# WEEK-8

Methods for water purification given in pharmacopeias.

- **Pre-purification**
- **Distillation**
- **Deionisation**
- **Reverse osmosis**
- **Ultrafiltration**
- **Electrodialysis**
- **Electrodeionisation**

# Pre-purification

**Particules, visible substances, organic and inorganic materials and ions can be removed in this step.**

- **Microporous filters**
- **Filtering from activated carbon**
- **Softening**
- **Organic scavengers**
- **Addition of chemical additives**

**can be used**


## Prefiltration

- They are initial/coarse filters which removes solid contaminants of 7-10 micrometers. These contaminants usually comes from the source water and affects the equipment performance.
- These filters can be granular bed or cartridge type and can be prepared from sand, carbon, cellulose..
- If the filter is activated carbon, it can adsord low MW organic materias and oxidizing additives such as chlorine and remove them from water. By this way they can protect the surfaces and membranes of equipments.
- However a biofilm can be produced by microorganism growth inside carbon filter cartridges and therefore, sanitation is important.

## Additives

- They are controlling the microorganisms by use of sanitants such as ozone
- They enhance the removal of suspended solids by use of flocculating agents
- They adjust the pH for more effectively removing carbonate and ammonia by reverse osmosis

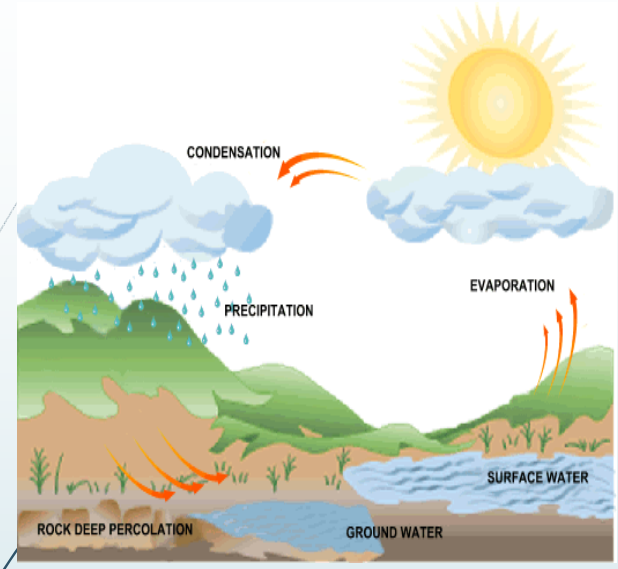
## Organic scavengers

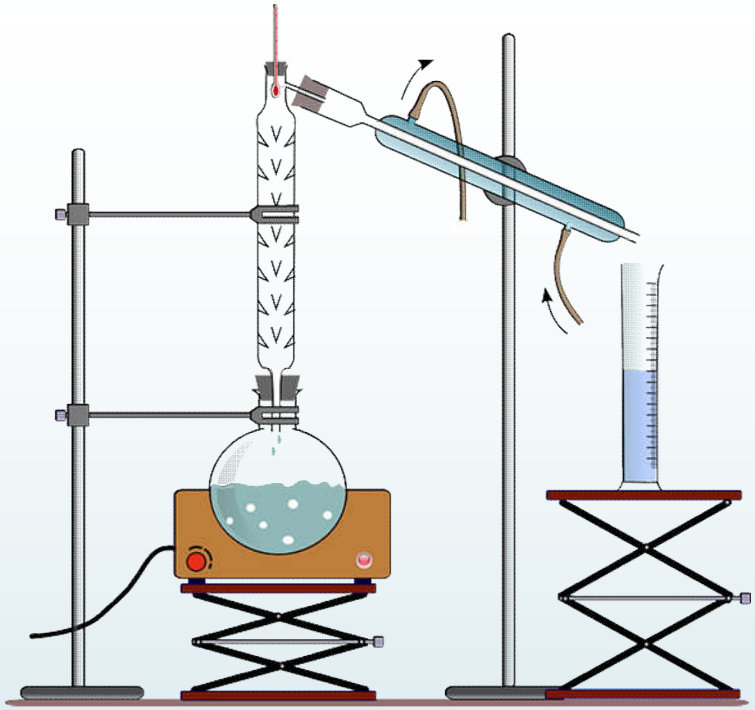
- They are weak anion-exchange resins which are capable of removing organic material and endotoxins from water.

## Softeners

- They are sodium based cation-exchange resins which are capable of water-hardness ions; Ca and Mg.

# Distillation



Distillation is a process in which a liquid or vapour mixture of two or more substances is separated into its component fractions of desired purity, by the application and removal of heat.

