WEEK-9

Types of deionization

- **Conventional method**

  1st step is water passage from the column involving strong cationic resin

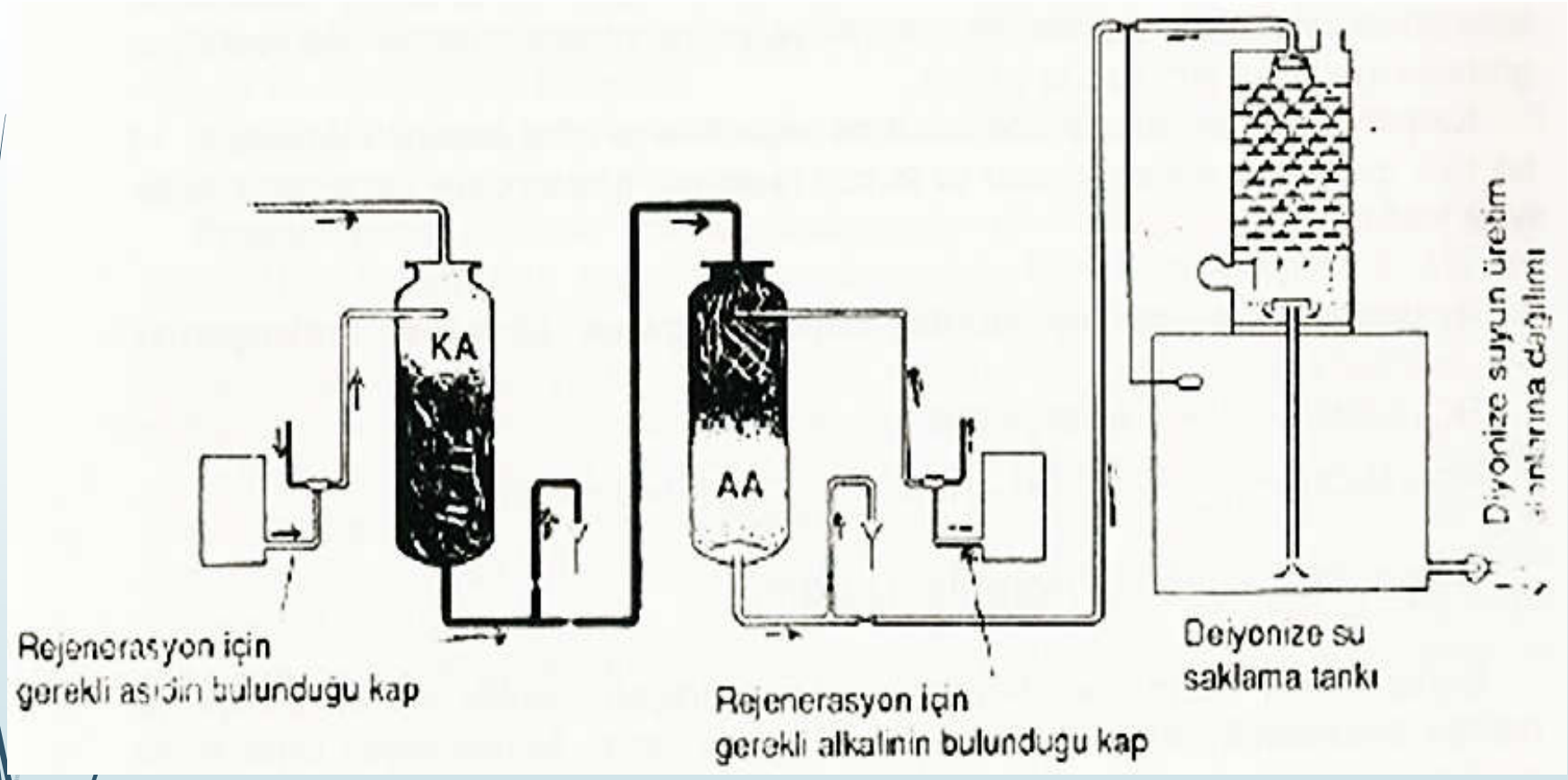
  2nd step is water passage from the column involving poor anionic resin

