DISTILLATION

"It is defined as separation of components of liquid mixture by process involving vaporization & then condensation at another place."

It involves two steps:

01). Converting a liquid into vapour.

02). Transferring the vapour to another place & recovering the liquid by condensation.

The feed liquid is knowns as "Distillation" and the condensate liquid is called "Distillate or Condensate".

APPLICATIONS

- Separation of volatile oil.
- Purification of organic solvents.
- Manufacturing of official preparation.
- Refineries of petroleum products.
- Recovery of solvents.
- Separation of drugs obtained from plant & animals.
- Purification of drugs obtained from chemical process.

IDEAL SOLUTION

"Ideal solutions are defined as the one which there is no change in the properties of the components other that dilution when they are mixed to form a solution."

Example: Methanol & water.

DALTON'S LAW

"Daltons law of partial pressure states that pressure extract by a mixture of gases is equal to sum of partial vapour pressure exerted by each gas."

RAOULT'S LAW

"It states that partial vapor pressure of each volatile components is equal to vapour pressure of pure components multiplied by its mole fraction in the solution at a given temperature. "

SIMPLE DISTILLATION

It is the process of a converting single constituents for liquid (mixture) into its vapour, transferring the vapour to another place & recovering the liquid by condensing the vapour. Usually by allowing it to coming contact with cold surface.

PRINCIPLE

Liquid boil when its vapour pressure is equal to atmospheric pressure. Simple distillation conducted at its boiling point.

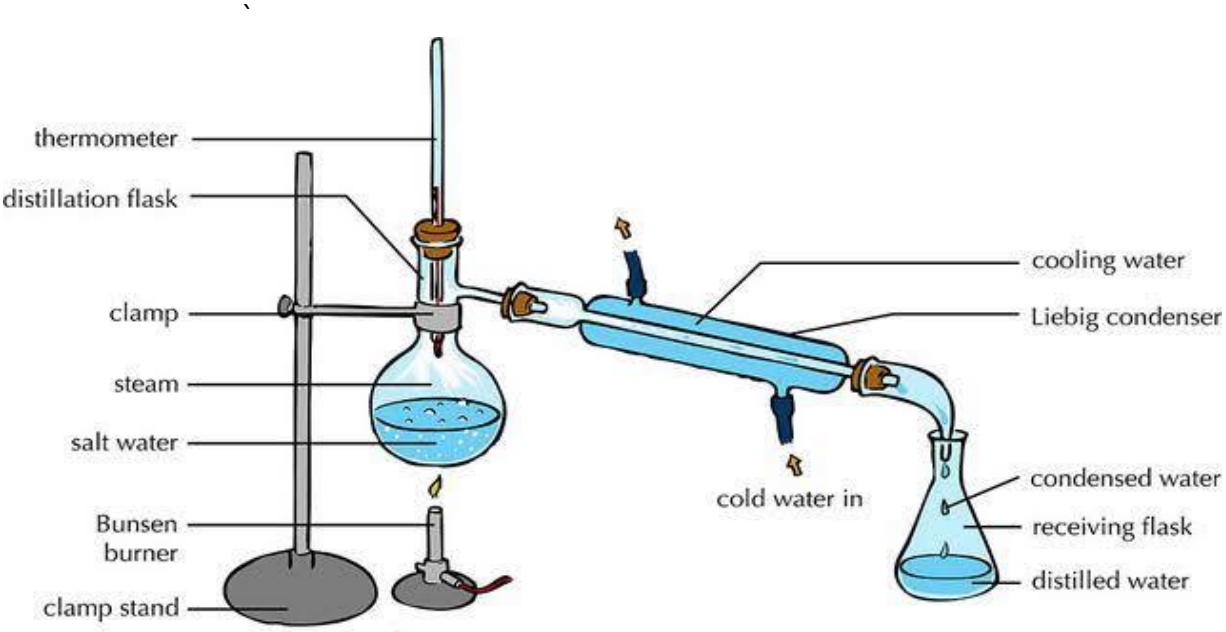
The higher the relative volatility of liquid the better the separation. Heat is supplied to liquid so that it boils & resulting vapour condensed.

