**8.3.2 Hydrocracking**

Hydrocracking is a high-pressure high-temperature process with catalyst for the conversion of petroleum feedstocks in the presence of H2 gas; C–C bonds are cleaved, in addition to the removal of heteroatomic species. Example is the conversion of light gases and naphtha to jet fuel.

**8.4 Reforming Process**

Reforming process is the conversion of hydrocarbons with low octane number into hydrocarbons having higher octane number; e.g., the conversion of n-paraffin into an iso-paraffin.

**8.4.1 Thermal reforming**

Thermal reforming is a process using heat (but no catalyst) to effect molecular rearrangement of low octane naphtha into gasoline of higher antiknock quality.

Thermal reforming was a natural development from older thermal cracking processes; cracking converts heavier oils into gasoline, whereas reforming convert (reforms) gasoline into higher-octane gasoline.

A feedstock such naphtha or a straight-run gasoline is heated to 510°C- 595°C in a furnace with pressures from 400- 1000 psi. As the heated naphtha leaves the furnace, it is cooled or quenched by the addition of cold naphtha. The material then enters a fractional distillation tower where any heavy products are separated. The remainder of the reformed material leaves the top of the tower to be separated into gases and reformate. ***Reformate is gasoline*** with high octane number (65- 80) due to the cracking of longer-chain paraffins into higher-octane olefins.

**8.4.2 Catalytic Reforming**

Catalytic reforming convert low octane gasoline into high octane number (90-95) ***reformate*** (higher antiknock quality) by rearranging the HC molecules of gasoline. Catalytic reforming is conducted in the presence of hydrogen over catalysts, which may be supported on alumina or silica–alumina.

Catalytic reforming is usually carried out by feeding naphtha (after pretreating

with hydrogen if necessary) and hydrogen mixture to a furnace, where the mixture is heated to the desired temperature, 450°C- 520°C and then passed through fixed-bed catalytic reactors at hydrogen pressures of 100-1000 psi.

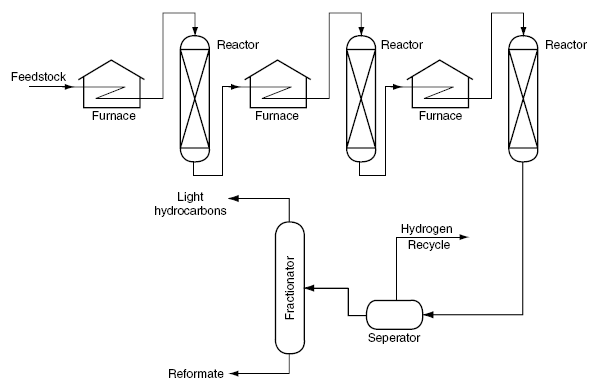


Figure-5 Catalytic reforming Process

**8.5 Isomerization Process**

It is a process for the conversion of straight chain paraffin hydrocarbon into branched chain paraffin hydrocarbon with the same atomic composition. Conversion of straight chain paraffin HC (e.g., butanes, pentanes and hexanes) to their isomers yields gasoline components of high octane rating.

In the process of isomerization, pure butane or a mixture of isomeric butanes (Figure-6), is mixed with hydrogen (to inhibit olefin formation) and passed to the reactor, at 110°C-170°C and 200 - 300 psi in the presence of AlCl3 catalyst. The product is cooled, the hydrogen separated and the cracked gases are then removed in a stabilizer column. The stabilizer bottom product is passed to isobutanization column where the normal butane is separated from the isobutane and recycled.

