Gas-Liquid operations Equipment

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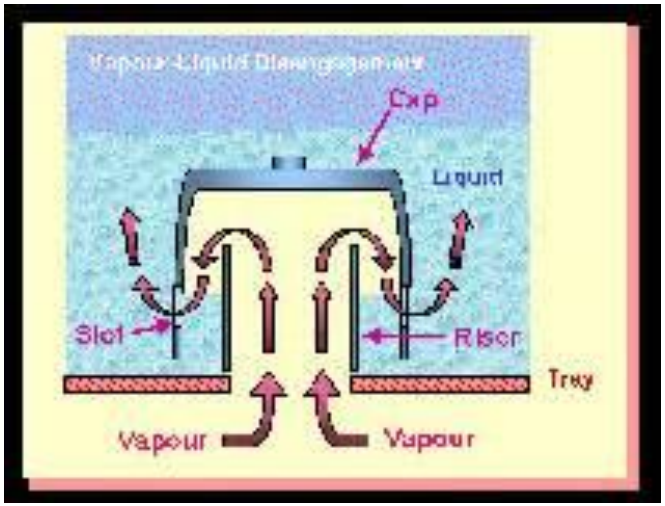
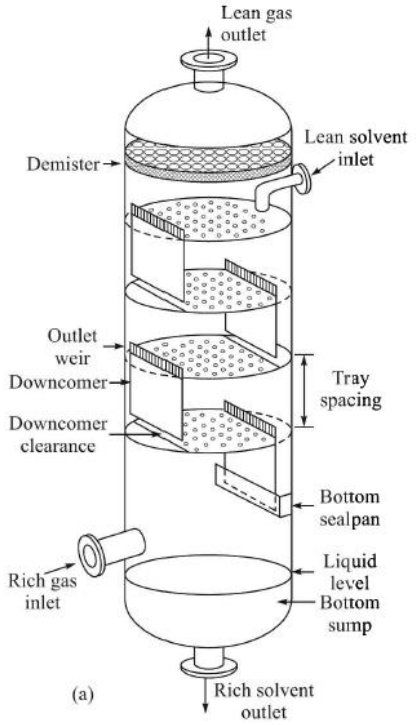




TOPIC

- Equipment for gas-liquid operations.
- Gas dispersion.
- Liquid dispersion.

Introduction

- The liquid is dispersed in the form of droplets or discontinuous films in a continuous gas phase (example: spray tower , packed tower ,venturi scrubbers, etc.)

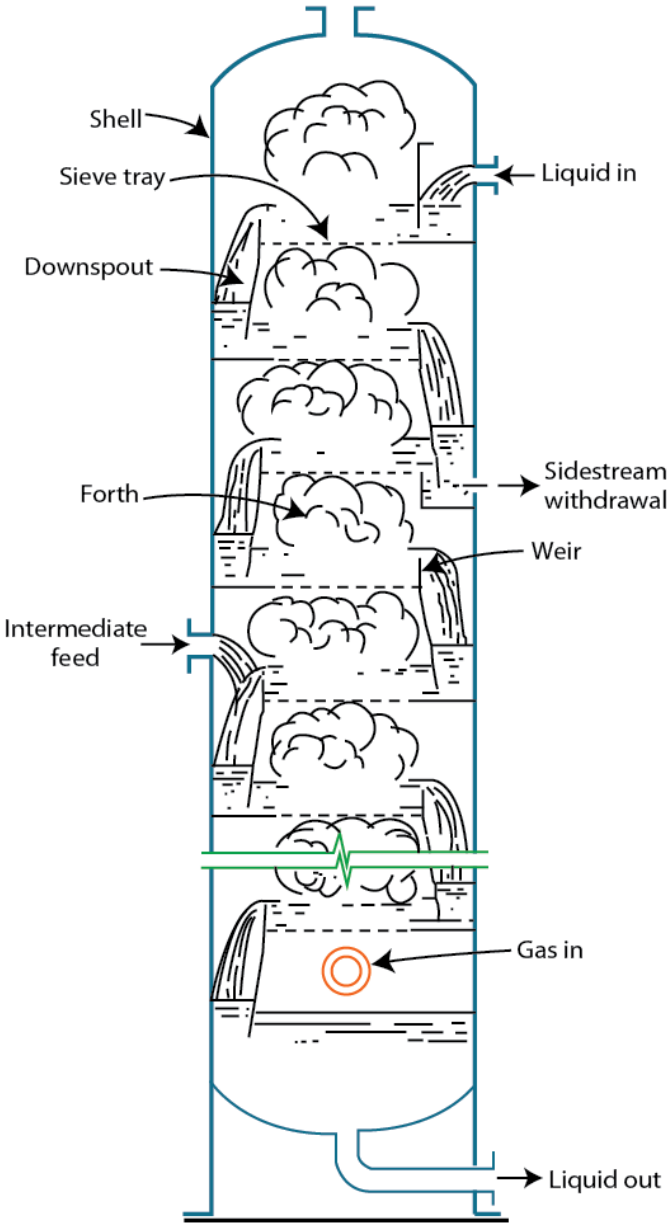
- The gas is dispersed in liquid in form of bubbles (e.g. tray tower, bubble column, agitated column etc).

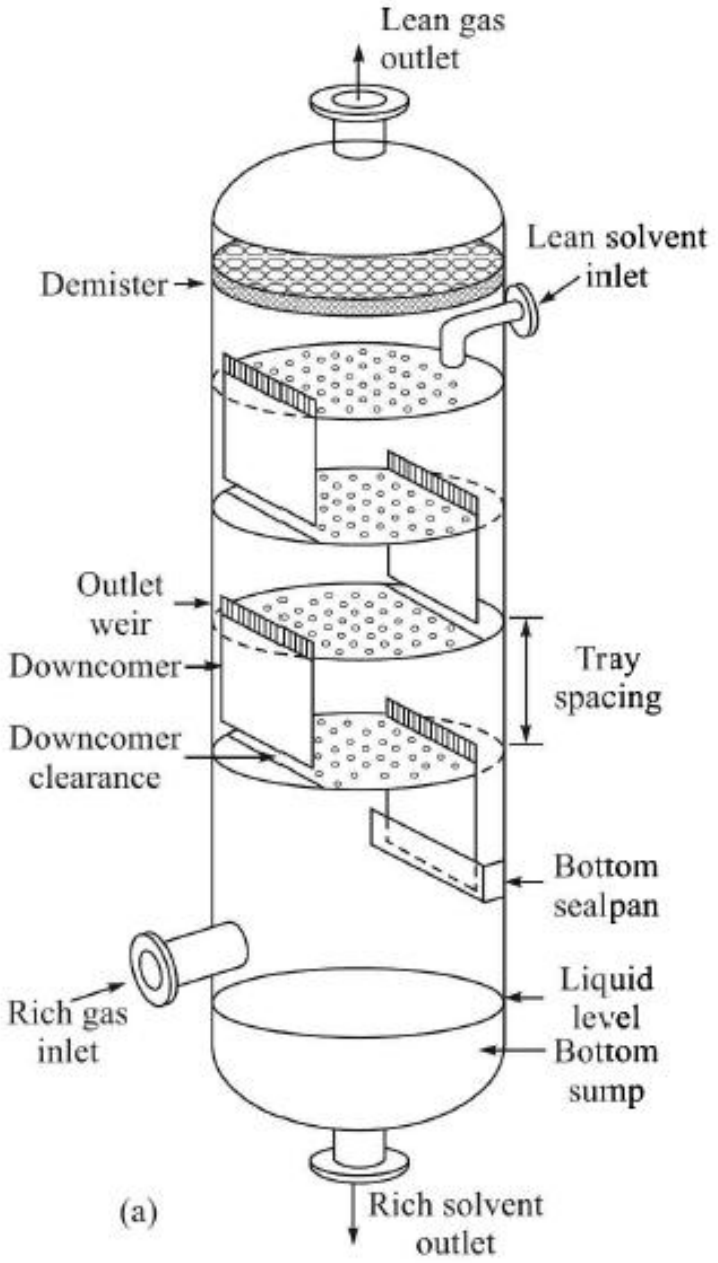
- Sometimes both gas and liquid phases are continuous (for example, “a falling film contactor” which is used for gas-liquid reactions).

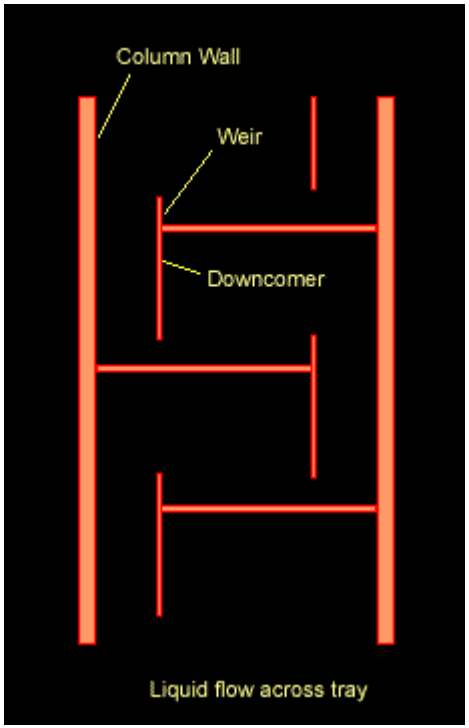
- Tray and packed columns are most widely used for gas – liquid contacting for gas absorption, stripping, distillation.

- These are also used for liquid-liquid extraction.

Gas dispersed	**Liquid dispersed**
Plate columns	Packed towers
Bubble-cap columns	Spray towers
Sieve-plate columns	Venturi towers
Valve-tray columns	Wetted wall tower
Agitated vessels	
Sparged vessel	


Shell
Sieve tray
Liquid in
Downspout
Sidestream
withdrawal
Forth
Weir
Intermediate
feed
Gas in
Liquid out


Lean gas
outlet
Lean solvent
inlet
Demister
Outlet
weir
Downcomer
Downcomer
clearance
Tray
spacing
Bottom
sealpan
Rich gas
inlet
Liquid
level
Bottom
sump
Rich solvent
outlet
(a)