CONSTRUCTION

It consists of a distillation flask with a side arm sloping downwards. A condenser if fitted into the side arm by means of a cork.

The condenser is usually is water condenser.

The condenser is connected to receiver flask by means of adaptor.



PROCEDURE

The liquid is to be distilled its filled into the flask. A thermometer is inserted in to the cork & fixed to the flask. The water is circulated through jacket of condenser. The heat is supplied & content is heated & boiled after some time. The vapour rises up & passes down the side arm into the condenser the temperature rises rapidly & reaches a constant value the temperature is equal to the boiling point of liquid finally the vapour form are condense & collected in to receiver.

APPLICATIONS

- → It is used for preparation distilled water & water for injection.
- → Volatile & aromatic water are prepared.
- → Nonvolatile solid are separated from volatile liquid.

FLASH DISTILLATION

It is defined as the process in which the enter liquid is suddenly vaporized by passing it term high pressure zone to low.

PRINCIPLE

When a hot liquid mixture is allowed to enter form high pressure zone to vaporized suddenly during this process the chamber get cooled the individual vapour. Vapour phase molecule of high boiling fraction get condensed, while low boiling fraction remain as vapour. This process requires for the equilibrium to reach & therefore the liquid & vapour are held in contact with each other for some period of time & then are separated.

The vapour are further condensed & collected.

CONSTRUCTION

It consists of a pump, which is connected to a feed reservoir. Pump helps in pumping the feed into heating chamber which consists of suitable heating mechanism.

The other end of the pipe is directly introduced into the vapour-liquid separator through a reducing valve. The vapour outlet is provide at the top of the separator & liquid outlet is provided at the bottom.