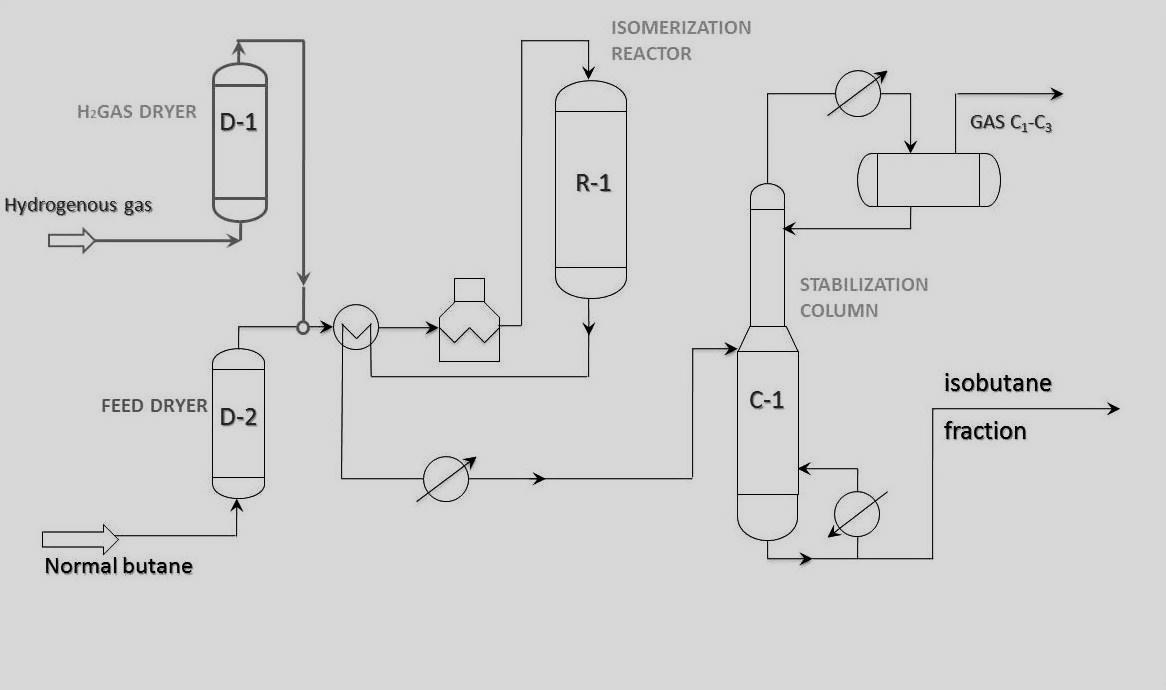


Figure-6 A butane isomerization unit.

**8.6 Alkylation Process**

Alkylation is the combination of a branched chain HC (e.g.,isobutane) with an olefin (e.g., ethylene, propylene, butylene) to form higher isoparaffins. So the process transforms low molecular weight isoparaffin and alkenes molecules into larger isoparaffins with a high octane number. Since olefins are reactive (unstable) and are responsible for exhaust pollutants, their conversion to high octane isoparaffins is desirable. In refinery practice, only isobutane is alkylated by reaction with normal butene and isooctane is the product.

The process occurs in presence of a strong acting acid as [catalyst](https://en.wikipedia.org/wiki/Catalyst). The acid can be either [sulfuric acid](https://en.wikipedia.org/wiki/Sulfuric_acid) or [hydrofluoric acid](https://en.wikipedia.org/wiki/Hydrofluoric_acid) (HF). The product [isooctane](https://en.wikipedia.org/wiki/Isooctane) is a premium [gasoline](https://en.wikipedia.org/wiki/Gasoline) blending stock because it has exceptional antiknock properties and is clean burning. Conditions of catalytic alkylation; olefins (propylene, butylene) are combined with isobutane in the presence of an acid catalyst (sulfuric acid or hydrofluoric acid) at low temperatures and pressures (18°C- 40°C) and 14.8- 150 psi (Figure-8). Alkylate is composed of a mixture of isoparaffins which have octane numbers that vary with the olefins from which they were made. All alkylates, however, have high octane numbers (> 87) which makes them particularly valuable.

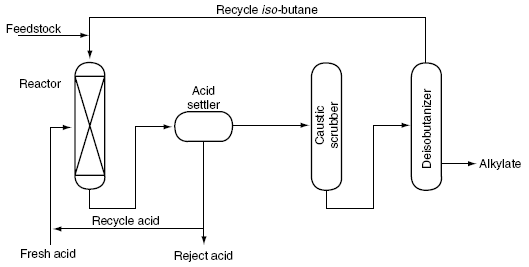


Figure-8 An alkylation unit (sulfuric acid catalyst).

**8.7 Polymerization Process**

Polymerization is the process by which two olefin gases are combined and converted to higher molecular weight paraffin liquid products which may be suitable for gasoline (polymer gasoline) or other liquid fuels. Polymer gasoline is the product of polymerization of gaseous hydrocarbons to hydrocarbons boiling in the gasoline range. The feedstock usually consists of propylene and butylenes from cracking processes or may even be selective olefins for dimer, trimer, or tetramer production.

