DESIGN OF ATMOSPHERIC CRUDE DISTILLATION COLUMN

CONTENT

- Introduction
- Factors affecting design of the atmospheric distillation column
- Calculation procedure
- Tower conditions

FACTORS AFFECTING THE DESIGN

1. Nature of crude
2. (a) Flash zone condition – The temperature and pressure at the flash zone

   (b) Overflash – The vaporization of crude over and above the overhead and side-stream products[kept in the range of 3-6 LV%(liquid volume) on crude]

   (c) Bottom stripping steam – Used to recover the light component from the bottom liquid.(normal rates are 12-24 kg/m^3 of column bottom)

   (d) Fractionation – It is the difference between the 5% point on ASTM curve of heavy cut and 95% point on the ASTM curve of light cut of two adjacent side products cuts.

CALCULATION PROCEDURE

1. Obtain a design basis

    (a) Feed rate and service factor

    (b) Cut range

    (c) The complete crude assay must be obtained

2. Prepare distillation and flash vaporization curves

    (a) Plot EFV curves using Edmister, Maxwell and computer methods

    (b) Construct TBP curves for the products using TBP curve of the crude

3. Prepare tables of physical properties and material

4. Ideal fractionation

- It is the difference between 5% and 95 % points on ASTM curve obtained from the ideal TBP curves of heavier and lighter cuts.
- Positive difference is called a gap and a negative difference is called an overlap.
- In case of side steam stripped, 50% of the deviation is added to 95% points of lighter cuts and subtract 50% of the deviation from the heavier cut.
- Then corrected ASTM curves are converted into EFV curves.
- The deviation can be corrected with a factor ‘F’(product of number of trays between the two adjacent side-draw off streams and the internal reflux ratio.
- With this the number of fractionating trays are determined.

5.Flash zone conditions

- At max. cooling water temperature the bubble pressure product(reflux drum pressure) is calculated.
- Then the flash zone pressure =(Reflux drum pressure + condenser + overhead line and pressure drop in trays).
- The bottom stripping steam quantity and overflash are f the flash zone temperature.
- If ΣS is the sum of LV% of all the distillate streams, then vaporization in the flash zone is–