- **Reverse method**

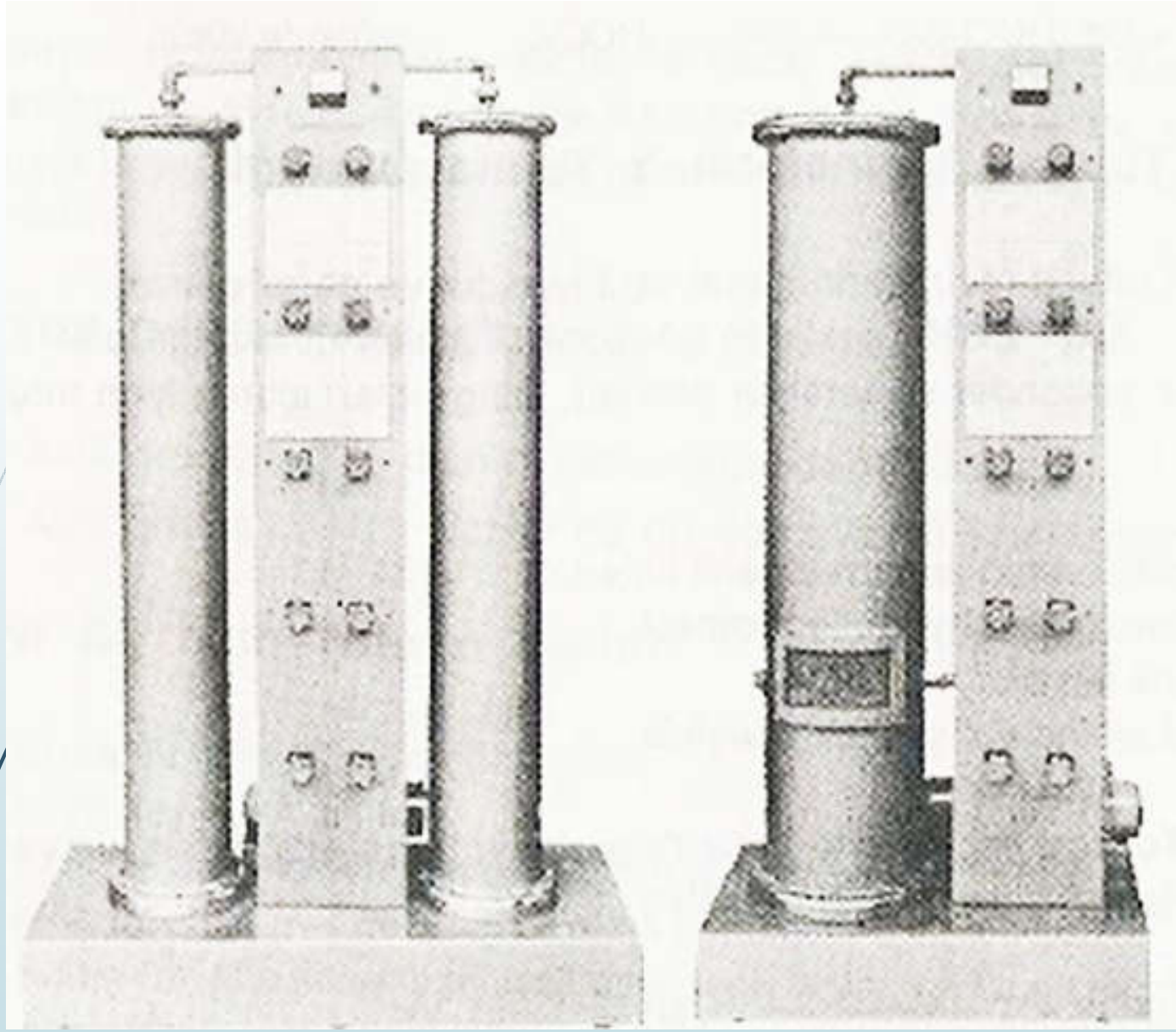
  First anionic resin then cationic resin can be used

- **Mixed bed method**

  Both resin types are found in the same column in a mixed state.



