

# Custom Solutions Group LLC

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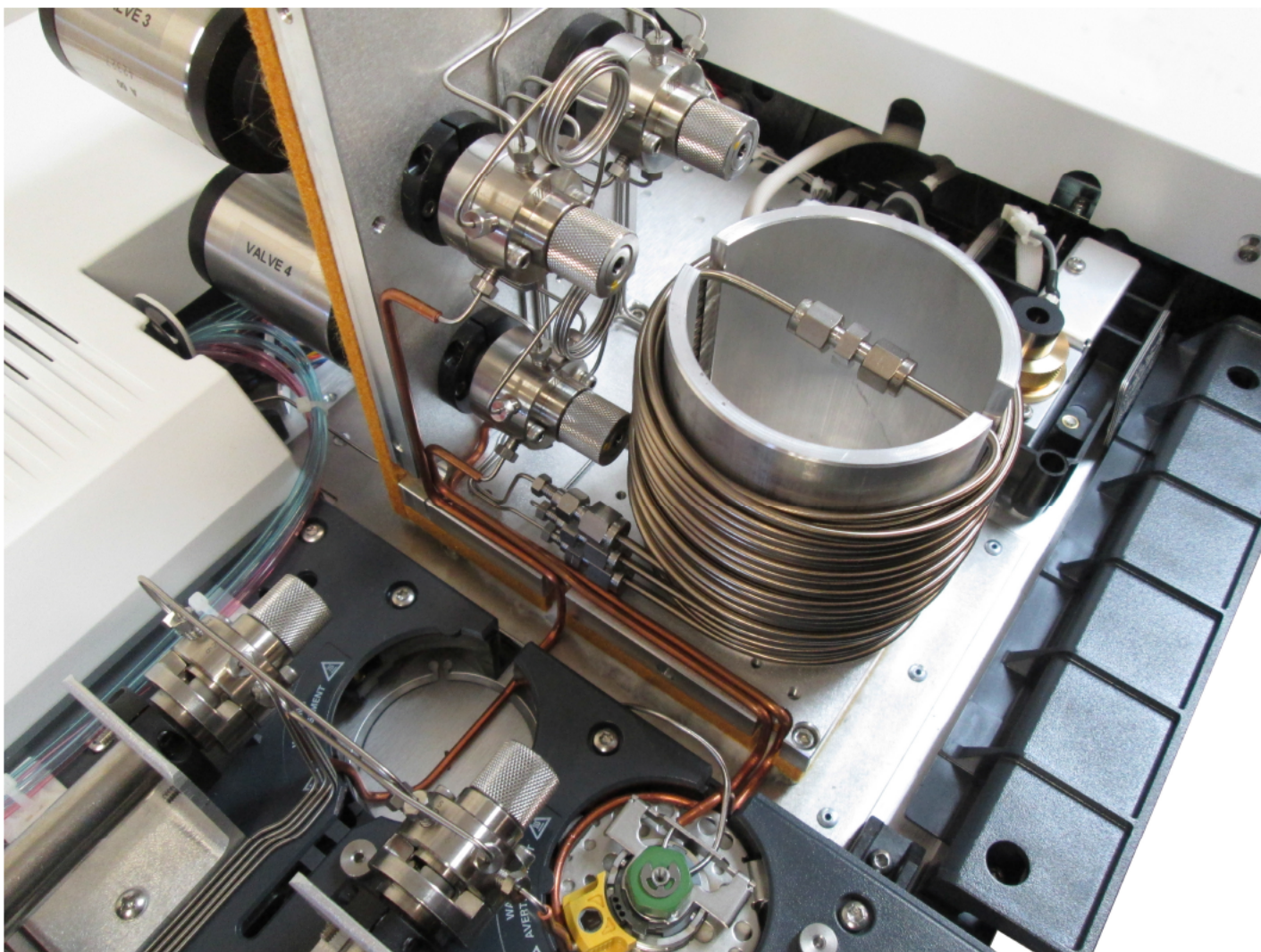
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## Natural Gas and Natural Gas Liquids

Custom Solutions Group LLC provides a wide variety of high quality solutions in natural gas and natural-gas-liquids gas chromatography. Our natural gas and natural-gas-liquids analyzers meet and exceed industry standard methods from the GPA (Gas Processors Association), ASTM (American Society of Test and Measurement), UOP (Universal Oil Products), and ISO (International Standards Organization).