$$V1 = \sum S + OF - ST$$

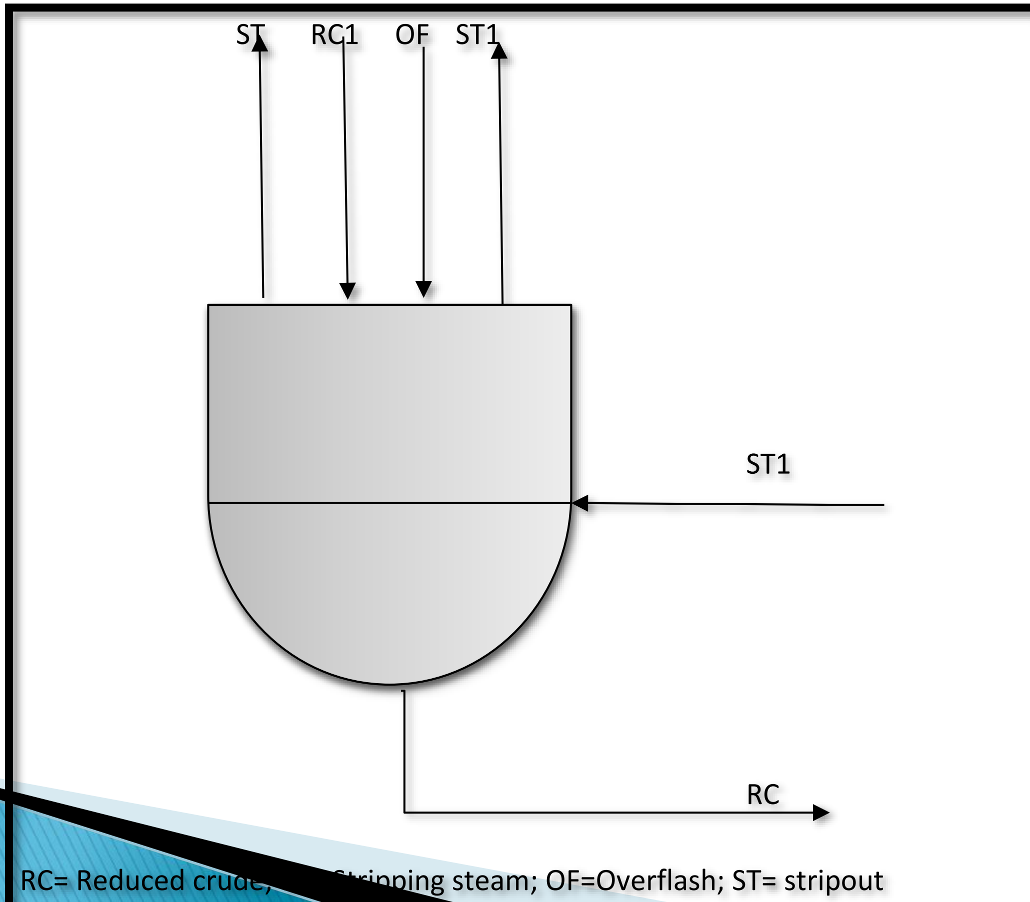
Where OF = overflash LV%

ST = strip out

- From the flash curve of the crude, the temperature at wh achieved is found at the flash zone pressure.
- The temperature should be less then max. permissible t zone.
- If it does exceed, the quantities of the overflash and the are changed un permissible temperature is obtained

Tower conditions

- Tower bottom temperature – To find the tower bottom temperature apply heat and material balance in the following figure



$$RC_1 = RC + ST - OF$$

IN

Stream	State	Temperature, °C	Kg/h	Kcal/kg	Kcal/h
RC1	L	t_f	RC_1	h_{RC1}	H_{RC1}
OF	L	$t_f - 5$	OF	h_{OF}	H_{OF}
Steam	V	t_S	ST_1	h_S	H_S
Total					$H_{RC1} + H_{OF} + Hs$

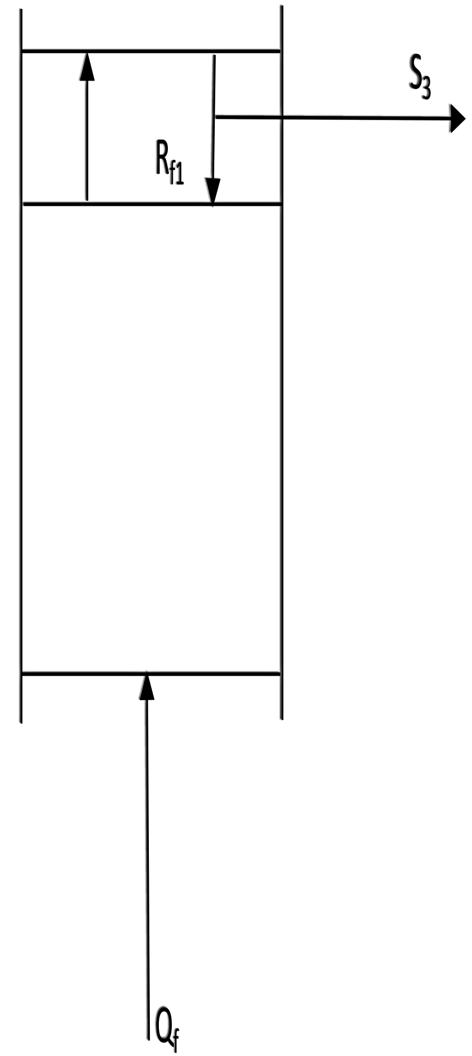
OUT

Stream	State	Temperature, °C	Kg/h	Kcal/kg	Kcal/h
RC	L	t_x	RC	h_{RC}	H_x
ST	V	$t_f - 5$	ST	h_{ST}	H_{ST}
Steam	V	$t_f - 5$	ST_1	h_{ST1}	H_{ST1}
Total					$H_x + H_{ST} + H_{ST1}$

- By equating heat in and heat out, value of Hx and h_{RC} can be found.
- Temperature t_x corresponding to an enthalpy of h_{RC} is found with the help of enthalpy curve for reduced crude.

