

CATALYTIC CRACKING REACTION

Petroleum fractions of higher molecular weight than gasoline such as gas oil, other heavy oil fractions are used as feedstock and heated in presence of a catalyst and cracked into smaller.

The catalytic cracking has several inherent advantages over less efficient thermal cracking.

Carried out in the presence of a catalyst at a much milder conditions like lower temperature and pressure / no pressure.

This reaction is of two main types, fixed bed catalytic cracking reaction and moving (fluidized) (FCC) bed catalytic cracking and the products obtained are blended into the refinery gasoline feed.

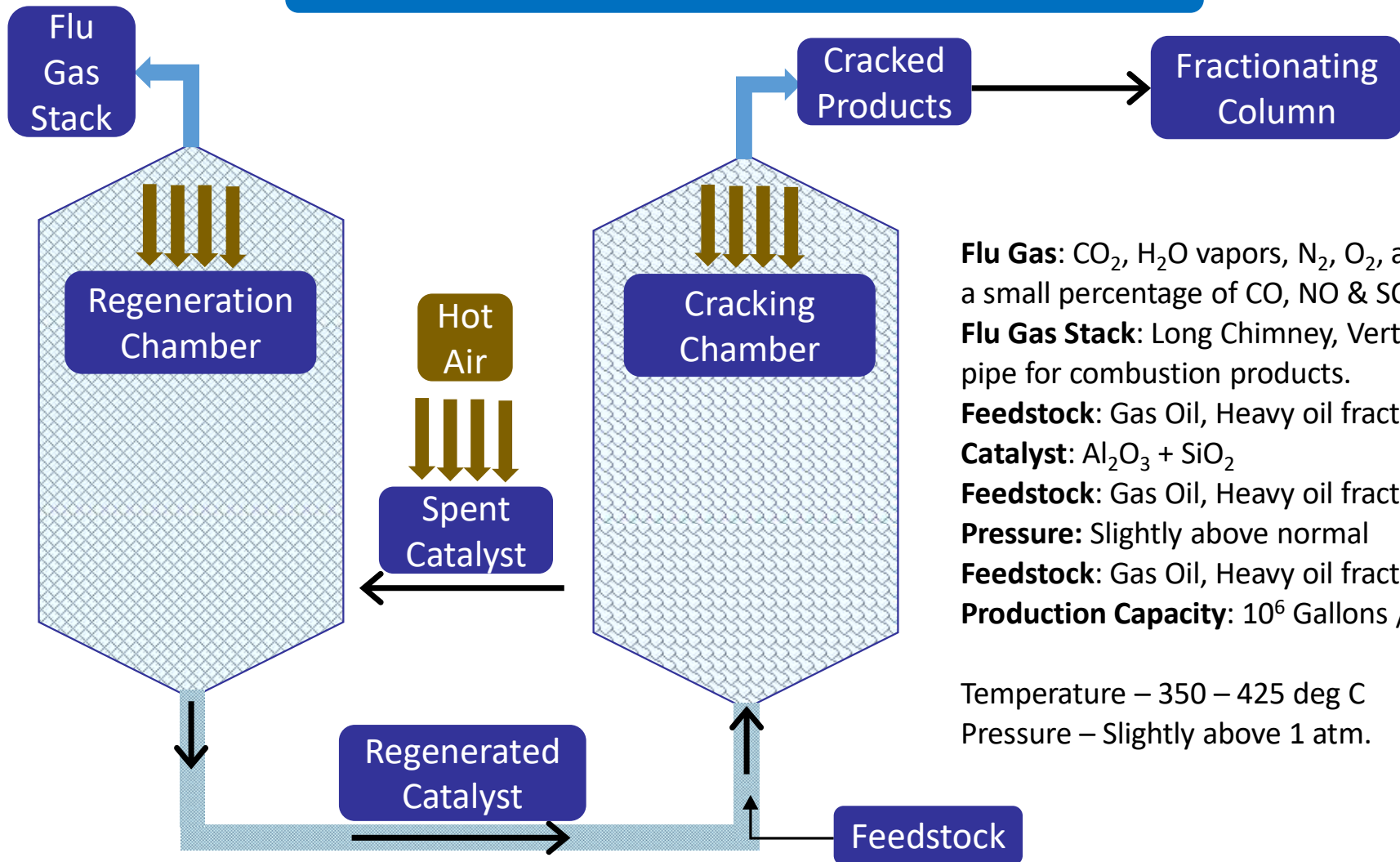
The FCC has more advantages over the fixed bed cracking. There are two main designs for FCC reactors.

