Natural Gas Processing NGL Fractionation - Vapor Phase Samples

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Emerson Process Management's on-line chromatographs improve process control by providing measured results of composition in NGL fractionation facilities. The compositional data provided by the gas chromatograph in column overheads (gas-phase), column bottoms, and inlets (liquid phase) can be used to produce tighter overhead product specifications and reduce operating costs. This application addresses the analysis of vapor-phase samples produced from de-ethanizer inlets, overheads, and bottoms, and depropanizer and debutanizer overheads.

The Process

NGL (natural gas liquids) fractionation is a process used in gas processing plants to remove NGLs from natural gas. These NGLs are the ethane, propane, butane, and pentanes plus (natural gasoline) found in natural gas.

Liquid fractionation towers (columns) are used to separate and remove NGLs. They can be controlled to produce pure-vapor-phase products from the overhead by optimizing the inlet feed flow rate, reflux flow rate, reboiler temperature, reflux temperature, and column pressure.

The following process conditions in Table 1 and Table 2, typical of an NGL fractionation facility, serve as an example for design of a process gas chromatograph (GC) system. This type of information is required to properly quote the gas chromatograph and sample conditioning system.

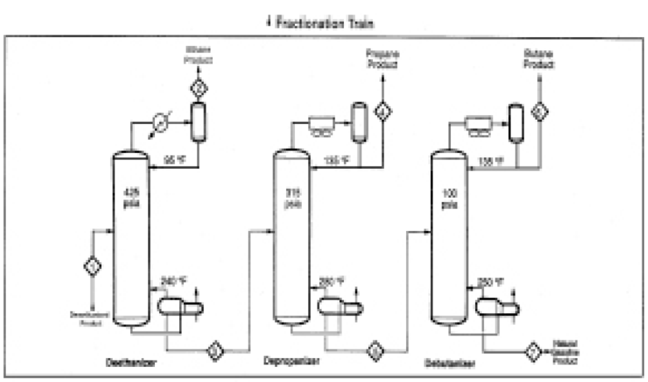

Figure 1

The Sample Conditioning System

One of the most important but overlooked facets of designing an online analytical system for gas processing facilities is the sample conditioning system (SCS). The sample delivered to the GC must truly represent the process media if the measurement is to be accurate and meaningful.

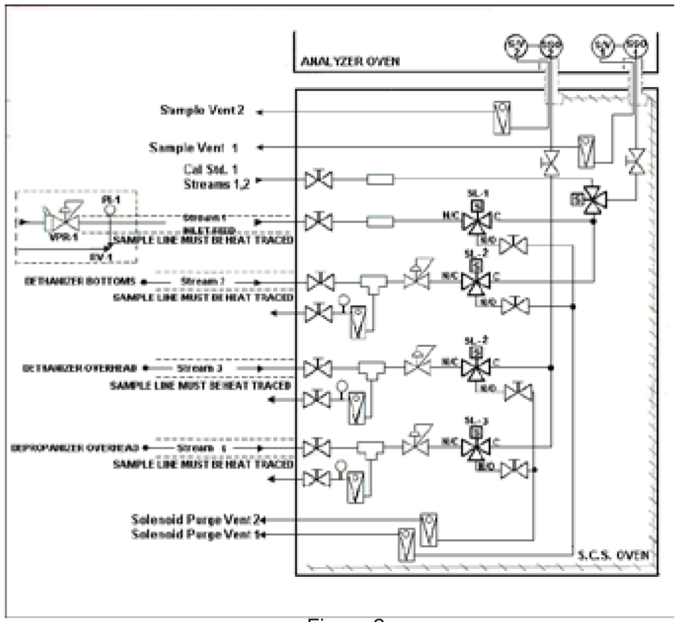

Figure 2

Component (mole %)	Inlet feed	De-eth over-hd	De-prop over-hd	De-but over-hd	De-eth over-hd	De-prop bottom	De-but bottom
Nitrogen	Trace	Trace	0	0	0	0	0
Methane	0-3%	0-2%	0	0	0	0	0
C02	0-3%	0-2%	Trace	0	0	0	0
Ethane	0-35%	0-100%	0-10%	Trace	0-10%	Trace	0
Propane	0-35%	0-20%	0-100%	0-55	0-60%	0-5%	Trace
Iso-Butane	0-15%	0-2%	0-5%	0-50%	0-20%	0-30%	0-2%
N-Butane	0-15%	Trace	Trace	0-70%	0-40%	0-50%	0-15%
Iso-Pentane	0-5%	0	0	0-2%	0-5%	0-10%	0-30%
N-Pentane	0-5%	0	0	0-2%	0-5%	0-10%	0-35%
Hexanes+	0-3%	0	0	Trace	0-10%	0-40%	0-55%