Net heat up the flash zone

Stream	State	Temperature, °C	Kg/h	kcal./kg	Kcal/h
S_1	V	t_f	S_1	h_1	H_1
S_2	V	t_f	S_2	h_2	H_2
RV	V	t_f	RV	h_3	H_3
ST	V	$t_f - 5$	ST	h_{ST}	H_{ST}
Steam	V	$t_f - 5$	ST_1	h_{ST1}	H_{ST1}
Total	$HT_2 = H_1 + H_2 + H_3 + H_{ST} + H_{ST1}$				
					OUT
OF	L	$t_f - 5$	OF	h_{OF}	H_{OF}



Net heat up flash zone; $Q_f = HT_2 - H_{OF}$

- Now for the draw-off temperature of the first slide stream
- Assume the draw off tray be *n.*

temperature of vapour to tray n = t_{v1}

temperature of liquid leaving tray n = t_{L1}

$$= t_{v1} - \frac{1}{2}(100\%\ point\ on\ EFV - \ 0\%\ point$$

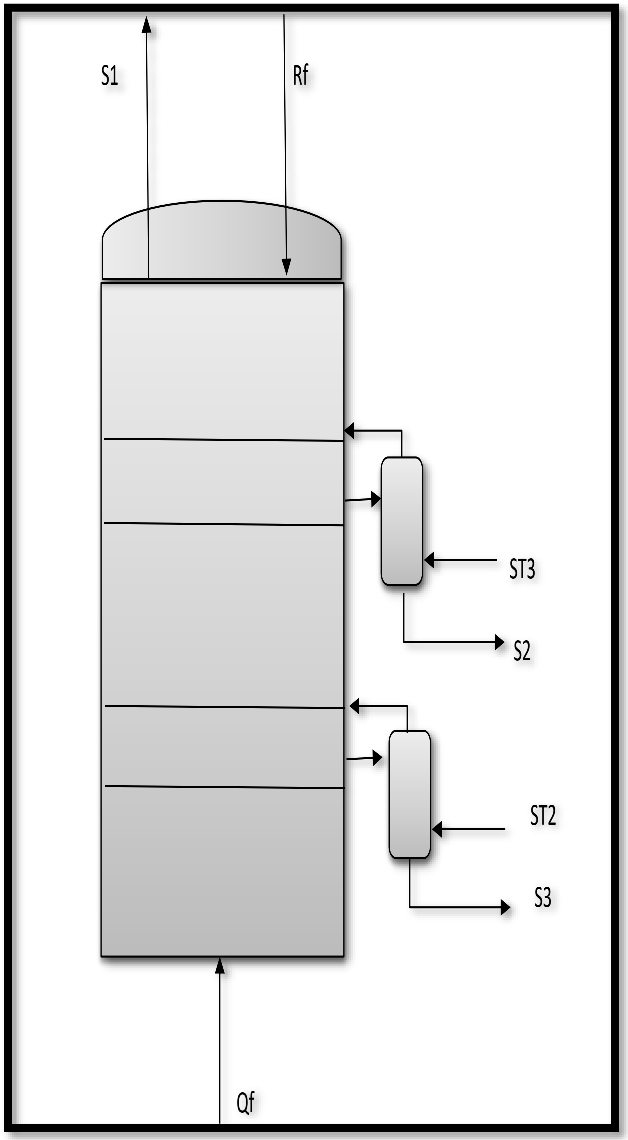
- Applying heat and material balance around the section and ca
  by equating heat in , heat out.
- Then calculate the partial pressure of the side stream by the f
- Partial pressure of side stream = $\text{Total pressure} \times \frac{Moles}{Moles\ of\ S1, S2\ \&\ S3}$
- Find 40% point on the EFV curve of the side stream S_3 at this
  difference.
- Add this difference to 100% point on EFV to get t_{v1}.
- If this value is not within ±3°C of the assumed value of t_{v1} , re
  with a new assumed value of t_{v1}.

Recovery of the heat

- To recover the max. heat and to have uniform vapour and liquid loads in the column, intermediate refluxes are withdrawn.
- They exchange heat with cold streams and returned to the column.
- And 80% of the heat available for removal by internal reflux can be removed by circulating reflux.
- The calculations for the other side draw-off temperature are done in the similar fashion.

Column overhead temperature

- The tower top temperature must be equal the dew point of the overhead vapour.
- This corresponds to the 100% point temperature on the EFV curve of the top product at its partial pressure calculated at the top tray.



