Low Pressure Storage tanks (Non-Refrigerated)

Low pressure storage tanks

Low pressure storage tanks are divided in following category:

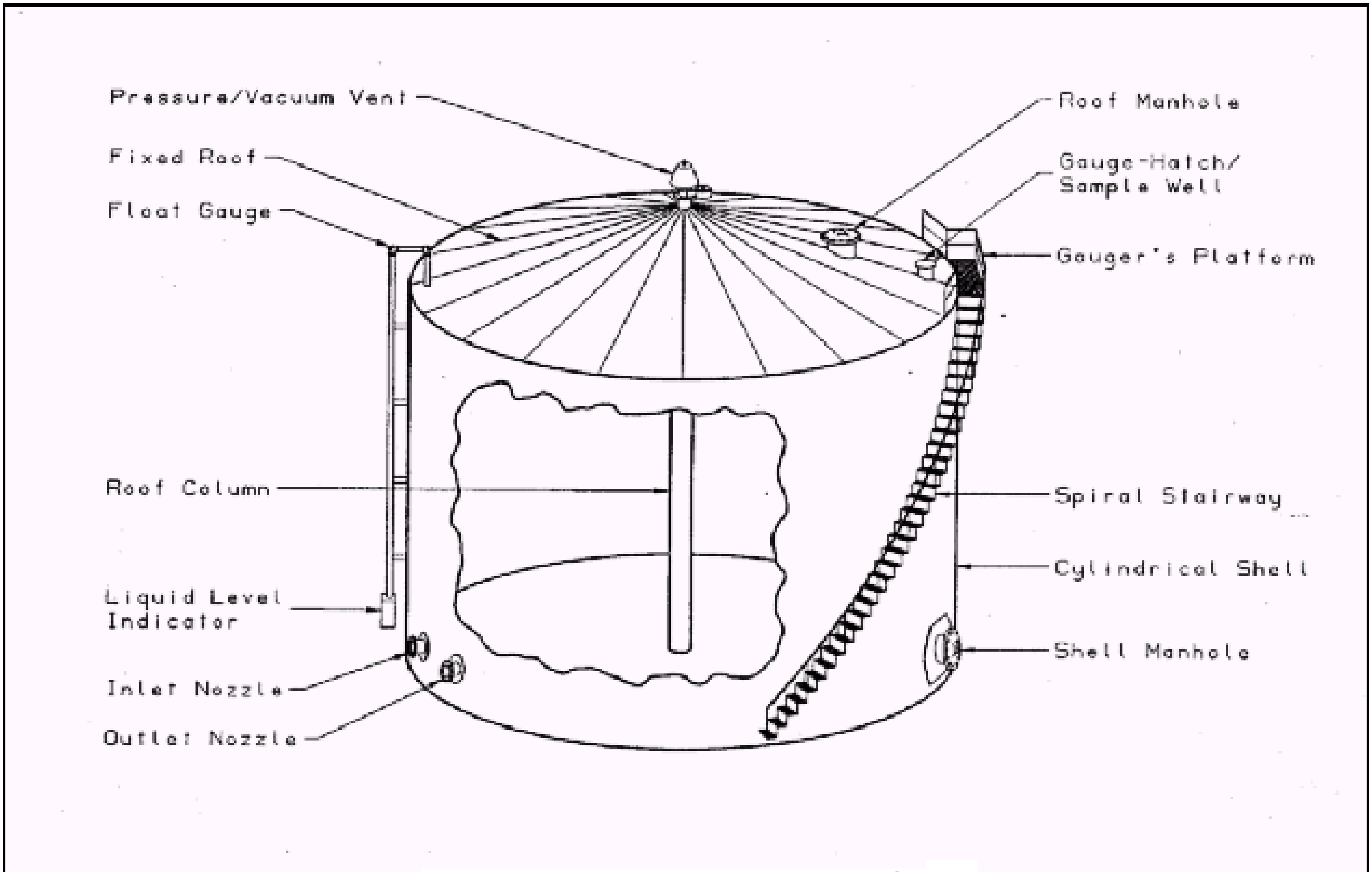
1. Cone roof tank.
2. External Floating roof tank.
3. Internal floating cum cone roof tank.
4. Dome roof tank.

1.Cone roof tank

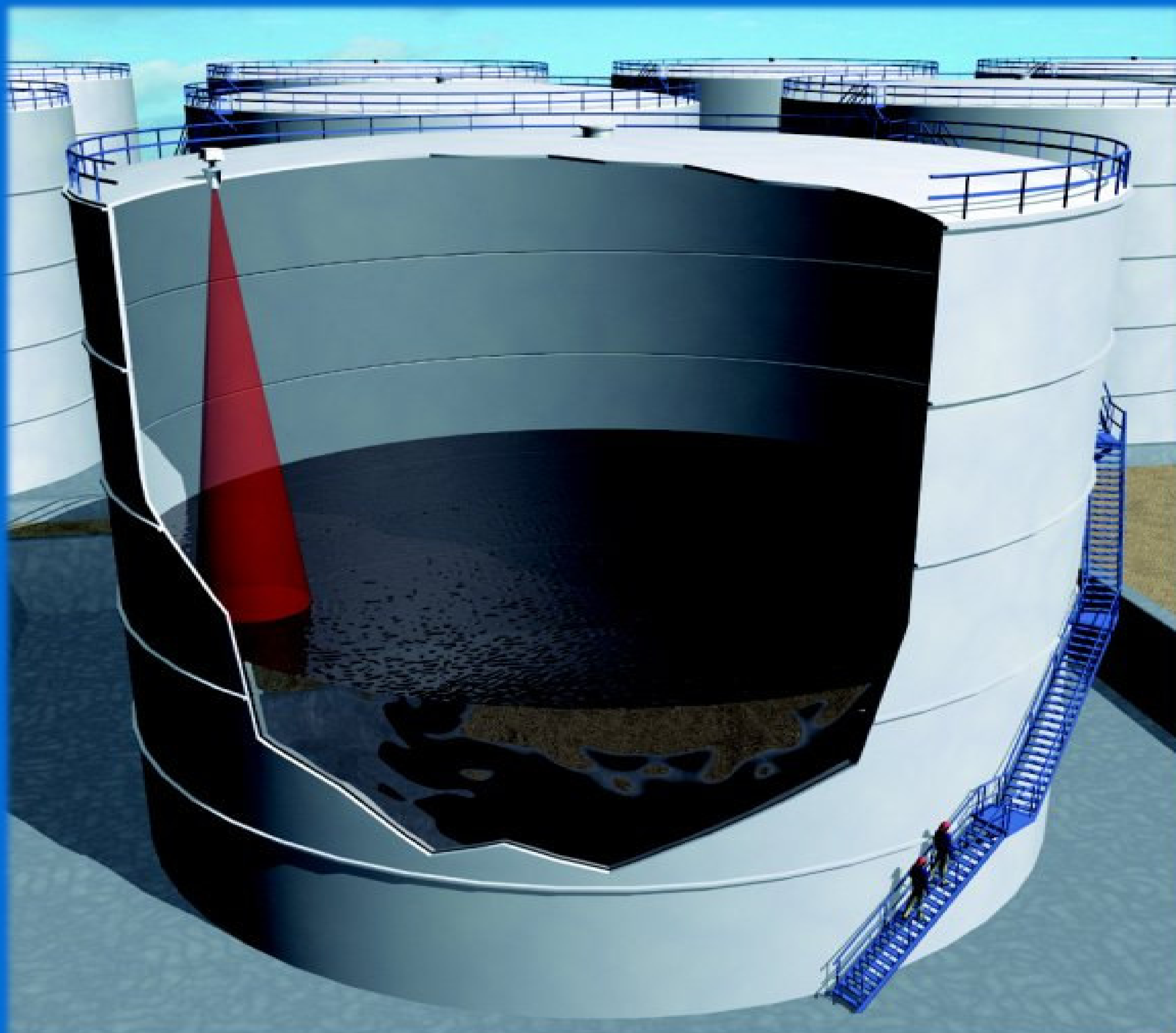
- The cone roof tanks are designed as per the API-650 for petroleum services, otherwise, for non-petroleum services , Indian standard IS-803 is followed.
- The self supported roof is used up-to 12.5 M Ǿ and beyond 12.5 M Ǿ , roof is supported internally using internal truss framing. The cone roof tanks are divided into three categories based on the storage pressure.

Type-	Design pressure/ vacuum, " WC.	Diameter, Ǿ M	Accessories
Atmosphere Pressure tank	Full of water or liquid Which ever is heavier.	3 to 48 M	Goose necked open vent with bird guard mesh
Low pressure tank	8" WC (200 mm WC) +full of water or liquid whichever is heavier and (-) 2.5" WC (-65 mm WC) vacuum	3 to 39 M	1)Nitrogen or inert gas Blanketing. 2)Breather-valve (PVRV).
Medium pressure tank	22.5" W C (571.5" WC+ full of water or liquid whichever is heavier and (-) 2.5 " WC (-65mmWC) Vacuum	3 to 20 M	1)Nitrogen or inert gas Blanketing. 2)Breather-valve (PVRV).

Cone roof tank



Cone roof tank



2. External Floating roof tank

- ***This type of tank operates at atmospheric pressure, small rim vapour space is being freely vented. In general, they are recommended for diameters above 15 meters. The diameter of the floating roof tank shall be at least be equals to its height or higher to enable the use of a normal rolling ladder for access to the roof. The floating roof tanks are either "Single deck pontoon type " or " Double deck pontoon type".***
- ***The True Vapour Pressure of storing petroleum products or crude should not exceed 12.5 Psia (0.85 Kg/cm2a) at the maximum storage temperature. Normally in India, it is restricted to 11 Psia (0.77Kg/cm2a).***