- Distillation is done on the basis of differences in their volatilities in a boiling liquid mixture.
- Distillation is a physical separation process, and not a chemical reaction.

**1. Non-volatile residue such as;**

*particulates

*inorganic substances

*high MW substances

*microorganisms

**2. Organic substances having different boiling points than water**

can be removed by this method.

iPrinciple: Separation of components from a liquid mixture via distillation depends on the differences in boiling points of the individual components. And also depends on the vapour pressure characteristics of liquid mixtures.

## BASIC DISTILLATION EQUIPMENTS

Simple distillation is the process of converting a liquid into its vapour, transferring the vapour to another place and recovering the liquid by condensing the vapour.

- ✓ **Distiller**

**is the place volatile material is vaporized**

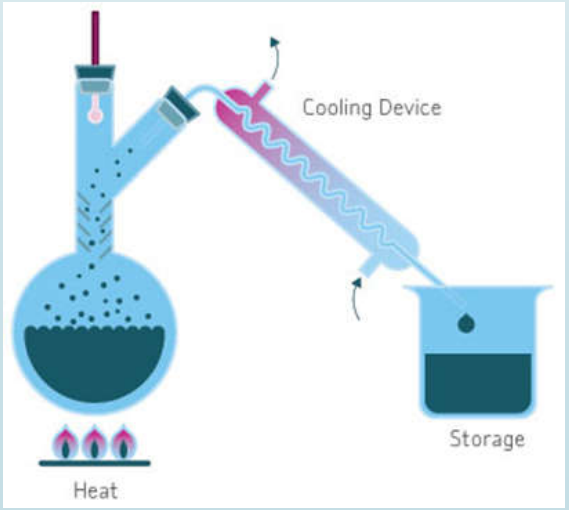
- ✓ **Condanser**

**is the heat exchanger**

**heat source can be electricity, gas, water vapour ..)**

- ✓ **Receiver**

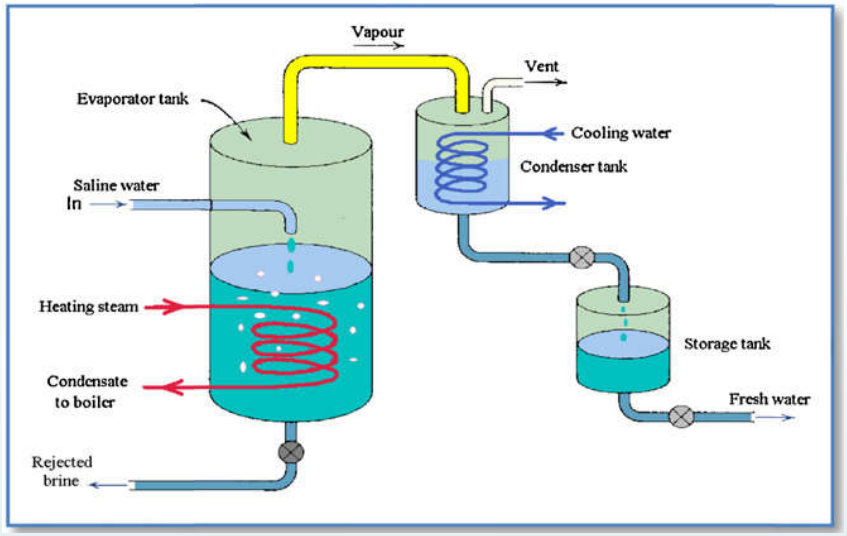
**İs the place distillate is collected.**