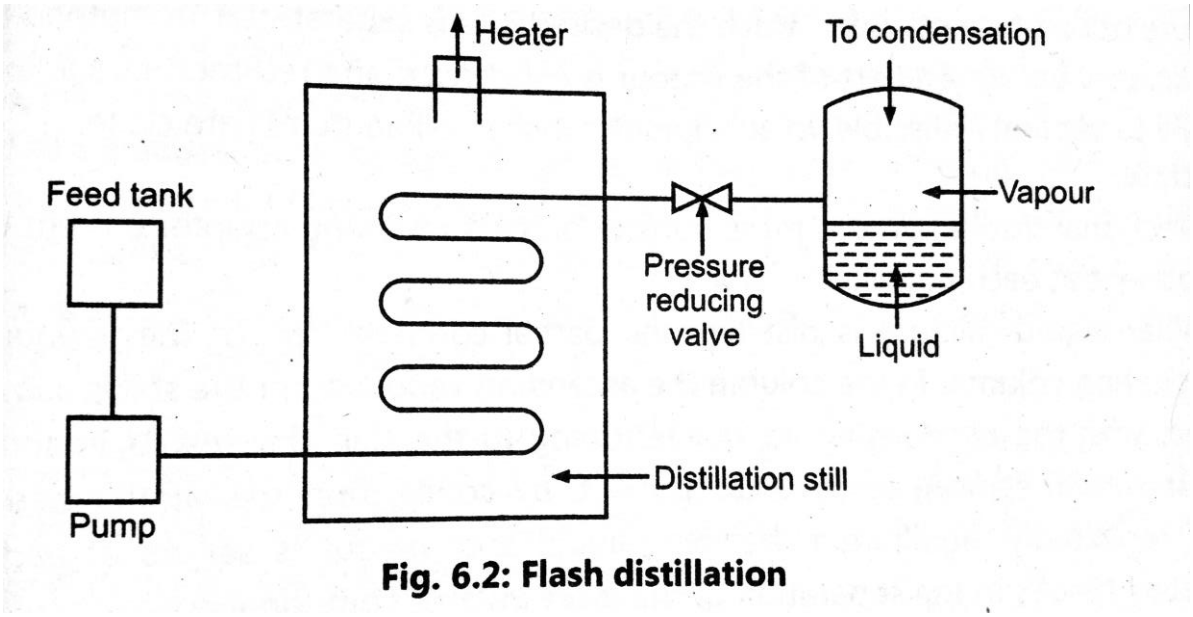


Fig. 6.2: Flash distillation

WORKING

The feed is pumped through a heater at a certain pressure. The liquids get heated, which enters the vapour-liquid separator through a pressure reducing valve. Due to the drop-in pressure the liquid flashes, which further enhances the vaporization process.

Suddenly vaporization induces cooling. The individual vapour phase molecules of high boiling fraction get condensed while the low boiling fraction remains as vapour.

The mixture is allowed for a sufficient time, so that vapour & liquid portions separate & achieve equilibrium.

USES

It is used for separating components, which boils at widely different temperatures.

It is widely used in petroleum industry.

ADVANTAGES

- → It is used for obtaining multi-components.
- → It can be used in continuous mode.

DISADVANTAGES

- ❑ It is not suitable for two components systems.
- ❑ It is not suitable if the separated components are needed in pure quality.

FRACTIONAL DISTILLATION

It is the type of distillation process which involve separation of mixable liquids. The process involves repeated distillation & condensation & the mixture I usually separated into components parts; the separation happens when the mixture is heated at a certain temperature. Where fraction of the mixture starts to vaporized.

PRINCIPLE

The basic principle of this type of distillation is that differ boil & evaporates at different temperature so when the mixture is heated, substance with power boiling point start to boil first & convert in to vapour.

CONSTRUCTION

It consists of a fractionating column, distillation flask, condenser, receiver & heat source. The fractionating column is inserted between the still & condenser at the top of column, a condenser is provided & heat is supplied at the bottom of the column.

