Water distiller

Distillation: it's a separation process that **involves** heating a liquid to its boiling point, transferring the vapour to a different portion of the apparatus, *then* condensing the vapour *and* collecting the condensate in another container.

This technique is one of the most useful for separating a mixture of liquids when the components have **different boiling points.** Chemically, distillation is the principal method for purifying liquids (e.g. samples, or solvents for performing reactions). Successful distillation *depends on* several factors, including the difference in boiling points of the materials in the mixture, and therefore the difference in their vapour pressures, the type of apparatus used, and the care exercised by the experimentalist.

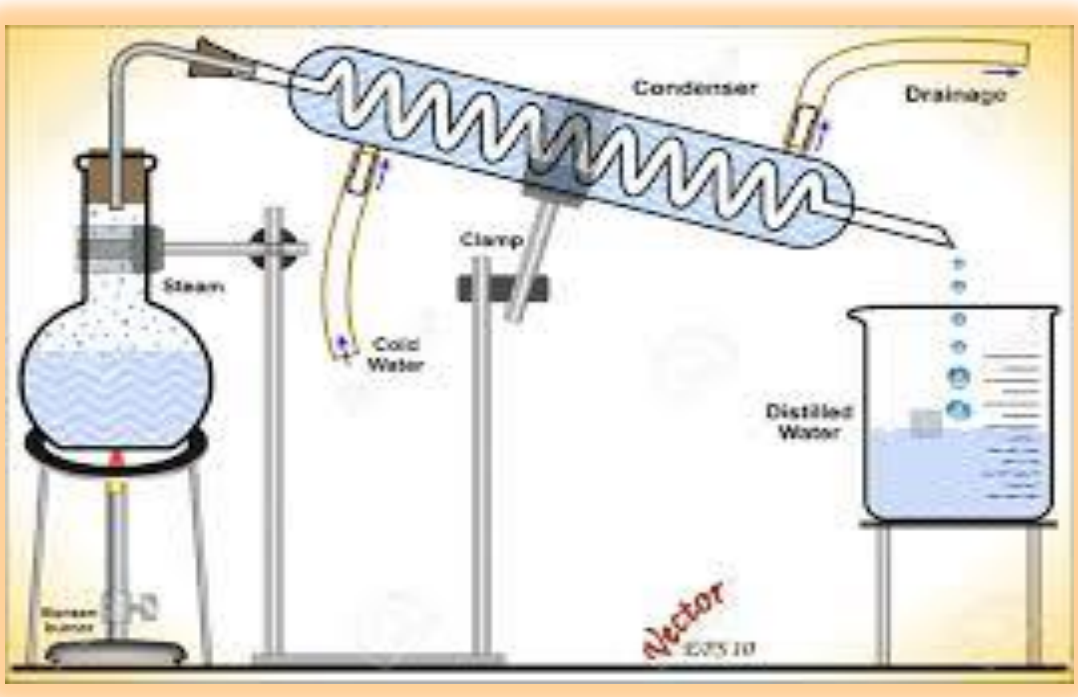

Fig. 1 water distilator

Distillation of a Pure Liquid

A pure liquid has a constant boiling point as long as liquid and vapour are in equilibrium. In a simple distillation of a pure substance, as the temperature rises, the vapour pressure increases. As the vapour expands, it passes out of the heated portion of the apparatus until it comes into contact with the cold surface of the water-cooled condenser. When the vapour is cooled, it condenses and passes down the condenser into the receiver.

How does distillation work?

Distillation works by **exploiting the different boiling temperatures of liquids**. To separate two or more liquids by distillation, you first heat them in a flask. The more volatile liquid *(the liquid with the lower boiling point)* will typically evaporate first and the vapor will pass into a condensing column, where it can revert into a liquid (condense) on the cool glass where it trickles into a collection flask.

Heating further will cause the less volatile liquids to evaporate and distill at higher temperatures.

The two main kinds of distillation are **simple distillation** and **fractional distillation**, and both are used widely.

Simple Distillation

The setup for a simple distillation is shown in Figure 2. A simple distillation apparatus *consists of* a boiling flask (round-bottom flask) attached to an adapter holding a thermometer (to determine the boiling temperature of the liquid). The adapter connects to a condenser into which cold water is constantly passed through. The condenser leads into a collection flask for the purified liquid.

