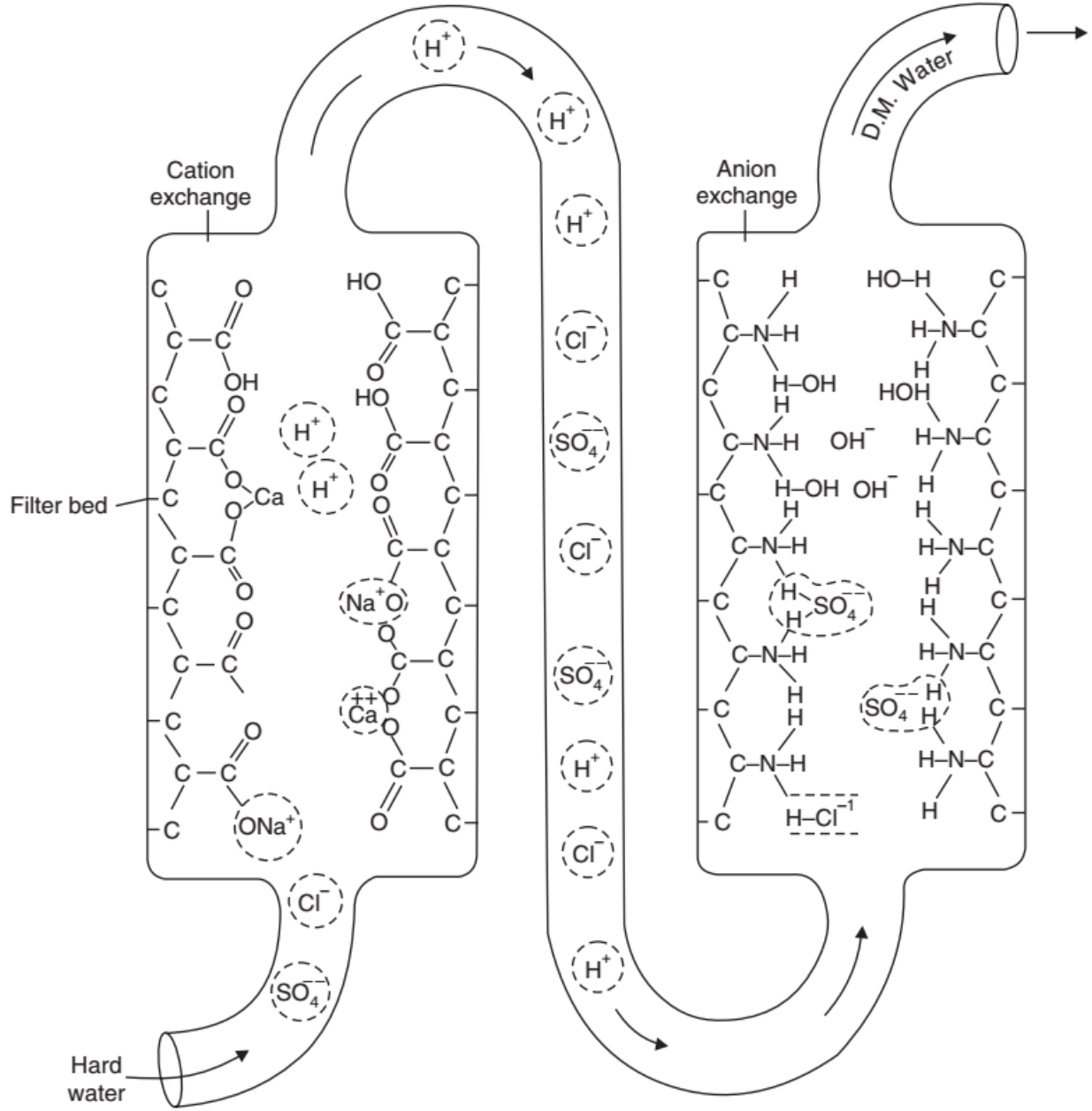
Cation exchange
Anion exchange
D.M. Water
Filter bed
Hard water
Cation exchange reaction:
$2R^-H^+ + Ca^{+2} \rightleftharpoons CaR_2 + 2H^+$
Anion exchange reaction:
$RNH_2 + H_2O \rightleftharpoons R\overset{+}{N}H_3OH^-$
$R\overset{+}{N}H_3OH^- + Cl^- \rightleftharpoons R\overset{+}{N}H_3Cl^- + OH^-$

Regeneration of ion exchange resin

- After a while, the resin loses all its H^+ and OH^- content and is exhausted and needs to be regenerated
- A cation exchange resin is regenerated by passing dil HCl or dil. H_2SO_4

$$R_2Ca^{2+} + 2H^+ \longrightarrow 2RH^+ + Ca^{2+}$$

- An anion exchange resin is regenerated by passing dil NaOH

$$R_2SO_4^{2-} + 2OH^- \longrightarrow 2ROH^- + SO_4^{2+}$$

- After regeneration, the resins are washed with DI water and the washings discarded

- **Advantages-** Highly acidic or alkaline water can be softened
- Softening upto 2ppm

- **Disadvantages-** expensive
- Turbidity can cause troubles

Mixed bed de-ioniser

- A single cylinder with an intimate mixture of cation and anion exchangers
- Hard water comes in contact very effectively, a number of times – equivalent to passing through a series of cation and anion exchangers
- Results in hardness less than 1ppm

Ultrafiltration and nanofiltration for disinfection

- Filtration is a process of removing particulate matter from water by forcing the water through a porous media
- The size of materials that can be removed during filtration depends upon the size of the pores of the filter
- An ultrafiltration filter has a pore size around 0.01 micron
- A nanofiltration filter has a pore size around 0.001 micron
- Reverse osmosis filters have a pore size around 0.0001 micron

Ultrafiltration would remove large particles, macromolecules, bacteria, protozoa and may remove some viruses.
Ultrafiltration cannot remove dissolved substances unless they are first adsorbed (with activated carbon) or coagulated (with alum or iron salts).

Nanofiltration removes most organic molecules, nearly all viruses, most of the natural organic matter and a range of salts. Nanofiltration removes divalent ions, which make water hard, so nanofiltration is often used to soften hard water.

polysulfone and cellulose acetate are the most commonly used membrane materials