Column Wall
Weir
Downcomer
Liquid flow across tray

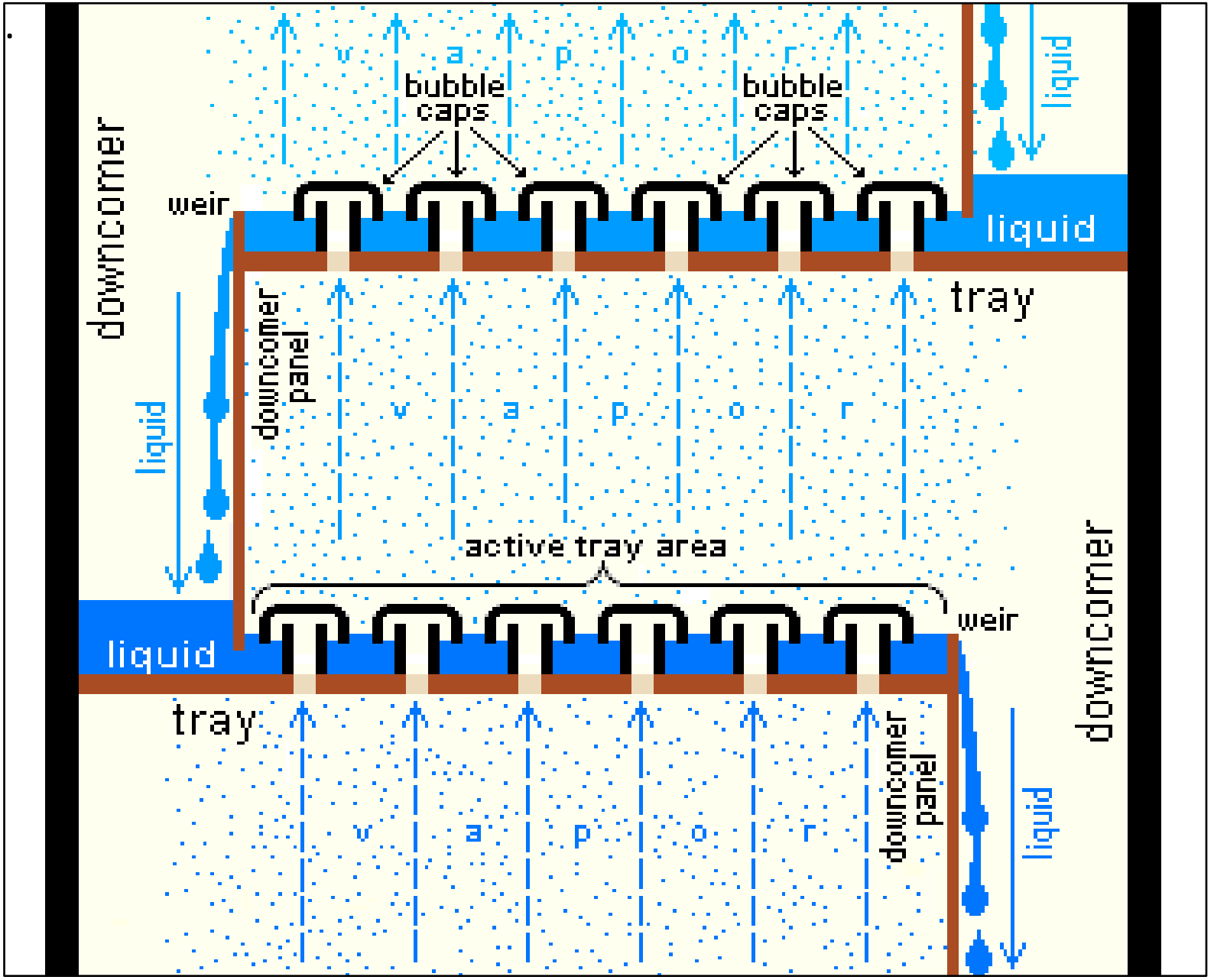

Bubble Cap Trays
Bubble cap trays may be combined with valve trays within a fractionator, depending on the desired product and/or gas stream. Industry uses both bubble and valve trays but the latter tends to be used more often in new installations.

Tray or Plate Column

❑Tray tower internals

1) Different types of trays
2) Weirs
3) Down comers
4) Entrainment, Mist eliminator, Nozzles

- **Flooding, Loading, Coning, Weeping & Dumping** in tray tower


downcomer
vapor
bubble caps
bubble caps
weir
liquid
liquid
tray
downcomer panel
liquid
vapor
active tray area
weir
liquid
tray
downcomer
vapor
downcomer panel
liquid

(Tray tower)

Tray or Plate column:

- A tray column primarily consist of a vertical cylindrical shell and a set of 'tower internals' that include

(i) Tray or plates on which the gas-liquid contact occurs.

(ii) Arrangement for flow of the liquid from one tray to the lower one through the downcomer.

(iii) Inlet and outlet nozzles for the two phases.

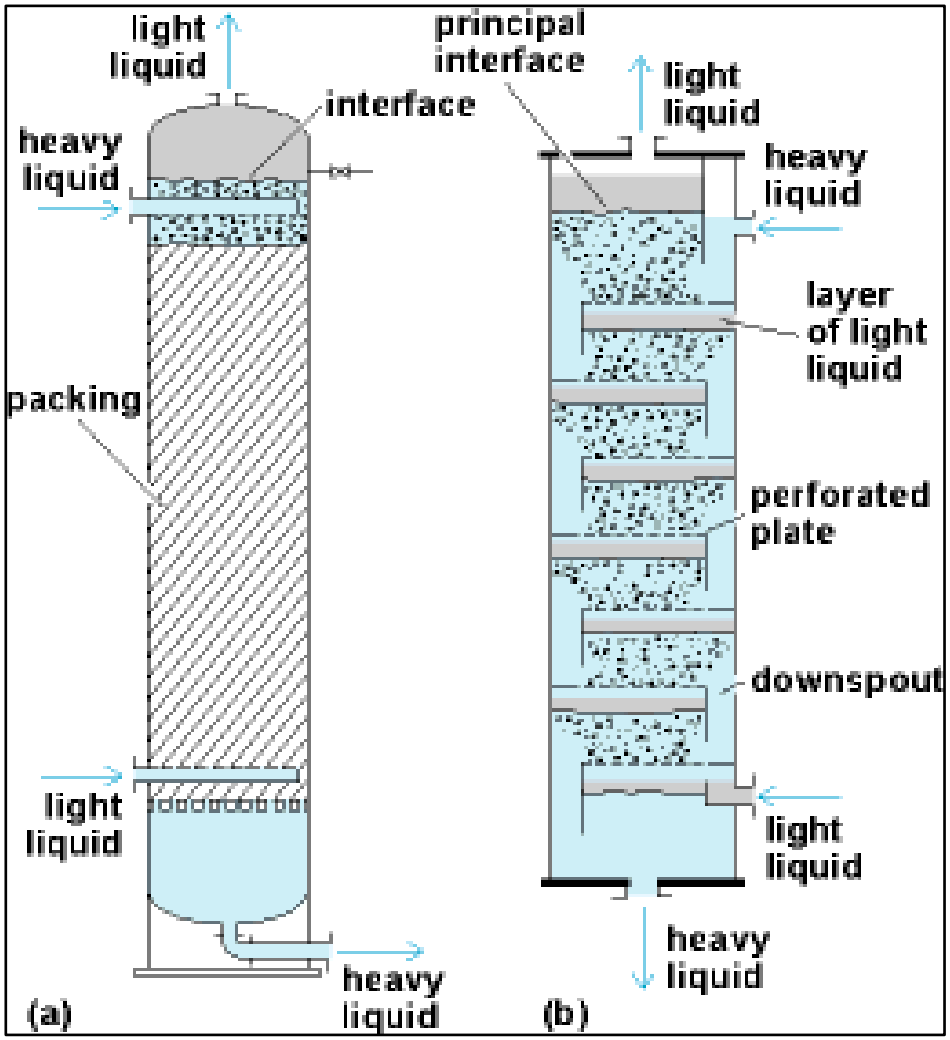
- In a gas absorption application, the liquid enters the top tray through a nozzle. It impinges on a baffle plate, moves across the tray and flows into the lower through a 'downcomer'.

- The sieve trays shown in figure are made of perforated metal sheets. The gas through upwards and vigorously bubbles through the liquid on a tray, forming a turbulent ‘gas-liquid dispersion’ in which bubble breakage and coalescence occur continuously.

- Mass transfer from the gas to the liquid phase occurs depending on the direction of the driving force.

- The liquid flows across a tray and then over a ‘weir’ to enter into the downcomer. The downcomer is a region near the wall, separated by a ‘downcomer plate’ , in which the bubble get disengaged from the liquid.

- The clear liquid flows to the next lower tray. Each tray acts as a stage in which the liquid flowing down from the upper tray and the gas flowing up from the lower tray come in to contact; the tower as cascade.


light liquid
interface
heavy liquid
packing
light liquid
heavy liquid
(a)
principal interface
light liquid
heavy liquid
layer of light liquid
perforated plate
downspout
light liquid
heavy liquid
(b)

tray column

The shell:

- The shell is usually made of a metal or an alloy. Plastic shell are also used sometimes.

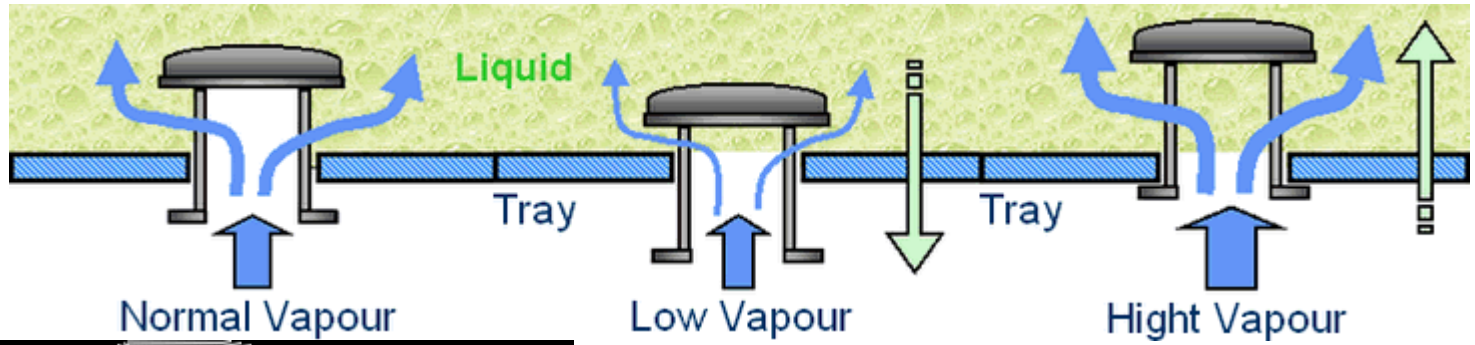
- The material is selected on the basis of corrosiveness of the fluids, temperature and pressure conditions, and cost.

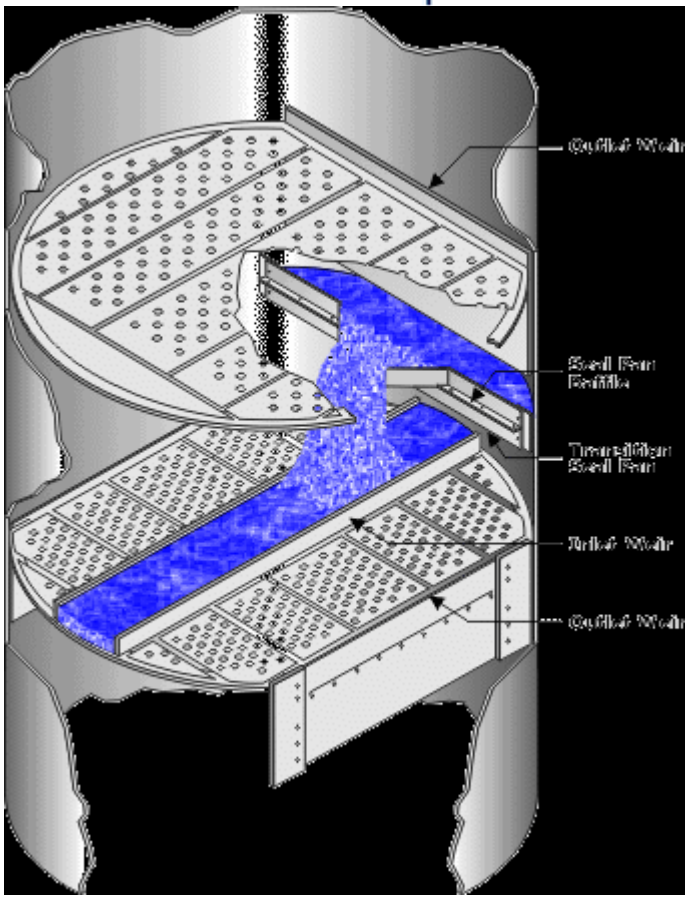
- Tray tower of diameter less than 1 meter are rarely used. On the other extreme, towers as big as 10 meter in diameter are known to be in use.