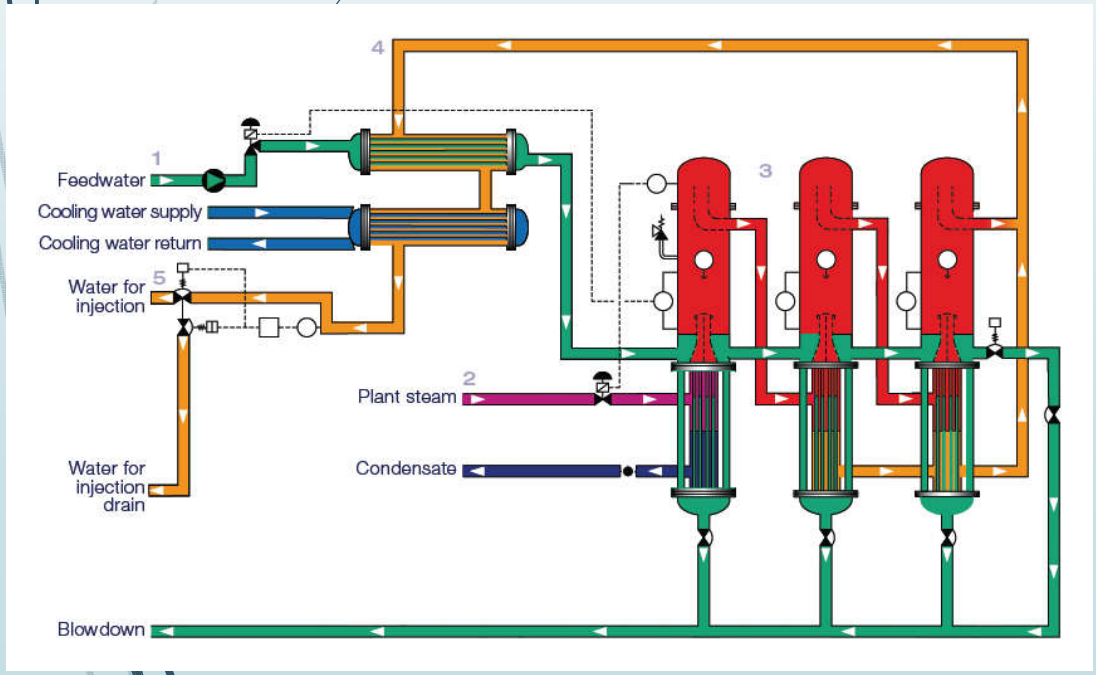


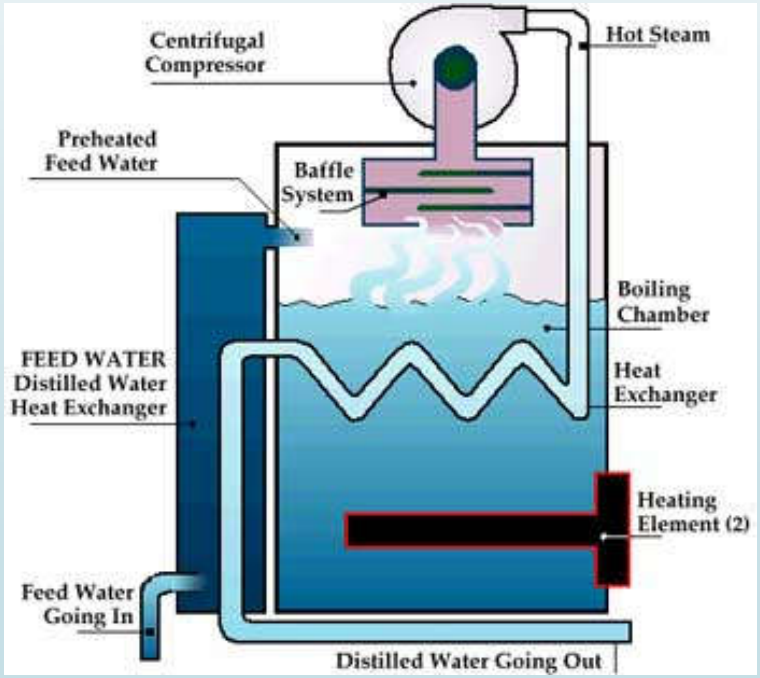
In distillation;

- Single effect
- Multieffect
- Vapour compression

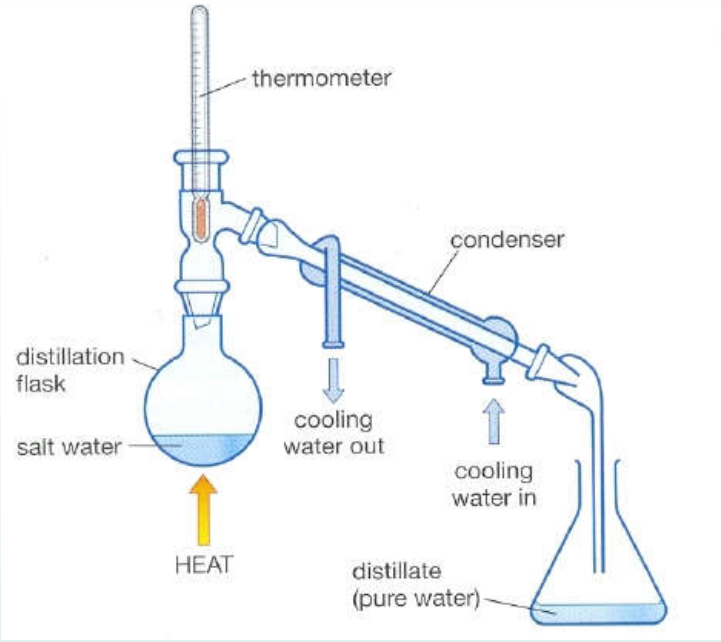
methods can be used.