Conventional method

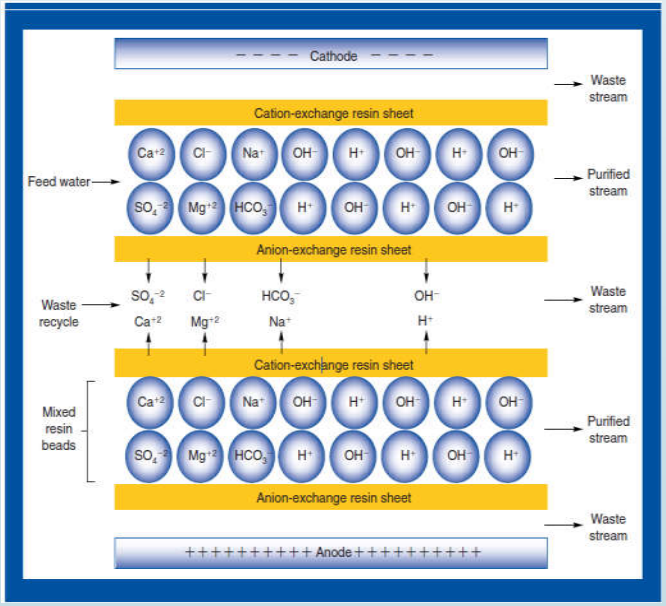


Double bed method

Mixed bed method

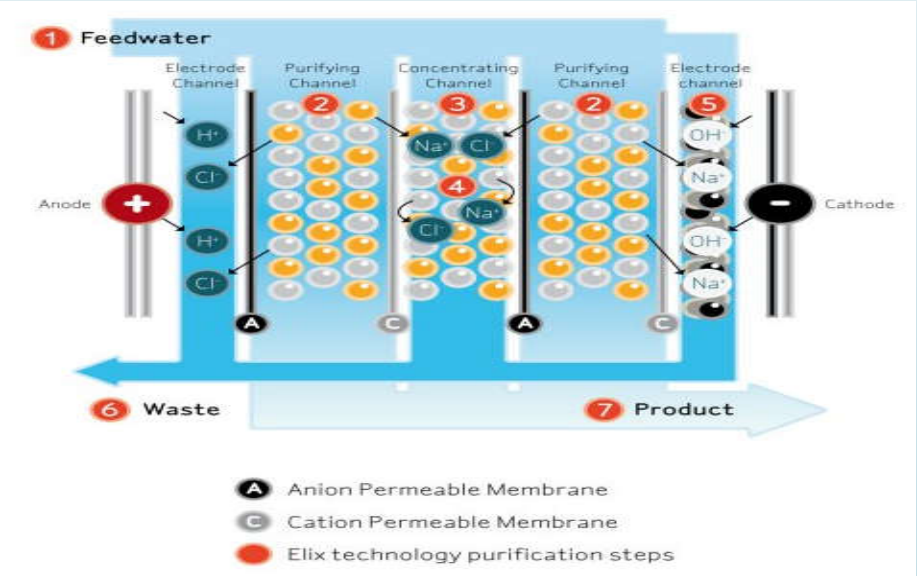
Electrodeionization

- Contains a combination of mixed resin, selectively permeable membrane and electric charge to povide continuous flow (product and waste water)and continuous regeneration.
- Produces very high water purity