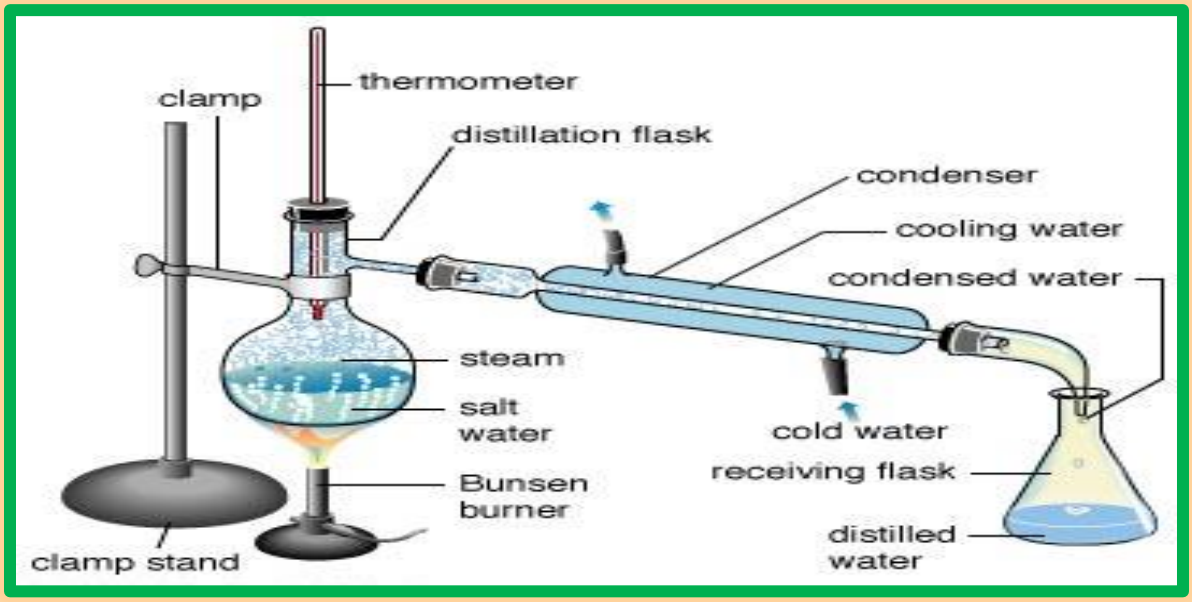

Fig. 2 simple water distilator

Fractional Distillation

Fractional distillation is essentially the same as simple distillation *except* that a **fractionating column is placed between the boiling flask and the condenser.** The fractionating column is usually filled with glass or plastic beads. These beads improve the separation between the liquids being -distilled.

The reason that fractional distillation gives better separation between the liquids is **because** the glass beads in the fractionating column provide "**theoretical plates**" on which the refluxing liquid can condense, re-evaporate, and condense again, essentially distilling the compound over and over. The *more volatile* liquids will tend to push towards the top of the fractionating column, while *lower boiling* liquids will stay towards the bottom, giving a better separation between the liquids.

Of course, the more theoretical plates that you add to a column (the more surfaces or beads), the longer the distillation will take, and the more energy required to keep re-evaporating liquid in the fractionating column

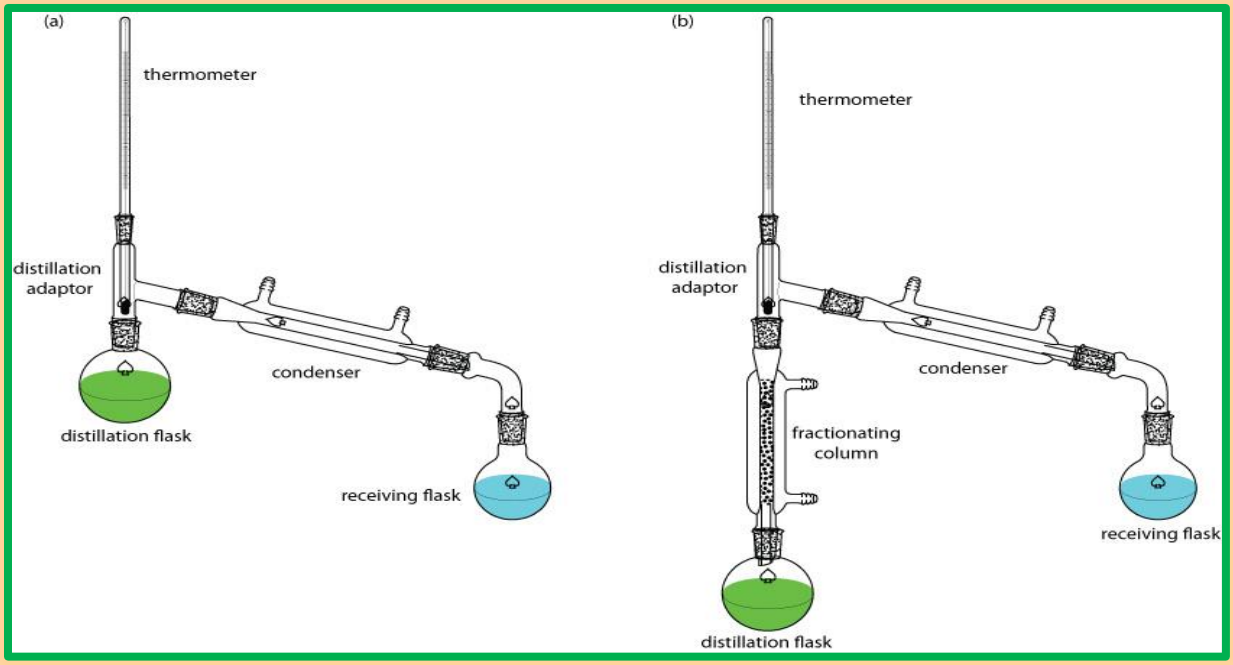

Fig. 3 simple distilator apparatus and fractional distilator apparatus

The choice of whether to use fractional distillation or simple distillation **depends on** the two liquids being separated. Typically, using simple distillation is preferable because the apparatus is, well, simpler, and a simple distillation typically goes faster than a fractional distillation (and requires less energy). On the other hand, fractional distillation gives better separation between the liquids. The choice of whether to use simple or fractional distillation, then, depends usually on the difference in boiling temperatures between the two liquids. **If** there is a **large difference** in the boiling points (>70°C) between the two liquids then simple distillation is probably the best option. On

the other hand, if there is only a **small temperature difference** between the two liquids a fractional distillation is the preferable option.

	Simple distillation	Fractional distillation
Advantages	1. simpler setup than fractional 2. faster distillation times 3. consumes less energy than fractional distillation	1. much better separation between liquids than simple distillation 2. can morereadily purify complex mixtures than simple distillation
Disadvantages	1. requires the liquids to have large boiling point differences (>70°C) 2. gives poorer separation than fractional distillation 3. only works well with relatively pure liquids	1. more complicated setup than simple distillation 2. takes longer for liquids to distill 3. consumes more energy than simple distillation
Best used for:	separating relatively pure liquids with large boiling differences or liquids with solid impurities	Separating complex mixtures of liquids with smaller boiling point separations.