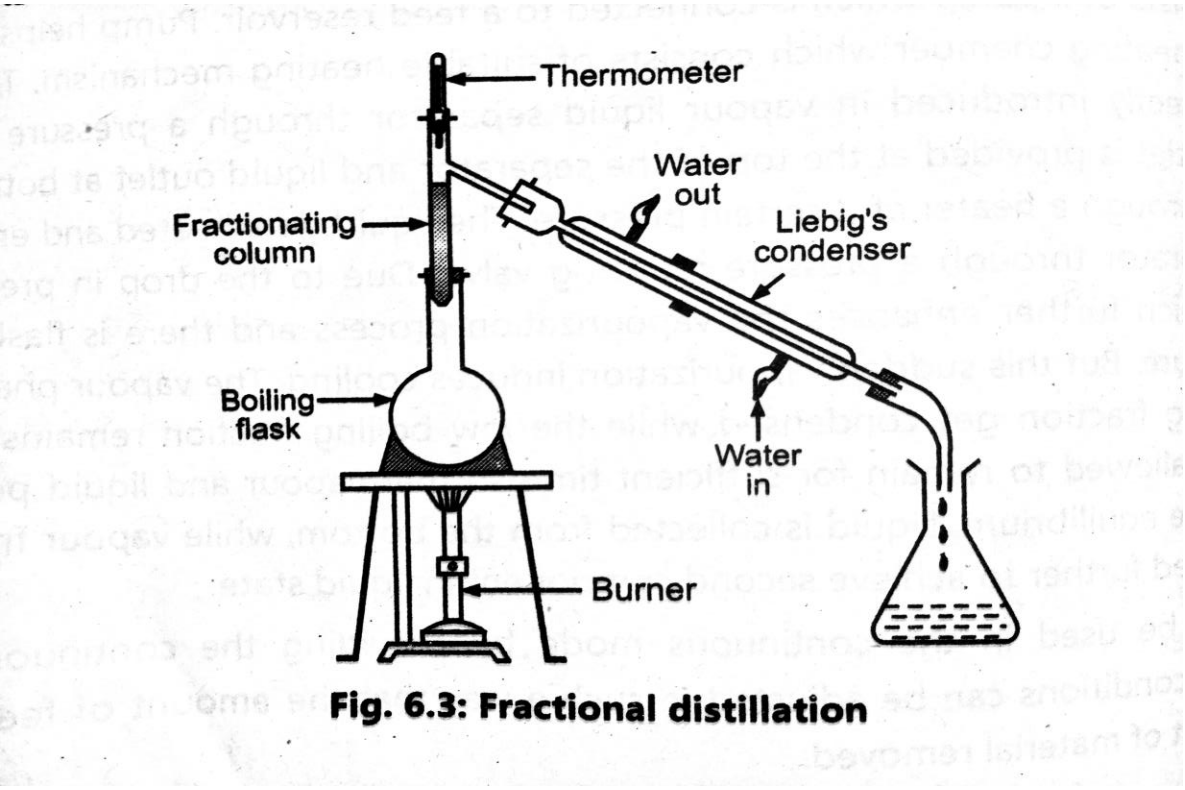


Fig. 6.3: Fractional distillation

WORKING

The mixture to be distilled is feed to the boiler & heated. A mixture of two mixable liquids A & B is taken where A have more volatility then B.

The solution is added into the flask, heat is applied & the mixture starts to boil the vapour are formed having large amount of vapour from liquid A. these vapour moves through the fractalizing column into the condenser where it is cool down to form a liquid which is collected into the receiver. Vaporization & condensation takes place throughout the process until two mixtures are separated completely.

USES

Use for purification of water as well as separating water & acetone.

Use in several industries like oil binaries & chemical plants for purification & separation of organic compounds.

ADVANTAGES

It is used for separating large amount of mixable liquid according to their boiling point.

Example: acetone & water.

DISADVANTAGES

This method cannot be used to separate mixable liquid from azeotropic mixture.

DISTILLATION UNDER REDUCE PRESSURE

it is defined as a process in which liquids is distilled at a temperature lower than its boiling point by applications of vacuum.

PRINCIPLE

Liquid boil when its vapour pressure is equal to atmospheric pressure. If the external pressure is reduced by applications of vacuum, the boiling point of liquid decreases therefore the liquid boils at lower temperature.

CONSTRUCTION

Distillation under reduced pressure or vacuum is carried out in a specially designed glass apparatus. A to necked 'Claisen's flask' is used, the main neck of which is fitted with along capillary tube (capillary tubes avoids bumping) & the side neck being fitted with a thermometer.

The side tube is connected to a condenser carrying a receiver at the other end. The receiver is attached to a vacuum pump to reduce the pressure. The pressure is measured with the help of a manometer.

