Water

- The most important solvent for pharmaceutical solutions is water.
- The standards for which are found in the USP and specify five degrees of purity. These are entitled as follows

1. Water
2. Purified water (Distilled water)
3. Water for injection
4. Sterile water for injection
5. Bacteriostatic water for injection

Water
Tap water or drinking water
Uses

- It is allowed to use in

1. Washing and the extraction of crude drug
2. In the preparation of products for external use
3. In other preparations in which the difference between water and purified water is of no consequence

- Water, USP, is not suitable for general pharmaceutical use because of considerable amount of dissolved solids present

What is the difference between water and purified water

- The only difference between water and purified water lie in the amount of total dissolved solids.
- A 100 ml water evaporation on steam bath and drying in an oven at 105^{o}C results in not more than 100mg residue, dissolved solids (0.1%).
- A 100 ml purified water on evaporation and drying results in not more than 1 mg dissolved solids (0.001%).
- So purified water 100 times more free of dissolved solids than is water

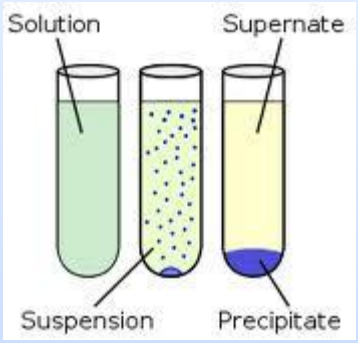
Dissolved solids in water

- Sodium chloride
- Potassium chloride
- Calcium sulfate
- Magnesium bicarbonate

Because of the chemical incompatibilities of dissolved solids present and chemical agent being added; the pharmacist should be aware about specific singes that could be seen during compounding of pharmaceutical solutions.

Signs of incompatibilities

- The development of precipitate



- Effervescence

- discoloration

Properties of water USP

- Water is clear, colorless and practically tasteless and odorless, even near the boiling point.
- Its pH is neutral or just slightly alkaline.

❖ Note: the deviation from neutrality to slight acidity or alkalinity is due to the composition of the dissolved solids and due to dissolved carbon dioxide or ammonia.

Purified Water, USP

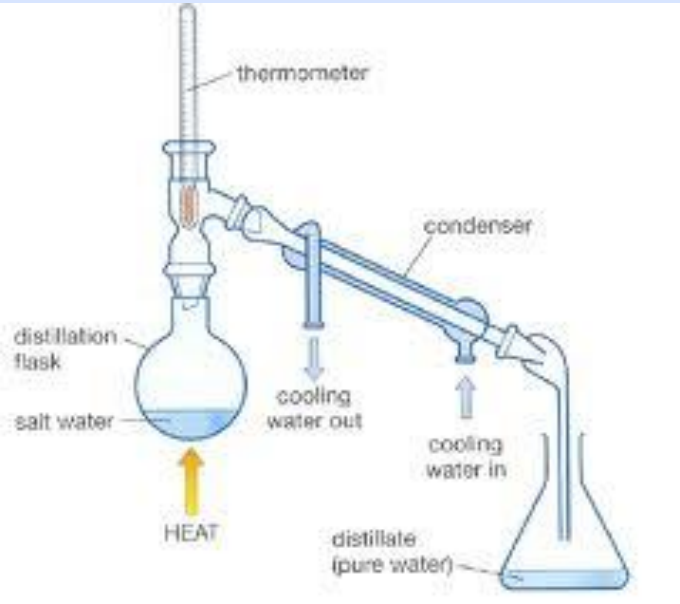
- it is used in the preparation of all medication containing water except ampoules, injections, some official external preparations, such as liniments, and other specialized products.