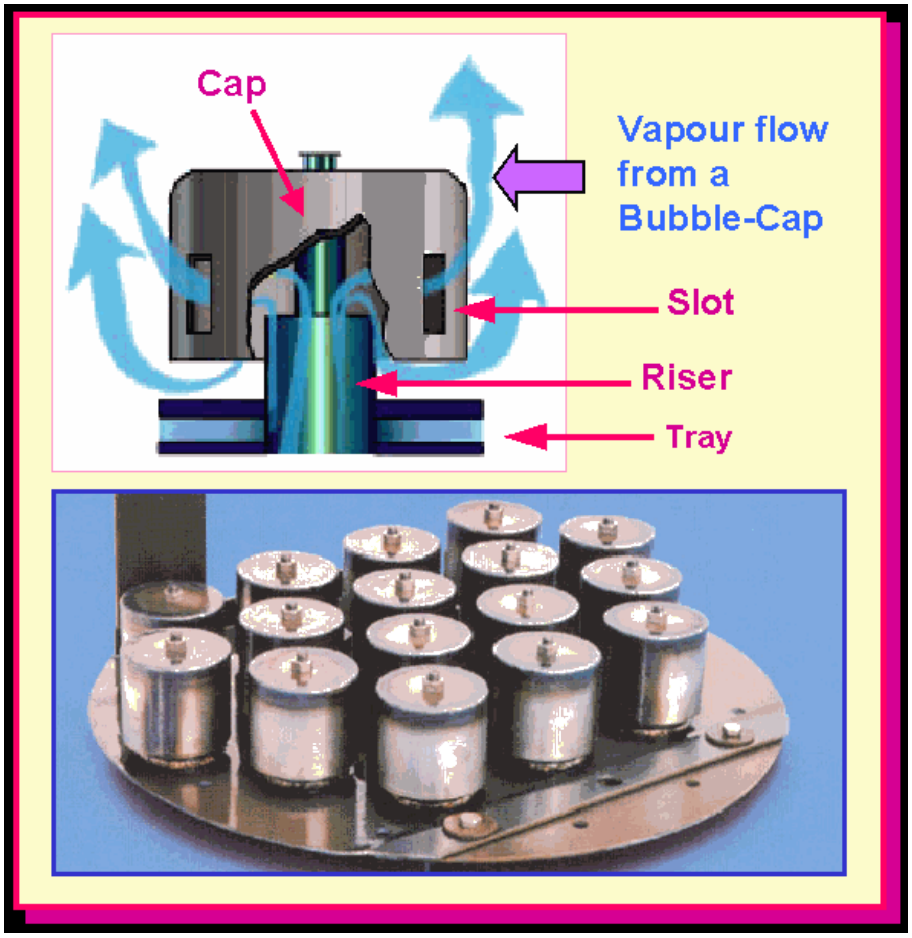
The Tray:

- A tray has two major functions:

1. It allows the gas to flow through the holes or passages; the gas vigorously bubbles through the liquid to from a ‘gas-liquid dispersion’. The tray holds the dispersion on it.
2. The trays separate the column in a number of compartments each of which constitutes a stage. Mass transfer between the phases occurs on a tray. Therefore, the trays as a whole constitute the heart of a column.

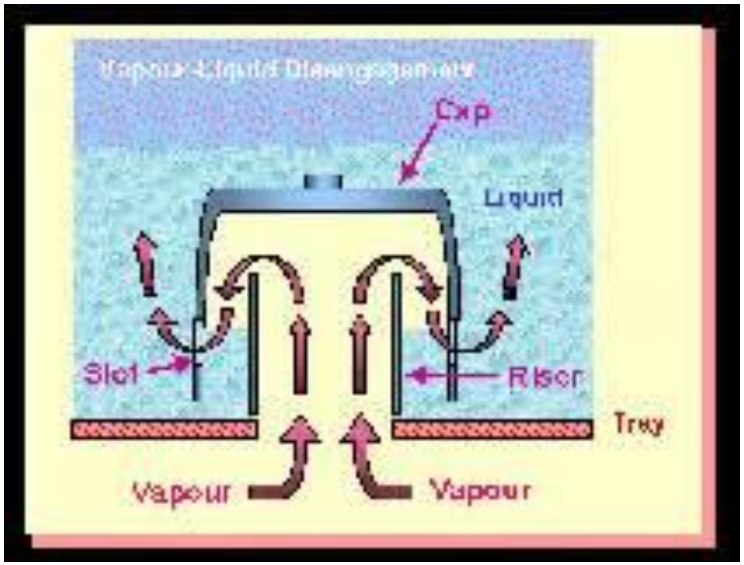

Liquid
Tray
Tray
Normal Vapour
Low Vapour
Hight Vapour




Cap
Vapour flow from a Bubble-Cap
Slot
Riser
Tray

Bubble cap Tray:

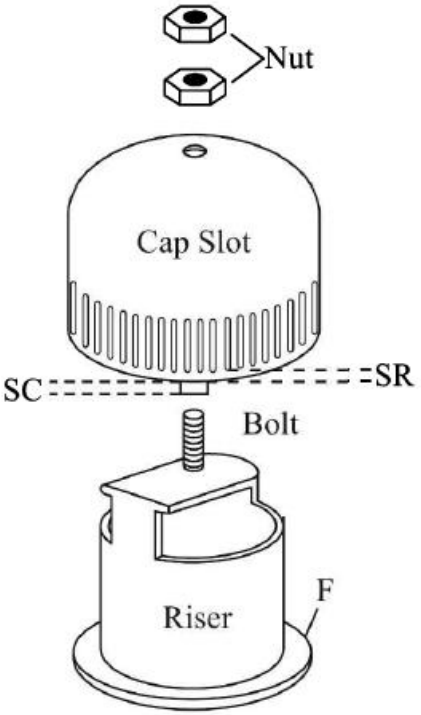
- This is the oldest type of tray.
- A bubble-cap consists of two major components – a bell-shaped ‘cap’ and a ‘riser’.

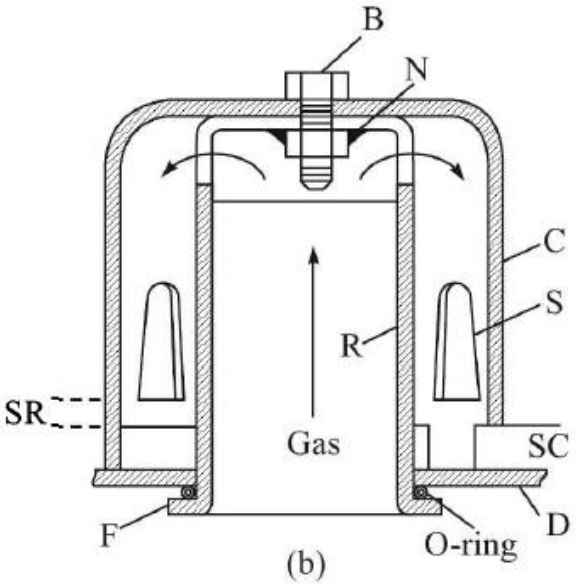


- In this figure shows a typical bubble cap design. The riser is inserted through a hole on the tray floor and the bell shaped cap is bolted to it.

- The riser or chimney is a piece of tube with a flared or expanded bottom end. In fact, the riser acts as the vapour passage and also hold the cap.

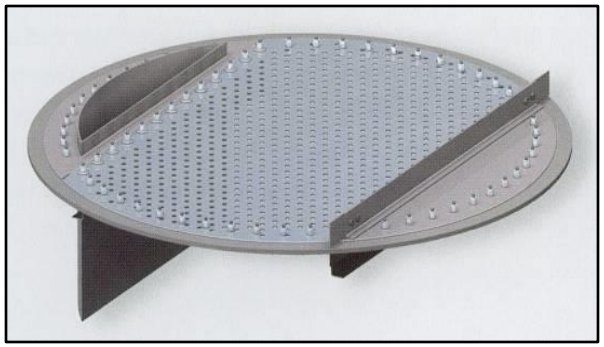
- The shape of the slots may be rectangular, triangular, trapezoidal, or saw-tooth type.
- 1-6’ dia.
- Slots in caps: 12-70





The Sieve Tray:

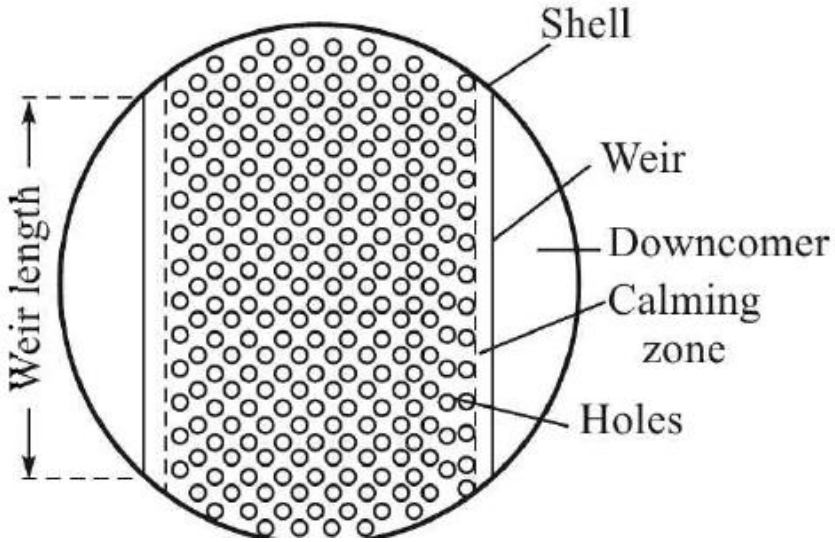
- This is the simplest types of the tray in which the bubble caps are replaced by holes or perforations for entrance of the gas into the liquid.

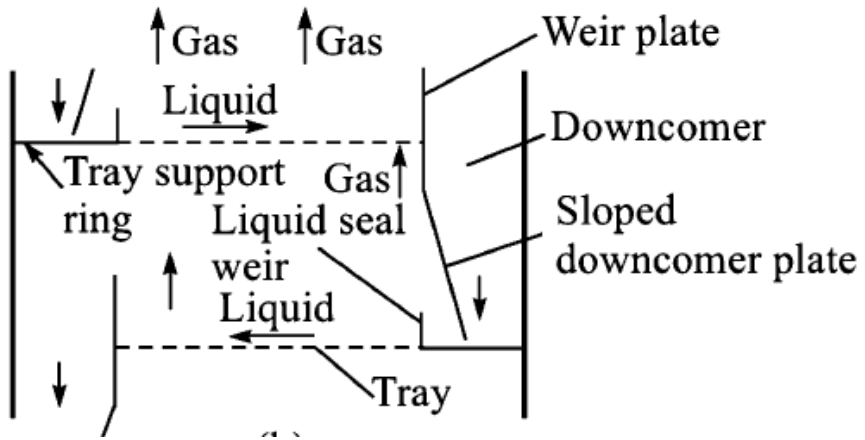


(The sieve tray)

- The holes are of relatively small diameter usually ranging from 1/8 to ½ inch. For clean services, use of a hole diameter of 3/16 inch is common. Small holes enhance tray capacity, reduce entrainment, reduce weeping, promote forth regime operation and exhibit better mass transfer.
- Holes are made by punching or drilling a tray sheet in order to reduce the labour cost. (arranged in equilateral triangular pitch)

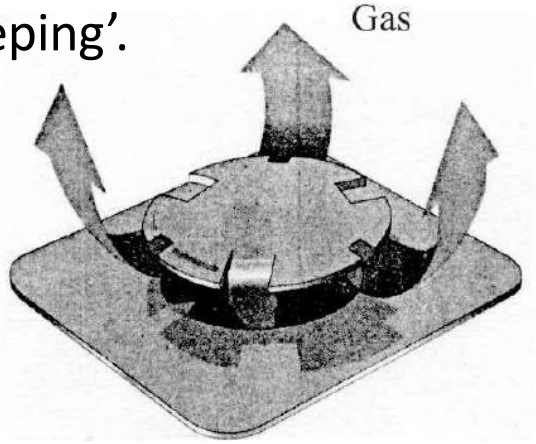
- Pitch = 2.5 dH and 5dH
- Free area = 6-10 % (Free area= hole area/tower C/S)





The Valve Tray:

- The valve tray provides variable area for the gas or vapour flow depending upon the flow rate or ‘throughput’. This is way it is called ‘ valve tray
- A common valve tray has sufficiently large punched holes on the tray floor, each fitted with a movable disk, generally circular.
- A disk has guides that can slide vertically up or down along the thickness of the tray floor. The opening for the gas flow changes in this way, but the disk is always held in the same vertical line.
- As the gas flow rate increases, the disk is automatically raised. It settles down at a low vapour rate to prevent ‘weeping’.



- A few problem common to all kinds of valve trays are

(i) mechanical wear and corrosion because of continuous movement of the valve legs.