Table 1

Typical Stream Compositions (mole %)

Process Conditions	Inlet feed	De-eth over-hd	De-prop over-hd	De-but over-hd	De-eth over-hd	De-prop bottom	De-but bottom
Pressure at sample point	400 psig	30 psig	15 psig	20 psig	400 psig	260 psig	100 psig
Temperature at sample point	70° F (21.1° C)	95° F (35° C)	80° F (26.7° C)	130° F (54.4° C)	220° F (104° C)	260° F (126.7° C)	200° F (93.3° C)
Phase at sample point	Liquid	Vapor	Vapor	Vapor	Liquid	Liquid	Liquid
Ethane	Vapor	Vapor	Vapor	Vapor	Liquid	Liquid	Liquid
Propane	Vapor	Vapor	Vapor	Vapor	Vapor	Liquid	Liquid

Table 2
Typical Process Conditions

Samples may be transported to the GC in either gas or liquid phase, but they will ultimately be analyzed in the gas phase only. Selection of sample location and careful attention to sample phase (liquid or gas) is required to ensure optimum system performance.

Gas Chromatograph Location

The gas chromatograph should be located as close to the sample point as possible to allow for short sample transport lines. GCs requiring instrument air for air-bath ovens frequently force a compromise between the location of the analyzer building and available site space to locate the building. The GC location will determine the sample system lag time, which can account for the majority of the overall system lag time.

There is a trade-off between cost and analytical speed when considering the location of a common analyzer building. Sample transport time (lag time) can introduce a large delay into the response of the analytical system. The best solution for minimizing sample lag time is to reduce the volume of sample in the transport lines and the sample conditioning system. By minimizing the volume, the velocity at which the sample travels can be increased. Shorter sample lines and smaller diameter tubing (1/8 inch from 1/4 inch) both help to reduce sample volumes.

Vaporizing liquid samples will reduce the sample volume and increase the sample velocity a great deal. Once a liquid or heavy vapor phase sample has been vaporized, the sample transport tubing must be heattraced. There is a trade-off in terms of installation costs; heat tracing can be costly when multiple sample lines travel several hundred feet. Installation costs for liquid sample lines are substantially less than for heat-traced vapor-phase sample lines. The trade-off, however, is in the decision to preserve NGL product. Liquid phase sample transport lines carry a much greater volume of sample that may have to travel at higher flow rates and bypass the GC to minimize lag time. If this liquid bypass cannot return to a low pressure in the process it may have to return to the flare line. It may be considered wasteful to return it high volumes of on-spec products to the flare stack.

An alternative solution is to locate the GCs outdoors close to the sample point, rather than in a central analyzer building. This can greatly reduce the volume of sample in the sample transport lines which increases the speed of the overall system and minimizes the volume of sample that may have to return to the flare line. Additionally, installed costs are reduced.

Environmental Testing

Emerson extensively utilizes environmental temperature chambers for quality-control testing. Every GC manufactured must operate to specification in a walk-in environmental test chamber that cycles between 0° F and 130° F (-18° C and 54° C) for a minimum of 24 hours. This improves the reliability of chromatographs mounted in temperature-controlled environments by detecting premature component failures. It also allows the end user to mount GCs in outdoor environments with confidence knowing that the GC has actually been tested to ensure that it still meets performance specifications in temperature extremes.

This process of hardening the equipment for outdoor mounting can allow the end user to vastly reduce the installed costs associated with buildings and temperature control. These buildings can often cost as much as the GCs themselves. When viewed from the perspective of installed cost and long-term cost of ownership, Emerson’s GCs offer significant reductions in cost due to the increased reliability over the long term. No other manufacturer performs temperature testing as a routine Routine quality control procedures in manufacturing require that GCs operate on calibration gas in environmental chambers for 24 hours. Temperature is cycled in the chambers from 0-130° F (-18-54° C) to verify that GC performance specifications are met prior to shipment. This process hardens the GC for tough outdoor installations. step in the manufacturing process on all GCs shipped. Emerson performs this function from 0-130° F (-18-54° C) over 24 hours on all GCs shipped (both the Daniel® Danalyzer and Rosemount Analytical® brands), which is how we support our claim to be able to operate reliably in harsh environments.

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