What is Reverse Osmosis ?

　　Reverse osmosis or RO is a filtration method that is used to remove ions and molecules from a solution by applying pressure to the solution on one side of a semipermeable or selective membrane. Large molecules (solute) can't cross the membrane, so they remain on one side. Water (solvent) can cross the membrane. The result is that solute molecules become more concentrated on one side of the membrane, while the opposite side becomes more dilute.

　　How Reverse Osmosis Works

　　In order to understand reverse osmosis, it helps to first understand how mass is transported via diffusion and regular osmosis. Diffusion is the movement of molecules from a region of higher concentration to a region of lower concentration. Osmosis is a special case of diffusion in which the molecules are water and the concentration gradient occurs across a semipermeable membrane. The semipermeable membrane allows the passage of water, but notions (e.g., Na+, Ca2+, Cl-) or larger molecules (e.g., glucose, urea, bacteria). Diffusion and osmosis are thermodynamically favorable and will continue until equilibrium is reached. Osmosis can be slowed, stopped, or even reversed if sufficient pressure is applied to the membrane from the 'concentrated' side of the membrane.

　　Reverse osmosis occurs when the water is moved across the membrane against the concentration gradient, from lower concentration to higher concentration. To illustrate, imagine a semipermeable membrane with fresh water on one side and a concentrated aqueous solution on the other side. If normal osmosis takes place, the fresh water will cross the membrane to dilute the concentrated solution. In reverse osmosis, pressure is exerted on the side with the concentrated solution to force the water molecules through the membrane to the freshwater side.

　　There are different pore sizes of membranes used for reverse osmosis. While a small pore size does a better job of filtration, it takes longer to move water. It's sort of like trying to pour water through a strainer (large holes or pores) compared to trying to pour it through a paper towel (smaller holes). However, reverse osmosis is different from simple membrane filtration because it involves diffusion and is affected by flow rate and pressure.

　　Uses of Reverse Osmosis

　　Reverse osmosis is often used in commercial and residential water filtration. It is also one of the methods used to desalinate seawater. Reverse osmosis not only reduces salt, but can also filter out metals, organic contaminants, and pathogens. Sometimes reverse osmosis is used to purify liquids in which water is an undesirable impurity. For example, reverse osmosis can be used to purify ethanol or grain alcohol to increase its proof.

　　History of Reverse Osmosis

　　Reverse osmosis is not a new purification technique. The first examples of osmosis through semipermeable membranes was described by Jean-Antoine Nollet in 1748. While the process was known in laboratories, it wasn't used for desalination of seawater until 1950 at the University of California in Los Angeles. Multiple researchers refined methods of using reverse osmosis to purify water, but the process was so slow that it wasn't practical on a commercial scale. New polymers allowed for the production of more efficient membranes. By the beginning of the 21st century, desalination plants became capable of desalinating water at the rate of 15 million gallons per day, with around 15,000 plants in operation or planned.

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