Thermal Cracking Processes Coking

Other Types of Coking

Lecture 13

Fluid Coking

- The vacuum residue is converted to valuable products as naphtha, diesel and coker gas oil.
- Fluid catalytic crackers use catalysts to aid cracking and here cracking and coking are catalyzed by coke particles.
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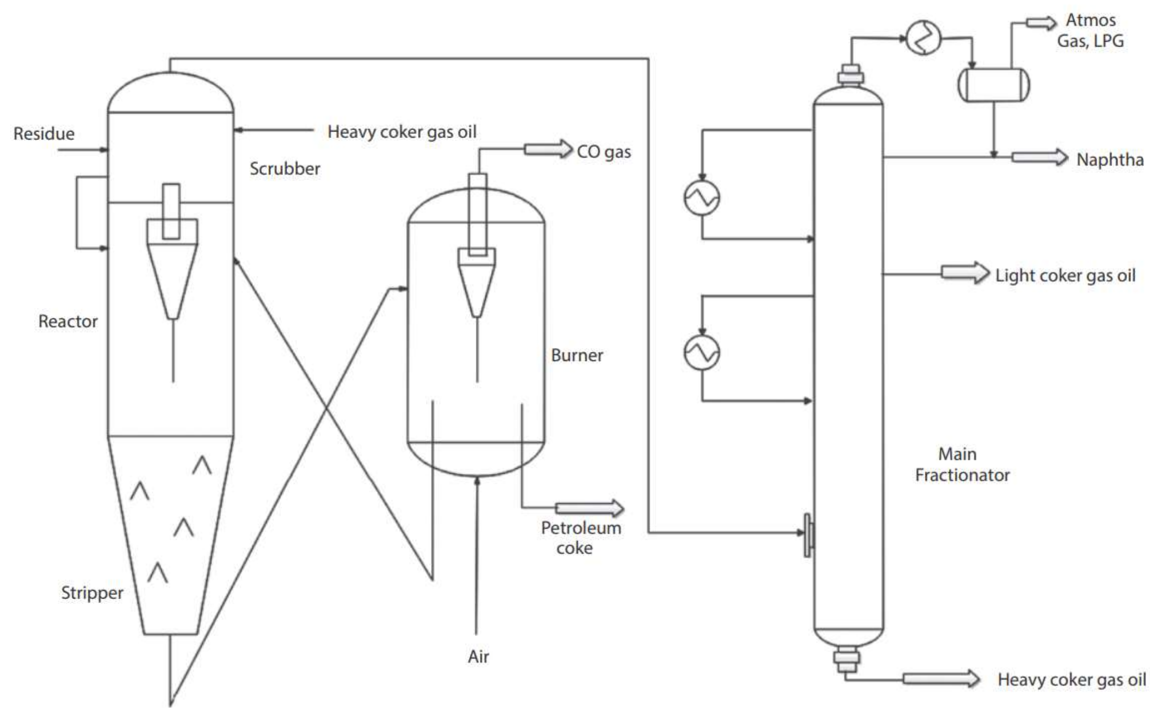