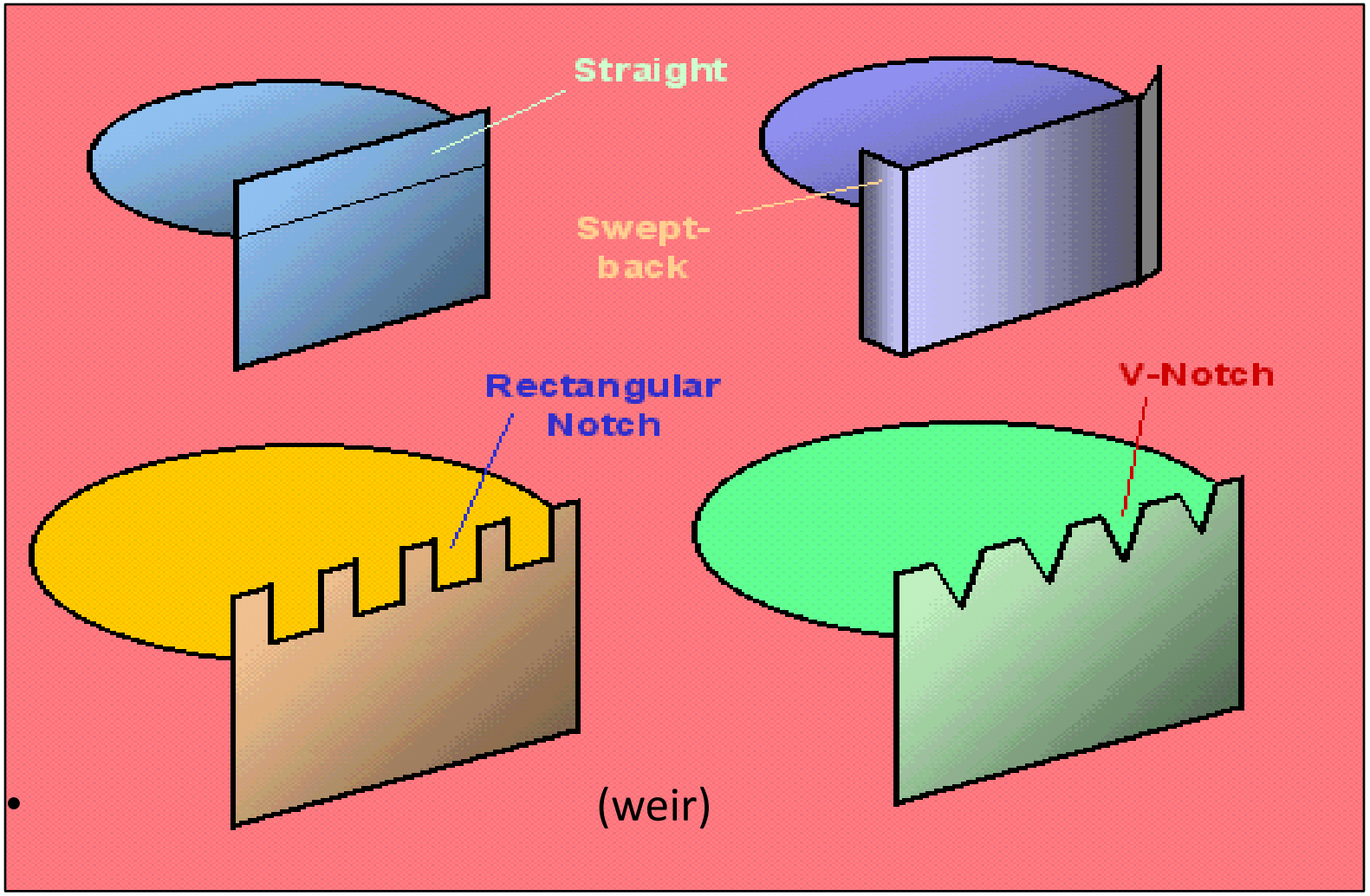
(ii) sticking of the disk on the tray if there is sticky deposition on the tray.

- Excessive opening of the valve at a low gas rate causes weeping and valves should therefore be heavy enough to prevent this. On the other hand, heavy valves incur a greater pressure drop.

- 12 to 16 valves per ft2
- Orifice: 1.5 and 2 inch
- Disk rise 3/16 to 7/16 inch
- 10-15 % active tray area
- Flexibility, high turndown ratio, low cost:highly used in Abs, dis.

Weir:

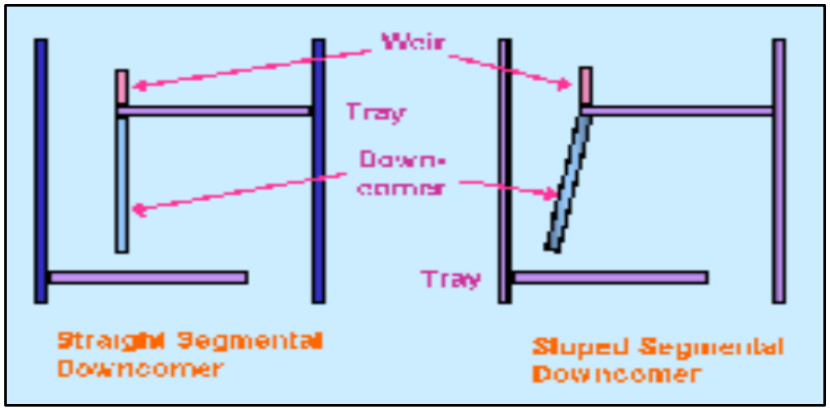
- The function of a weir is to maintain a desired liquid level on the tray.
- Typical weir height is between 2 to 4 inch. Low weirs are frequently used in low pressure column.
- Notched weir are commonly used for low liquid loads.
- The higher the liquid level, the higher the tray pressure drop. Higher liquid level also imply more liquid hold up on the tray, which may be undesirable if the liquid is toxic or hazardous.
- The weir length may vary from 60 to 80% of the tower diameter.



- (weir)

Downcomer:

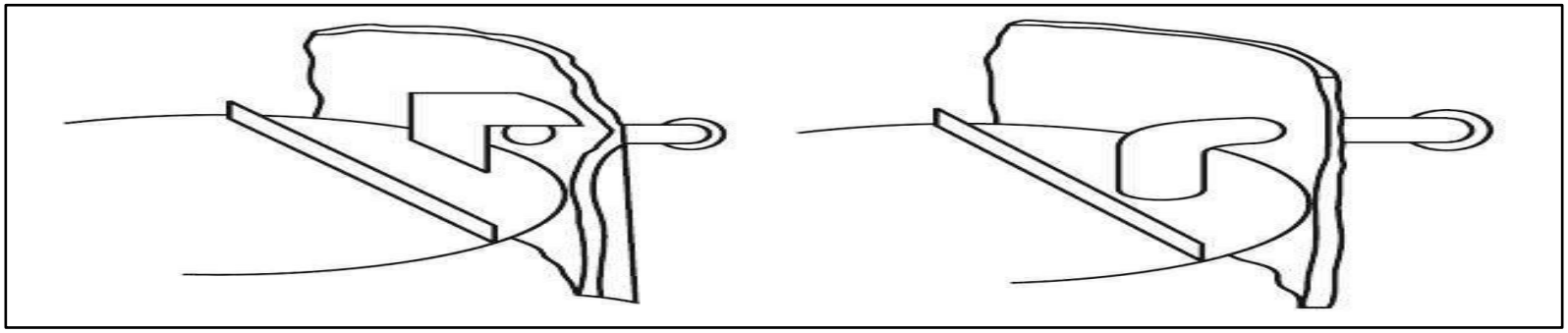
- Downcomer are used to guide liquid flow from an upper tray to a lower tray.
- The liquid, along with some dispersed gas or vapour bubbles, overflows the weir and enters the downcomer.



- The Downcomer must provide sufficient residence time for gas-liquid disengagement.
- The 'clear liquid' velocity in the downcomer normally ranges between 0.3 to 0.5 ft/s.
- The downcomer plate may be straight or inclined.

Nozzle:

- A tower for contacting a liquid and a vapour should be provided with a few nozzles for feed entry, entry of reflux at the top and of the reboiler vapour return at the bottom, and for product withdrawal from the tower.
- primary criterion of a feed nozzle design is to ensure that the feed is introduced with minimum splashing or jetting. The feed should be evenly distributed and mixed with internal liquid or vapour.



Mist Eliminator :

- Even under normal operating conditions, a little entrainment of liquid in the up flowing vapour may occur.
- In order to prevent entrainment in the vapour leaving the top tray, a pad made of wire mesh or a pack of suitably bent and spaced thin sheets is fitted above it.
- The droplets are retained after they strike the surface of the pad. Such a device is called ‘ mist eliminator’.

Problems related to tray tower:

Entrainment:

- When a gas bubbles through the liquid pool vigorously, droplets of liquid are formed in the vapour space by quite a few mechanisms including shearing action of the gas jet of the liquid film as a gas bubble bursts.

- Depending upon the size of a droplet, its velocity of projection and the drag force action on it due to the gas velocity, the droplet may descend back into the liquid on the tray or may be carried into the tray above.

- The phenomenon of carry over of the suspended droplets into the upper tray is called ‘ entrainment’.

Flooding:

- When the liquid flowrate is very high, in comparison with gas flowrate the liquid fills the downcomer as well as an entire tray space and eventually the entire column. This phenomenon is called ‘ flooding’.

Priming:

- Priming is an exaggerated condition of liquid entrainment. Due to high gas flowrate, liquid from the bottom trays are carried away along with the gas to the top tray. This phenomenon is called ‘priming’.

Coning:

- Coning in a tray tower occurs due to low liquid flowrate when compared to gas which results in pushing of the liquid away from the tray opening.

Weeping:

- If a very small fraction of the liquid flows from a tray to lower one through perforation or openings of the tray, the phenomenon is called ‘ weeping’.
- Weeping causes some reduction of the tray efficiency. Weeping occurs at low gas flowrate compared to liquid flowrate.

Dumping:

- When the gas flow rate is very low, in comparison to liquid flow rate, liquid flows from a tray opening without entering into downcomer. This phenomenon is called ‘ dumping’.

Problems related to tray tower:

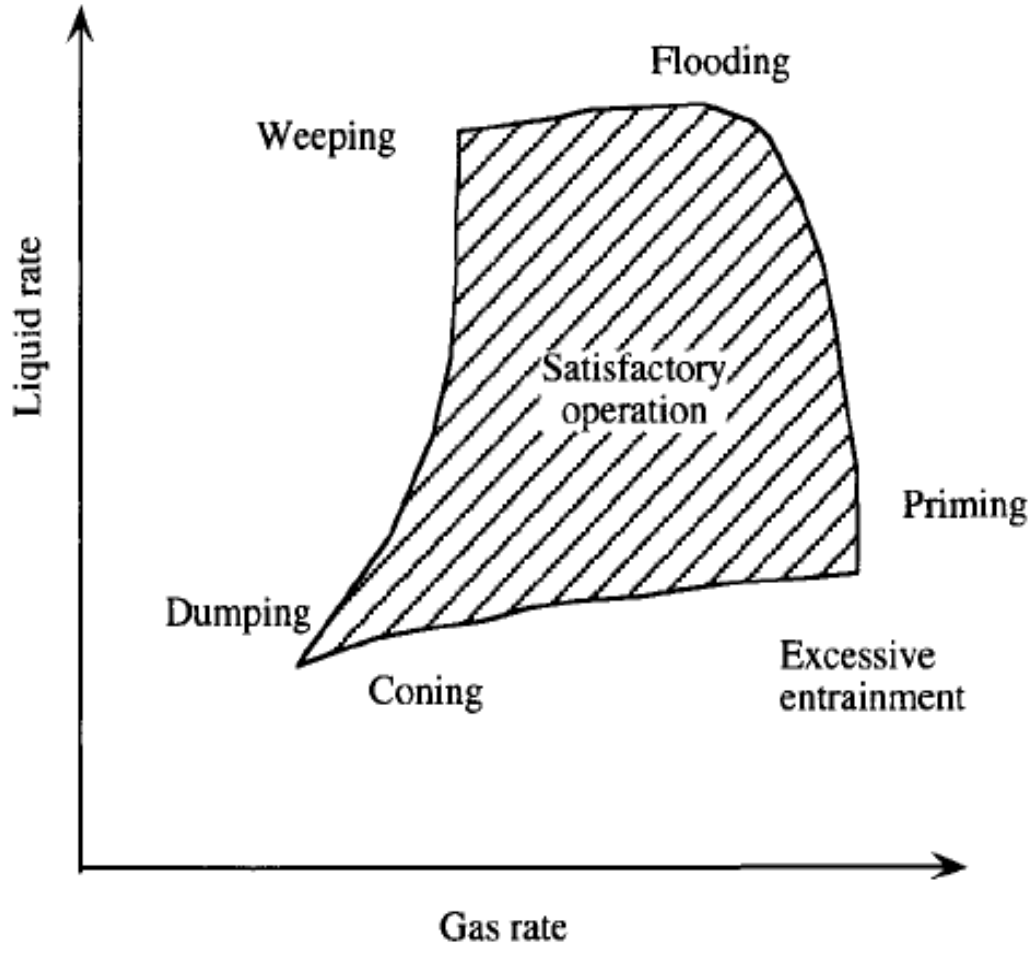
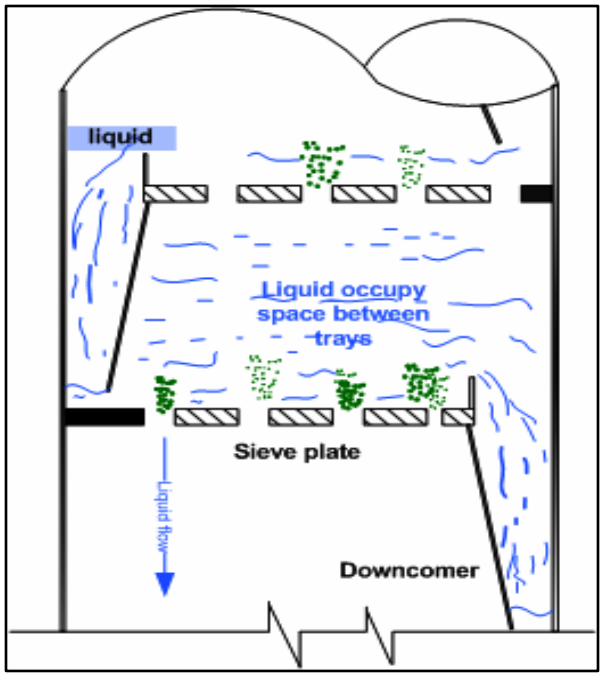