- ✓ Feed water must be drinking/potable water.
- ✓ However, deionised water is more useful as feed water as it avoids stalactite formation.




- ✓ Storage of the prepared water is also as important as production.
- ✓ If not used immediately, it is sterilized for 1 hour at 120 °C.
- ✓ In large scale productions it is stored at 80 °C and above at constant temperature or under UV irradiation

# Deionization

**In this method, ion exchange resins are used for removing ions from the water.**

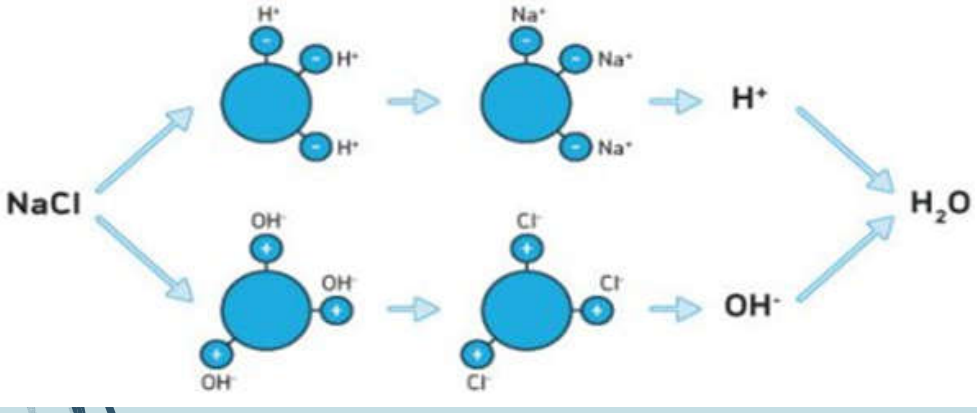
Deionized water can be used for,

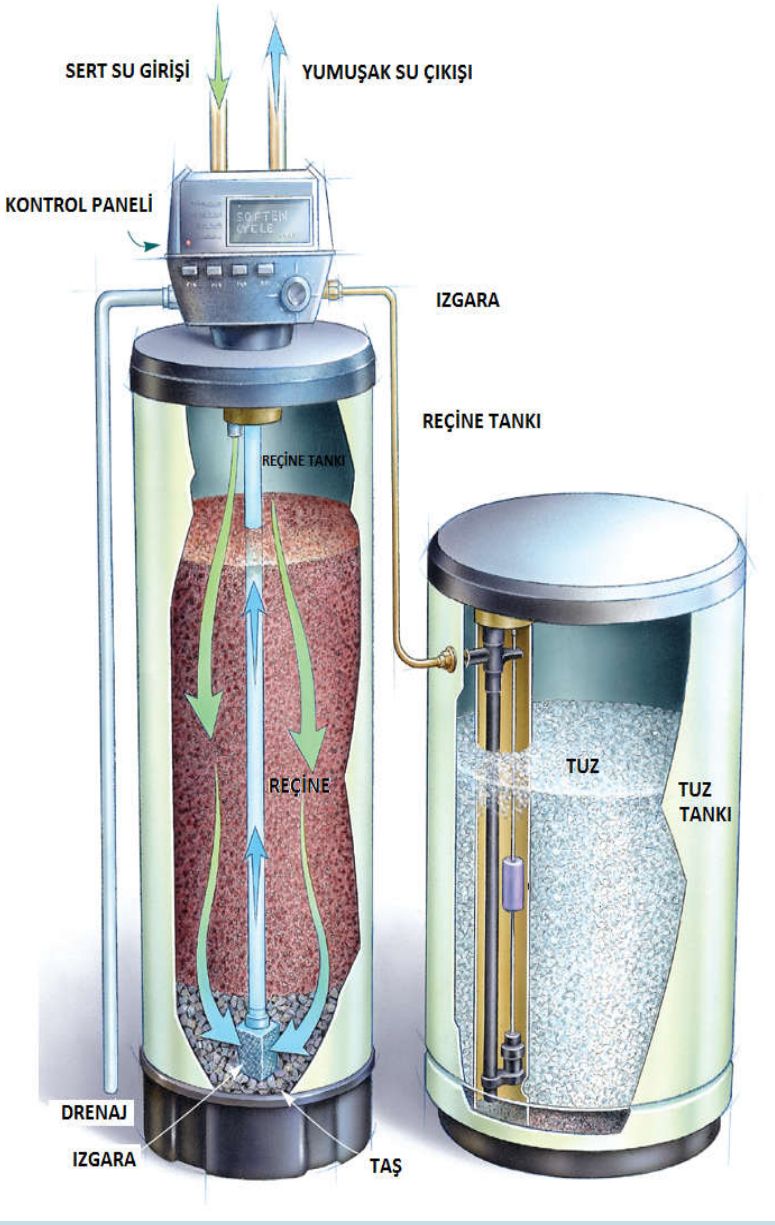
- ✓ glassware cleaning (especially high volume bottles)
- ✓ non-parenteral liquid dosage form preparation
- ✓ Suitable as feed water for distillation
- ✓ Can not be used as parenteral (involves pyrogen)

