# LITTLE FLOWER COLLEGE
# DEPARTMENT OF CHEMISTRY

## TOPIC : COKE FORMATION ON CATALYST

PRESENTED BY

ROSE THERESA M

# ➢FOULING / COKING

- Physical deposition of species from the fluid phase onto the catalyst surface is fouling.
- Fouling of catalyst due to carbon deposition is coking .
- Coking is a high severity thermal cracking operation intended for continuous conversion of heavy low-grade residual oils like crude, vacuum residue , tars , pitches into more valuable lighter products like gases , naphtha , gas oil , fuel , and coke.
- Gas oil is major product obtained and used as feedstock for catalytic cracking unit.

- The coke obtained may be used as fuel , for electrode manufacture or for production of chemicals.

- Coke may contain
  - Soot , produced in gas phase ( non – catalytic carbon)
  - Ordered or disordered carbon , produced on an inert surface (surface carbon)
  - Condensed high molecular weight aromatic compounds which may be liquid or solid(tar).

Coking processes are of two types :

1. delayed coking
2. fluid coking

# Delayed coking

- It is semi continuous type of coking.
- In this heated charge is transferred to large soaking drums where a long residence time is provided to complete the cracking reaction.
- Here the feedstock is atmospheric residuum.
- It is introduced to the fractionator and heated
- The lighter products are removed from the side
- The remaining bottom products along with the recycle stream from the coking drum, are shifted to furnace where they are further heated to a temperature of 480 to 515 C

• From the furnance the heated materials are transferred to one of the pair of coking and soaking drums where the cracking reaction continue.

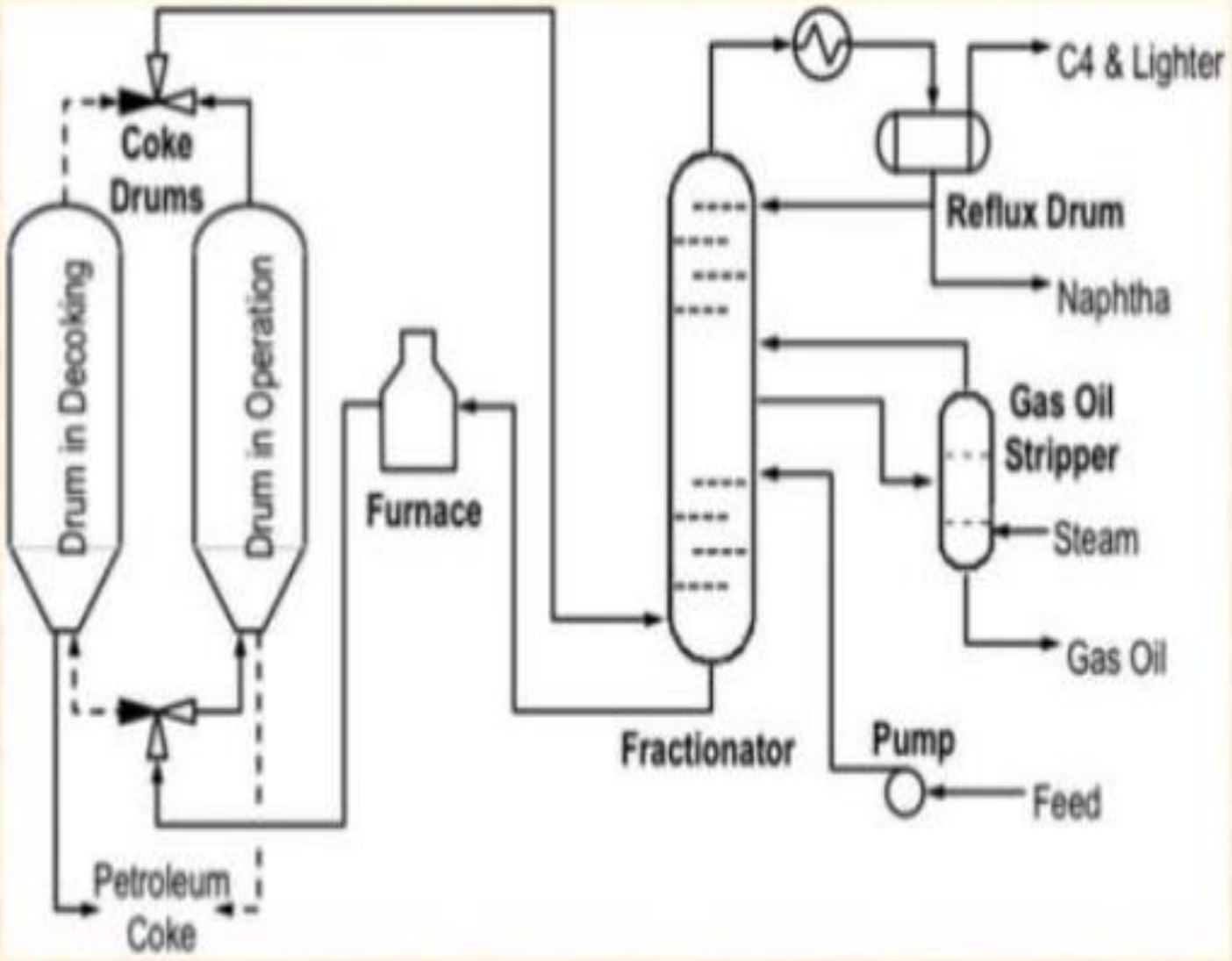
- The cracked products go to the fractionator where gas, naphtha , and gas oil is removed and coke deposited on the inner surface of drum.

