Thermal Cracking Processes Coking

Lecture 12

Coking

- Coking is a thermal cracking process as the operation is often considered to be the last stage in the refining since the heaviest fraction (pitch or tar) is converted into very useful products. Coking is a process by which the vacuum residue obtained from vacuum column is processed to making carbon electrodes.
- The process of coking is rather complex involving batch and continuous operations *as it produces solid, liquid and gaseous products.*

Coking types

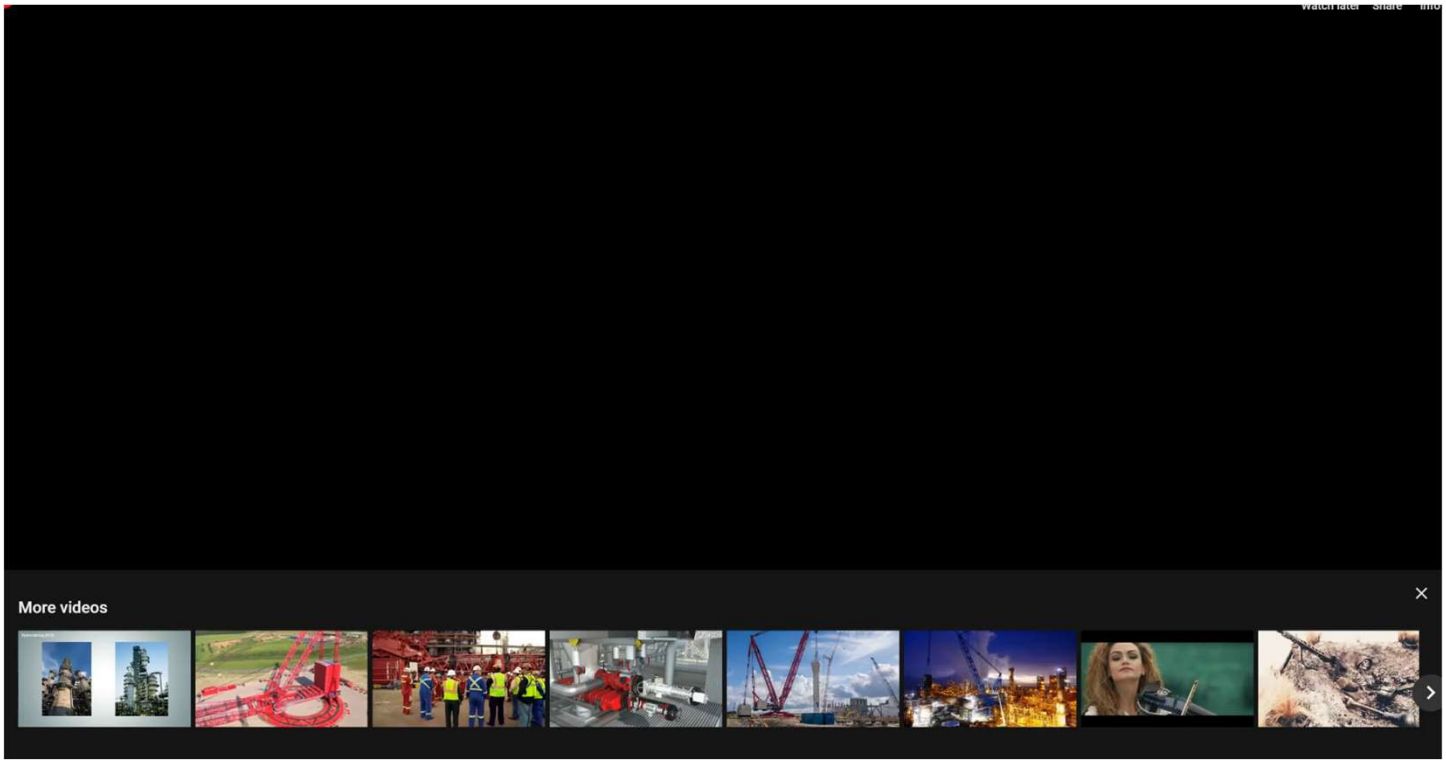
Delayed Coking

- Objective
  - The process objective is to convert low-value residue to valuable products such as naphtha, diesel and coker gas oil.
- Where this process occur?
  - This process occurs in a large vessel at a slow pace (delayed), and it is the most important process among the various coking methods (the precursor to delayed coking is the two-coil cracking process).
- Capabilities
  - It is capable of cracking all types of feed materials, including solvent extracts. Thermo-cracking increases the hydrogen/ carbon ratio by carbon rejection in a semi-batch process.
- Feed Condition
  - The feed to the delayed coker can be any undesirable heavy stream that contains high metal content. This could be from a vacuum residue, a fluid catalytic cracking slurry and visbreaking tar (residues).
  - The products from the coker are unsaturated gas (C1 – C4), olefins *C C* and iC_4. The olefins are very desirable feedstocks to the petrochemical industry. Isobutane (iC4) and olefins are sent to the alkylation units, and the C_3/C_4 gases are sent to the LPG plant.
  - The coker unit is the only unit in the refinery that produces coke. The highly aromatic naphtha does not require reforming and is sent to the gasoline pool. Light coker gas oil is hydrotreated and sent to the kerosene pool. Heavy coker gas oil is sent to the FCC for further cracking.

Delayed Coking Process Steps

- In delayed coking process, heating is carried out in the furnace to initiate cracking, and the chemical reactions are completed in huge and tall coke drums.
- Several coke drums in series are operated in a cyclic manner. While one drum is being filled, the other drums are in the process of coking and decoking. By orderly rotating of the drums, the process can be termed continuous, and a minimum of two drums are essential even for small capacity plants.
- Superheated feed in a large coke drum is flashed where the coke remains, and vapors leave the top and returns to the distillation column.
- The heavy oils and light oils are recycled in different ratios to maximize the yield of either coke or distillates as per the requirement. The off-line coke drum is drilled, and the petroleum coke is removed via hydro-jetting.

Replacing for the Large drums in one of the refinery…



https://youtu.be/6KUDX1gLlF8

The expected yield of coke

- The expected yield of coke may be ~ 30% for reduced crudes or 80% for tars and pitches. Coke from these units contains volatile matter up to 8–15%, and the bulk density of the coke obtained may be around 9 kg per liter.

CDE (Conradson Decarbonizing Efficiency) of the plant may be reaching up to 99.8% [5]. The conditions and parameters in delayed coking are given:

Heavy oil, discharge temperature, °C	470–520
Coking temperature, °C	450–470
Pressure in coke drums, atm.	5–6
Drum diameter, m.	4–5
Drum height, m.	14–20
Thickness of drum walls, mm	~40

What are the licensors that provide the technologies for the coking method?

- The following licensors have provided the technologies for the delayed coking method:

  - ABB Lummus Global
  - Conoco Philips
  - Exxon Mobile Research
  - Foster Wheeler/UOP LLG

What are the delayed coking unit operations consist of?

What are the product of delayed coking unit?

Figure shows the schematic of the delayed coking process.