

Tikrit University

The College of Petroleum Processes Engineering

Petroleum Systems Control Engineering

Department

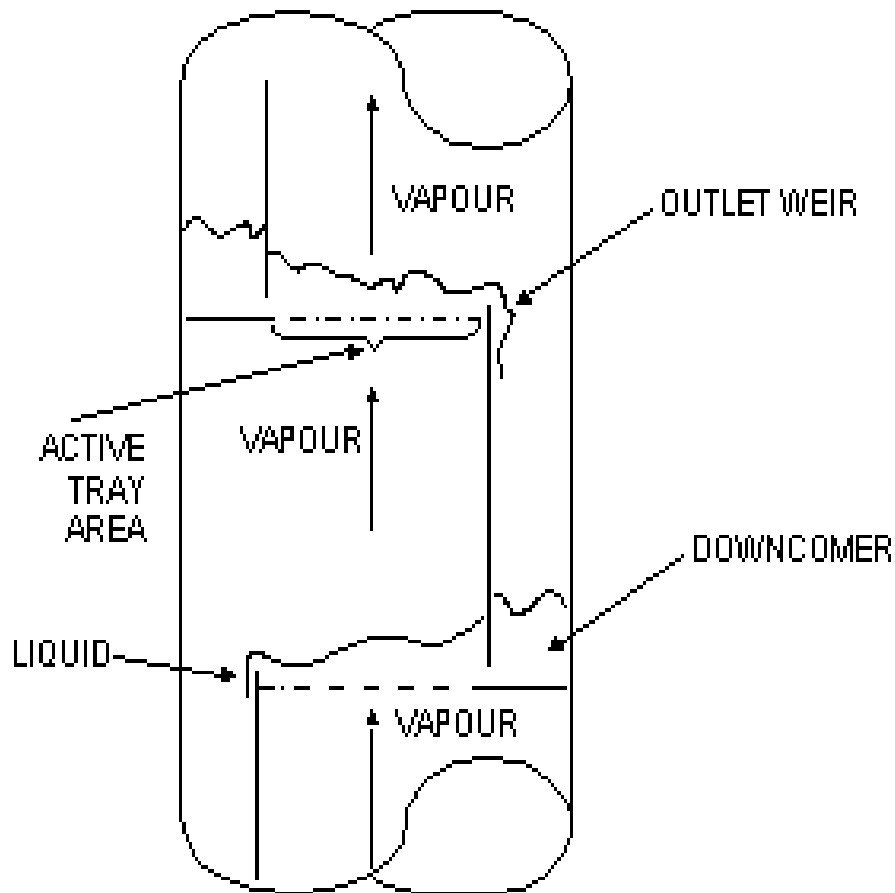
Petroleum Refining Processes

Fourth Class

Lecture 8

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Liquid vapor flow in a tray column



- ✚ Each tray has 2 conduits, one on each side, called 'downcomers'.
- ✚ Liquid falls through the downcomers by gravity from one tray to the one below it.
- ✚ A weir on the tray ensures that there is always some liquid (holdup) on the tray at a suitable height, e.g. such that the bubble caps are covered by liquid.
- ✚ Vapour flows up the column and is forced to pass through the liquid, via the openings on each tray.
- ✚ The area allowed for the passage of vapour on each tray is called the active tray area.

Reflux (heat removal) is provided throughout the tower by:

- ✚ Condensing the tower overhead vapors and returning a portion of the liquid to the top of the tower as a reflux (external reflux).
- ✚ Withdrawing a liquid stream from some intermediate location in the enriching section of the tower, cooling it, then returning it back to the tower a couple of trays above (this is called pumparound) this provides an internal reflux within the tower.
- ✚ Part of the condensate (the naphtha and the water) collected in the O/H accumulator is returned to the top of the tower as external reflux, and the remainder is sent to the stabilizer section of the crude unit (or the refinery gas plant).
- ✚ The reflux (being at a lower temperature) controls the temperature of the top of the tower thus the quality (end point) of the O/H product.

O/H Condensing System:

- ✚ The fractionators O/H vapors (usually consisting of gas, un-stabilized naphtha and the stripping steam).
- ✚ The pentane and heavier fraction (C5+) is condensed in the overhead cooling system.
- ✚ The butane and lighter (C4-) remain in the gas phase.
- ✚ Ammonia solution is injected to crude column vapor line and on top tray to control acids formed by hydrolysis of the salt present (e.g. $\text{Na}^+\text{Cl}^- + \text{H}_2\text{O} \rightarrow \text{HCl} + \text{NaOH}$).
- ✚ Corrosion inhibitor is also added to prevent corrosion due to HCl and H₂S present.