- To continue operation two drums are used.

- When one is in use and other is being cleaned

- The temperature in coke drum ranges from 415 to 450 C and drum pressure varies from 1atm to 7 atm.

# Delayed coking



# Fluid coking

- It is a continuous process.
- In this pitch is sprayed into a fluidized bed of hot coke particles . The use of a fluidized bed requires shorter contact time than delayed coking and coking reactions are carried out at higher temperature.
- The yield of coke is less but yield of other liquid products are more.
- In this process two vessels are used :
  - Reactor
  - burner

•By burning the coke , heat is generated and it is transferred to reactor .

- In the reactor , coke particles remain present in fluidized form.

- At the bottom of reactor , steam is introduced to keep the bed fluidized.

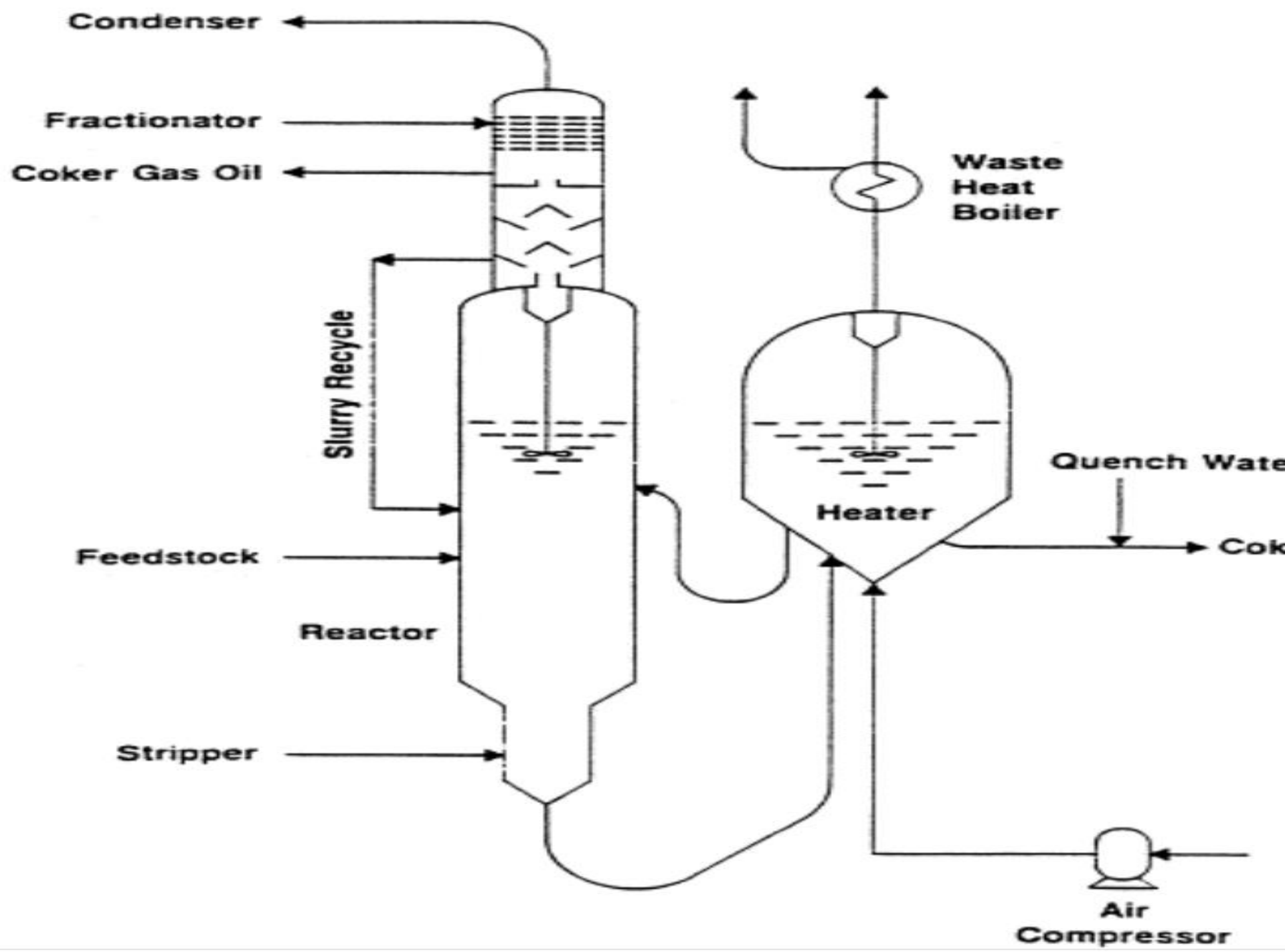
- The pitch coming from bottom of vacuum tower , at around 260 to 370 C is injected directly into the reactor.

•The temperature in reactor is 480- 570 and pressure is atmospheric .

- At these condition , the incoming feed is partly vaporised and partly deposited on fluidized coke particles.

- Since heat is supplied by circulating coke particles no further pre heat arrangement is required for the feed.

- The temperature in bed of burner varies from 590 – 650 . The pressure in burner varies from 1.34 to 2.7 atmosphere.


