# Improving Natural Gas Liquids Plant 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 on-line compositional measurements. One example of how process gas chromatographs are used for improving process operations can be found in natural gas liquids plants.

The liquids extracted from natural gas are an important source of feedstock for a number of other petrochemical processes. The ethane and propane are used as feed to ethylene plants and a refinery's alkylation unit uses the iso-butane. To separate these compounds from the natural gas liquids (NGL), a series of distillation towers is used to separate the methane, pentane and heavier streams into individual pure product streams.

## The Natural Gas Liquids (NGL) Plant

Since the various hydrocarbons in the NGL stream are easily separated by their boiling point, the NGL feed moves from one distillation (fractionator) tower to another. Each tower separates one of the hydrocarbon products and sends the remaining product on to the next tower (see Figure 1).

The product moves from the demethanizer tower where the methane is removed as the overhead product stream to the deethanizer tower for the ethane and on to the depropanizer tower for the propane.

Since there are two types of butanes in the NGL stream, it takes two towers to separate them into pure product streams. The first step is the debutanizer that separates the two butanes (iso-$C_4$ and the normal-$C_4$) from the remaining NGL stream. The $iC_4$ and $nC_4$ are then separated from each other in the $C_4$ splitter tower.

The $C_5$ and heavier components remaining in the NGL stream is typically left as a $C_5$+ product stream to be used in other processes such as refinery gasoline blending.

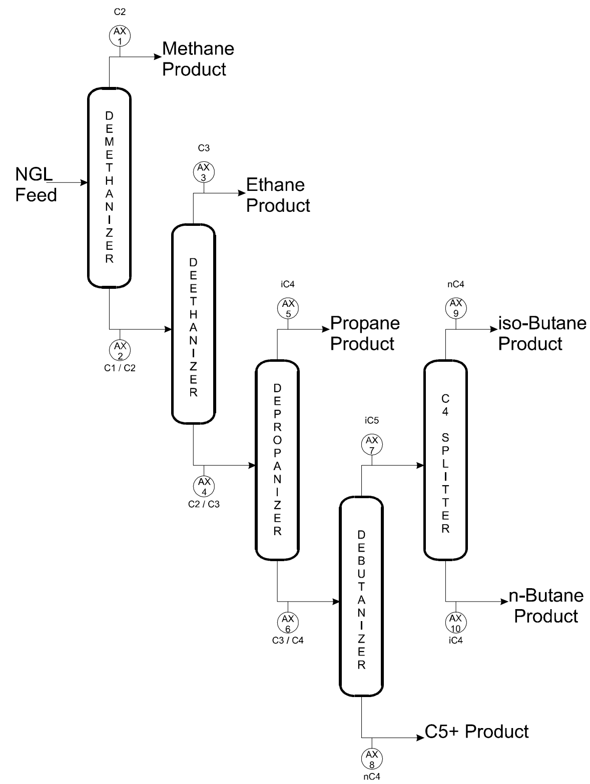


***Figure 1 - Flow Diagram of a Typical NGL Plant***

## Improving Unit Performance With Process Gas Chromatographs

An NGL plant uses a number of process gas chromatographs since they play such a critical role in optimizing the distillation tower operation as well as assuring that each of the product streams meet specifications. This is the primary role of the analyzers AX #1, #3, #5, #8, #9 and #10 as listed on Figure 1.

On the various bottom streams, it is necessary to perform a ratio analysis. For example, on the deethanizer tower, a process gas chromatograph typically monitors the ethane product for impurities such as $C_3$ to insure that the heavy impurities are kept within specification. However, measuring the lighter compounds like $C_1$ is pointless at this stage because it is lighter than the product being made and can't be kept out of the overhead stream no matter at what the reflux ratio is set. To control the lighter compounds in the overheads, they must be controlled in the feed stream before entering the tower. A ratio of the $C_1$ to $C_2$ on the bottom streams of the demethanizer is performed to compensate for the compositional changes that occur in the deethanizer tower (AX #2 in Figure 1).

This same ratio measurement is then done on the deethanizer bottom streams (AX #4 in Figure 1) and depropanizer bottom streams (AX #6 in Figure 1)

A summary of these applications can be seen in Figure 2.

### The Emerson Solution

Emerson has a long history of providing process gas chromatographs for the natural gas industry. Emerson's process gas chromatographs set the standard for on-line process measurement by supplying analyzers that are both robust and capable of handling the analytical requirements.

| Analyzer # | Stream | Components Measured | Measurement Objective |
|---|---|---|---|
| 1 | Demethanizer overhead | $C_2$ | Minimize $C_2$+ impurities in methane product |
| 2 | Demethanizer bottoms | $C_1$, $C_2$ | Minimize $C_1$ impurities in ethane product |
| 3 | Deethanizer overhead | $C_3$ | Minimize $C_3$+ impurities in ethane product |
| 4 | Deethanizer bottoms | $C_2$, $C_3$ | Minimize $C_2$ impurities in propane product |
| 5 | Depropanizer overhead | $iC_4$ | Minimize $iC_4$+ impurities in propane product |
| 6 | Depropanizer bottoms | $C_3$, $iC_4$ | Minimize $C_3$ impurities in iso-butane product |
| 7 | Debutanizer overhead | $iC_5$ | Minimize $iC_5$+ impurities in n-butane product |
| 8 | Debutanizer bottoms | $nC_4$ | Minimize $nC_4$ impurities in $C_5$+ product |
| 9 | $C_4$ splitter overhead | $nC_4$ | Minimize $nC_4$+ impurities in iso-butane product |
| 10 | $C_4$ splitter bottoms | $iC_4$ | Minimize $iC_4$ impurities in n-butane product |

***Figure 2 - Summary of Process Gas Chromatograph Applications in a Typical NGL Plant***



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