- Assuming top temperature to be t_1 and fixing the reflux drum temperature at t_d.

IN

Stream	State	Temperature, °C	Kg/h	Kcal/kg	Kcal/h
Qnet					Q_f
Reflux R_f	L	t_d	R_f	h_{RF}	H_{Rf}
Steam	V	t_s	$ST_2 + ST_3$	h_{ST}	H_{ST}
Total					$Q_f + H_{Rf} + H_{ST}$

OUT

S_1	V	t_{S1}	S_1	h_{S1}	H_{S1}
S_2	L	t_{S2}	S_2	h_{S2}	H_{S2}
S_3	L	t_{S3}	S_3	h_{S3}	H_{S3}
Steam	V	t_1	$ST_1 + ST_2 + ST_3$	h_{St1}	H_{St1}
R_f	L	t_1	R_f	H_{RF1}	H_{RF1}
Total					$H_{S1} + H_{S2} + H_{S3} + H_{St1} + H_{RF1}$

- Find R_f by equating heat in and heat out.
- Partial pressure in hydrocarbons =

$$\frac{Moles\ of\ S1 + Moles\ of\ Rf}{Moles\ of\ S1 + Moles\ of\ Rf + Moles\ of\ steam} \times \text{T}$$

- Now finding the 100% on the EFV curve of the top pro pressure and see if it is within ±3°C assumed temper
- If it is not so then repeat the calculation for a new as
- Knowing the column overhead conditions and the ref the condenser load can be calculated by difference.

CONTENT

1) Types of the fired heaters.
2) Important component of the fired heaters.
3) Operation and Maintenance of fired heaters.
4) Design aspects of the process fired heaters.

1) Types of the fired heaters:-

a) Helical coil heater

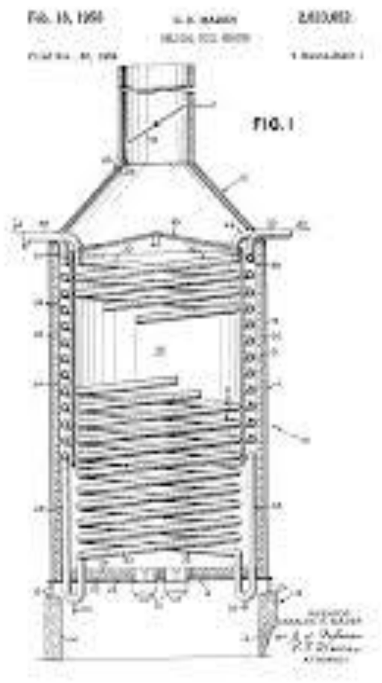
b) Cylindrical heater

c) Box heater and Twin-cell heater

d) Terrace wall reformer and Multizone pyrolysis furnace

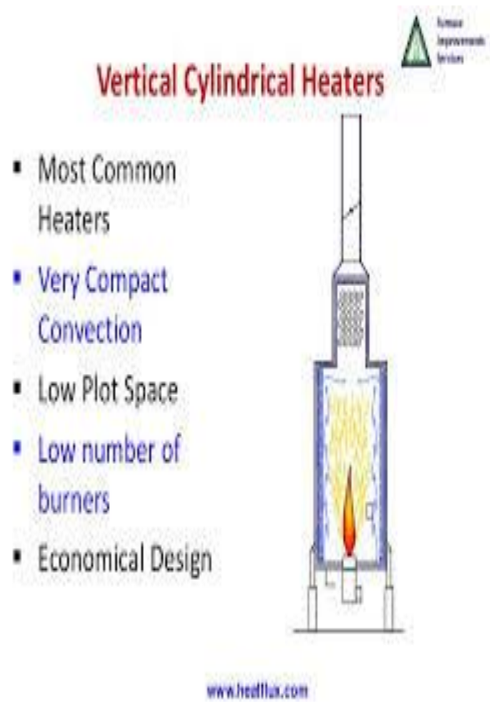
a) Helical coil heater:-

- In this heater the heat absorbing surface is arranged in the form of a helical coil.
- It is less expensive design and favoured for the small heat duty.