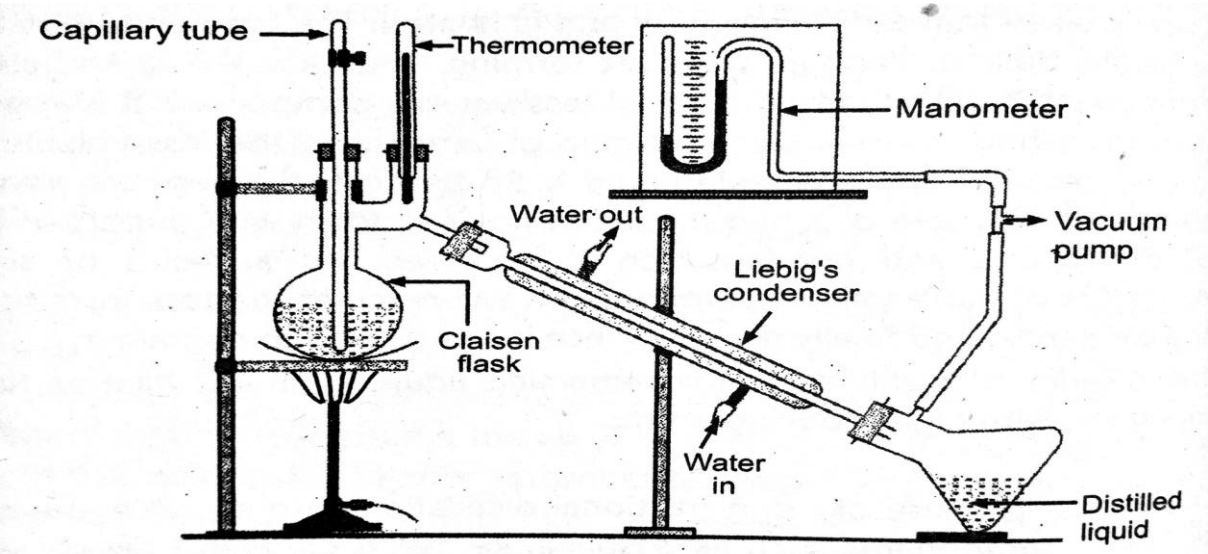


Fig. 6.4: Distillation under reduced pressure

WORKING

The liquid to be distilled is filled into the flask. The reducing vacuum applied and content or heated gradually. The temperature rises & get vaporized rapidly due to vacuum. the vapour passes through the condenser & conduced is collected into the receiver.

The temperature is noted which is less than the boiling point of the liquids.

ADVANTAGES

This method is used for the compound which degraded or higher temperature.

Example: Enzymes, vitamins & alkaloids etc.

DISADVANTAGES

- In vacuum distillation persistent foaming occurs.
- Not suitable for preparation of semi-solids or solid extracts.

STEAM DISTILLATION

PRINCIPLE

Steam distillation is a method of distillation carried out with the help of steam & used for separation of high boiling substance from non-volatile impurities.

A mixture of immixible liquids begainst to boil when the some of their vapour pressure, is equal to atmospheric pressure.

For volatile- substance which are mixable with water steam distillation involve the principle of fractional distillation.

CONSTRUCTIONS

It consists of steam can with a cork having two holes in one-hole safety tube is attached & through another hole a vent tube is pumped, the other the bent tube is connected to the flask, containing non-aqueous liquids.

A delivery tube is insulted is the second flask which connect flask & condenser.