Figure 4.7 Operating characteristics of sieve trays.

Flooding

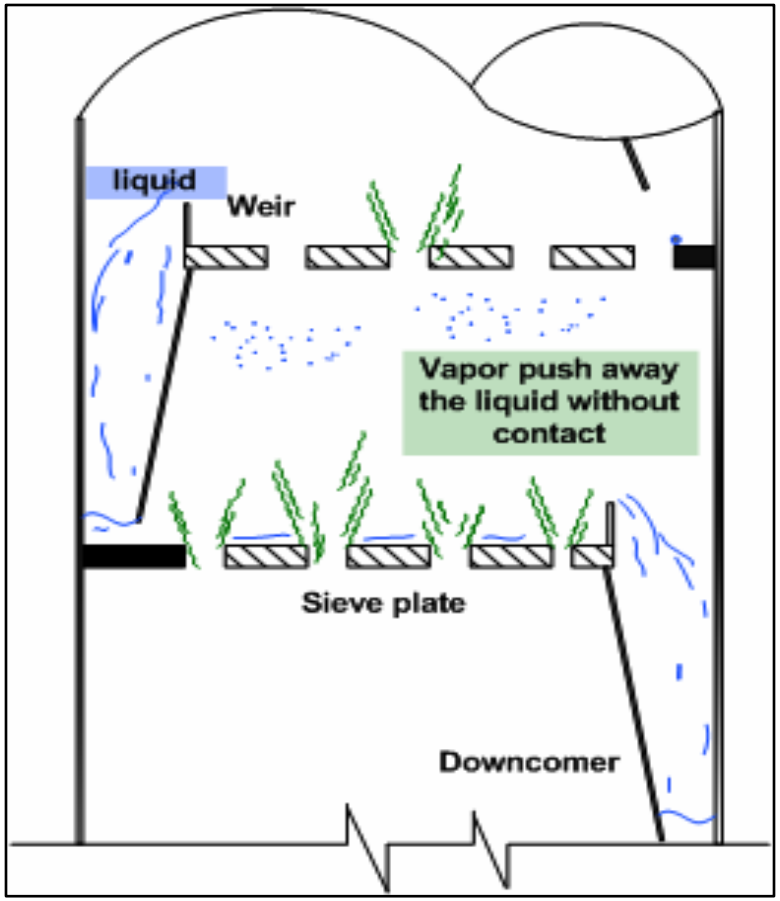
- The point at which this effect occurs the velocities of which a column is operated is called as flooding velocities.



- Downcomer and space between the trays are completely filled up by the liquid than the tower is said to be flooded, due to high pressure drop due to increased flow rates of the streams.

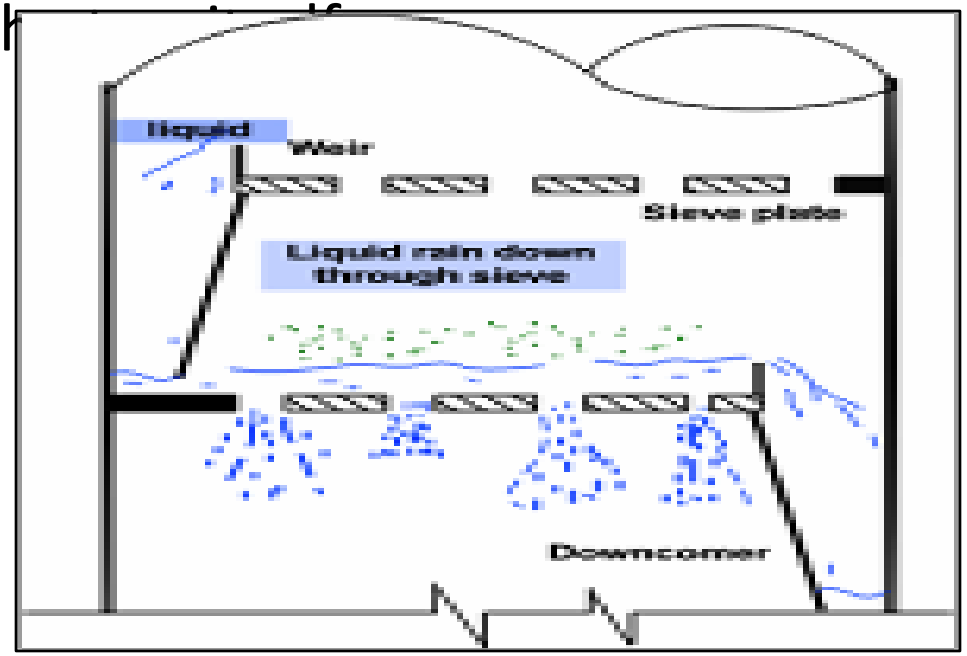
Coning

❑Coning in a Tray Tower occurs due to low liquids flow velocities when compared to gas which results in pushing of the liquid away from the tray openings.



Weeping:

- Weeping in a Sieve Tray Column is due to at low gas velocity which is not equal to liquid flow velocity, and the liquid is not enough resisted to hold on the tray pass from the down comers, complete liquid will flow through the openings in th

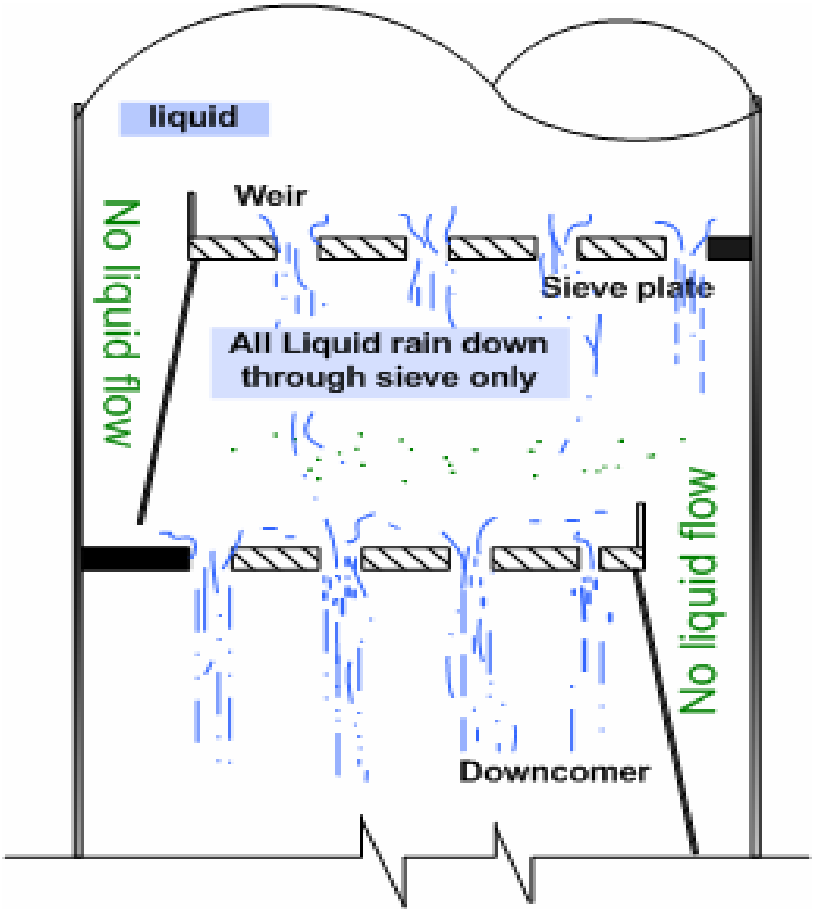


-

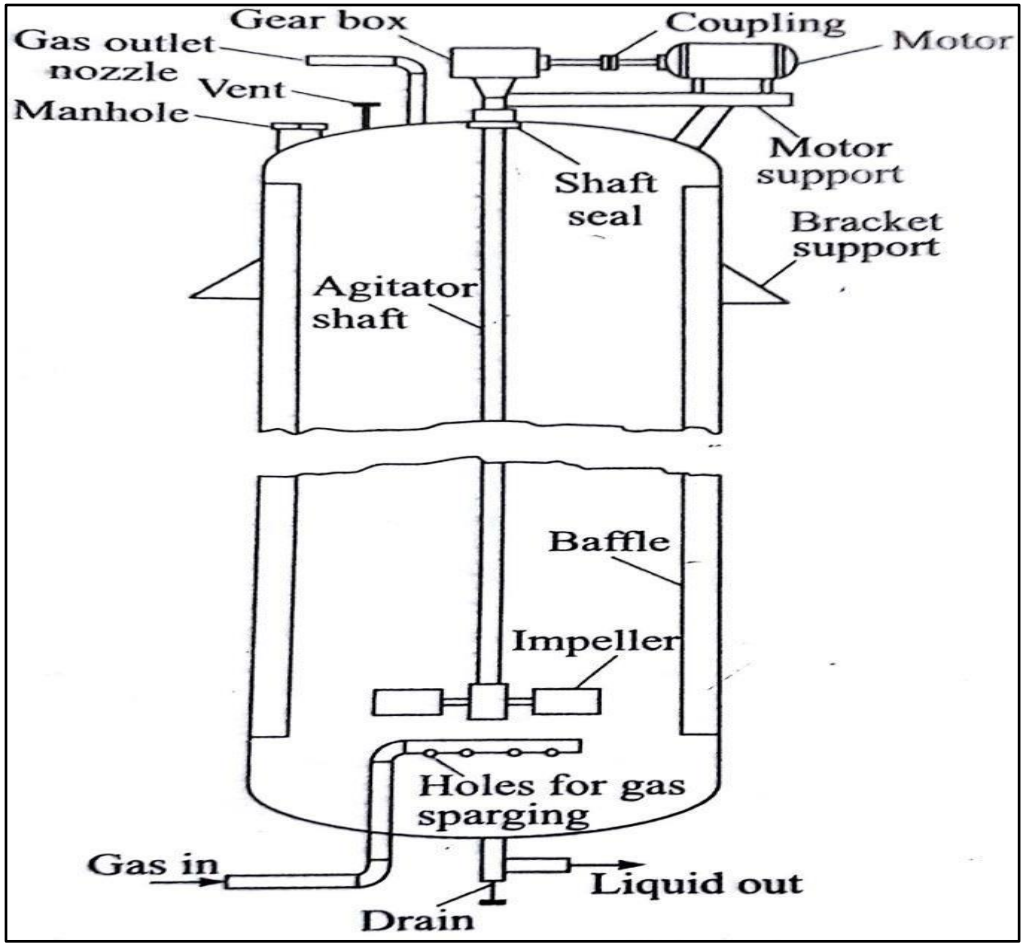
- so, weeping occurs when gas velocities (in a plate column) are too low. Most of the liquid is rained down from tray openings and some through the downcomer.