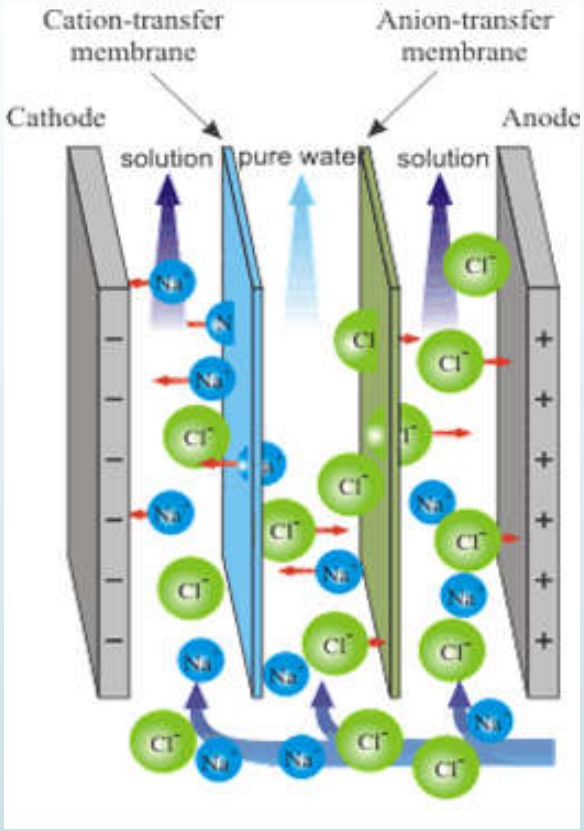
Electrodeionization

- Unlike other water treatment processes, electrodeionization does not require any chemical treatment. Instead , the process utilizes a mild electrical current from electrodes to deionize water.
- This process separates impurities and regenerates resin to produce ultra-pure water.
- EDI is often a supplemental step to reverse osmosis , which relies on semi-permeable membranes to filter impurities from water.



Electrodialysis

- This is a similar process that uses only electricity and selectively permeable membranes together.
- They can separate the removed ions, small organic molecules and some colloidal particles from water stream.
- It is less efficient than electrodeionization process as it does not contain a resin.



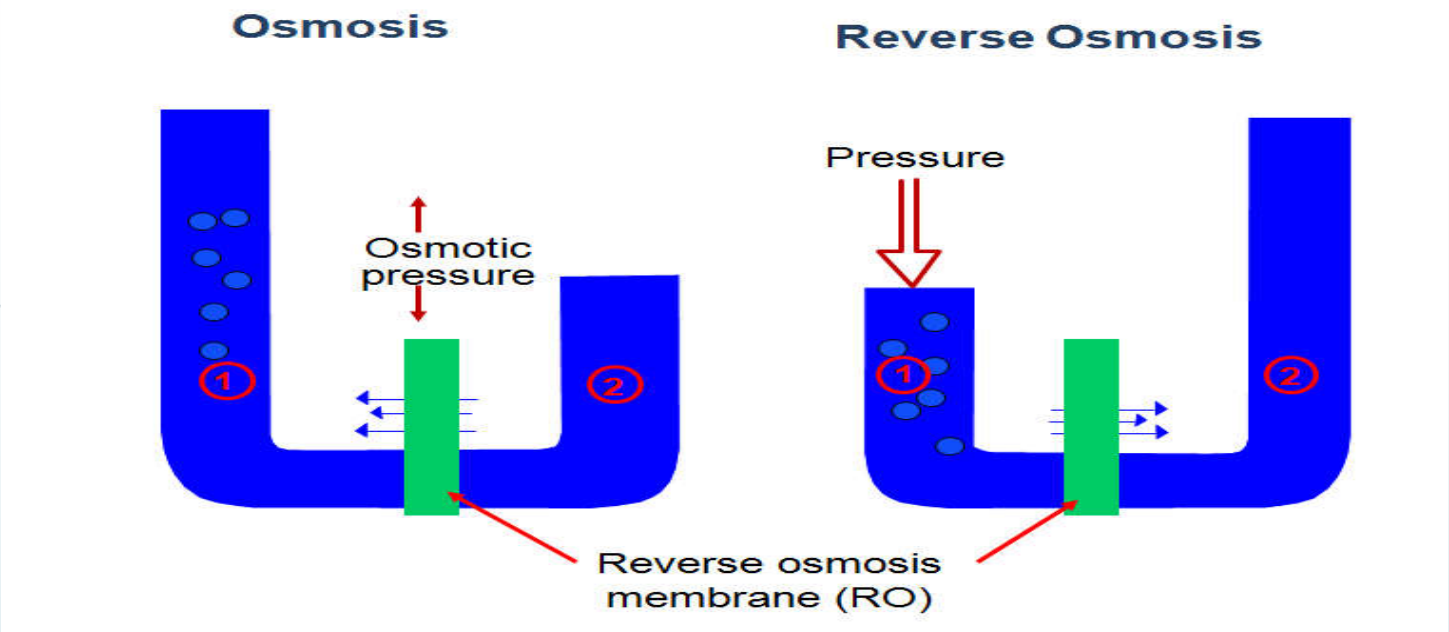
Reverse Osmosis

- is a process in which pressure greater than the natural osmotic pressure is applied on the high concentration side of the membrane, forcing the water to travel through the membrane from higher to lower chamber.
- Reverse osmosis membranes also hold back suspended impurities; such as, silt, colloidal particles and microorganisms by virtue of their ultra-fine pore size

- **Particles under 1 nm**
- **Organic molecules over 200 Da**
- **Microorganisms**

can be removed

Chloride, ammonia, CO_2 can pass through reverse osmosis membranes; therefore, water must be prefiltrated from activated carbon.