There are 2 types of ion exchange resins;

- Cation exchange resins
- ✓ which carry acid groups on their surface and
- ✓ traps cations from water

- Anion exchange resins
- ✓ which carry alkaline groups on their surface and
- ✓ traps anions from water


NaCl
H⁺
H⁺
H⁺
Na⁺
Na⁺
Na⁺
H⁺
OH⁻
OH⁻
OH⁻
Cl⁻
Cl⁻
Cl⁻
OH⁻
H₂O


SERT SU GİRİŞİ
YUMUŞAK SU ÇIKIŞI
KONTROL PANELİ
IZGARA
REÇİNE TANKI
REÇİNE TANKI
REÇİNE
TUZ
TUZ TANKI
DRENAJ
IZGARA
TAŞ

## Functional groups for cation exchange resins

- ✓ carboxyl,
- ✓ Sulphonic acid, etc..

Example: phenol formaldehyde sulphonic acid resins
polystyren sulphonic acid resins

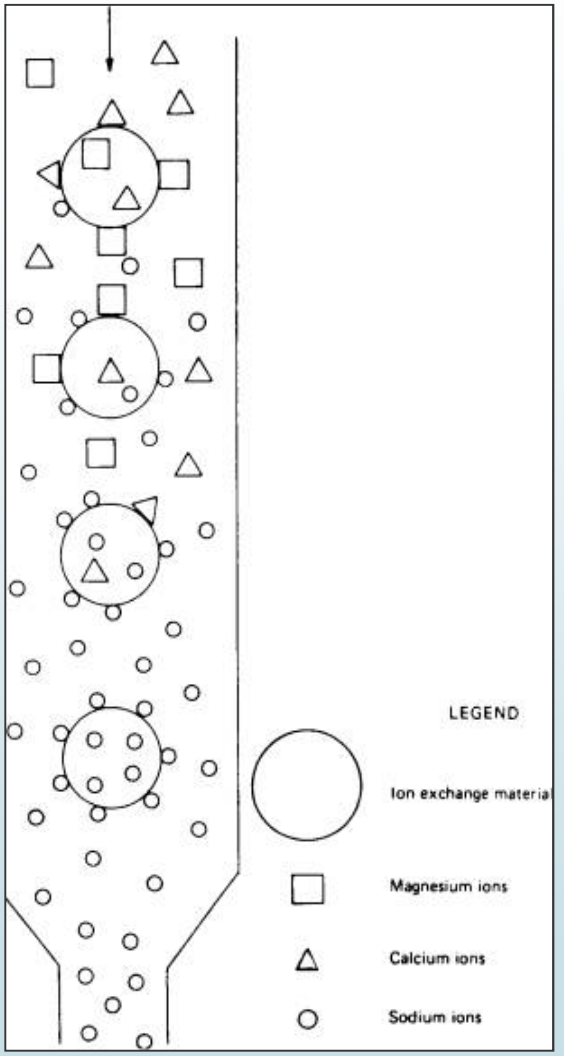
## Functional groups for anion exchange resins

- ✓ amino groups , etc.

Example: quaterner ammonium-aromatic amin resins

## Characteristics of resins

- ✓ Does not dissolve in water or solvents,
- ✓ Resistant to heat,
- ✓ Resistant to acid and alkaline chemicals,
- ✓ Mechanically stable,
- ✓ Mekanik direnci iyi olmalı,
- ✓ Porous structured
- ✓ Must not swell highly



## Problems of ion exchange resins,

- Microorganisms can easily grow on the surface of ion exchange resins if the system is not continuously used (in stagnant water)and irregularly regenerated

- Cation exchange resins can be regenerated by mineral acids and anion exchange resins can be regenerated by alkaline medium.

- Regeneration also enhances the exchange capacity
- Microrganisms in the water cannot be removed by this method