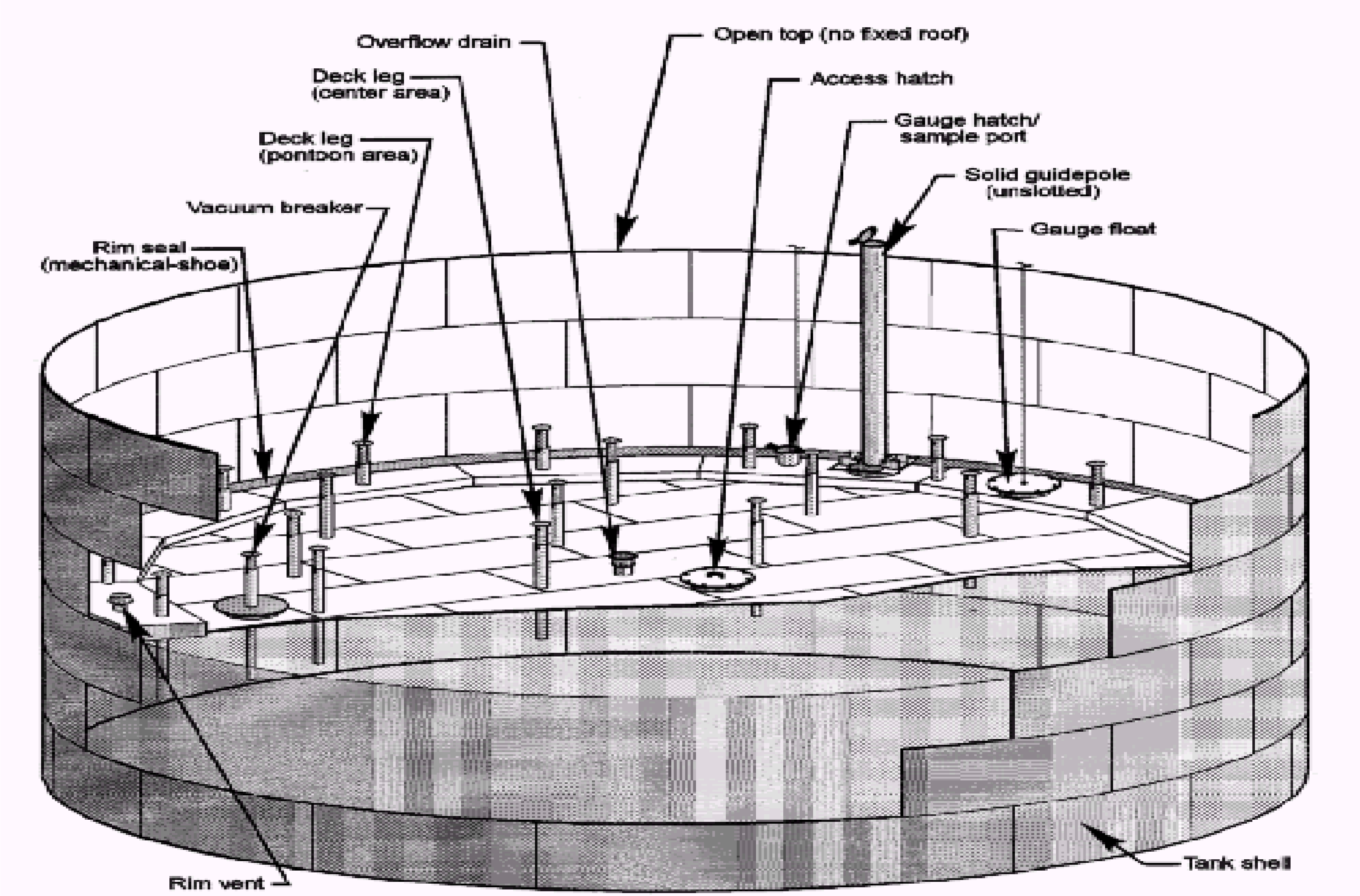
-Continue---

- ***An advisable range of deck travel speed is 5-20 meters/min but in case where higher pumping rate is required or large tank diameter is used, the deck travel speed goes as higher as 30 meters/min. The designers should note, speed exceeds above could lead to adverse effect on deck stability.***

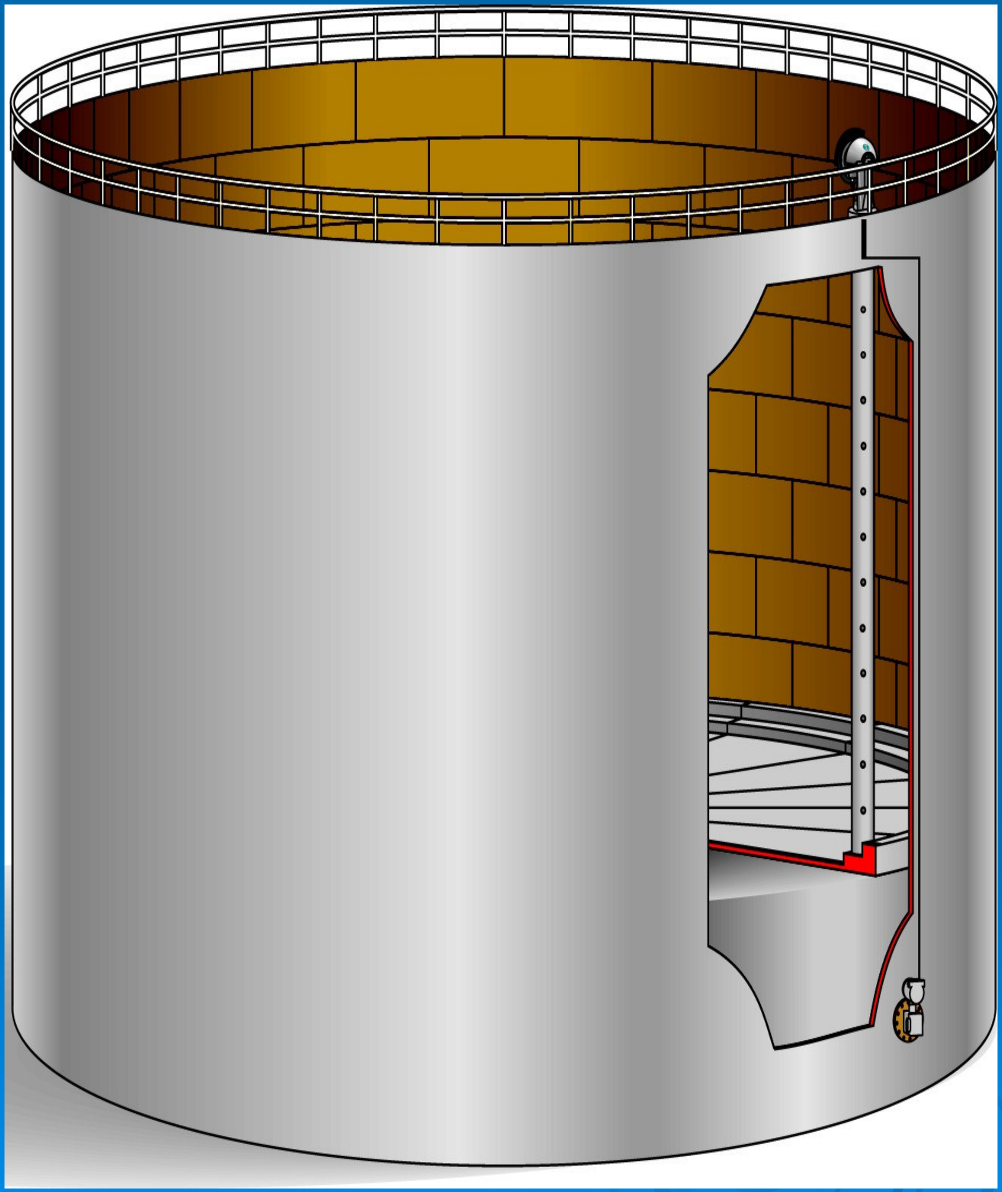
- ***The tank is designed as per API-650 and vapour loss from the tank is calculated using the "API-2527".***

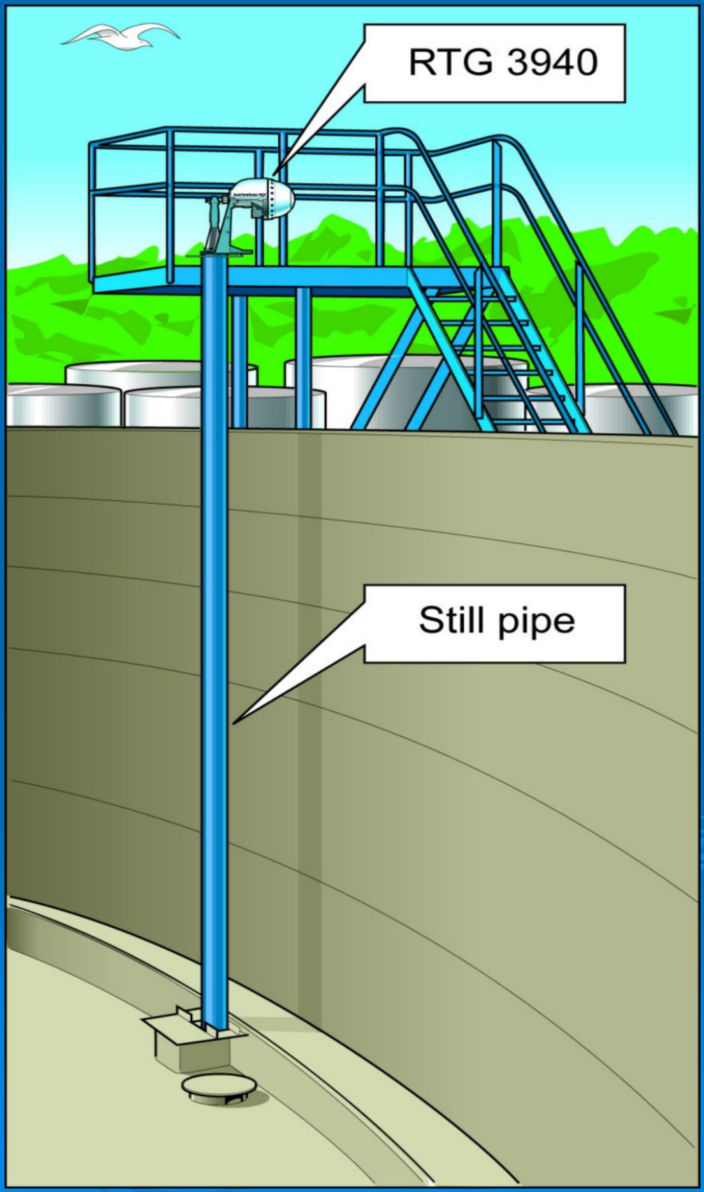
Type	Design Pressure, inches of WC	Height, M	Accessories
Floating roof tank	Atm. + Full of water or liquid whichever is heavier	15 to 92 M	Rim seal, rolling ladder, vacuum vent, rainwater draining funnel, emergency vent