Dumping:

❑In the event of severe weeping, no liquid reaches the downspouts. Complete liquid drop down by the tray opening only. This phenomenon is known as dumping.



Agitated vessels



(Agitated vessel)

- Mechanically agitated vessels have been used for Gas-liquid contacting since long.
- The schematic of an agitated vessels in which the gas is dispersed as bubble in the continuous liquid phase. Such vessel is provided with,

i) an agitator with a suitable impeller

ii) Inlet and outlet nozzles

iii) Baffles

iv) A drain and a vent

v) A manhole for the purpose of cleaning & maintenance

- A stuffing box, or preferably a ‘ mechanical seal ‘,is used to prevent the leakage of the gas at the top where the shaft enters the vessel.

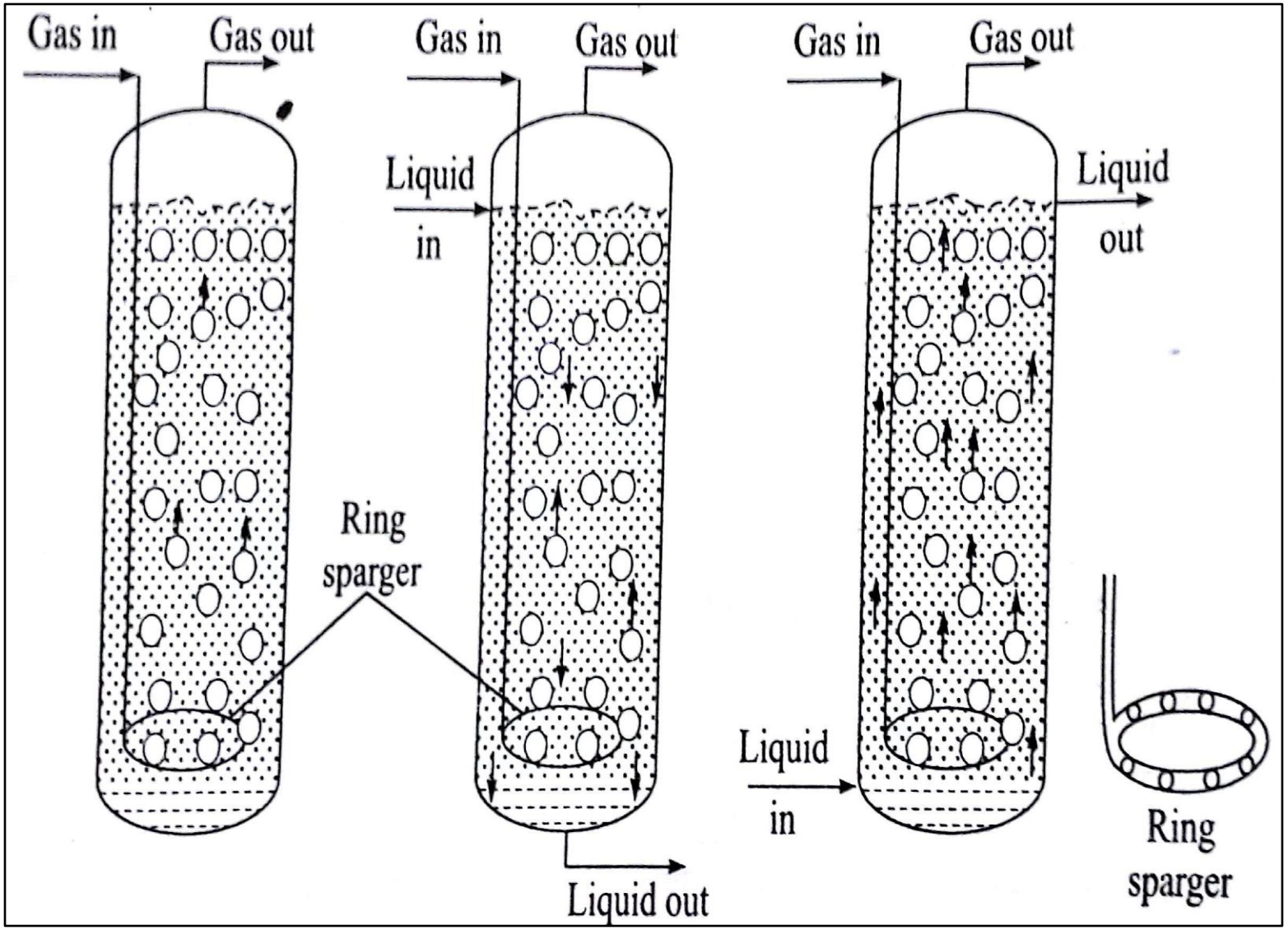
- The shaft is held by bearings at the gear box and at the shaft seal.

- The agitator motor may be supported on I-beams mounted on the vessel itself.
- A gear box is used to maintain the required speed of the shaft. An agitated vessel for gas absorption contains a few ‘internals’ such as the gas sparger, baffles, and an agitator shaft with impellers.
- The gas is sparged below the impeller midway between the centre and the periphery of the impeller. It is dispersed in the form of small bubbles by the shear stress created by impeller rotation. This greatly increases the gas-liquid interfacial area of contact and also the mass transfer coefficients.
- A variety of impeller designs are available. The turbine, disk and paddle type impellers are more common. Four vertical baffles are used to prevent the formation of a vortex at the freeliquid surface. The baffles also help to increase the turbulence in the tank.

- Thin metal plates having a width equal to 8 to 10% of the tank
- diameter, spot -welded to the tank, act as the baffles.
- The power input to the impeller depends upon a number of factors such as the impeller design and rpm, liquid properties, the gas rate, and the presence of suspended solids, etc.
- The impeller is usually located at about 1/3 of the liquid depth from the bottom.
- The superficial gas velocity is kept- low in range the range of 0.1 to 0.25 ft /s.
- The impeller tip speed may be as high as 50 ft /s.

- Agitated vessels are used when the dissolved gas undergoes a chemical reaction in the liquid. This vessel is not used for physical absorption since ‘back mixing’ in the liquid phase substantially reduces the mass transfer driving force.
- Hydrogenation of vegetable oils in the presence of suspended nickel catalyst, absorption of carbon dioxide in a lime slurry to make precipitated calcium carbonate, liquid-phase oxidation and chlorination in organic synthesis, etc. is a few common cases of application.

The Bubble Column



- The bubble column is another important equipment used for carrying out gas-liquid reactions.
- A bubble column consists of a tall tower fed with the gas at the bottom through a gas sparger.
- It has a simple construction and does not contain any moving parts but sometimes may have immersed cooling tubes or coils for removing the heat of absorption and reaction.
- The liquid may be fed batch wise or continuously. Both cocurrent (upflow of the liquid) and countercurrent (downflow of the liquid) operations of a continuous bubble column are possible.
- Multiple-orifice gas spargers made from pipes or tubes in the form of concentric rings are frequently used.

- Bubble columns are used as aerobic fermenters and also for aerobic treatment. Bubble columns have found applications in organic oxidation reactions, gas-liquid or gas-liquid-solid reactions.
- Since a bubble column does not usually have internals and moving components, it is suitable for use in processing corrosive gas-liquid systems.
- A bubble column may be provided with a ‘draft tube’ in order to create a much better and smooth liquid recirculation in the device.

Topic

1. Liquid disperse
    - 1.1 Venturi scrubber
    - 1.2 Wetted wall tower
    - 1.3 Spray and spray towers
    - 1.4 Packed tower
        - 1.4.1 Tower internals
    - 1.5 Tray tower vs. packed tower
2. References

1.Liquid disperse Equipments

- This group include devices in which the liquid is disperse into thin film or drops , such as wetted wall towers , spray and spray towers , the various packed towers . The packed towers are the most important of the group.

1) Venturi scrubber

- In this device which is similar to ejector , the gas is drawn into a throat of venturi by a stream of absorbing liquid sprayed into the convergent duct section , as shown in fig.
- The device is used especially where the liquid contains a suspended solid , which would plug the otherwise more commonly used tray and packed towers , and where low gas-pressure drop is required e.g. SO2 from furnace gases with slurries of limestone, lime or magnesia.

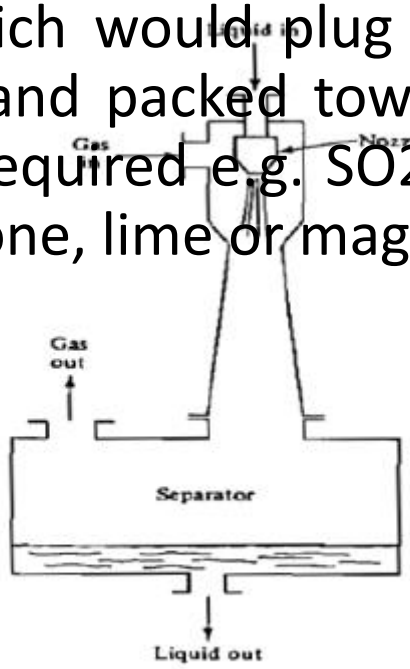


Figure 1.1 venturi scrubber

2) Wetted wall towers

- A falling-film column (or wetted-wall column) is a particular chemical equipment used to achieve mass and heat transfer between two fluid phases (in general one gas phase and one liquid phase).
- It is essentially formed by a vertical tube-shaped vessel: the liquid stream flows through the inner wall of the tube and the gas stream flows in correspondence of the centre of the tube.
- In the most common case, the column contains one liquid stream and one gas stream. The liquid forms a thin film that covers the inner surface of the vessel, instead the gas stream is normally injected from the bottom of the column, so the two fluids are subjected to a counter-current exchange of matter and heat, that happens in correspondence of the gas-liquid interface.Sometimes, the same equipment is used to achieve the co-current mass and heat transfer between to immiscible liquids.

Application

- Because of its easiness of modelling, falling-film column is in generally used as laboratory equipment, for example the measures experimentally the values of transport coefficients.
- It is not used instead in an industrial scale, because it is associated to low values of surface area and liquid hold-up respect to other typologies of gas-liquid contactors (e.g. a packed column or a plate column).

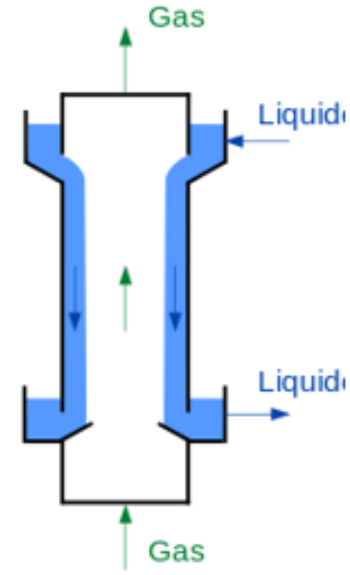


Fig 1.2 wetted wall tower

3) Spray and Spray towers

- The Liquid Can Be Sprayed Into A Gas Stream By Means Of A Nozzle Which Disperse The Liquid Into A Fine Spray Of Drops . The Flow May Be Counter Current , As In Vertical Towers With The Liquid Sprayed Downward , Or Parallel , As In Horizontal Spray Chambers
- These Devices Have The Advantage Of Low Pressure Drop For The Gas But Also Have A Number Of Disadvantages .
- There Is A Relatively High Pumping Cost For The Liquid , Owing To The Pressure Drop Through The Spray Nozzle . The Tendency For Entrainment Of Liquid By The Gas Leaving Is Considerable , And Mist Eliminator Will Almost Always Be Necessary .

- Unless The Diameter/Length Ratio Can Not Be Taken .

Ordinarily However , The Diameter/Length Ratio Can Not Be Made Very Small Since Then The Spray Would Quickly Reach The Walls Of The Tower And Become Ineffective As A Spray. Unless The Diameter/Length Ratio Can Not Be Taken .

