**8. CHEMICAL PROCESSING TECHNOLOGY**

Conversion processes, of which thermal and catalytic cracking are examples, were recognized as a means of producing valuable lighter products from heavier nonvolatile materials. The crude oil and fractions processing method are:

**8.1 Thermal Cracking**

Thermal cracking is defined as the thermal decomposition under pressure of large HC molecules to form smaller molecules.

**8.1.1 Visbreaking**

Visbreaking (viscosity breaking) is a process for reducing the viscosity of heavy feed stocks (atmospheric and vacuum residue) by controlled thermal decomposition. It is essentially introduced as a mild thermal cracking operation that could be used to reduce the viscosity of residue and produce light products. In a typical visbreaking operation (Figure-1), a crude oil residue is passed through cracking furnace (high temp. short residence time) where it is heated to a temperature of 480°C, under an outlet pressure of about 100 psi. The heating coils in the furnace are arranged to provide a soaking section of low heat density (low temp. long residence time), where the charge remains until the visbreaking reactions are completed and the cracked products are then passed into a flash-distillation chamber.

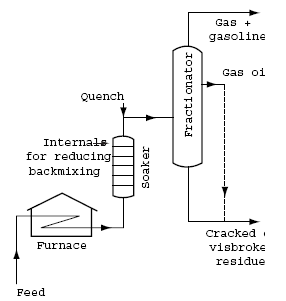


Figure-1 A soaker visbreaker system

The material fractionated to produce a low quality gasoline as an overhead product and light gas oil as bottom. The liquid products from the flash chamber are cooled with a gas oil flux and then sent to a vacuum fractionator. This yields a heavy gas oil distillate and a residual tar of reduced viscosity.

**8.1.2 Coking**

Coking is a thermal process designed to completely convert residual petroleum products such as pitch or tar into gas, naphtha, kerosene, gas oil, and coke. The coke obtained is usually used as fuel but specialty uses, such as electrode manufacture, production of chemicals and metallurgical coke are also possible and increases the value of the coke. Technologies that result in the production of coke are:

**8.1.2.1 Delayed Coking** is a semi-continuous process in which the heated charge is transferred to large coking drums, which provide the long residence time needed to allow the cracking reactions to proceed to completion (Figur-2).

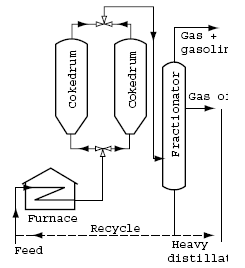


Figure-2 A delayed coking

A furnace heated the feedstock to temperature 480°C- 515°C and then enters one of a pair of coking drums where the cracking reactions continue. The cracked products leave as overheads, and coke deposits form on the inner surface of the drum. To give continuous operation, two drums are used; while one is on stream, the other is being cleaned. The temperature in the coke drum ranges from 415°C- 450°C with pressures from 15- 90 psi. Overhead products go to the fractionator, where naphtha and heating oil fractions are recovered. The heavy distillate of fractionator bottom is combined with preheated fresh feed and recycled to the furnace.

**8.1.2.2 Fluid Coking** is a continuous process which uses the fluidized solids technique to convert atmospheric and vacuum residue to more valuable products (Figure-3). The residuum is coked by being sprayed into a fluidized bed of hot, fine coke particles, which permits the coking reactions to be conducted at higher temperatures and shorter contact times than can be employed in delayed coking.

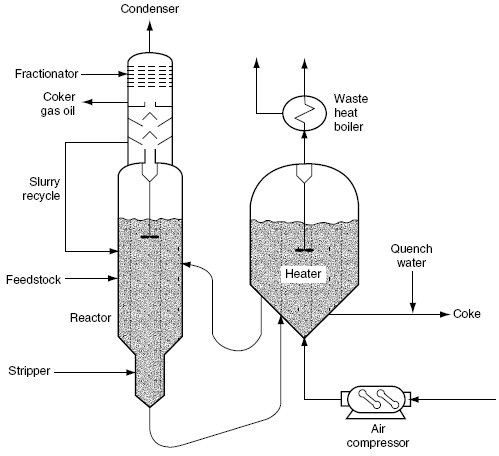


Figure-3 A fluidized coker

Fluid coking uses two vessels, a reactor and a heater (burner); coke particles are circulated between these to transfer heat (generated by burning a portion of the coke) to the reactor. The reactor holds a bed of fluidized coke particles, and steam is introduced at the bottom of the reactor to fluidize the bed.

