

# Refining Industry Fluidized-Bed Catalytic Cracking Unit

## Process Gas Chromatograph Application Note

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Fluidized-Bed Catalytic Cracking (FCC) is the most important and widely used refinery process for converting low value, heavy oils into more valuable gasoline and lighter products. The typical FCC process will convert 75% or more of the heavy oils into gasoline and lighter products. Originally, chemical cracking was accomplished by thermally heating the oil to extremely high temperatures, but the catalytic process has almost completely replaced thermal cracking. The catalytic process produces more gasoline with a higher octane value, and with less unsaturated compounds. The light gases produced by the catalytic process are sent to a Vapor Recovery Unit (VRU), where the olefins are recovered. The olefins will then be used as feed to an alkylation unit for conversion to high octane products.

The cracking process produces carbon (coke) which remains attached to the catalyst particle and rapidly lowers its activity. To maintain the catalyst activity at a usable level, it is necessary to regenerate the catalyst by burning off the coke with air. As a result, the catalyst is continuously moved from the reactor to the regenerator and back to the reactor.

The fresh feed and recycle gas oil streams are preheated and enter the reactor at the base of the feed riser, where they are mixed with the hot, regenerated catalyst. The heat from the catalyst vaporizes the feed and brings it up to the desired temperature. The mixture of catalyst and hydrocarbon vapor travels up the riser into the reactor. The catalyst is a very fine particle, therefore the mixture of catalyst and vapor behaves like a fluid.

The cracking reactions start when the feed contacts the hot catalyst in the riser and continues until the hot oil vapors are separated from the catalyst in the reactor. The catalyst leaving the reactor is called spent catalyst and contains hydrocarbons absorbed on the surface. These are removed by steam stripping before the catalyst leaves the reactor. The spent catalyst is separated from the hydrocarbons by a cyclone stripper with the hydrocarbons leaving

the top of the reactor and the catalyst traveling down a pipe to the regenerator. The hydrocarbon vapors leaving the top of the reactor are sent to the main fractionator.

In the regenerator, coke is burned off the catalyst with air. The flue gas leaving the regenerator contains a large quantity of carbon monoxide which is burned to carbon dioxide in a CO furnace (or waste heat boiler) to recover the available heat. The catalyst leaves the regenerator through the bottom to be mixed with the feed stream.

The main fractionator acts the same as a crude tower by separating the hydrocarbons into a variety of boiling fractions; i.e., gasoline, naphthas, gas oils, etc. A recycle of uncracked heavy oils are sent back to the feed of the unit. The light gas from the main fractionator is sent to the VRU.

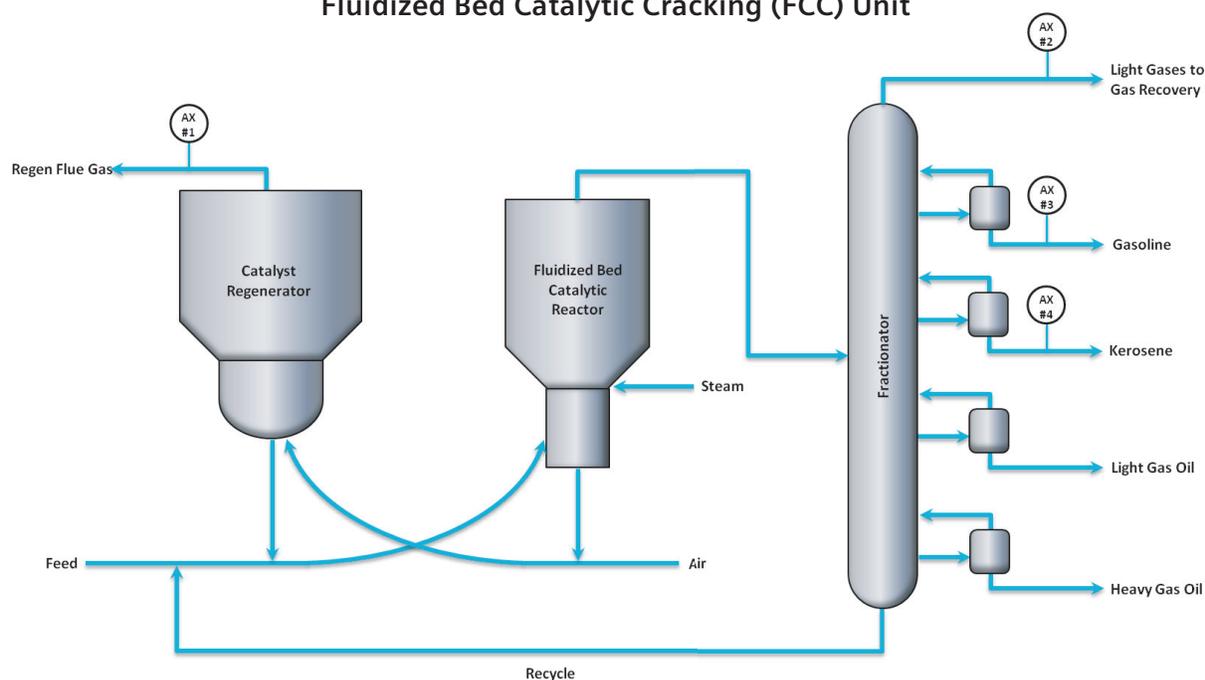
The gasoline is treated and sent to the blending pool. The gas oils are either sent to final product blending pools or are sent to a hydrocracking unit.

### Typical GC Measurements

Process gas chromatographs are used in three locations on a typical FCC unit:

- 1. Regenerator Overhead** – monitors CO and CO<sub>2</sub> for the completeness of the catalyst cleaning. This is a difficult application because of the high temperatures at the sample point and the high particle concentration that needs to be filtered out.
- 2. Fractionator Overhead/Light Gases** – monitors all light gases up to C<sub>5</sub> to minimize the loss of C<sub>5+</sub> as well as to improve C<sub>4</sub> and C<sub>5</sub> olefin production.
- 3. Gasoline Side Draw** – does a simulated distillation to maximize gasoline production.
- 4. Kerosene Side Draw** – does a simulated distillation to maximize kerosene production.

## Fluidized Bed Catalytic Cracking (FCC) Unit



| Analyzer No. | Stream                     | Components Measured             | Measurement Objective  |
|--------------|----------------------------|---------------------------------|--|
| 1            | Regenerator Flue Gas       | CO, CO <sub>2</sub>             | Monitor efficiency of the catalyst regeneration  |
| 2            | Main Fractionator Overhead | H <sub>2</sub> – C <sub>5</sub> | Minimize loss of the C <sub>5</sub> + fraction as well as monitor the C <sub>4</sub> – C <sub>5</sub> Olefins production |
| 3            | Gasoline Side Draw         | Simulated distillation          | Maximize gasoline production   |
| 4            | Kerosene Side Draw         | Simulated distillation          | Maximize kerosene production   |

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