Atmospheric Residue Section (bottom section)

Several trays are generally incorporated below the flash zone section and steam is introduced below the bottom tray to:

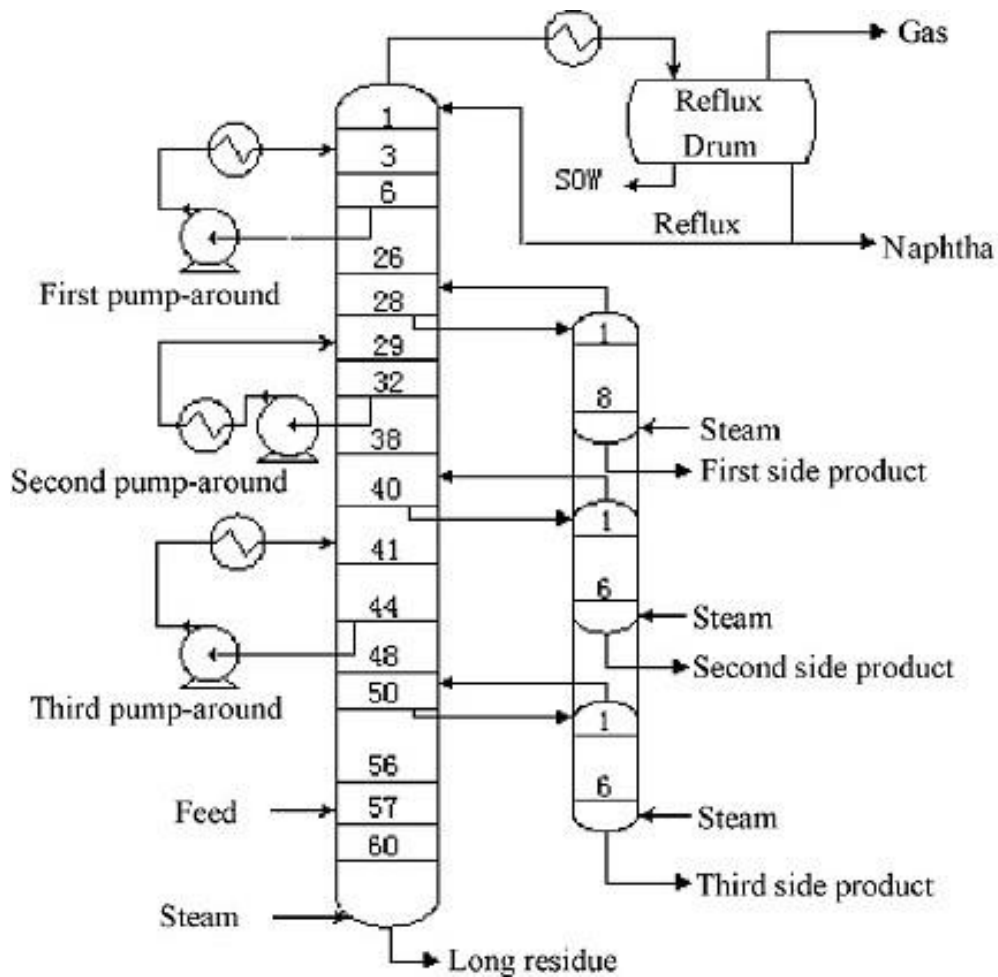
- ✚ Lower the partial pressure and, thus, the boiling point of the residue to avoid thermal cracking and degradation of the bottom product (Thermal cracking produces coke, which tends to block heat exchangers and other equipment resulting in poor heat transfer and lower efficiencies).
- ✚ Strip any remaining gas oil (more valuable) from the liquid in the flash zone (residue).
- ✚ Produce high-flash-point bottoms (by stripping the low boiling point material).

Stripping Stream

- ✚ Crude towers do not normally use reboilers because of the tendency of the residue to crack at high temperatures clogging the heat exchanger.
- ✚ Superheated steam is used instead to reduce the partial pressure of the hydrocarbon and thus lower the required vaporization temperature.

Side Draw Stripper (stripping the light ends)

- ✚ The liquid side stream withdrawn from the tower will contain low-boiling components, which lower the flash point of the product. (Because the lighter products in the vapor phase pass through the heavy products in the liquid phase and the two are in equilibrium on every tray).
- ✚ These 'light ends' are stripped from each side stream in a separate side-strippers.
- ✚ Side strippers is used to remove light ends from the product stream thus improving (increasing) their flash points & initial boiling point IBP.
 - Side strippers could be either **separated nor mounted side strippers**.



Three side strippers mounted on each other

- ✚ The strip-out /light ends (along with the stripping steam) leave the stripper at the top and enters the fractionator in the vapor zone directly above the tray of the side draw.
 - ✚ The stripped products withdraw from the bottom of each stripper.
- Products Draw (side streams)
- ✚ Kerosene product is drawn from kerosene tray and is introduced to the top tray of Kerosene stripper.
 - ✚ Diesel (light gasoil) product is drawn from light gasoil tray and is introduced to the top tray of diesel stripper.

- ✚ Each of the side stream products removed from the tower decrease the amount of liquid traffic below the point of draw-off.
- ✚ Increasing the amount of kerosene withdrawal, will result in a decrease in the amount of liquid going down through the tower.

This will lead to less condensation of vapors going up and more of the diesel cut will rise up and go into kerosene (↑FBP). ✚

The opposite is also true.

- ✚ The over flash is a liquid drawn from tray (above the flash zone) and returned to tray (below the flash zone).
- ✚ The over flash (which is 5 vol. % of the crude) helps to remove the heavy material from the diesel product and improves the fractionation (separation) between the diesel and the atmospheric residue cuts.