**8.2. Catalytic cracking**

Catalytic cracking is the most important method for converting high boiling petroleum fractions, such as gas oil, into gasoline. Thus, catalytic cracking in the usual commercial process involves contacting a gas oil faction with an active catalyst under suitable conditions of temperature, pressure, and residence time, so that a substantial part (>50%) of the gas oil is converted into gasoline usually in a single-pass operation.

The cracking of crude oil fractions occurs over many types of catalytic materials, but high yields are obtained with hydrated aluminum silicates. These may be either activated (acid-treated) natural clays of the bentonite type of silica–alumina or silica–magnesia preparations. Natural and synthetic catalysts can be used as pellets or beads and also in the form of powder; in either case, replacement are necessary because of attrition and gradual loss of efficiency. Catalysts are essential that:

1. be stable to withstand the physical impact of loading.

2. be resist the thermal shocks.

3. be withstand the action of CO2, air, N2 gases, and steam.

The catalysts are porous and highly adsorptive and their performance is affected markedly by the method of preparation. The catalytic cracking processes in use today can be classified as:

1) Moving Bed: In which the catalyst was allowed to fall slowly by gravity through the reactor and a regenerator vessels and was returned mechanically to the top.

2) Fluidized Bed: That is based on the fluidization propertied of fine powders, which enabled the catalyst to be transported continuously between the reactor and regenerator.

**8.3. Hydroprocesses**

The use of H2 gas in thermal processes is perhaps the most significant advance in refining technology. The presence of H2 gas during a thermal reaction of a petroleum feedstock will reduce many of the coke-forming reactions and enhance the yields of the lower boiling products such as gasoline, kerosene and jet fuel.

**8.3.1 Hydrotreating**

Hydrotreating is the removal of heteroatomic N2, O2, and S species by treatment of petroleum product at relatively low temperatures in the presence of hydrogen. Hydrotreating for the purpose of improving product quality without appreciable alteration of the boiling range (Figure -4), is carried out by charging the feed (coker oils or gas oils) to the reactor, together with H2 in the presence of catalyst. Most processes employ cobalt-molybdenum catalysts which generally contain about 10% of molybdenum oxide and 1% of cobalt oxide supported on alumina. The temperatures employed are in the range of 260°C-345°C, while the hydrogen pressures are about 500- 1000 psi. The reaction generally takes place in the vapor phase and produces gases such as methane, ethane, propane, and butane and light distillate and desulfurized gas oil. Generally, it is more economical to hydrotreat high-sulfur feedstocks prior to catalytic cracking than to hydrotreat the products from catalytic cracking.

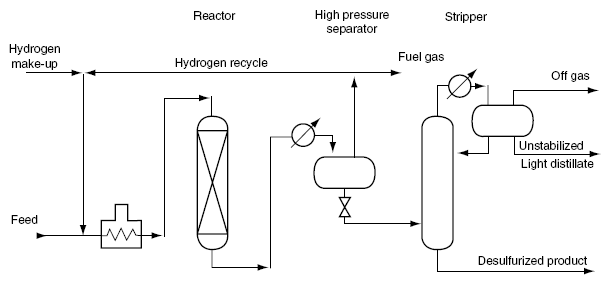


Figure-4 A distillate hydrotreater for hydrodesulfurization.

The advantages of hydrotreating processes are that:

(1) Sulfur is removed from feedstock, and corrosion is reduced.

(2) Carbon formation is reduced so that higher conversions result.

(3) The cracking quality of the gas oil fraction is improved.