



# Thermal Cracking Processes

## Lecture 8

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104

# Thermal Cracking Processes

- Thermal cracking is the cracking of short and long chain residues under severe thermal conditions.
- The liquid products from processes are highly olefinic, aromatic and have high-sulfur content.
  - They require hydrogen treatment to improve their properties.
- Coking is the process of carbon removal from the heavy residues in producing lighter components that are lower in sulfur as most of the sulfur is retained in the coke.
- The thermal treatment of hydrocarbons involves a free-radical mechanism where reactions take place in the initiation step.
- The reactions in the final step result in the formation of heavy fractions and coke.

# Classes of Thermal Cracking Processes

## Mild cracking (Visbreaking)

- The mild cracking involves sufficient heating to crack the residue just enough to lower its viscosity and to produce some light products.

## Delayed coking

- Delayed coking requires moderate thermal cracking to convert the residue into lighter products, leaving coke behind.

## Sever thermal Cracking

- The third process requires severe thermal cracking in which part of the coke is burned and used to heat the feed in the cracking reactor, as in fluid coking.
- In another part of the process, steam is used to crack most of the coke (flexi-coking).

# The conditions for industrial thermal cracking processes:

## Visbreaking

- Mild heating (471-493 °C) at (3.4-14bar)
- Reduced viscosity of fuel oil.
- Low conversion at 221 oC
- Heated oil or soaking drum

## Delayed coking

- Moderate heating (482-516 °C); 6.2 bar
- Soak drums (452-482oC)
- Residence time until they are full of coke
- Coke is removed hydraulically
- Coke Yield ~ 30% wt.

## Fluid coking and flexi-coking

- Sever heating ( 482-566 °C)at 0.7 bar.
- Fluidized bed with steam
- Higher yields of light ends
- Less coke yield (20% for fluid coking and 2% for flexi-coking)

# Vacuum distillation

- The vacuum distillation unit (VDU) follows the atmospheric or the crude distillation unit (CDU) in refineries.
- The bottom of the atmospheric distillation is known as the reduced crude or topped crude.
- The reduced crude bottoms from the atmospheric tower provide the feed to the vacuum column where the second stage of distillation takes place.

# Cracking does not occur in a vacuum column

- Cracking does not occur in a vacuum column because the column has a large diameter and is operated at very low pressure, and subsequently boiling takes place at a low temperature.

# Types of vacuum distillation columns

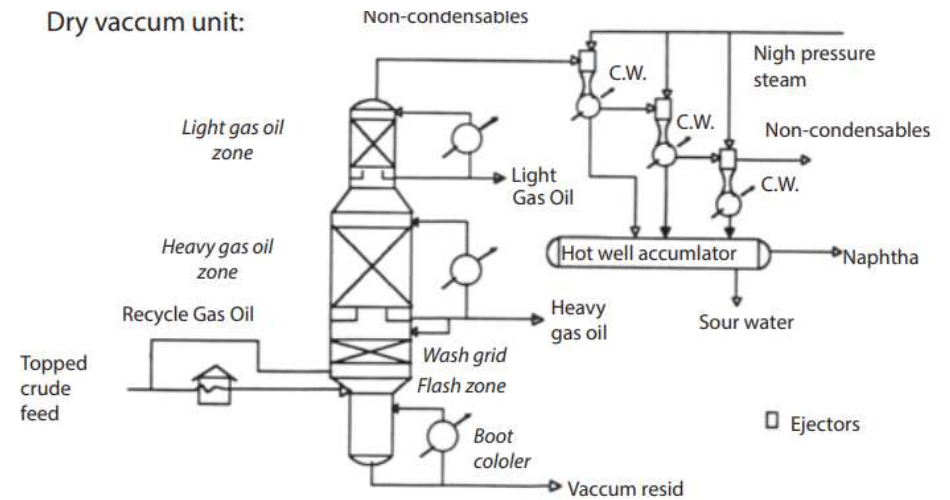
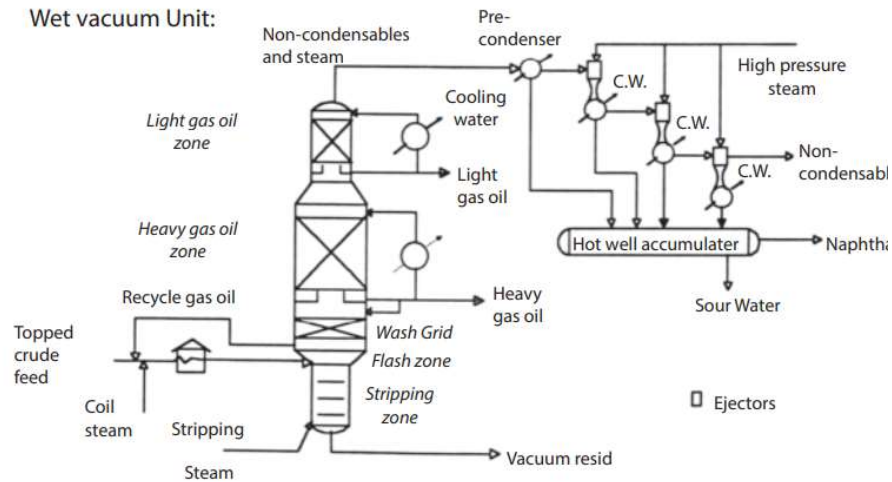
## wet type

- The wet type unit uses steam to reduce the partial pressure of oil in the flash zone of the column to the required level
- The wet type unit requires a huge quantity of steam, which is dependent on the amount of vacuum

## dry type

- The dry type unit depends solely on the effectiveness of the vacuum inside the column to vaporize the heavy oil
- The dry vacuum type has a higher flash zone temperature than the wet vacuum unit for the same service, and as it provides a boot cooling circuit to keep the column boot from coking and becoming plugged. The boot cooler sub-cools the liquid from the flash zone and prevents coking.

# Wet and dry vacuum units





# What is the both unit have? How it works?

- The both unit have a wash grid above the flash zone, the feed to the column enters the flash zone at very high velocity, and high amount of heavy liquid entertained in the flash zone vapor.
- The heavy gas oil that is returned to the column over the wash grid washes down the entrained liquids.