Analysis types include early re-group gas, early re-group liquid, extended analysis gas, extended analysis liquid, combinations of early re-group and extended analysis, acid gases, trace sulfur analysis, and rapid analysis. All systems emphasize simplicity, serviceability, functionality and the highest quality construction, Made-in-the-U.S.A.



## Early Re-Group Gases and Liquids

The most basic early re-group analysis of natural gas (C6+ or C7+) can use as little as one valve. This not only enhances serviceability and lowers costs, it also makes this design applicable to single-channel, smaller-footprint, less-expensive GC models. Moreover, early re-group models of gas and liquid use GPA-standard column combinations of DC200/500 on Chromasorb P, making results more defensible while avoiding the complexity of systems with more valves, more valve switching, more columns, and multiple detectors. For early re-group models, only one detector and only one GC supply gas are used.

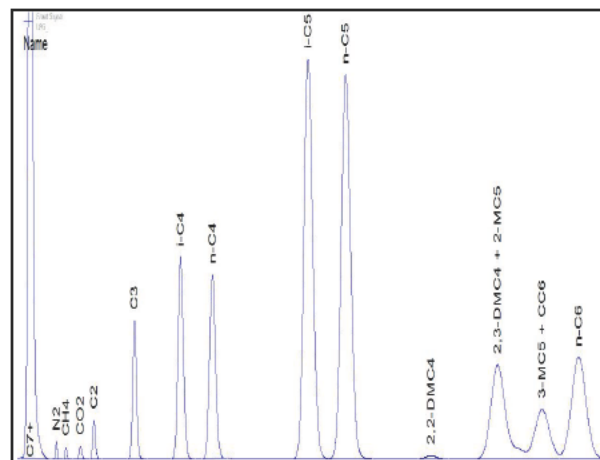
New hydraulic fracturing production techniques mean that liquid samples are getting heavier and heavier. Custom Solutions Group natural-gas-liquids analyzers meet this need by pulling the high-concentration C7+ peaks away from backflush valve switch, making clean, repeatable, and linear calculation of a wide variety of C7+ concentrations possible. Nitrogen, too, is well separated from the high concentration C7+ peak. Liquid analyzers come standard with a high pressure on/off valve and high pressure clear-view-tube on the Liquid Sample Out, so you can be sure that you have a single phase liquid sample with no flashing to gas and the most precise liquid results.

Because of the use of GPA standard column sets, it is possible to run gases and liquids on the same column sets with the same detector. Oxygen and nitrogen separation, as well as the analysis of hydrogen sulfide, can also be added to a single channel from a single injection, providing a complete suite of results from a single run. A second TCD channel on argon or nitrogen carrier can handle gas samples with helium and hydrogen.

Custom Solutions Group early re-group analyzers meet or exceed the performance criteria as specified in GPA 2261, GPA 2177, and ASTM D1945.



**Figure 1 – Liquid Sampling Valves and Liquid View Tube**



**Figure 2 – C7+ Chromatogram A**



**Figure 3 – Auxiliary Valve Oven DC200/500 Column Set**



## Extended Analyses of Gases and Liquids

Custom Solutions Group's extended analyzers are truly extended analyzers. Instead of grouping heavies or only identifying normal paraffins, Custom Solutions Group makes detailed identifications of complex C6+ fractions per GPA methodology, commonly up to seventy five peaks. Curve response factors, manual response factors, and unidentified response factors are accurately defined and double-checked, and analyses may be performed for gas or liquid samples on the same channel with the same program. This greatly simplifies the work of the natural gas analyst.

These days, because of hydraulic fracturing techniques, extended analysis is not just limited to light fractions, natural gasoline, and natural gas condensates. Heavier fractions must also be analyzed. Heavies beyond C12 are grouped by carbon number, and Custom Solutions Group can provide designs and strategies to handle the heavier samples. This means that lighter fractions and heavier fractions can be run on the same channel of the same machine without carry-over problems from heavy to light samples.

Most extended analyses are combined with early re-group analyses to provide a complete set of answers via TCD and FID. Calculations for the C6+ fraction can be combined, kept separate, or bridged by means of bridging components. The heaviest of liquids with high carbon dioxide content can also be analyzed for dissolved gas. When extended and early re-group analyses are combined, Custom Solutions Group keeps the packed columns sets and the capillary columns in separate temperature zones. The packed columns are run isothermal for the best TCD baseline stability. Capillary columns are run via column oven temperature programs. All packed columns are installed on mandrels for direct and consistent heating across the length of the column. Changes to the column oven program do not affect packed column separations. No other supplier provides such a complete set of solutions.