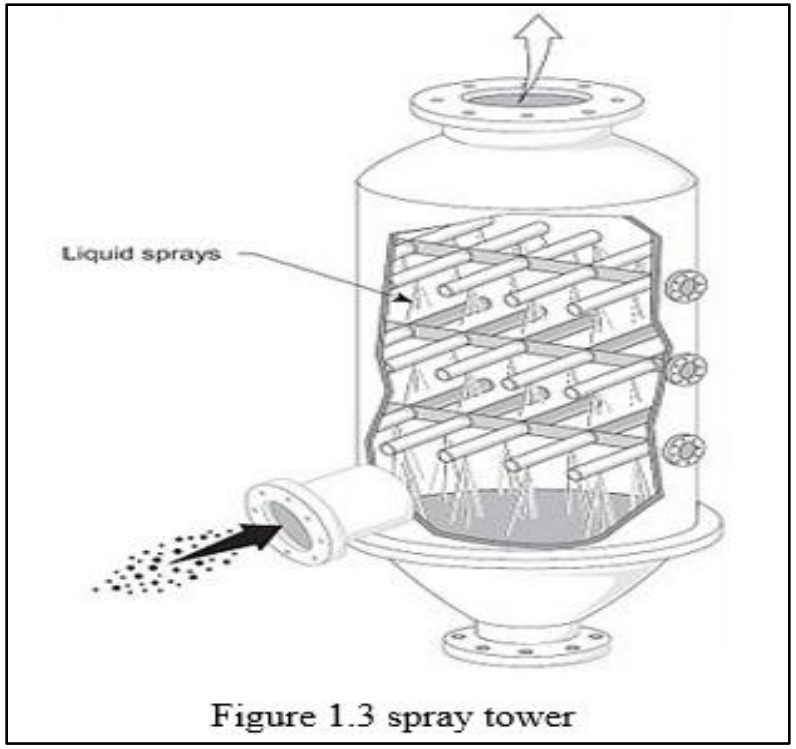
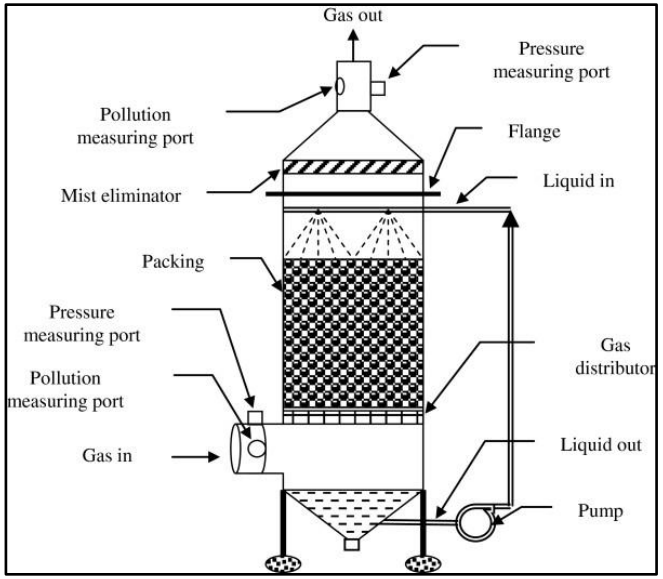


Figure 1.3 spray tower

4) Packed towers



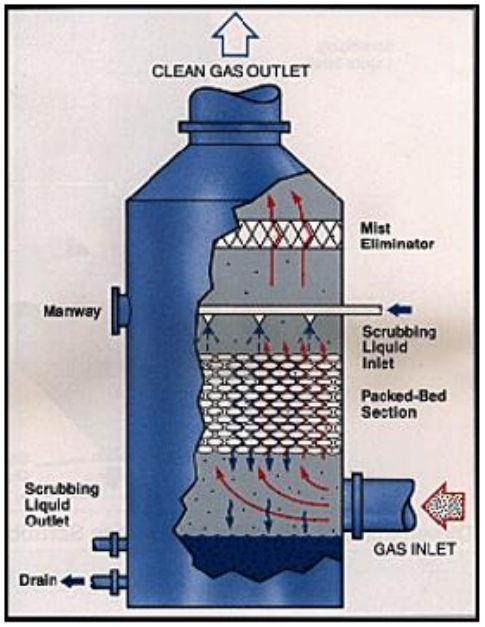


Figure 1.4 Packed tower

Packing - Basic Requirements

- chemically inert to the fluids
- strong but without excessive weight
- contain adequate passages (void volume) for both streams without excessive liquid hold-up or pressure drop
- provide good contact between the liquid and the gas.
- reasonable in cost .

- In chemical processing, a **packed bed** is a hollow tube, pipe, or other vessel that is filled with a packing material. The packing can be randomly filled with small objects like Raschig rings or else it can be a specifically designed structured packing.
- Packed beds may also contain catalyst particles or adsorbents such as zeolite pellets, granular activated carbon, etc.
- The purpose of a packed bed is typically to improve contact between two phases in a chemical or similar process. Packed beds can be used in a chemical reactor, a distillation process, or a scrubber, but packed beds have also been used to store heat in chemical plants.
- In this case, hot gases are allowed to escape through a vessel that is packed with a refractory material until the packing is hot. Air or other cool gas is then fed back to the plant through the hot bed, thereby pre-heating the air or gas feed.

Types of packing

1) Random Packing
2) Structured Packing
3) Grid packing

1) Random packing
   - First generation random packing
   - Second generation random packing
   - third generation random packing

Random packing

- Random packings are simply dumped into the tower during installation and allowed to fall at random.
- **1) Raschig rings:** Diameter ranges from 6 to 100 mm. Made of chemical stoneware or porcelain (Not used for alkali & acids), carbon (Except strongly oxidizing atmospheres), metals or plastics (deteriorates with certain organic solvents & oxygen bearing gases at elevated temperature)

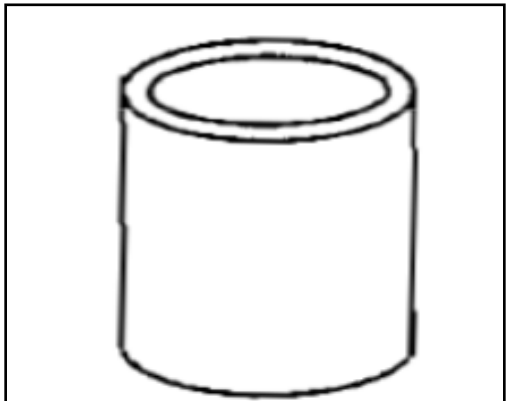


Figure 1.5 Raschig ring

2).Lessing ring :

- Lessing and others with internal classifications are less frequently used.(partition along the ring of the axis).partition increase the surface area, but advantages is rather the small in practice.
- 1) Cross partition ring: consists of two partition
- 2) Spiral ring: (internal helix)enhance the rate of mass transfer

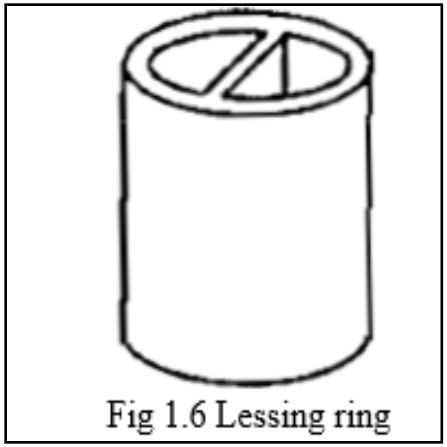


Fig 1.6 Lessing ring

3) Berl Saddle :

- (Chemical stoneware or plastics) 6 to 75 mm diameter.(first modern packing)
- Has large specific surface area and smaller voidage than racshing ring, and also pressure drop is less because of it's "aerodynamic shape".

Fig 1.7 Berl saddle

4) Intalox saddle :

- (Chemical stoneware or plastics) 6 to 75 mm diameter
- May be consider as first member of “Second generation random packing developed by norton chemical products corporation.
- It is improved version of berl seddle, which offers less form-friction to gas flow.

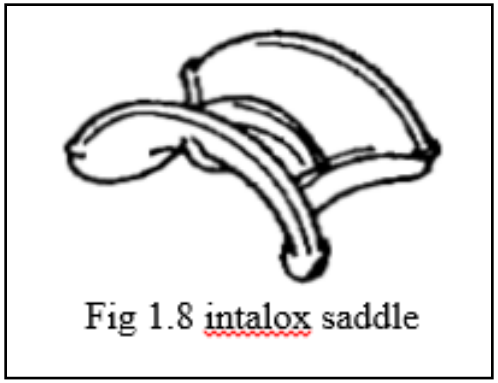


Fig 1.8 intalox saddle

5) Tellerette :

- (Plastics & metals)
- The smooth edges of intalox seddle are scalloped and holes inserted too make super intalox.

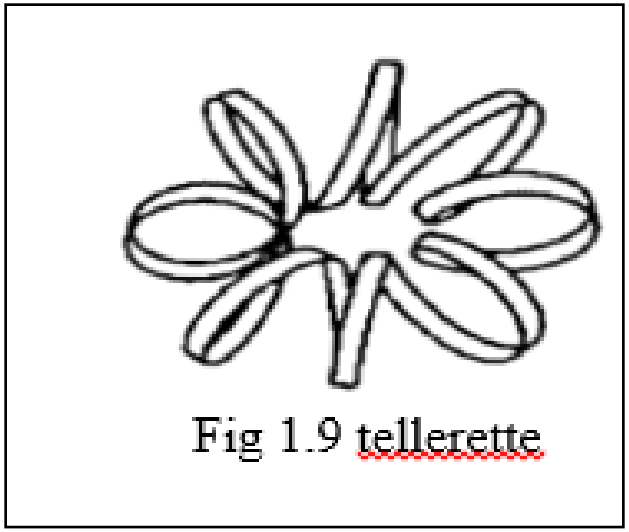


Fig 1.9 tellerette

6) Pall ring :

- The Pall ring attempts to increase the useful aspects of packing, by giving an increased number of edges to disrupt flow, whilst also reducing the volume taken up by the ring packing medium itself. Rather than using a solid-walled tube, the Pall ring resembles an open basket structure of thin bars. These form both a tube and also a radial structure of cross bars . Pall rings may be injection moulded of plastics, moulded of ceramics or press-formed from metal sheet. In order to prevent the breakage of ceramic or carbon packing , the tower may first be filled with water to reduce the velocity of falling object.

Fig 2.0 pall ring

Regular or Structured Packing

- Advantage of low pressure drop for gas side flow and greater fluid flow but on the other side requires more cost for installation.
- Stacked Raschig rings are economically practical in very large size only.

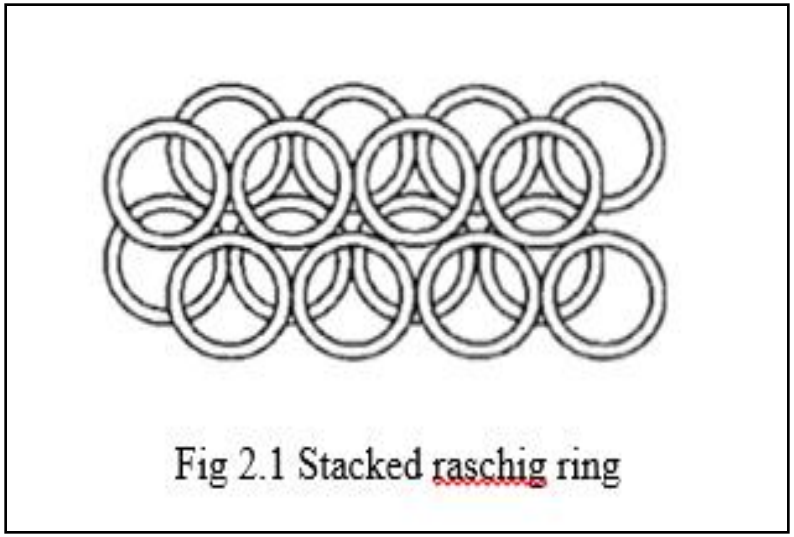


Fig 2.1 Stacked raschig ring

- Wood grids or hurdles are inexpensive and frequently used where large void volume is required.
- Woven wire screen rolled as a fabric into cylinders provide a large interfacial surface for contacted liquid and gas , and very low pressure drop.