External Floating Roof Tank



External floating roof tank





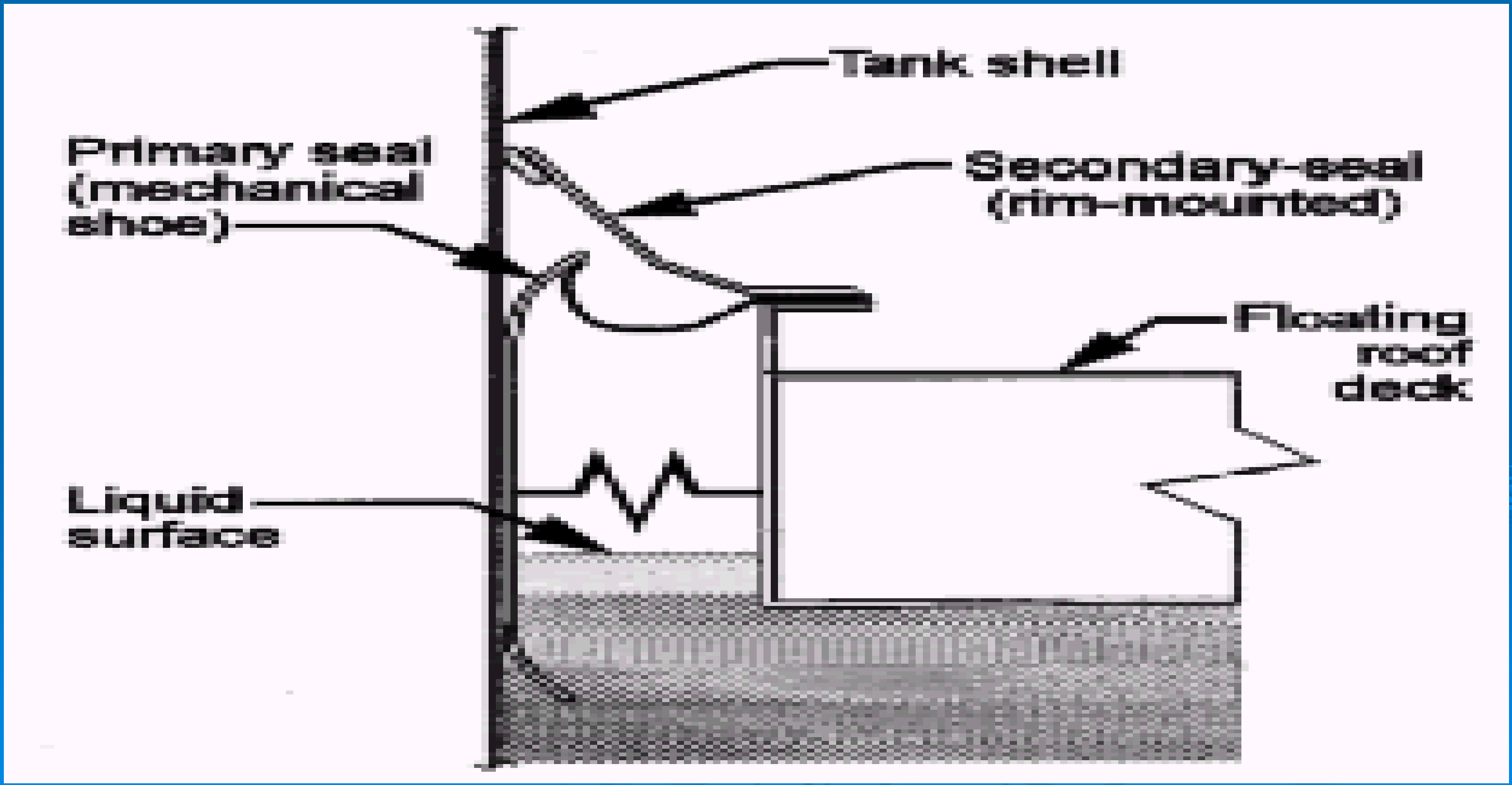
Rim Seal

Tank Construction And Rim-Seal System	Average-Fitting Seals		
	K_{Ra} (lb-mole/ft-yr)	K_{Rb} [lb-mole/(mph)^n-ft-yr]	n (dimensionless)
Welded Tanks			
Mechanical-shoe seal			
Primary only[b]	5.8	0.3	2.1
Shoe-mounted secondary	1.6	0.3	1.6
Rim-mounted secondary	0.6	0.4	1.0
Liquid-mounted seal			
Primary only	1.6	0.3	1.5
Weather shield	0.7	0.3	1.2
Rim-mounted secondary	0.3	0.6	0.3
Vapor-mounted seal			
Primary only	6.7[c]	0.2	3.0
Weather shield	3.3	0.1	3.0
Rim-mounted secondary	2.2	0.003	4.3

Rim Seal Loss = (K_{Ra} + K_{Rb} v^n)x(Tank and product parameters)

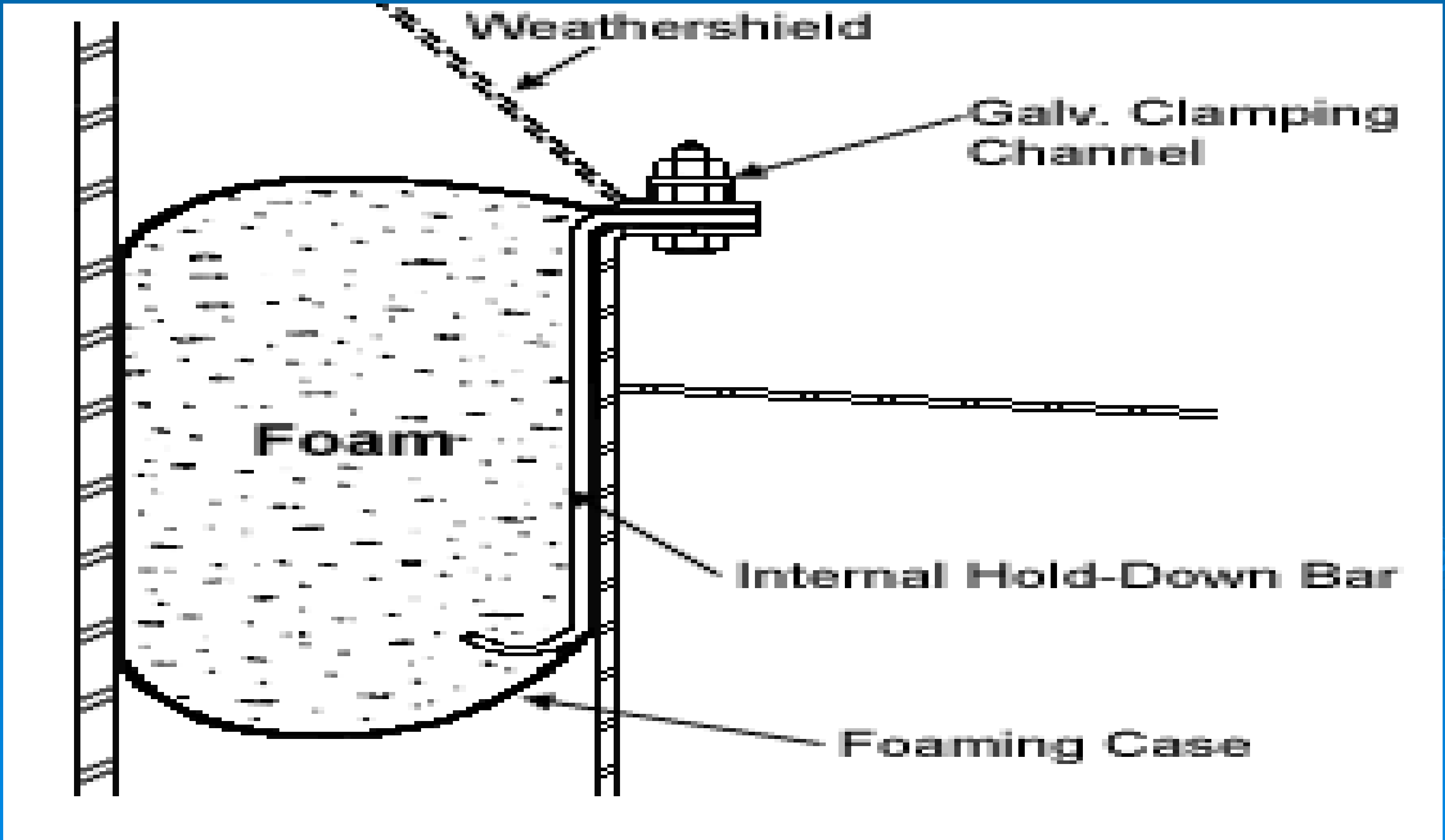
- *K_{Ra} - Zero wind speed Loss Factor.*
- *K_{Rb} - Wind Speed dependent Loss Factor (Zero in case of IFR)*
- *n - Seal Wind Speed Exponent.*
- *V - Wind Velocity*

Current Practice In India
Rim Mounted Secondary Seal Over Mechanical Shoe Primary Seal



Current Practice In India

Vapour Mounted Primary Foam Seal with Weather shield



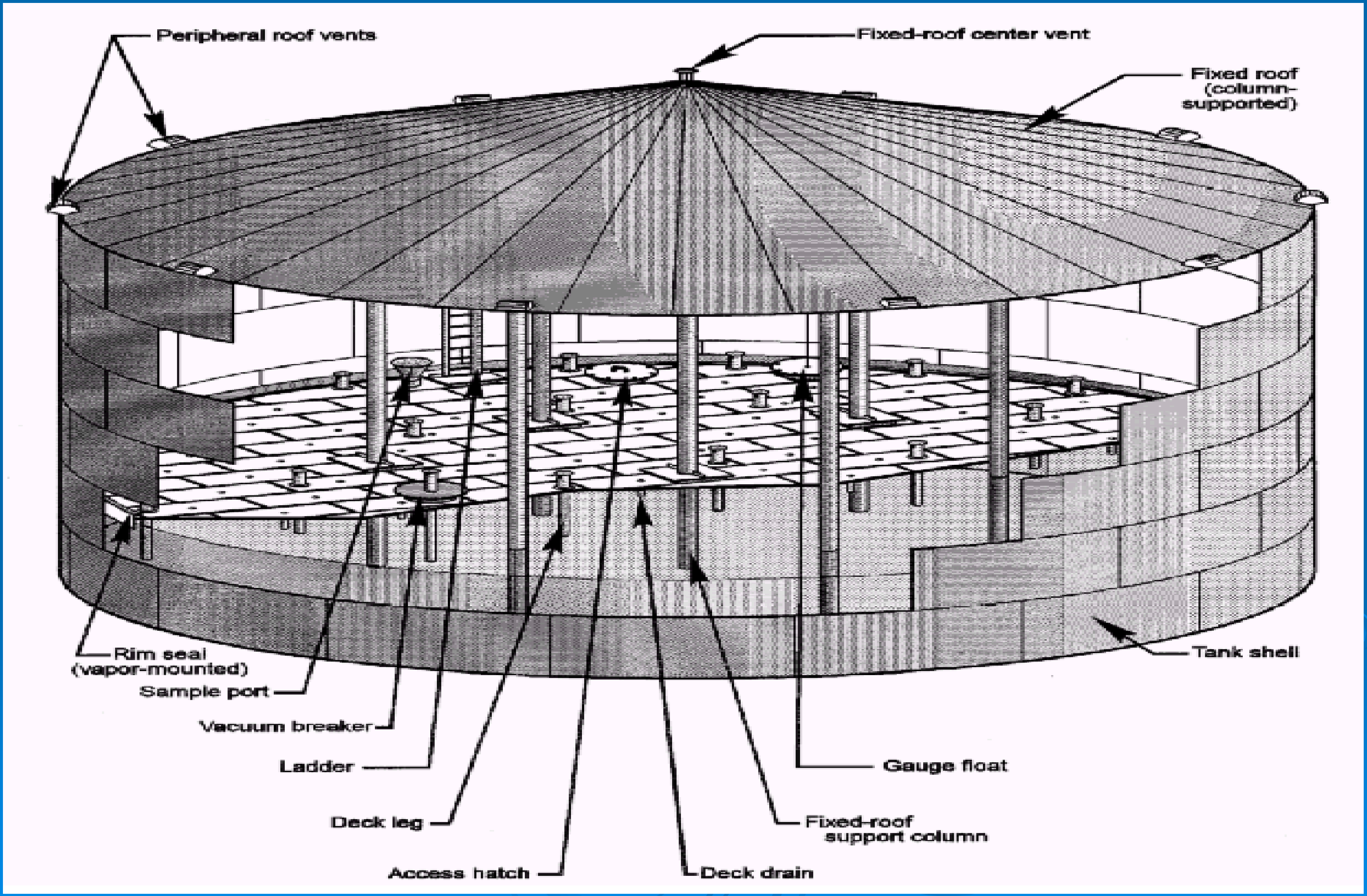
3.Internal Floating cum cone roof tank

- *A fixed roof cone tank may be provided with an internal floating cover beneath the cone to reduce the vapour losses and air pollution. It is being used in specific cases either to restrict the loss of costly material's or avoid air contamination by 'Carcinogenic" material like Benzene or restricts entry of rain water (ATF) etc.*

- *It is recommended that maximum diameter of this tank is limited to 39 Meters. Adequate ventilation is required in upper cone roof, as special cases, pressure/vacuum breather valves are used. Preferably the floating roof of self –buoyancy type shall be used. The tanks provided with floating cover beneath cone roof shall always be provided with High level alarms to protect upper cone roof against damage due to possible hit by the floating cover.*

- *The tank is designed as per API-650.*

Internal Floating Roof



4.Dome roof tank

- Dome roof tank is used to store liquid whose vapour pressure at ambient condition is more than atmospheric pressure but less than 25 psia . The typical example is various categories of Natural Gasoline Liquid (NGL) are stored in Dome roof tank. The tank is designed as per the API-620 code. This code covers, metal temperature does not exceed 250° F (121° C).