Olefins can be conveniently polymerized by means of an acid catalyst (Figure-9). Thus, the treated, olefin-rich feed stream is contacted with any acid catalyst such as sulfuric acid, copper pyrophosphate, and phosphoric acid loaded on an inert support at temperature 150°C- 220°C and pressure 150-1200 psi, depending on feedstock and product requirement. The process using liquid phosphoric acid catalyst is far more responsible to attempts to raise production by increasing temperature than the other processes.

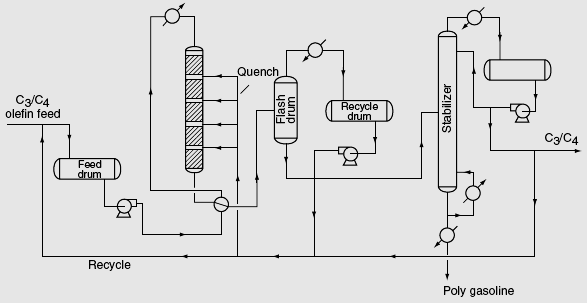


Figure-9 A polymerization unit.

**8.8 Solvent Processes**

**8.81 Deasphalting**

Solvent deasphalting processes are a major part of refinery operations and are not often appreciated for the tasks for which they are used. In the solvent deasphalting processes, an alkane is injected into the feedstock to disrupt the dispersion of components and causes the polar constituents to precipitate. Propane is extensively used for deasphalting and produces a deasphalted oil (DAO) and propane deasphalter asphalt (PDA or PD tar). Propane has unique solvent properties; at lower temperatures (38°C to 60°C), paraffins are very soluble in propane and at higher temperatures (about 93°C; 200°F) all hydrocarbons are almost insoluble in propane. A solvent deasphalting unit (Figure-10) processes the residuum from the vacuum distillation unit and produces deasphalted oil (DAO), used as feedstock for a fluid catalytic cracking unit, and the asphaltic residue (deasphalter tar, deasphalter bottoms) which, as a residual fraction, can only be used to produce asphalt or as a blend stock or visbreaker.

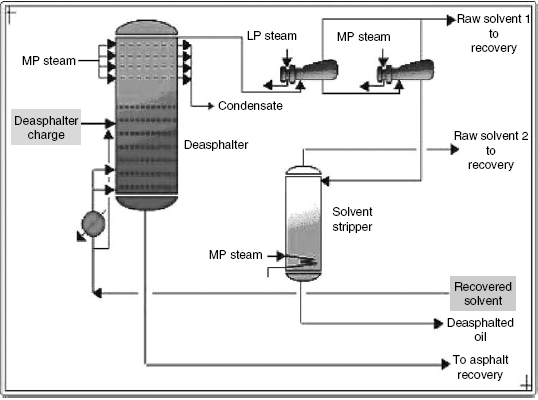


Figure-10 A deasphalting unit.

**8.8.2 Dewaxing**

Paraff inic crude oils often contain microcrystalline or paraffin waxes. The crude oil may be treated with a solvent such as methyl-ethyl- ketone (MEK) to remove this wax before it is processed. This is not a common practice, however and solvent dew axing processes are designed to remove wax from lubricating oils to give the product good fluidity characteristics at low temperatures (e.g ., low pour points) rather than from the whole crude oil. The mechanism of solvent dewaxing involves either the separation of wax as a soli d that crystallizes from the oil solution at low temperature or the separation of wax as a liquid that is extracted at temperatures above the melting point of the wax through preferential selectivity of the solvent. However, the former mechanism is the usual basis for commercial dewaxing processes. The process as now practiced involves mixing the feedstock with one to four times its volume of the ketone (Figure-11). The mixture is then heated until the oil is in solution and the solution is chilled at a slow, controlled rate in double-pipe, scraped-surface exchangers. Cold solvent, such as filtrate from the filters, passes through the two-inch annular space between the inner and outer pipes and chills the waxy oil solution flowing through the inner 6-in. pipe.

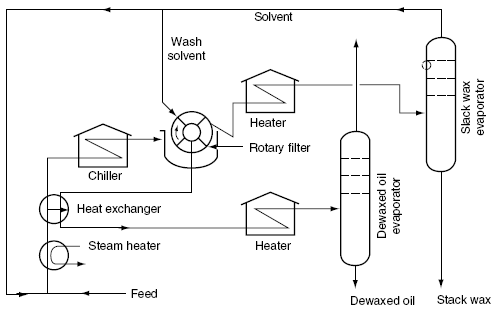


Figure-11 A solvent dewaxing unit.