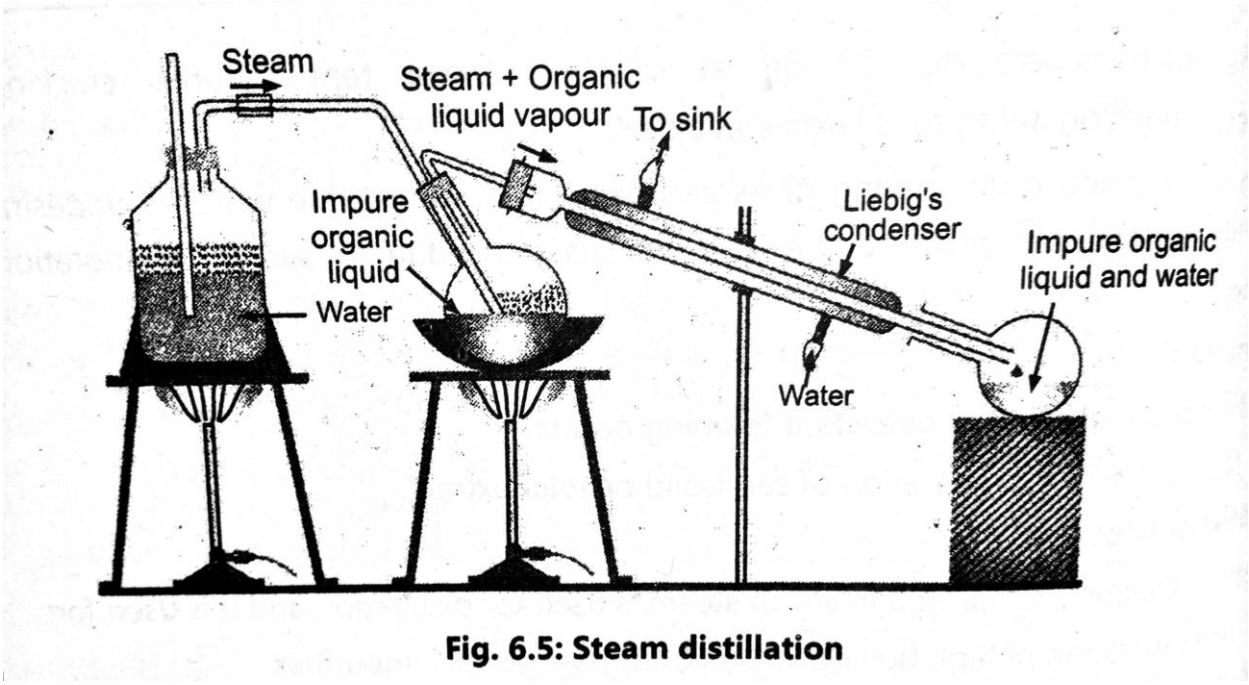


Fig. 6.5: Steam distillation

WORKING

The non-aqueous liquid is placed in the flask. The small quantity of water is added to it. Steam can be filled with water; the flask & steam can are heated simentionally. This steam carries the volatile oil & passes in to the condenser which is cooled in to the receiver the process is continued until all the non-aqueous liquid has been distilled.

In the receiver water & organic liquid forms two separate dyes which can be easily separated.

APPLICATION

- ❑ It is used of separation of immixible liquids.
  Example: Toluene & water.
- ❑ It is used for extraction of most of the volatile oil like clobe like.
- ❑ Camphor is also distilled by this method.

ADVANTAGES

- → Volatile oil can be separated at lower temperature is steam distillation, without loss of aroma.
- → It is useful in purification li liquids with high boiling points.
- → Provided molecular weight.

DISADVANTAGES

Not suitable when immixible liquids & water reacts with each other.

MOLECULAR DISTILLATION

A process in which each molecule in the vapour phase travels the mean free path & gets condensed individually without intermolecular collisions on application of vacuum.

PRINCIPLE

The substance to be distilled have very low vapour pressure i.e. viscous liquid, oils, waxy material & high molecular weight substance. These boils at very high temperature in order to decrease boiling point of liquid high vacuum is applied.

The mean free path of a molecule is defined as average distance through which a molecule can move without coming in to collision with each other. Its express as-

$$\lambda = \eta \sqrt{3}/p\delta$$

Where p = vapour pressure.

λ = density.

The mean free path can be increase by desecrating the viscosity.

REQUIRMENT FOR MOLECULAR DISTILLATION

01). The evaporating surface must bee closed to condensing surface this insure the molecular to come in contact with the condenser a soon as they leave the evaporating surface.

02). The liquid surface area must be large as possible, because the vapour is evoled from the surface of the molecule.

03). The molecular collision should be minimizing because the change of direction path of molecules.

APPLICATION

- More frequently used in the refining of fixed oils.
- Vitamin A is separated from fish liver oil.
- Purification of chemicals, “tricresyl phosphate”.

FALLING FILM MOLECULAR STILL

PRINCIPLE

In this method vaporization occurs from the film of liquid flowing down a heated surface under high vacuum. The vapors travel short distance & strike condenser.

Each molecule is condensed= individually & distillate is collected.

CONSTRUCTION

It consists of a vessel of diameter 1m, the wall of the vessel is provided with jacket.

Wipers are provided to the vessel wall which are connected to rotating head to motor & condenser are arranged very closed to wall of vessel.