Type	Design pre.," WC	Height, M	Accessories
Dome roof tank	10 psig/(-) 65mm WC or (-) 2.5" WC.	15 to 30 M	1) N2/ inert blanketing. 2) Vacuum port of breather valve 3) Safety valve

Type of Tank bottom

Mostly tank bottom plates are lap welded for field erected tanks and butt welded for shop fabricated tanks.

The tank bottom is designed as per the process requirement:

Following guidelines are followed for type of tank bottom:-

- ***Flat bottoms may be used for small tanks .***
- ***The cone up is preferred to accommodate settlement, which is usually larger at the tank center than the perimeter.***
- ***If settlements of less than 150 mm (6 in) are anticipated, either bottom up or down may be used.***
- ***Cone down bottoms are easier to clean when there is a large amount of sediment, as it may be flushed to the tank center.***

Refinery products:

- ***White oils:*** ***Naphtha ,MS, SKO, MTO,HSD, ATF, NGL***
- ***Black oils :*** ***Bitumen, FO, LSHS, Heavy gas oils.***
- ***Liquefied gases :*** ***LPG, Propane, Butane.***

Classification of petroleum products

Liquid Class	Flash point temperature	Petroleum products
A	Less than 23ºC	LPG, MS, Naphtha. NGL
B	23 ~ 65ºC	HSD, SKO, ATF
C	65 ~ 93ºC	FO, LDO
SAFE	> 93ºC	Bitumen

Selection of storage tanks

- *Vapour pressure of products.*
- *Allowable fugitive emission as per local norms.*
- *Losses allowed (cost of product).*
- *Tank size and cost economics.*

Typical guide for selecting the type of storage

VAPOR PRESSURE	TYPE OF STORAGE TANK	EXAMPLE
< 1.5 psia	Fixed Roof Tank	HSD, FO, Bitumin
1.5 to 11 psia	Internal /External Floating Roof Tank	Crude,MS, Naphtha, SKO, ATF, Benzene
> 11 psia	Dome roof/Bullets/Sphere	LPG, Propane, Butane,NGL

Comparison among various types of atmospheric storage tanks

- Basis: 1. Tank 28 M Diameter x 14 M height (8616 M3 volume)
  2. Typical Indian ambient conditions.
  3. Turnover/Year = 30

	Cone roof	External Floating roof	Internal floating cum cone roof
Naphtha loss (RVP: 10 Psia), tons/year.	776	182	11
Relative fixed investment.	1.0	1.3	1.4
Saving of loss comparison to Cone roof tank.	-	76-80%	98%

Storage tank accessories

A) Operational and maintenance reasons:

1) Level gauging for inventory control.
2) Temperature gauges for temperature measurement.
3) Man-holes for inspection, maintenance, cleaning and providing internals like mixers etc.
4) Mixer to avoid inconsistency in product composition.
5) Tank heater (Heating coils or suction heater) to help in phase separation (H/C and water) and also to maintain liquid fluidity.
6) PVRV/ Blanketing for evaporation loss control.
7) Water draw off nozzles for water draw .

B) Safety reasons:-

1) **Overpressure protection** (Safety valves, rupture disk, PVRV, gauge hatch, lifting man-hole,week roof construction etc) .
2) Dikes around the storage tanks for liquid containment during spillage.
3) Tank earthing , protection against static charge accumulation.
4) Purging arrangement to avoid air ingress in tank forming explosive mixture/product contamination.
5) **Fire protection** (Fire water, Sprinklers, fusible plugs, gas detection ,UV/IR detectors.)
6) **Overflow protection** (High level alarm and ESD at inlet to stop inflow).
7) Dip pipe with anti-siphon, avoid static charge generation/accumulation.

Over pressure/Vacuum in Tanks.

The storage tanks can get pressurised or vacuum pulled during following scenarios: -

- Liquid movement into or out of the tank.
- Tank in-breathing or out- breathing due to change in ambient temperature from day to night.
- Tank gets exposed to external fire.
- Heating coil rupture, residual left out water gets vaporises during heating of tank.
- Failure of inert blanketing control system.

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- ***Entry of low vapour pressure liquid due to back flow by mistake.***
- ***Vent gas treatment / vapour recovery unit failure.***
- ***Liquid overfilling.***
- ***Gas pressure transfer blow-off.***
- ***Gas blow –by.***
- ***Failure of cooling medium of run down of product to tank.***

- ***The scenarios which occurs during normal operations are <u>tank filling / emptying operation, blanketing gas failure and thermal in-breathing / out-breathing</u> due to continuous change in ambient temperatures from day to night, one season to other season are considered under "Normal venting".***
- ***All other scenarios do occur occasionally due to human error, failure of instruments and inadequate safety system falls under "Emergency venting".***

- ***As we have seen that storage tanks do get pressurised or vacuum pulled during the operation due to various normal and emergency scenarios, therefore, it is prime importance that venting and vacuum protection devices provided on the top of tank should be adequately sized for tank protection .***

Advantages of pressure/vacuum relief devices (Breather valve)

- *It protects tank against over pressurisation/vacuum rupture.*
- *It reduces loss of tank content.*
- *It controls " Fugitive" emission of hydrocarbon.*
- *It avoids corrosion in vicinity of plant.*
- *It restricts contamination of tank content.*
- *It restrict atmospheric air contamination by toxic chemicals.*

Tank safeguarding

- Over pressure protection and breathing requirement for atmospheric Tank shall be as per the API- STD-2000.

There is two types of safeguards:

a) In-breathing — i) Normal -- Thermal effects
-- Liquid out flow

b) Out-breathing. — i) Normal -- Thermal effects
-- Liquid in flow
-- Blanket gas C V Failure

ii) Emergency venting
-- Fire
-- Gas blow by
-- Failure of heating etc.

Estimation of venting requirement.

Table 1B—Normal Venting Requirements
(Nm^3/hr of Air per Cubic Meter per Hour of Liquid Flow)
B. Metric Units

Flash Point/Boiling Point[a]	Inbreathing		Outbreathing	
	Liquid Movement Out	Thermal	Liquid Movement In	Thermal
Flash Point ≥ 37.8°C	0.94	See Table 2B	1.01	See Table 2B
Boiling Point ≥ 148.9°C	0.94	" "	1.01	" "
Flash Point < 37.8°C	0.94	" "	2.02	" "
Boiling Point < 149°C	0.94	" "	2.02	" "

[a] Data on flash point or boiling point may be used. Where both are available, use flash point (See Appendix A).

Estimation of venting requirements.

Table 2B —Requirements for Thermal Venting Capacity
B. Metric Units

Tank Capacity	Inbreathing (Vacuum)	Outbreathing	
Column 1[d]	Column 2[a]	Column 3[b]	Column 4[c]
		Flash Point ≥ 37.8°C or Normal Boiling Point ≥ 148.9°C	Flash Point < 37.8°C or Normal Boiling Point < 148.9°C
Cubic Meters	Nm^3/h	Nm^3/h	Nm^3/h
10	1.69	1.01	1.69
20	3.37	2.02	3.37
100	16.9	10.1	16.9
200	33.7	20.2	33.7
300	50.6	30.3	50.6
500	84.3	50.6	84.3
700	118	70.8	118
1,000	169	101	169
1,500	253	152	253
2,000	337	202	337
3,000	506	303	506
3,180	536	388	536
4,000	647	472	647
5,000	787	537	787
6,000	896	602	896
7,000	1,003	646	1,003
8,000	1,077	682	1,077
9,000	1,136	726	1,136
10,000	1,210	807	1,210
12,000	1,345	888	1,345
14,000	1,480	969	1,480
16,000	1,615	1,047	1,615
18,000	1,745	1,126	1,745
20,000	1,877	1,307	1,877
25,000	2,179	1,378	2,179
30,000	2,495	1,497	2,495

Estimation of normal venting requirement.

Thus total normal venting capacity shall be at least the sum of the venting requirements for the liquid movement and the thermal effect.

Total out breathing = Out breathing due to liquid filling + Thermal out breathing.

Total inbreathing = In breathing due to liquid withdrawal + Thermal inbreathing.

Typical Normal Venting loss from cone roof tank.

- **Storage loss: 15 to 20 %** (Due to seasonal temperature change).
- **Working loss: 85 -80%** (Due to filling the tank)

PVRV controls only storage loss.

- ***It is common practice that tank inbreathing requirement is met by PCV supplying N2/ inert gas during in –breathing. The gas supply regulator should be such to supply minimum gas supply during normal operation.***
- ***For normal venting ,the vent is provided with " Breather valve" to conserve the losses. The Blanketing gas PCV and Breather valve should be matching capacity during failure.***
- ***It is common practice that if Breather valve is provided, there is no need to have " Flame arrestor", even flash point of storage liquid is less than 100 º F.***

- ***Open vent is provided if storage liquid is "Class C "liquid without " Flame arrestor " .***
- ***Open vent is also provided with "Class B "liquid with " Flame arrestor" for small capacity tank if storage temperature is less than flash point temperature and also conserving the vapor loss is no issue.***

Emergency venting

- Normally Emergency venting is relieved by normal Vent with breather valve. In case size comes to large than vent is split into number of vents . Alternatively ,emergency venting capacity is matched by the combination of normal vent and following arrangements provided on with the tank:

  -- Gauge hatch

  -- Weak roof

  -- Rupture disk

  -- Lifting type manhole

Breather valve (PVRV)

- **What is a Breather valve ?**
  - *The breather valve also known as Pressure/Vacuum relief valve. It is a protective device mounted on the top of a fixed roof atmospheric storage tank. Its primary function is to conserve the loss of storage content when the tank is in out-breathing mode.The purpose and selection of breather valve is mainly to control the in-breathing and out-breathing of storage tank by protecting the tank under over pressurisation and vacuum and possible rupture or imploding.*

Classification of Breather valves.

Based on the principle of operation, breather valves are classified in two types

- Direct acting breather valves.
  - Weight loaded.
  - Spring loaded.
- Pilot operated breather valves.

Principle of operation of direct acting type.

The principle of operation of a breather valve for direct acting is based on weight of pallet or the spring force acting on the pallet to keep the device closed. When the tank pressure or vacuum acting on the seat sealing area equals the opposing force acting on the pallet, the venting device is on threshold of opening. Any further increase in pressure or vacuum causes the pallet to begin to lift off the seat.

Pressure relief action.

PRESSURE RELIEF

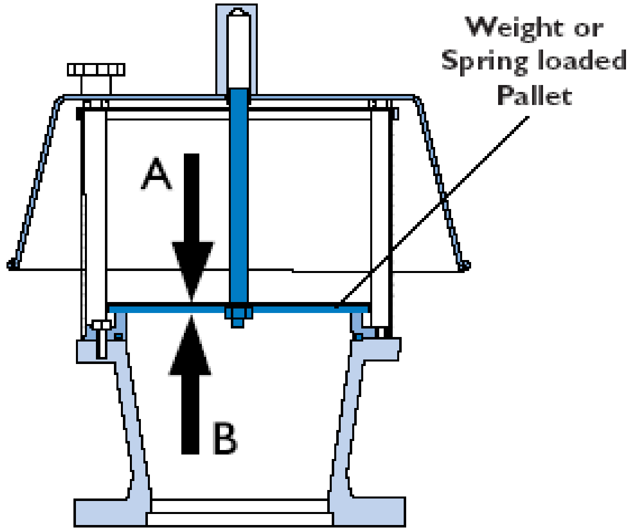


Fig. 3 Valve closed.
The downward acting force "A" (generated from either weights or a spring) provides the set pressure. This force is greater than the system operating force "B" acting upward.