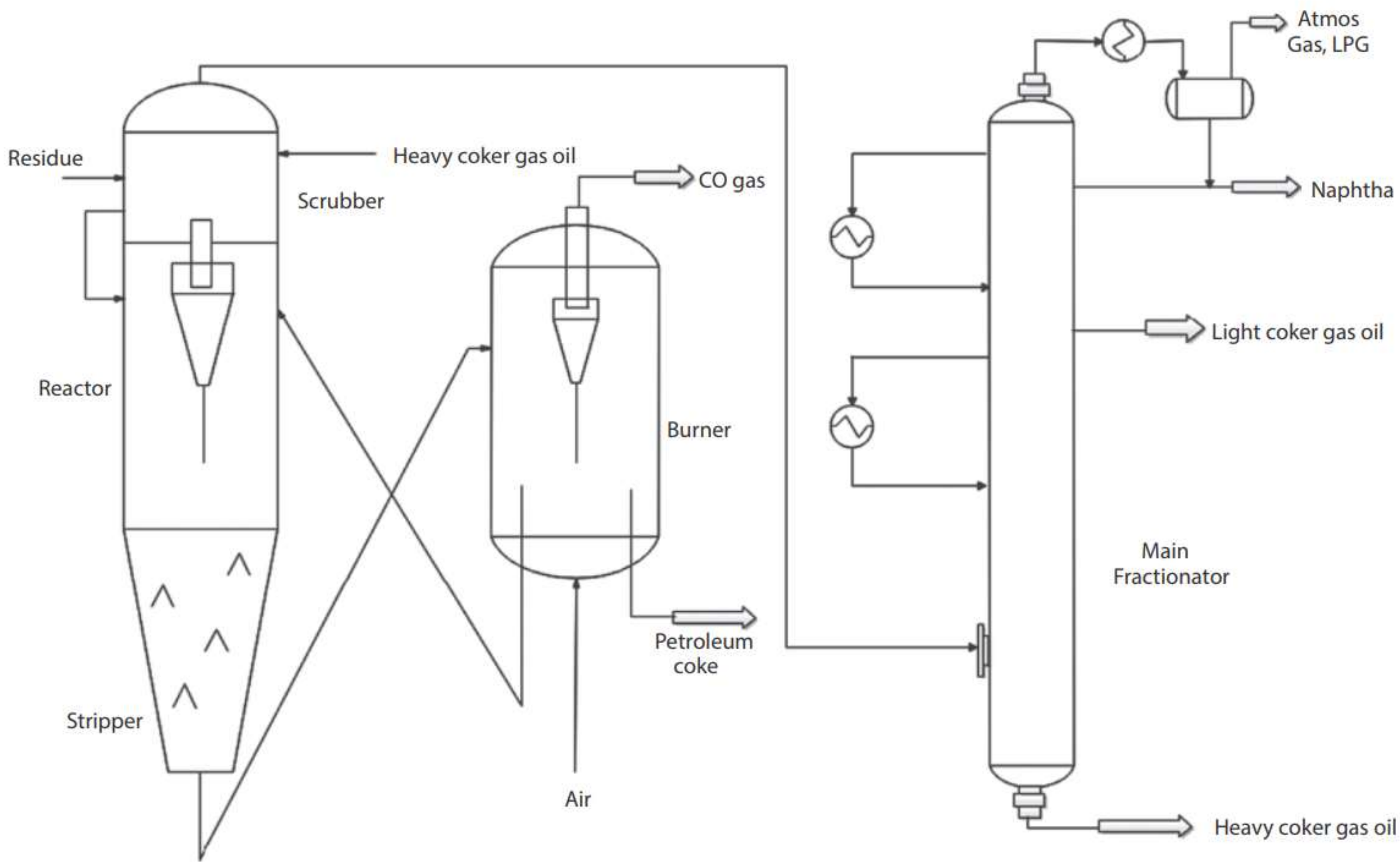
Typical yields and dispositions of delayed and fluid coking processes.

Product	Yield, wt% of feed	Disposition
Light ends	12.5–20	LPG
Naphtha	10–15	Naphtha hydrotreating
Light Coker Gas Oil	18–24	Distillate hydrotreating
Heavy Coker Gas Oil	30–40	Fluid catalytic cracking
Petroleum Coke	20–35	Sponge-carbon anodes; Needle-graphite electrodes Any coke-power generation

The process involves:

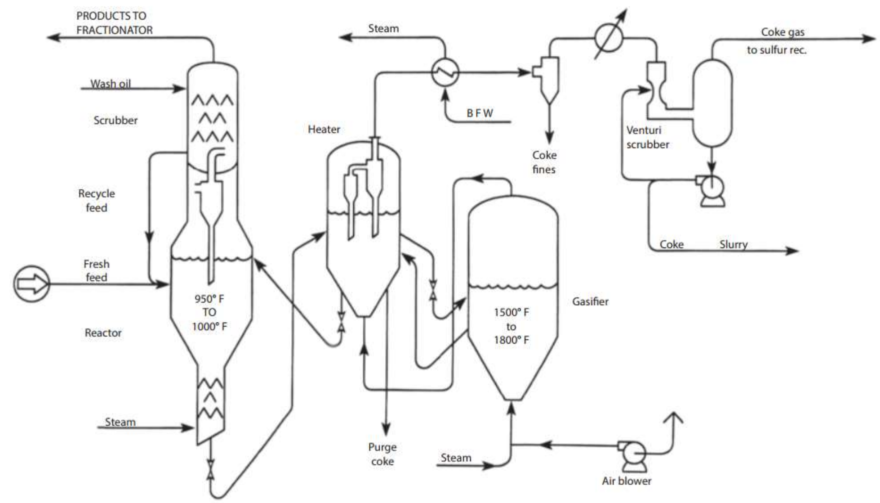
- Preheating the residue feed,
- Scrubbing the coke particles and providing primary condensing of reactor vapors by introducing the feed to the scrubber.
- The residue is atomized into a fluid coke bed, and thermocracking occurs on the particle surface.
- Coke particles leaving the reactor are steam stripped to remove remaining liquid hydrocarbons.
- Coke particles produced in the same unit assume more or less spherical shape and act as heat carriers while travelling from the burner (regenerator) to the reactor; and coke carriers in reverse travel.
- Some portion of steam stripped coke is burnt, and the remaining coke is taken out.
- The hot coke particles are in a state of fluidization caused by incoming vapors. Therefore, the effective continuous circulation of coke particles is unavoidable.
- Sub stoichiometric air is introduced to the burner to burn some of the coke and provide the necessary heat for the reactor, and the reactor vapors leave the scrubber and flow to the fractionator.

Process flow diagram of fluidic coking unit.



Flexi-Coking

- The feed consists of heavy residue and is fed into a scrubber fractionator reactor where thermal cracking occurs.
- Steam is admitted from the bottom, and the coke fines circulate through the heater where further coke formation takes place and then passes onto a gasifier where it encounters a stream of air and steam.
- Coke is withdrawn between the heater and the gasifier.
- The process heat is supplied by circulating hot coke between the heater and the reactor.
- Coke reacts with air and steam in the gasifier to produce heat and low Btu gas that can be used as fuel in furnaces and boilers.
- About 97% of the coke generated is consumed during the process as a small amount of coke is withdrawn from the heater and fine system which can be disposed in cement kilns or used in metals recovery.
- Partial gasification and oxygen-enrichment can be used to provide additional process flexibility.
- The primary advantage of the flexi coking (Figure beside) over fluid coking is that most of the heating value of the coke product is made available as low-sulfur fuel gas, which can be burned without an SO_2 removal system on the resulting stack gas, whereas the system would be required if coke that contains 3–8 wt% sulfur is burned directly in a boiler.



Process flow diagram of flexi-coking.

The yields for a typical Middle East vacuum residue (~25 wt%,Concarbon, ~5 wt% sulfur) are:

	Recycle	**Once-through**
Light ends, wt%	11.8	10.4
Naphtha (C_5, 350 °F), wt%	11.5	9.5
Distillate (350–650 °F), wt%	14.5	13.1
Heavy gas oil (650 °F_+), wt%	32.1	39.7
Low Btu gas, MBtu/bbl	1.2	1.1
C_{5+} Liquids, wt%	58.1	62.3

Contact Coking

- In contact coking, coke circulates between the reactor and the heater.
- A part of the coke is always necessary for supplying thermal energy, and the remaining portion is separated in the disengager. This method gives great flexibility in operation and control.

	Delayed coking	Fluid coking	Flexi coking	Contact coking
Gravity °API	15	15	18.9	18.8
Conradson Carbon Residue	9	9	11.7	11.7
Sulfur	1.2	1.2	0.6	0.6
Products				
C_3 and lighter fractions%	6	5	7.5	14.9
Coke%	22	11	13.0	20.0
CDE%	99.8	91.2	99.3	99.3

Note: CDE = Conradson Decarbonizing Efficiency.