Vacuum pump is also connected to the vessel.

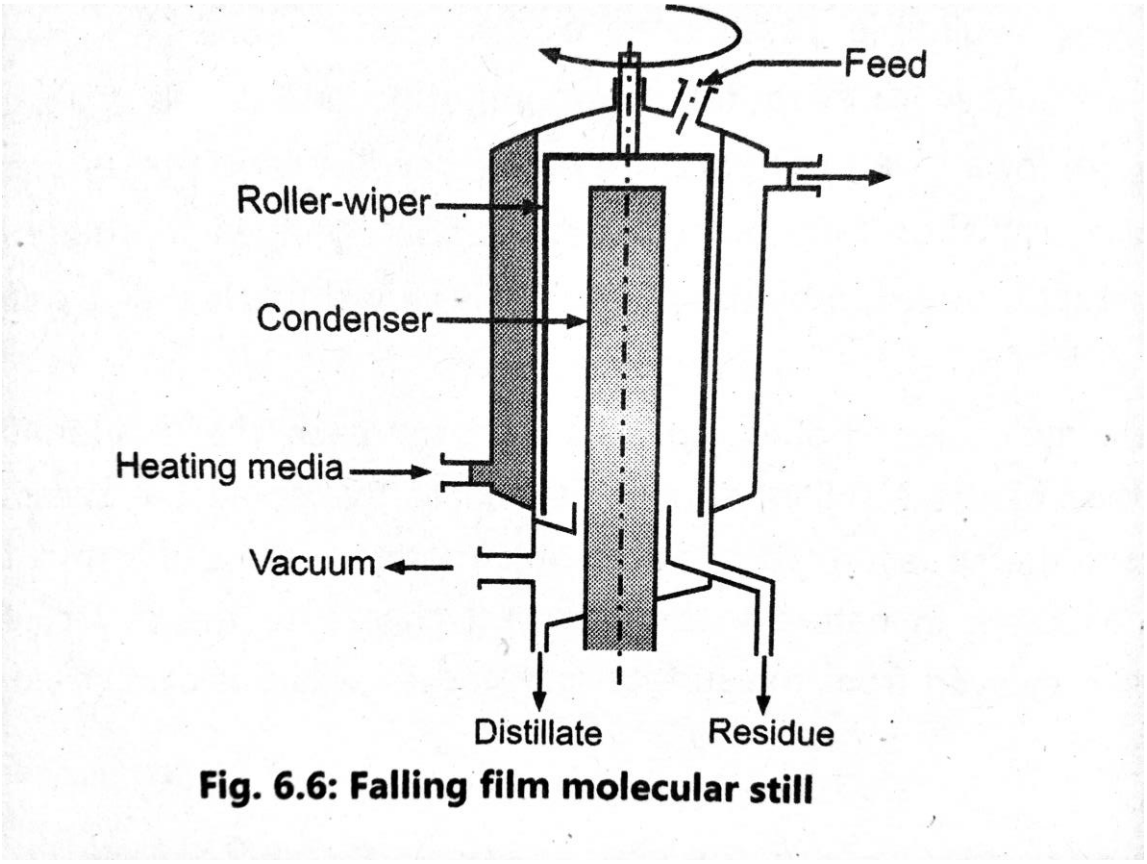


Fig. 6.6: Falling film molecular still

WORKING

The vessel is heated & vacuum is applied at the center. Wipers are allowed to rotate and it is entered as the liquid flow down it spread o from a film by wipers, which are moving at a speed of 3m/sec.

Since the moving at an already heated, the liquid films evaporate directly. Vapour travel its mean free path & strike the condenser, the condensate is collected in vessels.

USES

It is used purification chemicals such a di-methyl thalate.

Vitamin A is separated from oil.

ADVANTAGES

Short residence time of the feed.

Significantly lower temperature is required due to high vacuum.

DISADVANTAGES

This is not used for azeotropic mixture.