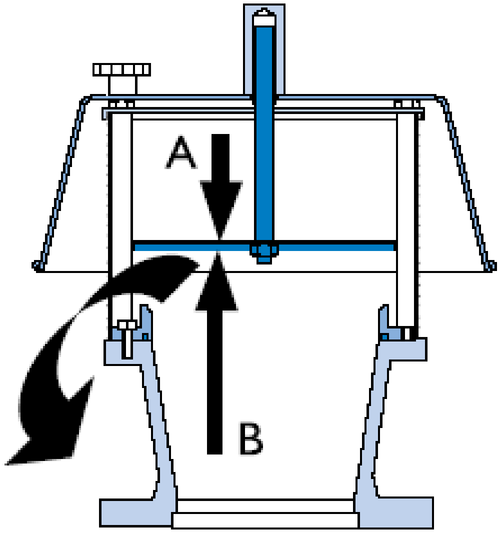


Fig. 4 Valve open.
When the system pressure force "B" increases to above force "A", the pallet lifts and the tank vapours are released to the atmosphere. If such vapours are not permitted to be vented to atmosphere, a piped vent version is available.

Vacuum relief action

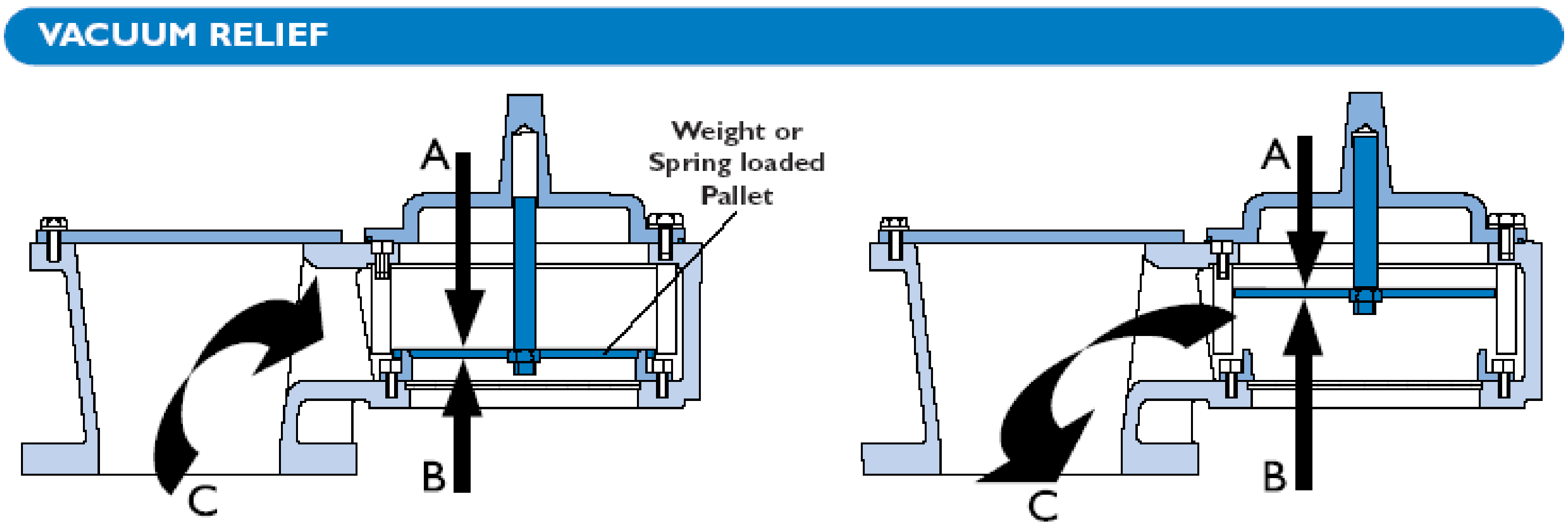


Fig. 1 Valve closed.
The downward acting force "A" (generated from either weights or a spring) provides the vacuum set pressure. This force is greater than the atmospheric force "B" acting upward. When the tank is filling, force "C" is generated, which acts with force "A" keeping the valve firmly closed.

Fig. 2 Valve open.
When the tank is emptying, a vacuum force "C" is generated, which helps to lift the pallet by acting with force "B" and against force "A". This allows the tank to breathe air in.

Combine pressure/vacuum relief action (PVRV)

COMBINED PRESSURE & VACUUM RELIEF

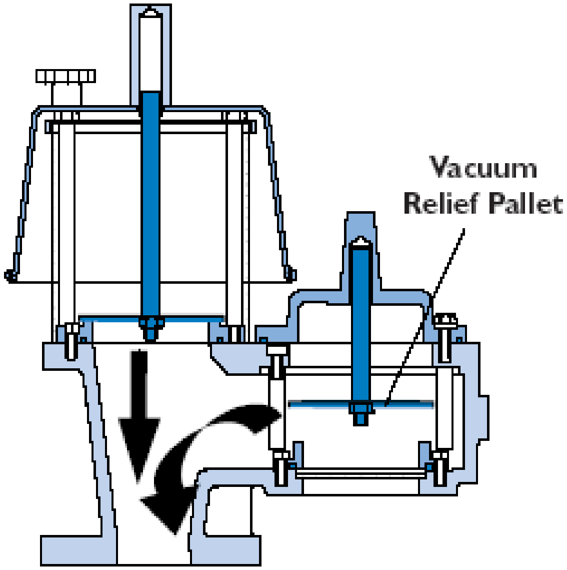


Fig. 5 Tank emptying.

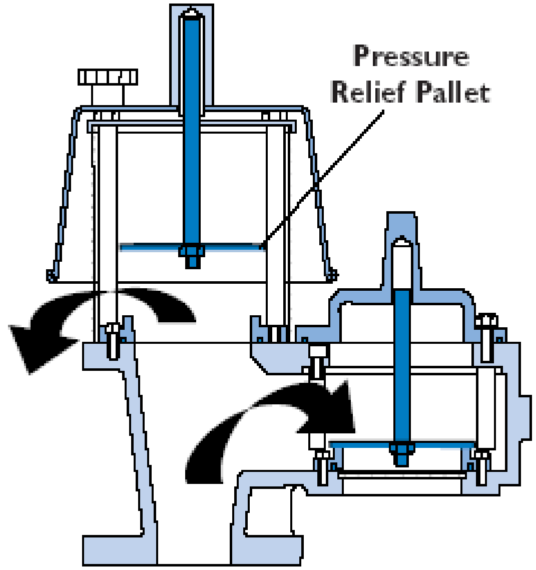


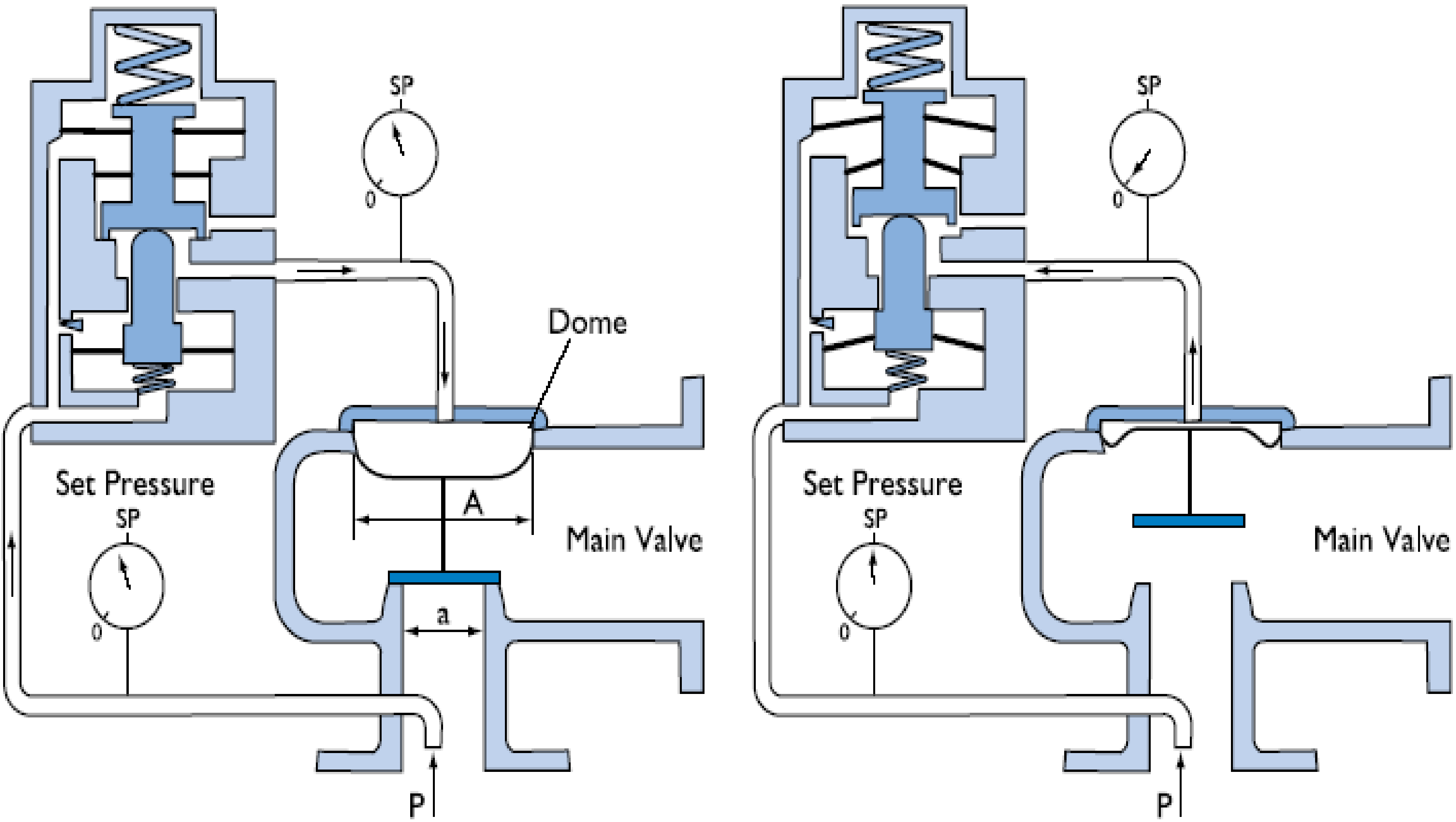
Fig. 6 Tank filling.

The operation of the Vacuum relief pallet and the Pressure relief are as explained above.