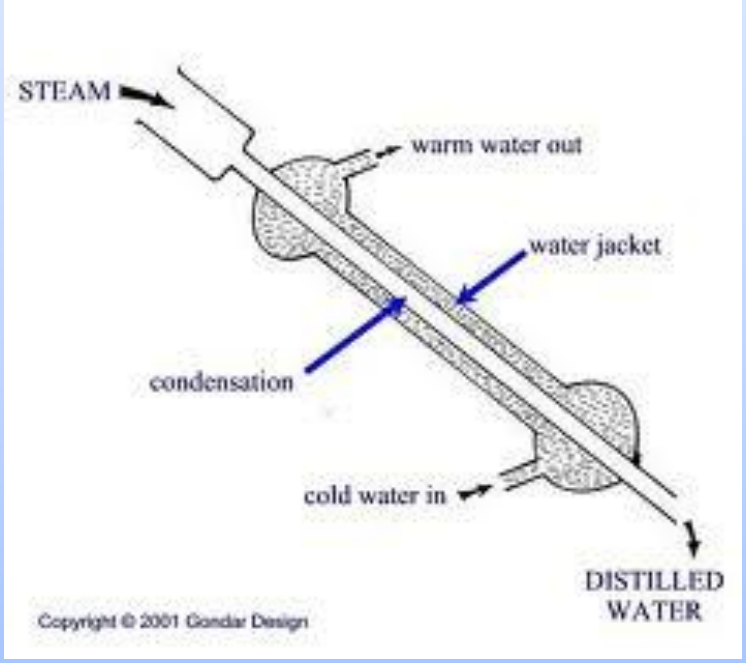
- Purified water, USP, formerly official as Distilled water, may be prepared by

1. Distillation
2. Deionization
3. Reverse osmosis

Distillation Method

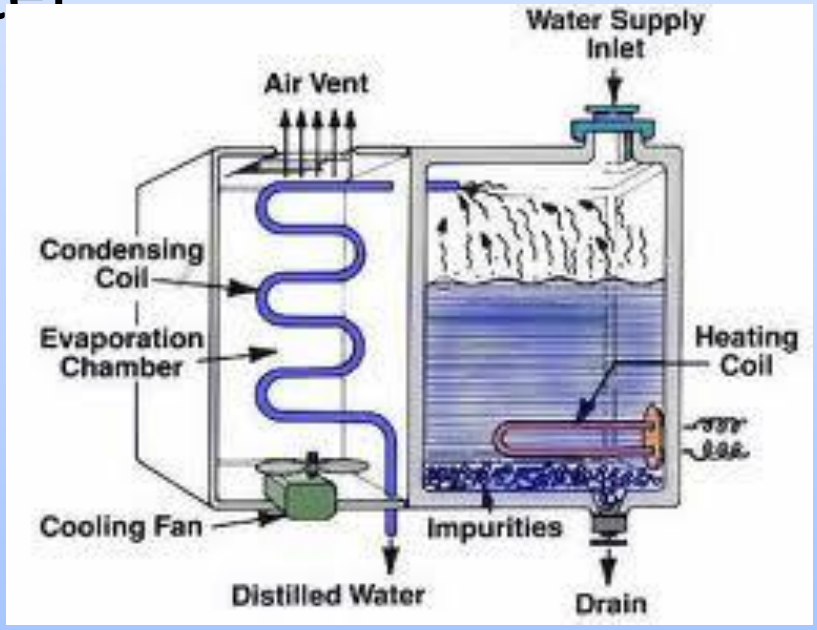
Distillation involves boiling the water and then condensing the steam into a clean container.





Distillation Method

- Many stills in various sizes and styles with capacity ranging from about 0.5 to 100 gallons of distillate per hour are available to prepare purified water

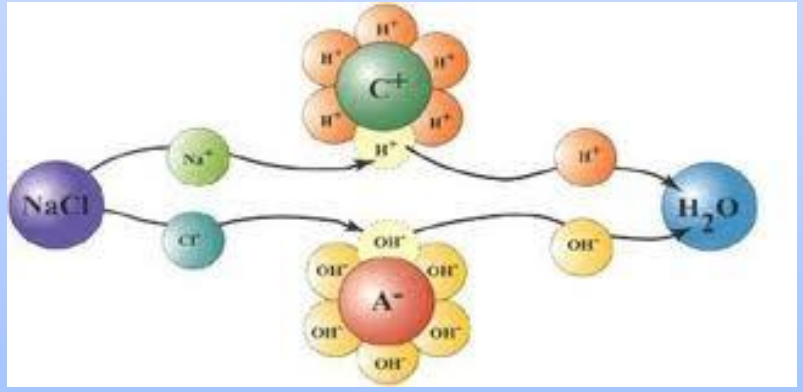


- Generally, the first portion of aqueous distillate (about the first 10% to 20%) must be discarded because it contains many foreign volatile substances usually found in urban drinking water, the usual starting material.
- Also, the last portion of water (about 10% of the original volume of water) remaining in the distillation apparatus must be discarded and not subjected to further distillation because distillation to dryness would undoubtedly result in decomposition of the remaining solid impurities to volatile substances that would distill and contaminate the previously collected portion of distillate.

