

Improving Refinery Fluid Catalytic Cracking Vapor Recovery Unit Performance with Process Gas Chromatographs

Process gas chromatographs have been used since the 1950s to provide real-time compositional data to process control systems. Today, there are tens of thousands of process gas chromatographs in use throughout the process industry making the gas chromatograph the analytical workhorse for online compositional measurements. One example of how process gas chromatographs are used for improving process operations can be found in the fluid catalytic cracking vapor recovery unit in a refinery.

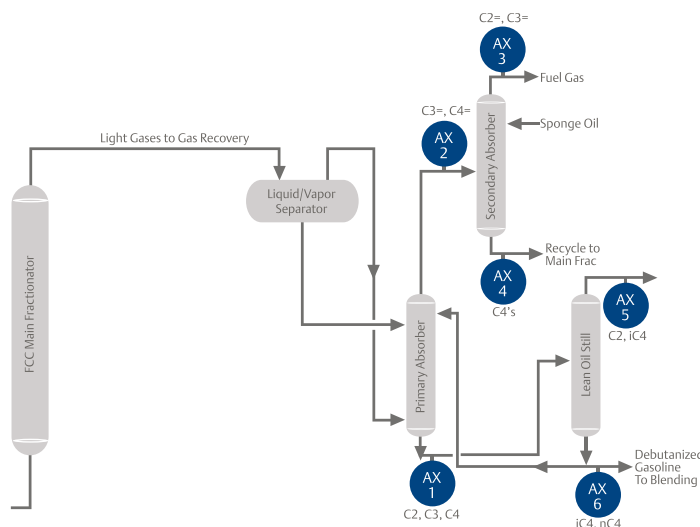
A number of processes in the refinery are devoted to improving the octane value of various petroleum streams such as within the alkylation unit. Unfortunately, the alkylation unit requires a source of butenes that is not typically found in refinery petroleum streams. One source does exist however, and that is the light gases generated by the fluid catalytic cracking (FCC) unit. So, many refineries recover butenes (and other olefins) from the light gas vapors leaving the main fractionator of the FCC unit.

The FCC Vapor Recovery Unit

The feed to the FCC vapor recovery unit is the light gas stream leaving the overhead of the main fractionator (see Figure 1). This stream is cooled enough to cause some of the components to turn to a liquid before it enters a vapor-liquid separator. The vapor and liquid enter a primary absorber at different points to create a counter-flow of liquid over the rising vapor. This is also to strip the C₃ and heavier compounds out of the vapor before it leaves the overhead of the absorber and enters the secondary absorber. The secondary absorber provides another opportunity to strip out the C₃ and heavier components from the vapor before it moves on to the fuel gas system.

The C₃ and heavier components from the primary absorber leave the bottom of the absorber and enter a lean oil still. The still separates the C₄ components rich in olefins needed for the alkylation unit from the rest of the stream. The remaining components become a debutanized gasoline fraction that can be used in the blending of gasoline.

Figure 1 - Flow Diagram of a Typical Fluid Catalytic Cracking Vapor Recovery Unit in a Refinery



Improving FCC VRU Performance with Process Gas Chromatographs

Several opportunities exist for process gas chromatographs to improve the FCC vapor recovery unit's performance. The first process gas chromatograph (AX #1 in Figure 1) monitors the C₂, C₃ and C₄ leaving the primary absorber. The measurement helps the control system minimize light gases entering the feed into the alkylation unit. C₂, C₃ and C₄ negatively impact the alkylation unit by reducing the octane levels.

The second process gas chromatograph (AX #2 in Figure 1) monitors C₃= and C₄= before they enter the secondary absorber. This is to help reduce the loss of valuable olefins into the fuel gas stream and more into the lean oil still and the alkylation unit.

The third process gas chromatograph (AX #3 in Figure 1) measures C₂= and C₃= in the overhead stream leaving the secondary absorber to prevent the loss of olefins into the fuel gas stream.

Another process gas analyzer is used to measure the C4s in the bottom stream leaving the secondary absorber. The measurement provides feedback to help minimize the recycling of light gases back to the FCC Main Fractionator.

The last two typical measurement points are the overhead and bottom streams of the lean oil still. The analyzer on the overhead stream (AX #5 in Figure 1) is to help minimize the impurities in the feed to the alkylation unit. The analyzer on the bottom stream (AX #6 in Figure 1) is to help control the amount of butanes in the gasoline stream which controls the gasoline's RVP. A summary of these applications can be seen in Figure 2.

The Emerson Solution

Emerson has a long history of providing process gas chromatographs to the refining industry. Emerson's process gas chromatographs have set the standard for online process measurement by supplying analyzers that are both robust and capable of handling the analytical requirements.

Table 1 - Summary of Process Gas Chromatograph Applications in a Typical Refinery Fluid Catalytic Cracking Vapor Recovery Unit

Analyzer #	Stream	Components Measured	Measurement Objective
1	Primary absorber bottom	C2 C3, C4	Minimize light gases in feed to alkylation unit
2	Primary absorber overhead	C3=, C4=	Minimize losses of olefins
3	Fuel gas	C2=, C3=	Minimize losses of olefins
4	Secondary absorber bottom	C4s	Minimize recycling of light gases
5	Lean oil still overhead	C2s, iC4	Reduce impurities in feed to alkylation unit
6	Lean oil still bottoms	iC4, nC4	Monitor Butane content to keep gasoline in RVP

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