Osmosis
Reverse Osmosis
Osmotic pressure
Pressure
1
2
1
2
Reverse osmosis membrane (RO)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Types of reverse osmosis membranes

- A reverse osmosis membrane must be freely permeable to water, highly impermeable to solutes, and able to withstand high operating pressures.
- It should ideally be tolerant of wide ranges of pH and temperature and should be resistant to attack by chemicals like free chlorine and by bacteria.
- Ideally, it should also be resistant to scaling and fouling by contaminants in the feed water.
- the pore size for R.O membrane is around 0.0001 microns

There are three major types of membranes:

- **Cellulosic**
- **Fully aromatic polyamide**
- **Thin film composite**

- Cellulose acetate membranes are inexpensive and easy to manufacture but suffer from several limitations such as to hydrolysis and can only be used over a limited pH range (low pH 3 to 5 and high pH 6 to 8)
- They have a high water permeability but reject low molecular weight contaminants poorly.

- Aromatic polyamide membranes have better resistance to hydrolysis and biological attack than cellulosic membranes.
- They have better salt rejection characteristics than cellulosic membranes.
- They can be operated over a pH range of 4 to 11.

- In the thin film composites the water flux and solute rejection characteristics are predominantly determined by the thin surface layer, whose thickness ranges from 0.01 to 0.1 micrometers

Advantages of reverse osmosis

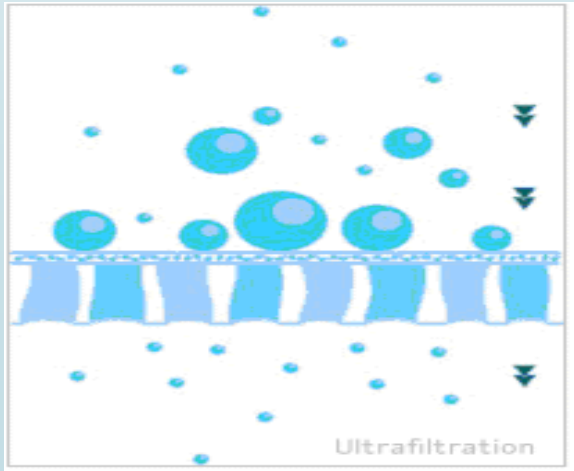
- Energy requirement is low
- RO systems can be installed on very small household basis
- Very high salt rejection rate (>99%)
- Excellent rejection of microorganisms and organic compounds

Disadvantages of reverse osmosis

- Pre-treatment is always required before reverse osmosis
- Low chemical compatibility-highly sensitive to pH
- Not compatible with micro organisms which have acetate attacking enzymes

ULTRAfiltration

- ✓ This is another technology using permeable membranes but unlike reverse osmosis it works by mechanical separation.
- ✓ Due to the ability of membranes endotoxins can also be removed.
- ✓ They can be appropriate for intermediate or final purification step.
- ✓ Care should be takent o avoid stagnant water conditions that could promote microorganism growth



Quality controls on pharmaceutical water (EP 5)

Purified water in bulk
- Appearance, color, odor, taste
- Aluminium
- Nitrates
- Sulphates
- Bacterial endotoxins

Highly purified water
- Appearance
- Aluminium
- Nitrates
- Heavy metals
- Bacterial endotoxins

Purified water in containers
- Acidity/Alkalinity
- Oxidisable substances
- Chloride
- Heavy metals
- Ammonium
- Calcium, magnesium
- Microbial contamination

Water for Injection (WFI)

WFI in bulk

- Appearance
- Nitrates
- Aluminium
- Heavy metals
- Bacterial endotoxins
- TOC
- Conductivity

Sterilised WFI

- Acidity/Alkalinity
- Conductivity
- Oxidisable substances
- Chlorides
- Nitrates
- Sulphates
- Aluminium
- Ammnium
- Calcium, Magnesium
- Residue on evaporation
- Particulate contamination
- Sterility
- Bacterial endotoxins