Deionization methods

- In deionization methods the exchangers are used, they are synthetic, polymeric resins of high molecular weight, which are insoluble in water and characterized by an unusually high content of free amino, sulfonic acid or phenolic functions.
- These resins are mainly of two types;

1. The cation, or acid, exchangers, which permit the replacement of cations in solution with hydrogen ion
2. The anion, or base, exchange resins, which permit the removal of anions.



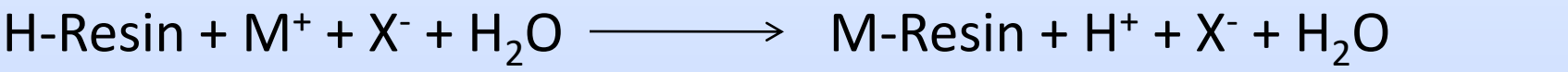
Advantages of deionization method

- Deionization possess a number of advantages when compared with distillation

1. Elimination of the use of heat
2. Simpler equipment, with less maintenance
3. Lower long-term costs and
4. Ease of production and storage

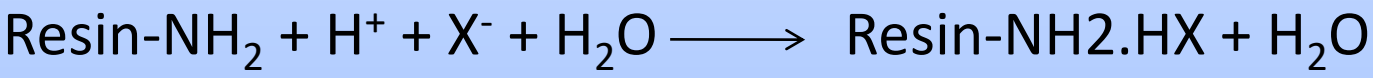
Deionization processes

1. Acid or cation, Exchange step: in this step, the cations of the salts are replaced with hydrogen ions. The cations so replaced remain behind, “fixed” to the resin.



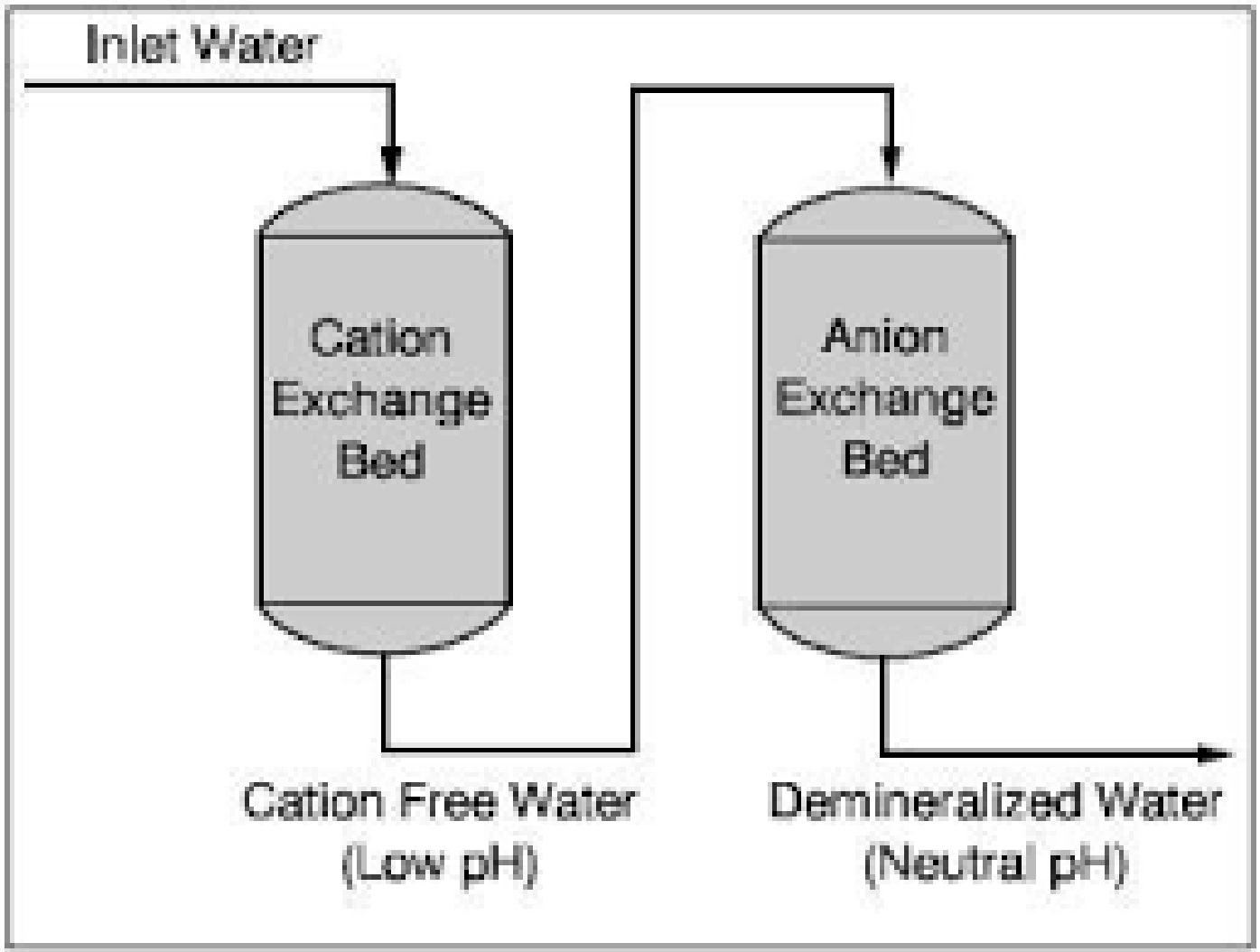
Where M^+ and X^- are the cation and the anion of a salt present in solution.