Condenser
Fractionator
Coker Gas Oil
Waste
Heat
Boiler
Slurry Recycle
Heater
Quench Wate
Feedstock
Cok
Reactor
Stripper
Air
Compressor

# Coke formation classification

- Coke sensitive reaction –unreactive coke is deposited on the active sites leading activity decline.
- Eg: catalytic cracking and hydrogenolysis.
- Coke insensitive reaction – relatively reactive coke precursors formed on active sites are readily removed by hydrogen .
- Eg: Fischer –tropsch synthesis , catalytic reforming and methanol synthesis

# Coke formation on supported metal catalysts

- Carbon may chemisorb strongly as monolayer or physically adsorb in multilayer and in either case blocks access of reactant on metal surface.
- Totally encapsulate a metal particle and thereby completely deactivate that particle .
- Plug micro or meso pores such that access of reactant is denied to many crystallites inside these pores.
- In extreme cases strong carbon filament is build in pores , causing the disintegration of catalyst pellets

# PREVENTIONS

- Avoid coke precursors
- Add gasifying agents (e.g. $H_2$, $H_2O$)
- Incorporate catalyst additives to increase rate of gasification (eg. In steam reforming. MgO, $K_2O$, $U_3O_8$, promote the gasification of carbon by facilitating $H_2O$ adsorption.
- Decrease acidity of oxide or sulfide
- Use shape selective molecular sieves
- Control on temperature

# THANK YOU