valves and are quickly closed by a quarter turn of the knob as in a gas cock. This is used in a cold water system at the entry point of the civic water line into the premises and is called stopcock.

The term 'valve' is normally used to indicate controlling and most often for stopping or fully opening supply to a line and fitting. While stopcocks are plug type, valves may be screw-down type or sliding-plate type (like gate valve).

There are pipe fittings to facilitate layout of pipelines for branching (tee), joining of two pipes (sockets, nipples) and change of direction of pipelines (bends).

Flushing cisterns are normally of two types – Plunger and siphon type, Bell type. Both are supplied with cold water through ball tap and fitted with an overflow discharge outlet.