

# Improving Expander Gas 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 expander gas plants.

Natural gas supplies nearly one-fifth of all the energy consumed in the U.S. During its journey from the natural gas fields to consumers' homes and businesses, it travels through an intricate network of transmission and distribution pipelines that crisscross the countryside.

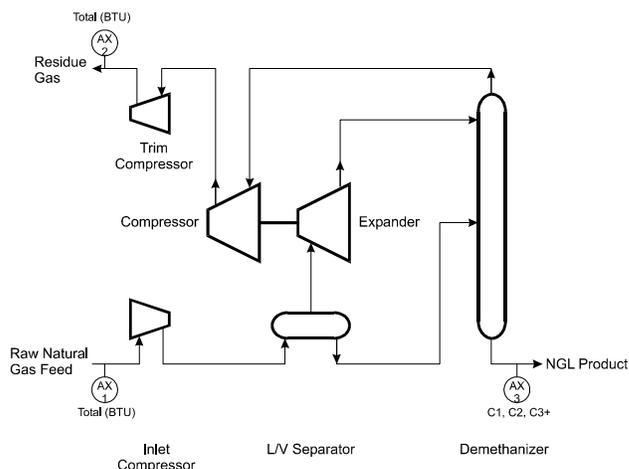
One of the first steps in the natural gas' journey is through a gas plant that straddles the pipeline extracting the heavier components for sale to chemical plants and returning a methane rich residue gas that becomes the natural gas with which consumers are familiar.

There are several different designs of natural gas plants in the world today but the most common design is the expander gas plant. Developed in the mid-1960s, it efficiently removes the ethane and heavier components from natural gas, which is often used as feedstock to chemical plants such as ethylene plants.

## The Expander Gas Plant

Before the raw natural gas is processed by the gas plant, it is treated to reduce  $H_2S$  and  $H_2O$  levels. This treated gas then enters the gas plant where it is often compressed to a higher pressure (see Figure 1). After compression, some of the heavier components will liquefy and are separated in a liquid/vapor separator. The liquids then continue on to the demethanizer while the remaining vapors will enter the expander.

In the expander, the pressure of the vapors is dropped dramatically resulting in a huge drop in the stream's temperature (less than  $-100^{\circ}F$ ). At these low temperatures, 90-95% of the ethane and heavier components will liquefy. Furthermore, the energy released during this expansion is used to recompress the final natural gas product by connecting the expander shaft to the compressor shaft.



**Figure 1 - Flow Diagram of a Typical Expander Gas Plant**

The stream from the expander enters a cryogenic demethanizer tower that separates the liquefied heavier compounds from the methane. The methane-rich stream leaves overhead and is recompressed to a pressure appropriate for the pipeline before leaving the plant. The natural gas liquids will leave the bottoms of the demethanizer as natural gas line product.

## Improving Unit Performance With Process Gas Chromatographs

The first two analysis points for process gas chromatographs (AX #1 and #2 in Figure 1), are a good example of using gas chromatographs for providing information on plant material balance. Part of the economics of the gas plant is to determine the BTU shrinkage across the plant. Measuring the BTU of the feed stream and then the residue product stream allows the BTU shrinkage to be calculated.

The third analysis point (AX #3 in Figure 1) is to measure the demethanizer bottom streams for the  $C_1/C_2$  ratio to get maximum recovery of the  $C_2$  without getting too much of the  $C_1$  as an impurity. If the stream is being sold as a product to a natural gas line plant, the stream may also measure the  $C_3$ ,  $C_4$  and  $C_5$  content.

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	Component Measured	Measurement Objective
1	Raw natural gas feed	Total (BTU)	Used to calculate BTU "shrinkage" across the plant
2	Residue gas product	Total (BTU)	Used to calculate BTU "shrinkage" across the plant
3	Demethanizer bottoms	$C_1, C_2$	Optimize control of the demethanizer tower

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

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#### Emerson Process Management

#### Rosemount Analytical Inc.

#### Process Analytic Division

1201 North Main Street

P. O. Box 901

Orrville, OH 44667-0901 USA

T 330.682.9010

Toll Free in US and Canada 800.433.6076

F 330.684.4434

e-mail: [gas.csc@EmersonProcess.com](mailto:gas.csc@EmersonProcess.com)

[www.processanalytic.com](http://www.processanalytic.com)