The “stacked” type reactors, where the reactor and catalyst generator are contained in a single vessel with the reactor above the catalyst generator.

The second one, is the “side-by-side” reactor where the reactor and catalyst generator are in two separate vessels.

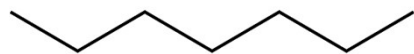
Both these reactors have unique features and parameters with satisfactory operation world over.

FLUIDIZED CATALYTIC CRACKING REACTION



CATALYTIC REFORMING REACTIONS

- **Reforming:** A chemical process that converts straight chain heavier hydrocarbons into branched chain, cyclic and aromatic hydrocarbons called “reformates” is known as petroleum reforming.
- **Catalytic Reforming:** Reforming done in the presence of a suitable catalyst is called catalytic reforming.
- By performing this reforming process the octane number of hydrocarbons increases as they tend to become compact.
- Aromatic hydrocarbons have highest octane number than non-aromatic / aliphatic hydrocarbons.
- After the catalytic reforming process the overall quality of gasoline can be enhanced significantly.



n-heptane

OCTANE NUMBER



isooctane

- The detonation resistance of gasoline defined with reference to n-heptane (0) and isooctane (100) (2,2,4-Trimethylpentane) as standard is called octane number. Higher the octane number lesser is the knocking tendency.
- The octane number of gasoline is “the percentage volume of iso-octane in a mixture of n-heptane and iso-octane blend, which has the same knocking characteristic as the gasoline sample under test”
- Straight Chain Hydrocarbons (**lowest ON**) < Branched Chain Hydrocarbons < Cycloalkanes < Alkenes < Aromatics (**higher ON**)
- Certain hydrocarbons are even more knock-resistant than iso-octane. Hence, the definition of octane number has been extended to allow for including hydrocarbons with octane numbers greater than 100.
- Therefore, a fuel with high octane rating runs an engine with very high compression and the fuel burns only when it is compressed and supposed to burn

KNOCKING PHENOMENON

- **Knocking:** It is a phenomenon occurring due to the ignition of the spark plug resulting in combustion of the air/fuel mixture when the cylinder starts and compression happens.
- Thermal shock waves are produced that hit the cylinder walls and piston, resulting in a rattling sound called “knocking” or “pinging”.
- **Knocking produces several adverse effects**
 - (a) Undesirable rattling sound
 - (b) Increased fuel consumption
 - (c) Decreased power output
 - (d) Mechanical damage due to overheating of spark-plug, piston and engine walls
 - (e) Unpleasant driving experience

KNOCKING AND ANTIKNOCKING

- **Remedial measures to prevent knocking**
- (a) Always use high rating gasoline
- (b) Utilize critical compression ratio of fuels
- (c) If necessary, use appropriate anti-knocking agents
- **Anti-knocking:** The tendency of reduced knocking is called antiknocking which is achieved by gasoline of high standards / rating.
- It is also achieved by adding / doping organometallic compounds to gasoline known as anti-knocking agents.
- Anti-knocking agents include tetraethyl lead (very cheap and widely used). Tetramethyl lead, mixed methyl lead, methyl tert-butyl ether and ethyl tert-butyl ether. The lead compounds end up giving Pb and PbO deposition and emission which are hazardous compounds. Hence, ethylene dibromide or dichloride is mixed with fuel to convert Pb and PbO into $PbBr_2/Cl_2$ that are much more volatile and can escape into air.
- The MTBE and ETBE also have several advantages such as they do not absorb moisture, the byproducts are not explosive as other ether compounds and they work by stopping the combustion chain reactions.
- The anti-knocking agents work by stopping the combustion process of chain reactions.