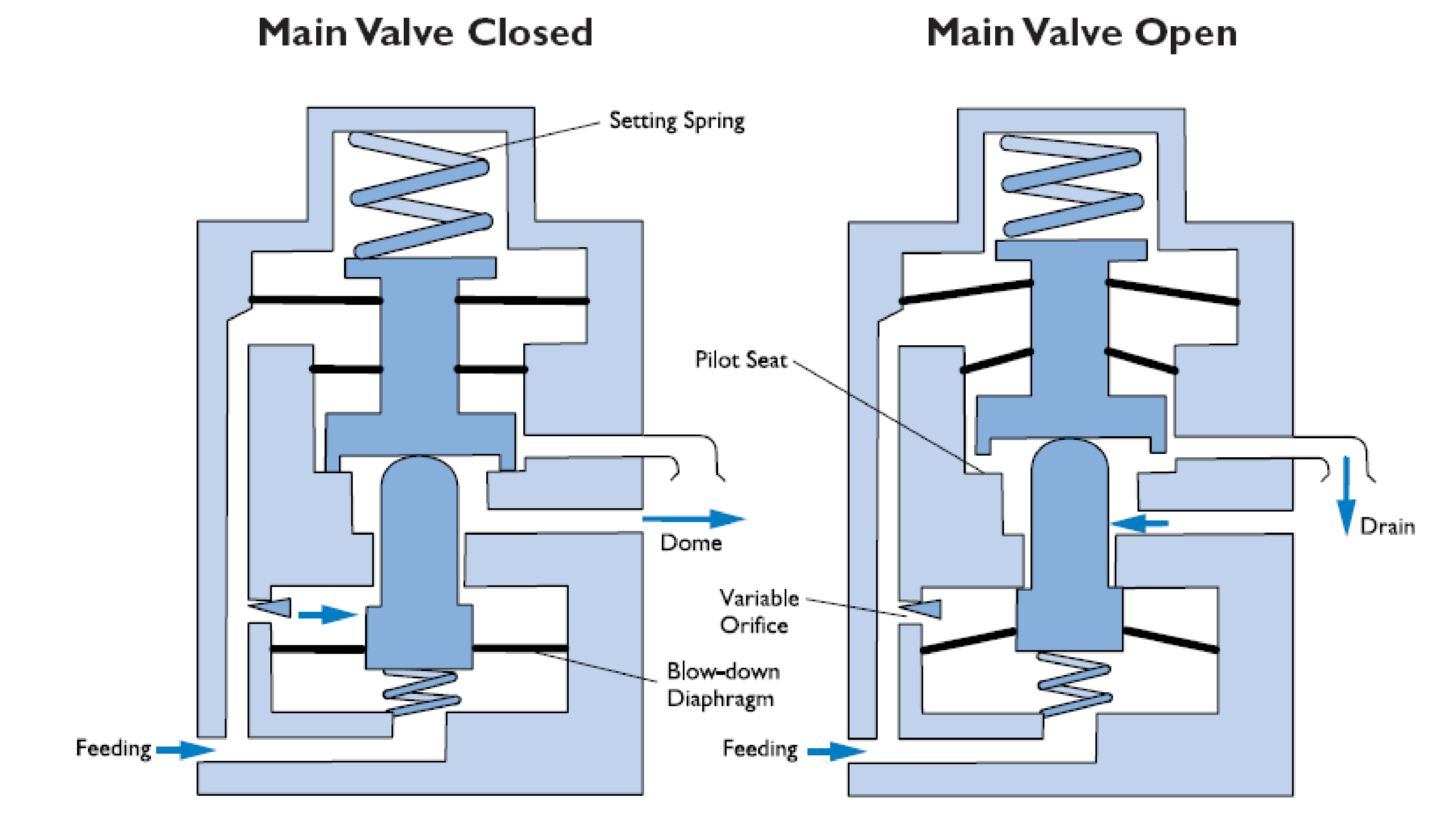
Principle of operation of Pilot operated valve

- The Pilot operated valve does not use spring or weights to keep the valve seat closed. The main seat is closed by tank pressure acting on a large diaphragm. This tank pressure covers an area greater than sealing area, so the net pressure force is always in a direction to keep the seat closed. The volume of above diaphragm is called as the dome. When the tank pressure increases to set pressure, the pilot actuates to reduce the pressure in the dome volume, the force holding the seat closed id reduced, and the seat lifts to permit tank pressure to discharge through the vent valve. When the tank pressure decreases, the pilot closes, the dome volume re-pressurizes, and the main seat closes.

Operation of Pilot operated valve.



Operation of Pilot operated valve



Comparison of Direct acting and Pilot operated system.

Characteristic	Direct acting	Pilot operated
Seat Tightness	Leakage rate increase with increasing pressure. Leakage may begin at the 75% of set pressure.	Leakage will decrease with increasing pressure. No leakage above 30% of S.P. A small amount of leakage at pilot may begin at 90% of set pressure.
Capacity /Over pressure	Rated capacity normally obtained at 200% of Set for pressure or vacuum.	Rated capacity obtained at 110% of set for pressure or vacuum.
Set pressure range - Typical	Weight loaded Pressure = 2 to 69 mbarg. Vacuum= -2 to – 43 mbarg Spring Loaded Pressure= 69 mbarg to 1.034barg. Vacuum=-43 mbarg to – 0.48 barg.	Pressure--- 5 to 1.034 barg. Vacuum--- - 5 to 1.013 barg

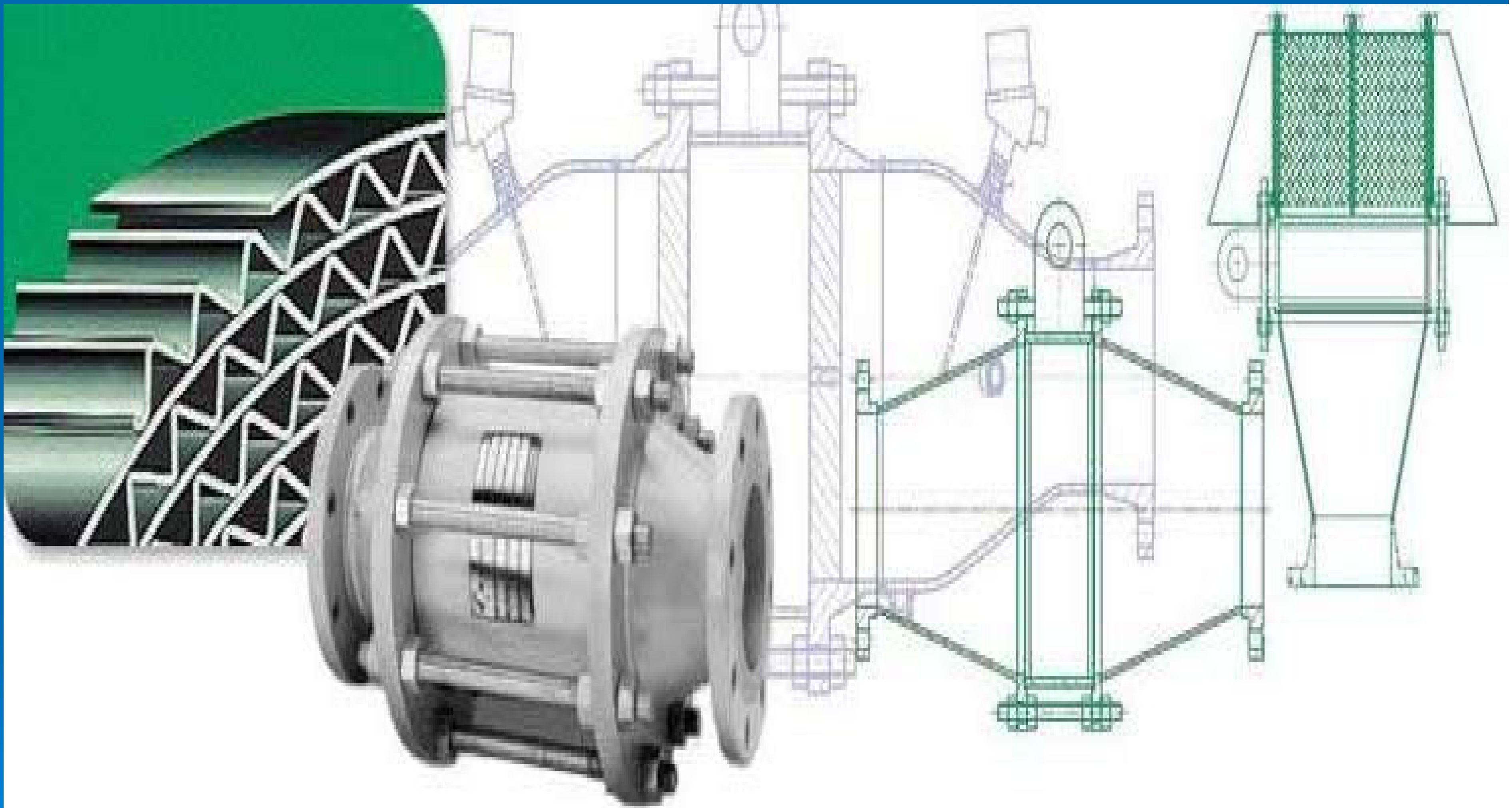
Flame arrestor

Synonymous to its name, flame arrestor can be termed as flame check valve. It's primary function is it's ability of arresting the propagation of flame front within the pipe and storage tanks in situation where a pre-mixed flammable explosive mixture flowing through the arrester matrix is ignited and stationary flame is established in the arrestor surface to function as a burner.

Flame Arrestor use

- Vent and vapour recovery, equalised headers of storage tanks and mobile tanks storing the flammable liquids.
- Vent boom of offshore platform.
- Gas pipelines, purge gas mains.
- Fuel gas line of boiler, waste gas burner, furnace, incinerator and gas turbines.
- Inlet and exhaust line of internal combustion engines, gas compressors.
- Loading and unloading lines of ship, road and rail tankers.
- Methane rich gas exhaust and other vent lines in mines.
- Ventilation shaft of enclosed shad where flammable gas or vapour is being handled.

Flame arrestor's construction details



Type of Flame arrestor

Type of Flame arrestor depends upon it service requirement ,available as:-

- Inline flame arrestor (Confined de-flagration).
- End of pipe flame arrestor (Un-confined de-flagration).
- Detonation arrestor (Arresting detonation).

Detonation arrestor has similar function as the both inline/end of pipe flame arrestor except <u>designed to withstand higher pressure and having capacity of quenching the detonation.</u> The flame arrestor is effective at near atmospheric pressure whereas higher pressure requires a detonation arrestor. If flashback occurs due to back- pressure, and the flame is allowed to settle on the arrestor element, a flame arrestor could fail because element is not designed for excessive burning.

De-flagration vs. Detonation

- ***De-flagration :- When reaction in combustion wave propagating at "Subsonic velocity" by the process of heat and diffusion, is called "De-flagration". If combustion wave propagated within a container with speed influenced by the container is called " Confined de-flagration". The Un-obstructed wave propagation is called "Unconfined de-flagration".***

  --- An arrestor is used to prevent the transmission of de-flagration is called as "De-flagration Arrestor" or " Flame arrestor".

