

Natural Gas Industry Expander Gas Plant

Process Gas Chromatograph Application Note

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The Expander Gas Plant is an important step in the processing of raw natural gas into commercial products such as pipeline-quality natural gas and natural gas liquids (NGL). The Expander Gas Plant is designed to extract ethane and heavier constituents of the raw natural gas through a cryogenic distillation process. The operator of the gas plant is typically billed for the "shrinkage" across the unit which is the BTU decrease between the raw gas feed and the residue gas.

The first gas chromatograph analysis point is the feed to the gas plant to determine the composition of the gases and the amount of BTU's entering the plant. In addition to calculating the BTU, the analyzer also calculates the specific gravity, and gallons per thousand cubic feet of gas of compressible liquids.

This gas flows into a compressor to increase the pressure from about 500 psi to 800 psi and subsequently causes an increase in temperature. The increase in pressure causes heavier hydrocarbons to liquefy despite the increase in temperature.

The vapor-liquid mixture enters a separator that splits the mixture into a vapor stream and a liquid stream. The liquid is sent directly to the demethanizer and enters the middle section, and the vapor is directed to an expander. The expander is connected to a compressor by a shaft creating an expander-compressor system. The compressor will increase the pressure of the residue gas later on in the process.

The vapor leaves the split control valve and goes through an expander which decreases the pressure from about 800 psi to

150 psi. The decrease in pressure causes a sharp decrease in temperature. The sudden drop in temperature results in phase change from vapor to liquid. These liquids enter the top of the demethanizer column to give better separation. A trim reboiler (not depicted on the diagram) located on the NGL Product outlet stream facilitates heating changes to control the C_1/C_2 ratio in the bottoms outlet. An analysis point on the NGL Product outlet stream is needed to maintain an optimum C_1/C_2 ratio.

The overhead gas from the top of the demethanizer column is predominantly methane gas with some ethane and minimal propane and heavier hydrocarbons. The residue gas is brought back up to 500 psi through the compressor. The gas flowing through the expander of the expander-compressor system turns the shaft connecting the two, and the turning shaft is the driving force for the compressor. The gas then leaves the compressor and is trimmed to the pipeline pressure by the trim compressor.

The overhead residue gas is the final sample point in the gas plant where the hydrocarbon and BTU content is measured.

In summary, the operation of the expander gas plant is designed for ethane and heavier hydrocarbon recovery from raw natural gas. The expander gas plant expands high pressure gas thus dropping the pressure to cool it. The gas gets down to about 100 below zero to drop out C_2 and heavier liquids for passage down the pipeline and sales to NGL users.

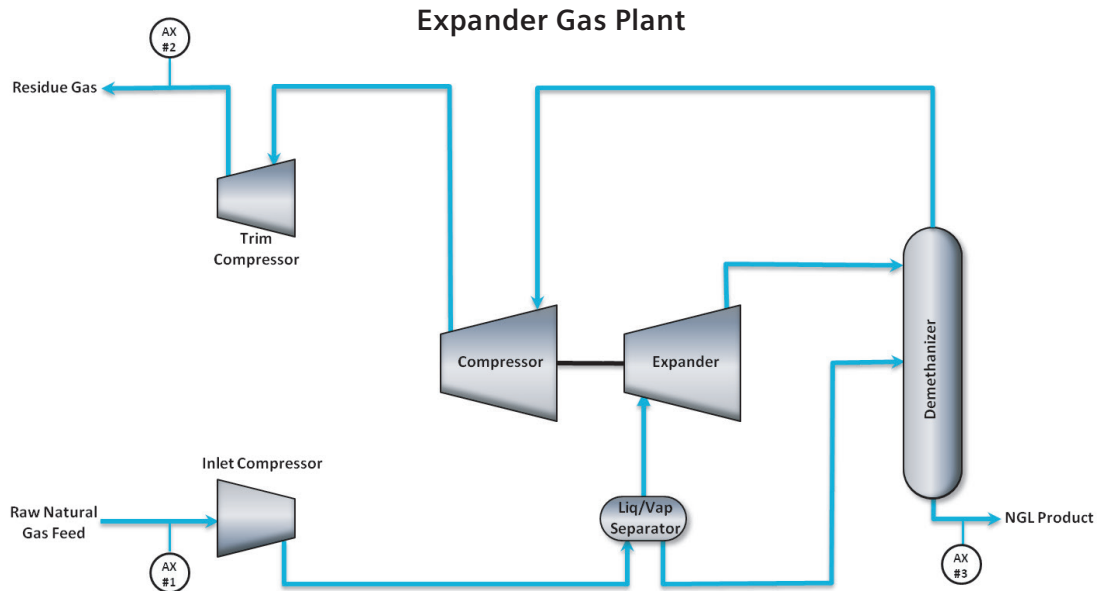
Typical GC measurements

The typical expander plant has three sites for analysis by a process gas chromatograph:

1. **Raw Natural Gas Feed** – this analyzer determines the feed composition and the amount of BTU's in the inlet stream.
2. **Residue Gas** – this analyzer determines the composition and the amount of BTU's in the outlet stream.
3. **Demethanizer Bottoms (NGL Product)** – this is a critical analyzer for the plant's efficient operation. By determining the C₁/C₂ ratio, the GC provides fast verification that the Demethanizer column is recovering the maximum amount of Ethane without exceeding the methane specifications.

Optional analyzer configurations:

- An optional analysis for GC #3 can be configured for the Demethanizer Bottoms (NGL Products) to determine the total composition of the outlet stream. While the optional configuration will not provide updates for the C₁/C₂ ratio as quickly, it does give the plant detailed NGL product composition information.
- Analyzers #1 and #2 can be combined into one analyzer. This configuration would have slower updates on their raw natural gas feed and their residue gas composition, but it will be a more cost effective solution for gas plants that have feed streams that does not change composition very quickly.



Analyzer No.	Stream	Components Measured	Measurement Objective
1	Raw Natural Gas Feed	Complete Analysis (BTU)	Determine BTU at inlet as well as optimize the plant's operation
2	Residue Gas	Complete Analysis (BTU)	Determine BTU at outlet as well as optimize the plant's operation
3	Natural Gas Liquids (NGL) Product Stream	C ₁ , C ₂	Maintain C ₁ to C ₂ ratio for optimum NGL recovery

For more information please contact:

5980 West Sam Houston Parkway North
Suite 500
Houston, TX 77041
713-939-7400
ProcessAnalyticsSales.industry@siemens.com

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Siemens Industry, Inc.
Process Automation
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100 Technology Drive,
Alpharetta, GA 30005
1-800-964-4114
info.us@siemens.com

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