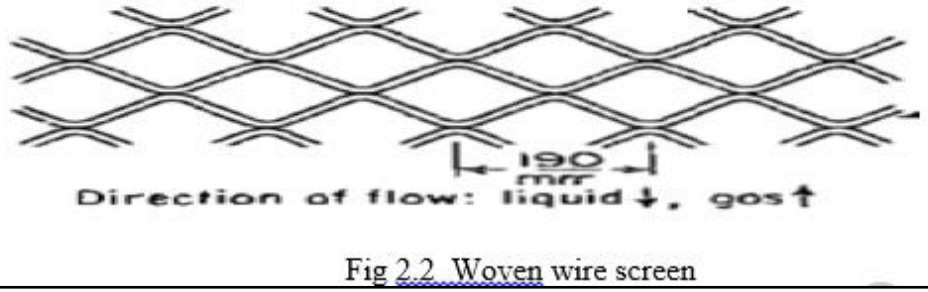


Fig 2.2 Woven wire screen

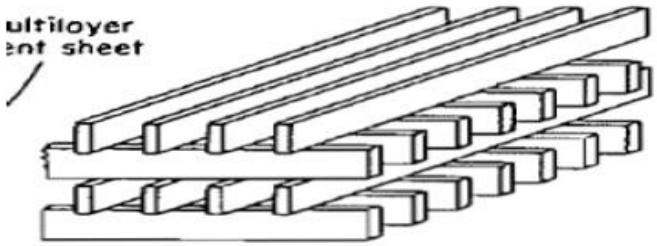


Fig 2.3 Wood grid

Tower shell

- These may be of wood , metal , chemical stoneware, acid proof brick , glass , plastic , glass-plastic lined metal or other material depending upon the corrosion condition.
- For ease of construction and strength they are circular in cross section.
- The shell should be strong enough to with stand the weight of packing and also the liquid held in the bed.

Packing support and gas distributor

- Every packed bed will need a support. Two critical factors to be considered in the design of a packing support are:
- It must physically retain and support the packed bed under operating conditions in the column including but not limited to packing type and size, design temperature, bed depth, operating liquid holdup, material of construction, corrosion allowance, material build up in the bed and surge conditions.
- It must have a high percentage of free area to allow unrestricted counter current flow of down coming liquid and upward flowing vapour .
- A bar grid which we have seen in above can be used but the support which have different passage way for liquid as well as gases can be used.

- It may be made up of metal , expanded metal ,ceramic , plastic etc.
- 1) The gas injection grid
- 2) Grid support
- 3) Cap type support plate

- A bad “GAS DISTRIBUTOR” creates channelling of the gas through the bed. This occurs when bed is not uniformly packed.

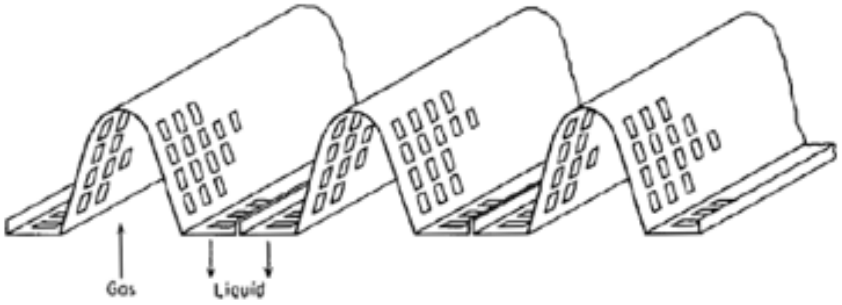
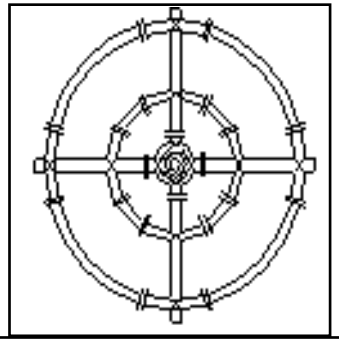


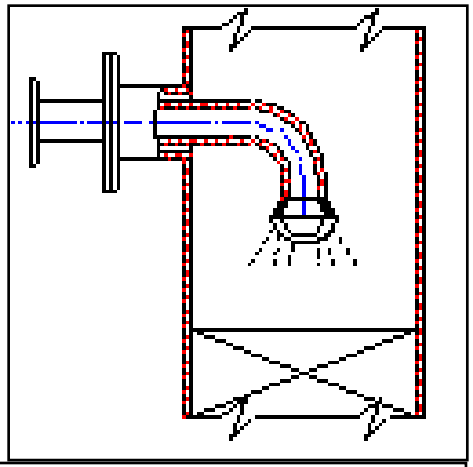
Fig 2.4 Multiple support beam

Liquid distribution

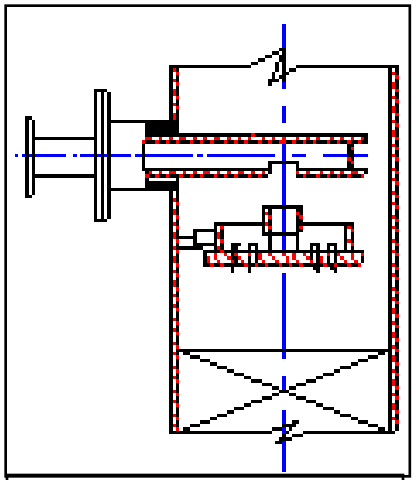
- Function: Uniformly distribute the liquid on the surfaces of packings.
- Spray Nozzles
- Ring of perforated pipe in small towers



Annular tubes with multi-holes



Shower nozzle type



Overflow pipes

- Dry packing is ineffective for mass transfer . Therefore it is required to wet the packing . The importance of adequate distribution of liquid is shown in fig.

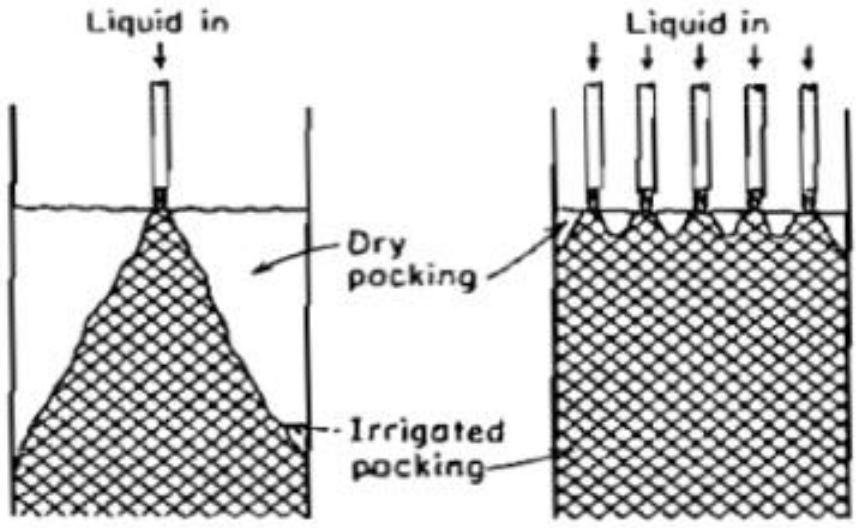


Fig 2.5 liquid distribution

Liquid redistributor

- Function: Reducing the non-uniform distribution of liquid, and reducing the wall flow.
- To maintain the uniform contact between the liquid and gas throughout the tower , it is provided at various length interval of tower depending upon the length and diameter of tower . e.g weir trough liquid redistributor.

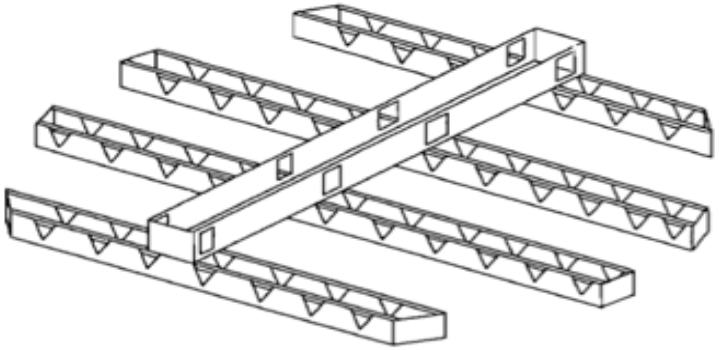


Fig 2.6 Weir Trough liquid redistributor

Packing restainers

- These are necessary when gas velocities are high and they are generally desirable to guard against lifting of packing during a sudden gas surge . heavy screens or bars may be used . For heavy ceramic packing , heavy bar plates resting freely on the top of the packing may be used . for plastics and other light weight packings , the restrainer is attached to tower shell.

Entrainment eliminator

- Function: Eliminating the entrained liquid drops in the gas stream at the outlet.
- During high gas velocity the gas may carry away liquid droplets . To remove the liquid droplets from outgoing gas mist eliminator is provided above the liquid inlet.

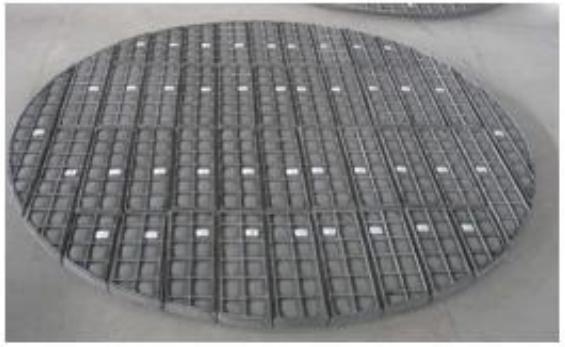


Fig 2.7 entrainment eliminator

- **Flooding and loading in tower :**

- When the gas flow is higher than amount of liquid flow rate, it started accumulate at tray and restrict the flow of gas and liquid holdup takes place on the upper side of tray this phenomenon is called "**loading**"
- If the gas flow rate is further increased, the liquid accumulation rate increased very sharply. Liquid accumulates more in upper region of the bed almost preventing the flow of gas. After that all liquid comes down with high pressure so column filled with liquid, This phenomenon is called "**flooding**".
- At that time column acts as "**bubble column**".

Choice of Tray tower vs. Packed tower

- The choice between a tray and packed tower for a particular application can only be made with complete assurance by costing each design. However, this will not always be worthwhile, or necessary, and the choice can usually be made, on the basis of experience by considering main advantages and disadvantages of each type; which are listed below:

- Plate towers can be designed to handle a wider range of liquid and gas flow-rates than packed towers.
- Packed towers are not suitable for very low liquid rates.
- The efficiency of a tray can be predicted with more certainty than the equivalent term for packing (HETP or HTU).
- Plate towers can be designed with more assurance than packed towers. There is always some doubt that good liquid distribution can be maintained throughout a packed tower under all operating conditions, particularly in large towers.
- It is easier to make provision for the withdrawal of side-streams from tray towers; coils can be installed on the trays.

- If the liquid causes fouling, or contains solids, it is easier to make provision for cleaning in a tray tower; man ways can be installed on the trays. With small diameter towers it may be cheaper to use packing and replace the packing when it becomes fouled.
- For corrosive liquids a packed tower will usually be cheaper than the equivalent plate tower.
- The liquid hold-up is appreciably lower in a packed tower than a plate tower . This can be important when the inventory of toxic or flammable liquids needs to be kept as small as possible for safety reasons.

- **Costs**: packed column tends are less expensive than plate column for small column diameter (<0.6 m).
- **For foaming liquid**: handling of foaming liquid in packed column is more appropriate because of the relatively low degree of agitation by the gas.
- **Working under stressed conditions** of temperature variations and pressure: the packing elements are easily breakable.

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5.https://www.google.co.in/search?q=wetted+wall+tower&biw=1366&bih=651&source=lnms&tbm=isch&sa=X&sqi=2&ved=0CAYQ_AUoAWoVChMInKTz5NCryAIVCxmOCh3jig9i#tbm=isch&q=spray+tower&imgrc=-T26V2HNaChLjM%3A

Thank you..!