2. Base, or anion, Exchange step: water is passed through a basic resin (usually a poly amine) and the anion remaining after step 1 is removed according to



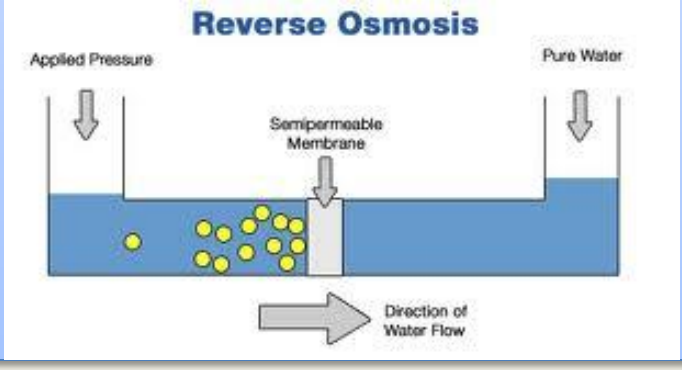
These two processes are successively or simultaneously employed to remove both cations and anions from water

Ion-exchange equipment
involves the passage of water through a column of cation and anion exchangers



Reverse osmosis

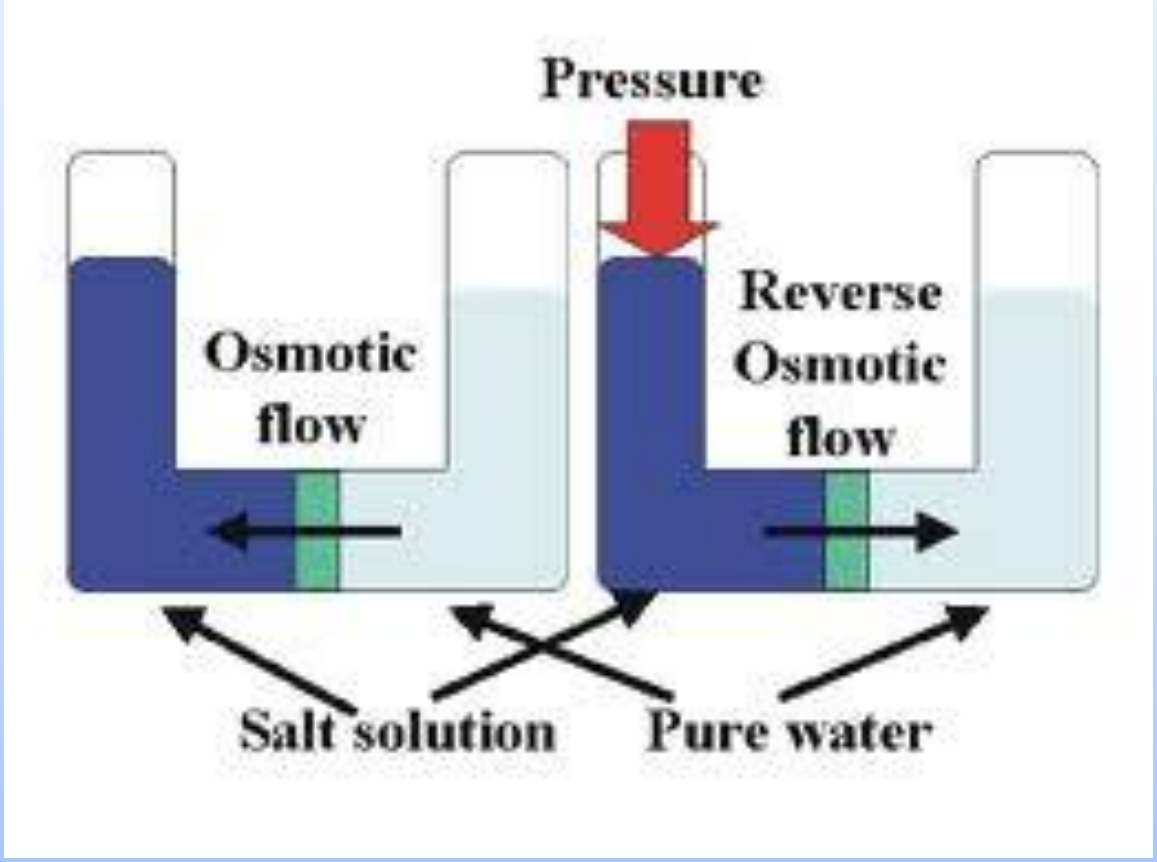
is a membrane-technology filtration method that removes many types of large molecules and ions from solutions by applying pressure to the solution when it is on one side of a selective membrane. The result is that the solute is retained on the pressurized side of the membrane and the pure solvent is allowed to pass to the other side. To be "selective," this membrane should not allow large molecules or ions through the pores (holes), but should allow smaller components of the solution (such as the solvent) to pass freely.



Osmosis and Reverse osmosis

- In the normal osmosis process, the solvent naturally moves from an area of low solute concentration (High Water Potential), through a membrane, to an area of high solute concentration (Low Water Potential). The movement of a pure solvent to equalize solute concentrations on each side of a membrane generates osmotic pressure.
- Applying an external pressure to reverse the natural flow of pure solvent, thus, is reverse osmosis. The process is similar to other membrane technology applications.
- Reverse osmosis, however, involves a diffusive mechanism so that separation efficiency is dependent on solute concentration, pressure, and water flux rate.
- Reverse osmosis is most commonly known for its use in drinking water purification from sea water, removing the salt and other substances from the water molecules.

Osmosis and Reverse Osmosis



Water for injection

- This is pyrogen-free water
- Purified by distillation
- For preparation of products for parenteral use
- It is intended for use as a solvent only in solutions that are to be sterilized after preparation.
- If it is to be used as a solvent in parenteral solutions prepared under aseptic conditions, water for injection must be sterilized before use.
- It contains no added substance and meets the requirements of the tests for purified water.
- It must meet the requirements of pyrogen test
- It must be made isotonic (by the addition of 900mg pyrogen-free sodium chloride for each 100ml)

Sterile water for injection, USP

- Used as a solvent vehicle or diluent for already sterilized and packaged injectable medication.
- The preparation must meet the requirements of the sterility test and pyrogen test and other tests under purified water.

Bacteriostatic water for injection, USP

- It is sterile water for injection containing bacteriostatic agents
- It may be packaged in single containers of not larger than 5 ml size and in multi-dose containers of not larger than 30 ml, the label of which indicates the name and the proportion of added agent
- Not for use in newborns