b) Vertical cylindrical heater:-

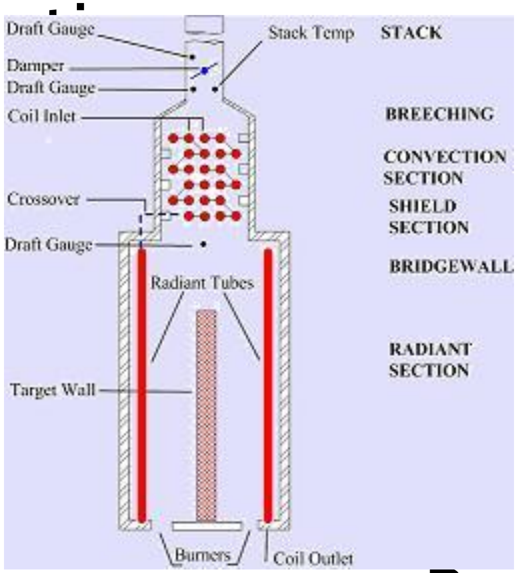
- These heaters occupy less plot space,do not require any tube pulling-out area for radiant tubes and less expensive.
- They are widely used and are favoured for the heat duty upto 35MW.

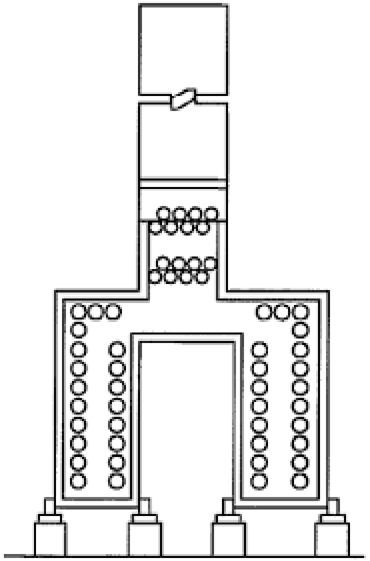


c) Box heater AND Twin-cell heater:-

In box heater, the radiant tubes are arranged either vertically or horizontally along the side of the fire-fox.

And in Twin- cell can be considered as two box heaters with a common convection se





Box-heater

Twin-cell heater

d)Terrace wall reformer and Multizone pyrolysis furnace

Terrace wall reformer provide the uniform heat and it's teperature upto 1100 C with 30 atm.

Multizone pyrolysis furnace are high temperature reaction furnace wherein ethane,naptha,Kerosene etc.are cracked to yield ethylene and olefins.

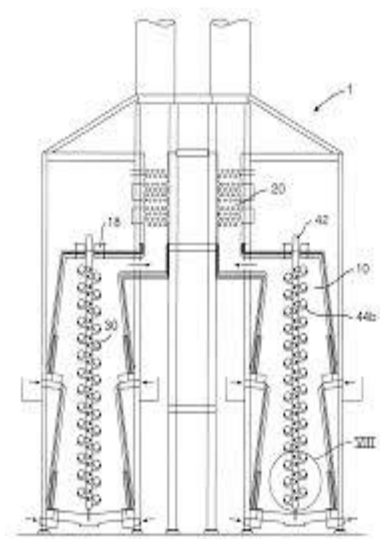


FIG. 7

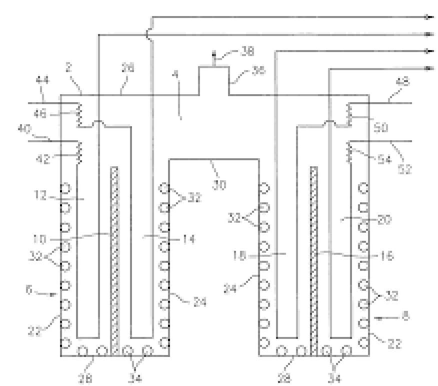


FIG. 1

Terrace wall reformer

Multizone pyrolysis furnace

2) Important component of the fired heaters:-

1) Tube/pipes
2) End fittings
3) Manifolds
4) Flanges
5) Extended surface elements
6) Tube support,guides and tube sheetes
7) Burner
8) Soot blower
9) Refractory
10) Stack and ducts
11) Structural members
12) instrumentation

3) Operation and Maintenance of fired heaters:-

1) Firing conditions
2) Draft
3) Flow
4) Snuffing steam
5) Decoking
6) Soot blowing
7) Maintenance of heaters

THANK YOU