---- Continue---

- ***<u>Detonation:-</u>*** ***When reaction in a combustion wave propagating at "Supersonic velocity" , it is called "Detonation". It can be "Stable detonation", if propagating wave velocity is equals to velocity of sound in the burnt gas.***

  --- An arrestor used to prevent the transmission of detonation (Explosion) is called " Detonation arrestor".

a) Inline Flame Arrestor

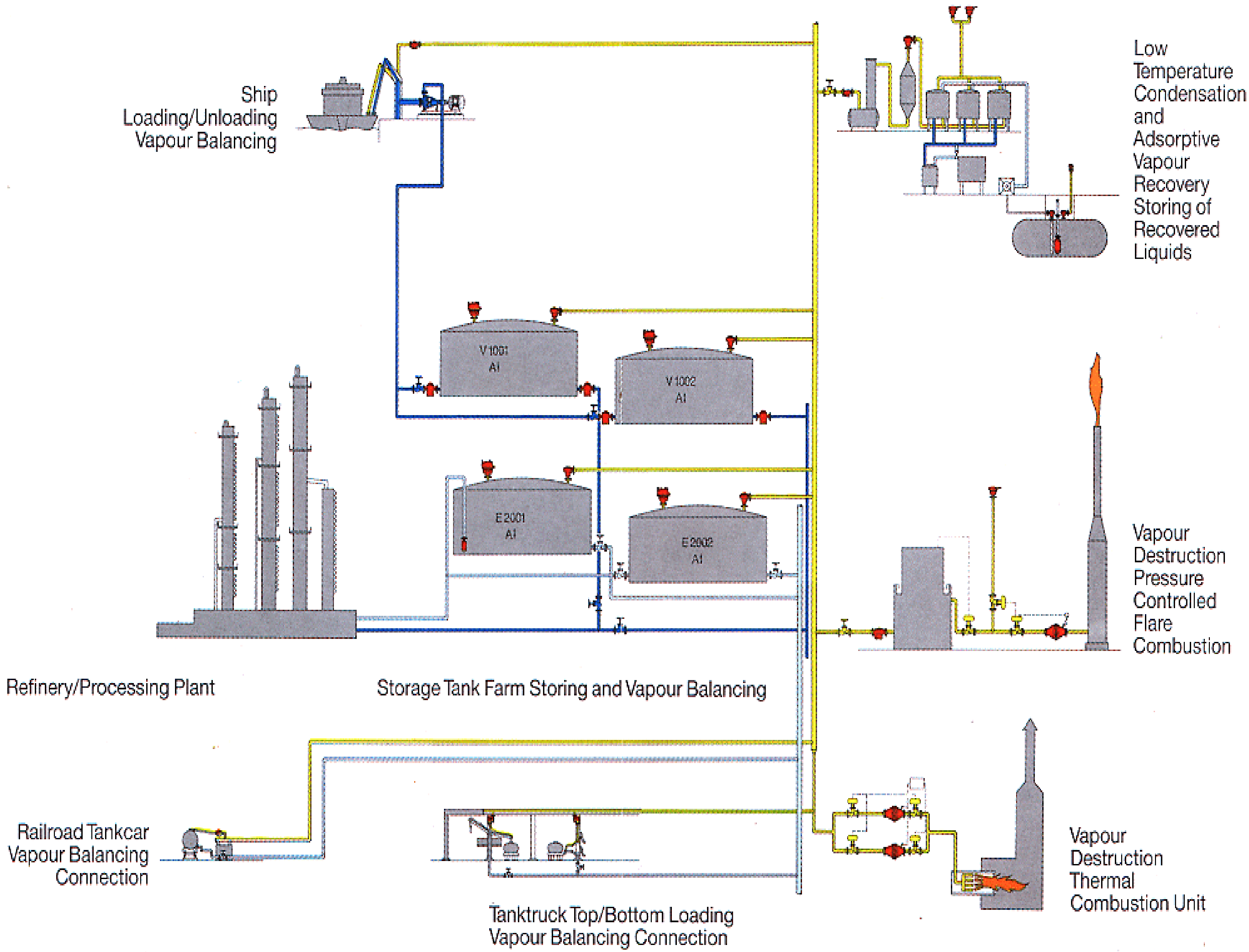
- This type of flame arrestor provides protection against "**Confined de-flagration**" and is used as in-line arrestor . It prevents the transmission of de-flagration along pipeline or duct where there is a length of pipe between the arrestor and the potential source of ignition. When there is more than one potential source of ignition in a piping network than, one of the following shall be recommended.
- Use of two or more de-flagration flame arrestors.
- Use of one arrestor, suitable for the maximum flame speed and pressure. This means use of detonation arrestor in place of de-flagration flame arrestor.
- The use of an arrestor equally effective in either direction.

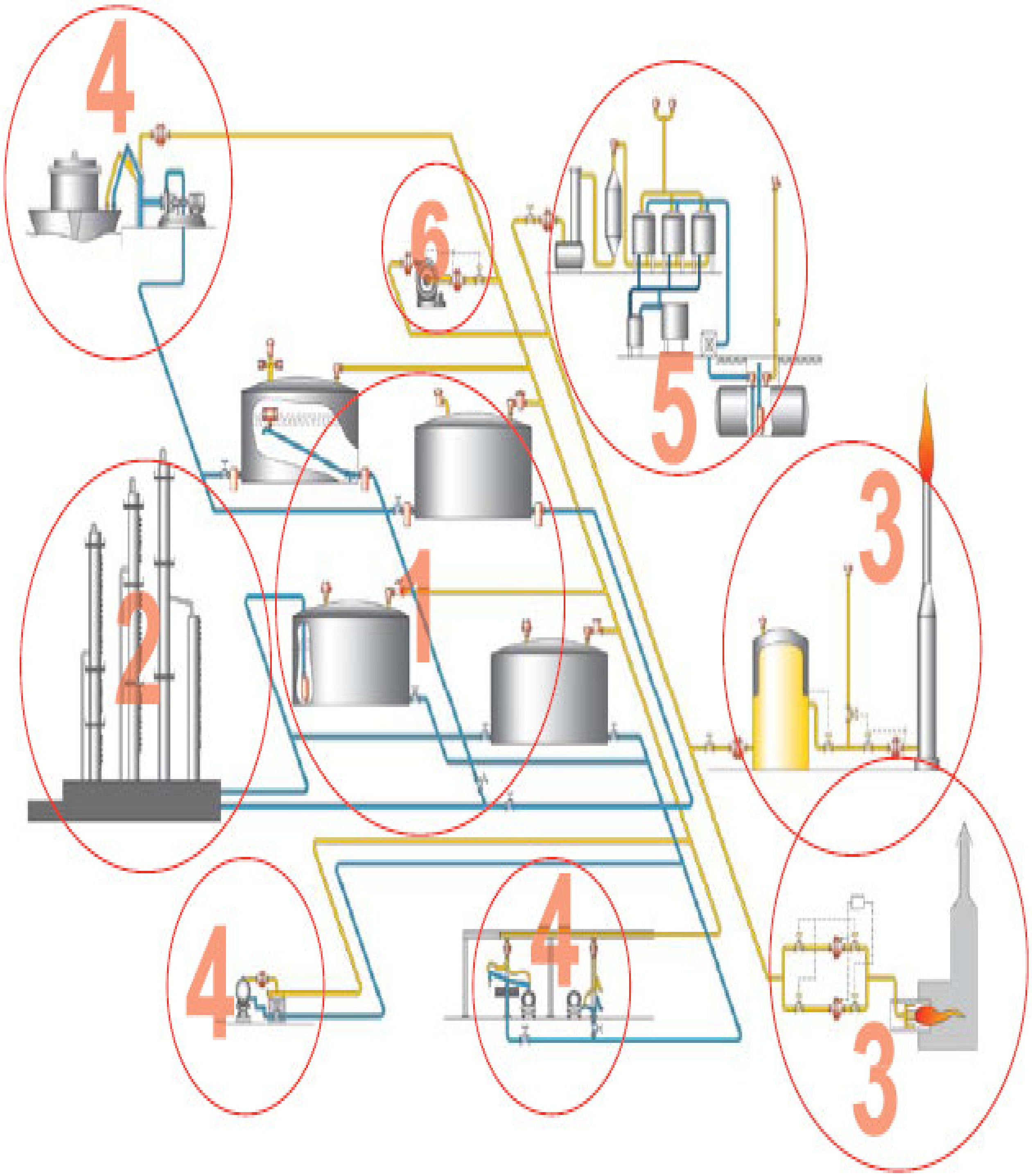
b) End of line flame arrestor

- This type of arrestor provides protection against "Unconfined de-flagration ", normally used at the end of line in vents to protect the process plants, storage or transportation vessels discharging the flammable material in the atmosphere. The flame arrestor prevents propagation of flame from atmosphere to the process plant or transportation vessel. The arrestor should be fitted at the end of pipe, there should not be any pipe piece between arrestor and atmosphere except the weather hood.

c) Detonation arrestor

- This type arrestor is used as in-line, to prevent the transmission of stable or over driven detonation .The detonation may be over driven with much higher pressure and flame speed than those associated with stable detonation. Although over driven detonations are unstable and decay to stable detonation. Detonation arrestors should be able to prevent their transmission.


Ship Loading/Unloading Vapour Balancing
Low Temperature Condensation and Adsorptive Vapour Recovery Storing of Recovered Liquids
V 1001 AI
V 1002 AI
E 2001 AI
E 2002 AI
Vapour Destruction Pressure Controlled Flare Combustion
Refinery/Processing Plant
Storage Tank Farm Storing and Vapour Balancing
Railroad Tankcar Vapour Balancing Connection
Tanktruck Top/Bottom Loading Vapour Balancing Connection
Vapour Destruction Thermal Combustion Unit



1.Storage tanks

2. Refinery complex.

3. Flare or incinerator

4. Compressors.

5. Vapour recovery

6. Ship unloading

Construction details

- The flame arrestor is made of casted body in which unique crimped metal element is housed. The crimped element stops an explosion and flame from spreading in the pipeline The element is manufactured using the crimping machine, comprises of a series of triangular passage or cells, height and length of which varied to suite the fluid properties and service requirement. To quench a flame and prevent the propagation of flame onward, it is essential to maintain the height of cells below the maximum experimental safe gap.

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(MESG) of gas/vapour handled. The depth of the element needs to be sufficient to ensure that the flame is quenched below its auto ignition temperature within the element before it leaves. Thus it avoids risk of re-ignition on the other side of the element is eliminated completely (The flame when enters the flame arrestor element, its temperature is progressively reduced so that the gas is cooled below the point of its auto ignition temperature thus avoids risk of re-ignition at outlet.).

Flame and Detonation arrestor grouping

- The flame and detonation arrestor groups are derived from BS-4683 part 2, BS- 5501 part 1 NEC 500, ISI-9570-1998 and NFPA 325 which classify the electrical apparatus for use in flammable atmosphere according to the "Maximum Experimental Safe Gap (MESG)" , "Maximum explosion pressure" and "Minimum ignition temperature" of the gases in the atmosphere. The flammable gases are divided in four groups, I, IIA, II B and II C based on above parameters.

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MESG (mm)	Gas group	Ignition energy (μ joules)
> = 0.9mm	IIA(Acetone, Methanol, C4H10, C6H14 etc)	> 180
0.9 to 0.5mm	IIB(C2H4, BD, EO, DEE, coke oven gas)	> 60 to 179
< 0.5mm	IIC (H2, C2H2, CS2)	>20 to 59

- ***Group I covers applications in coal mines gases.***
- ***Group II A covers common petroleum gases e.g. methane, ethane, propane, ammonia, Acetone and acetates etc.***
- ***Group II B covers more reactive gases and vapours like, ethylene, butadiene, ethylene oxide, ethers, formaldehyde, para-formaldehyde and tetra fluro- ethylene etc.***

For same pipe diameter and length , group II B gases give higher speed than group II A.

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- ***Group II C covers most reactive gases such as hydrogen, carbon disulphide, acetylene etc. For same pipe diameter and length group II C gases give higher speed than group II B.***

- ***Hydrogen at the specified proportion in the air gives the highest flame speed from group II C gases and similarly propane for group II A.***

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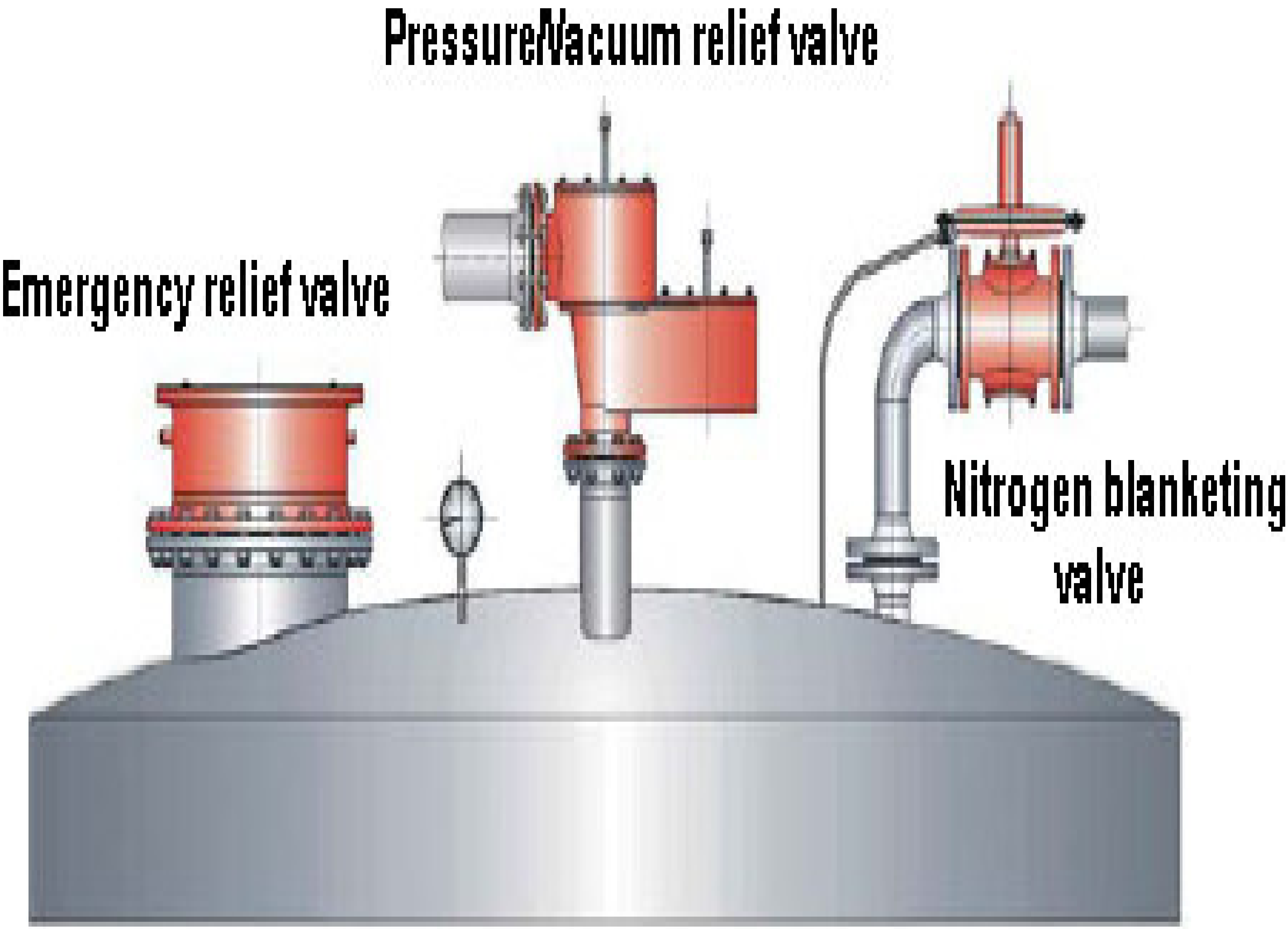
- ***For given diameter and length of pipe group II C arrestor can be used with any gas, II B arrestor can be used with group II A .***
- ***The size of passage within the element is relating to the quenching diameter (Diameter of the largest circular aperture which prevents flashback of flame in a pre-mixed and stationary gas mixture at a given temperature and pressure). The channels in group IIC arrestors are smaller than those in group II B which is turn is smaller than those of in group II A. Smaller is the size higher is the pressure drop for same volumetric flow rate.***


Pressure/Vacuum relief valve
Emergency relief valve
Nitrogen blanketing valve

Tanks grouping and containment dyke

- ***Tank Grouping (OISD-118):***

  i) Class A and B petroleum products can be stored in the same dyke but preferentially Class C shall be stored in separate dyke.

  ii) Tanks shall be arranged maximum in two rows in dyke, each tank shall be approachable from road. But the tanks of 50,000 M3 of bigger shall be lay out in single row.

- ***Containment dyke(OISD-118):***

  i) Group of petroleum tanks shall be located inside the dyke enclosed with road all around for fire tender movement.

  Aggregate capacity of one dyke shall not exceed

  a) 60,000 M3 for Fixed roof tanks

  b) 120,000 M3 for floating roof tanks

1) *Fixed cum floating roof tanks shall be considered as Fixed roof tank for dyke capacity.*

2) *If group of tanks contains both fixed and floating roof tanks than consider all as fixed roof.*

Dyke capacity(OISD-116):

_1) *Dyke capacity should be able to contain full capacity of largest tank in the dyke in case of emergency. The enclosure capacity is calculated after deducting volume of other tanks pads in dyke up to the height of dyke enclosure*

2) *Height of dyke shall be at least 1 .0M and not to exceed 2 M above average inside dyke grade level.*

3) *Conventionally tank height shall be 1.5 times of diameter but maximum height is limited to 20 M.*

Central Pollution Control Board

- In order to control Air pollution following norms are to be strictly adhere in storage area:

1) All types of petroleum storage tanks where petroleum content TVP is more than 11 psia and capacity is more than 500 M3, vapor control system is mandatory.

2) For Storage of Benzene : Followings should be followed .
   a) Fixed roof tank with vapor to incineration with 99.9% of removal efficiency for volatile organic compounds (VOC).
   b) Internal/External floating roof tanks with double seals, emission-reducing roof fitting and fitted with fixed roof with vapor removal efficiency of at least 99%.

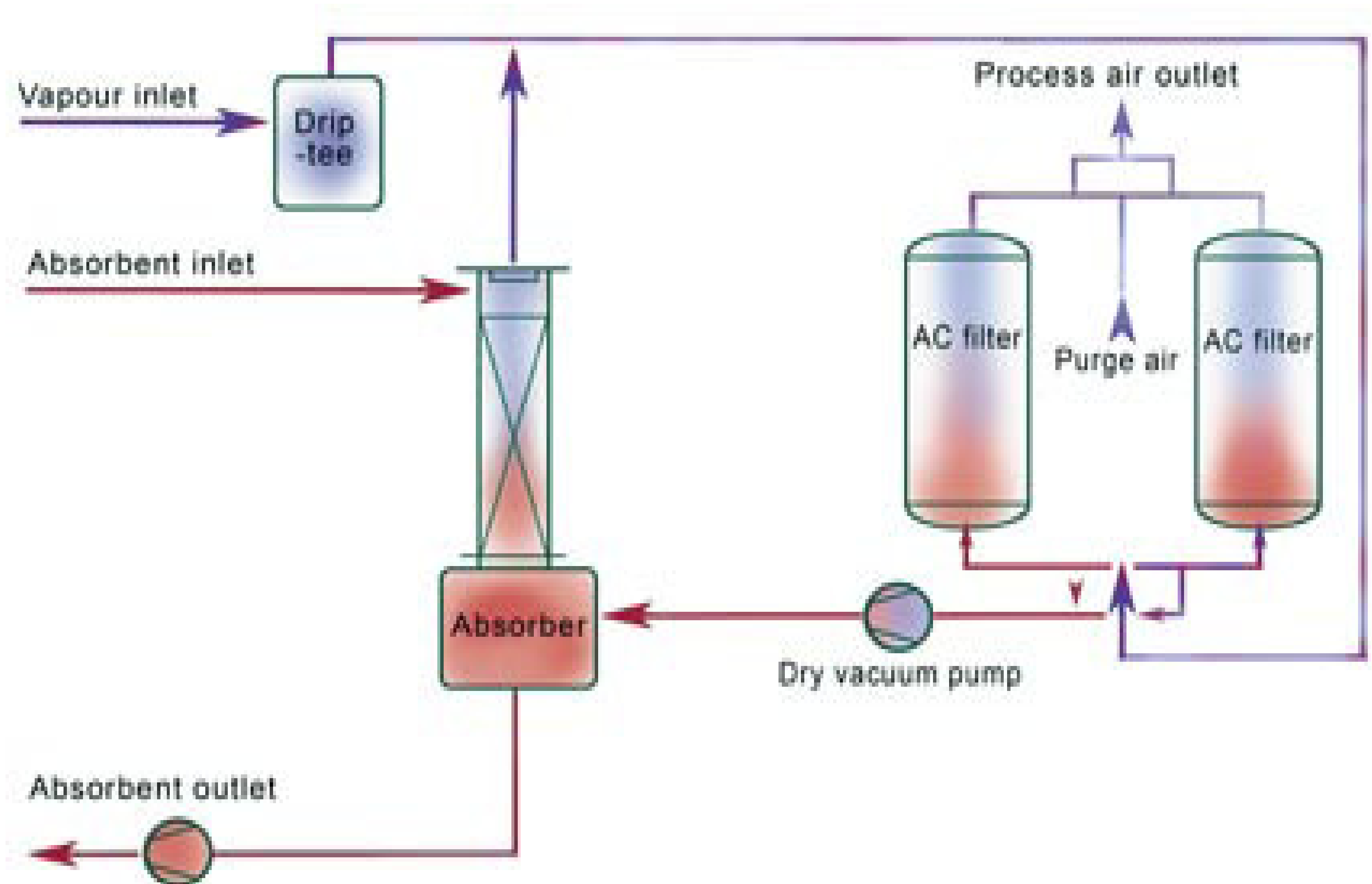
3) Storage of solvents for lube-base oil production (Furfural, NMP, MEK, Toluene)
   a) Internal floating roof tank with double seals and inert gas blanketing with vapor removal efficiency of at least 97%.

Vapour control system

1) Carbon adsorption:

The tank vapour are passed through a dual bed of granular carbon. H/C is adsorbed and bed is regenerated by pulling a vacuum. (using a liquid ring pump) and flushing it with air in reverse direction. The H/C liberated during the regeneration is absorbed into gasoline stream from storage in absorption column or are condensed by refrigeration.

Carbon Adsorption



2) Cryogenic Condensation.

The tank vapours are condensed at very low temperature { Around (–)90 °C }using liquid N2 }using a cold heat exchange medium. The condensed product can be pumped straight to storage and the amount of recovered product can thus be measured very easily.

3) Membrane Separation.

Hydrocarbon-selective membranes are used to separate the incoming vapours from the air. The necessary pressure differential across the membranes is created by compressing the incoming vapours with a compressor and/or pulling a vacuum at the other side with a vacuum pump. The concentrated gasoline vapours are recovered by passing them counter current to a gasoline stream from storage in a absorber column.

4)Vapour Incineration :

Tank vapours are routed to incinerator destroying H/C .

Competing Technologies

Technology	Capital cost	Operation cost	Safety	Recovery
Carbon Adsorption	Moderate to High	High	Low	High
Cryogenic Condensation	Moderate to High	Moderate	Moderate to High	Moderate
Membrane separation	Moderate	Low	High	High
Vapour Incineration	Moderate to High	High	Low	No

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