Custom Solutions Group's extended analyzers meet or exceed the requirements of GPA 2186 and GPA 2286.

## Acid Gases

Acid gases, gases high in hydrogen sulfide and carbon dioxide, pose a unique challenge. Separations and materials are modified to address these types of samples. Normally, this means that Valco valves and sample wetted tubing will be in Hastelloy C22, for maximum inertness and the longest life. If necessary, nickel filaments can also be used on the TCD.



Figure 4 – Extended Analysis Column



Figure 5 – Acid Gas and Trace Sulfur Auxillary Oven

## Trace Sulfur Analysis

Custom Solutions Group uses a variety of sulfur-specific detectors for speciation of trace sulfur compounds in natural gas and natural-gas-liquids. Normally, these sulfur-specific detectors include: FPD (Flame Photometric Detector), PFPD (Pulsed Flame Photometric Detector), and SCD (Sulfur Chemiluminescence Detector). Each of these detectors has advantages and disadvantages. Custom Solutions Group listens and studies the customer's need to understand which detector is most appropriate in each situation. Hydrogen sulfide, carbonyl sulfide, sulfur dioxide, mercaptans (thiols), and sulfides are commonly analyzed. Trace sulfur systems feature all silcosteel sample wetted lines, for maximum inertness to trace sulfur species, and column-specific separations. Column-specific separations are used because of FPD and PFPD quenching effects caused by the hydrocarbon matrix. Quenching can also be seen on recent models of the SCD, due to incomplete combustion of high purity hydrocarbon matrices, especially with large injection volumes. Either way, strategies are used to ensure both hydrogen sulfide and carbonyl sulfide are accurately and precisely measured down to double-digit and single-digit ppb levels without interference from C1 to C4 hydrocarbons, and instead of two detectors, only one detector is needed for a complete suite of results.

Custom Solutions Group's trace sulfur analyzers meet or exceed requirements of GPA 2199, ASTM D5504, ASTM D6228, and ASTM D5623.

## Rapid Analysis

Custom Solutions Group provides alternative rapid analysis solutions for the analysis of natural gas and natural-gas-liquids. These solutions feature micro-packed columns at isothermal temperature, backflush-to-vent techniques to speed analysis, and direct, straight-through injection using ultra-micro-bore boiling point columns. Run times are set to be as fast as Micro GC, without the disadvantages of Micro GC, such as: (1) the inability to run heavy, wet, or highly acidic samples, (2) closed loop non-linearity, (3) plugging of the injection wafer, and (4) expensive repair and replacement costs. In fact, Custom Solutions Group rapid natural gas and natural-gas-liquid analyzers can either run: (1) detailed extended analyses, without the need for carbon number grouping, in much less time than standard GPA methodology, or (2) carbon number groupings of the C6+ fraction in a matter of minutes, as per Micro GC methodology.

## Reporting

Custom Solutions Group has used a variety of reporting packages for the calculation of natural gas and natural gas-liquid results. Our preference is for Diablo Analytical's EZReporter NatGas Edition Software. EZReporter, which works in conjunction with a variety of chromatography data systems, provides individual and total results per physical constants from GPA 2145, TP-17, the GPSA Engineering Databook, ISO 6976, ASTM D3588, and ASTM DS 4B. Peak tables are user configurable, extended reporting can be used or not used, results can be bridged across multiple detectors, and calculations can be made for mole percent, weight percent, and liquid volume percent. Single or multiple channels of data can be normalized to 100 percent. Results can be exported to text files, and PDF reports can be automatically generated. Formulas to make additional calculations are user-configurable. Results from moisture analyzers, total sulfur analyzers, and Drager tubes can be included in the results table. Report formats are easily customized. (See Figure 6).

## Conclusion

Custom Solutions Group offers the widest variety of high quality solutions in natural gas and natural-gas-liquids gas chromatography. Custom Solutions Group analyzers feature simplicity, serviceability, functionality and the highest quality construction, Made-in-the-U.S.A.

Figure 6 – Customer Gas Analysis Report

## Sample Information

	Sample Information
Sample Name	GPA STD
Operator	System
Method Name	GPA 2177 C7+ Liq.met
Injection Date	2012-10-20 10:44:34
Report Date	2012-11-02 02:49:33
EZReporter Configuration File	C7+ Liquid Armstrong.cfg
Source Data File	GPA STD028.dat
NGA Phys. Property Data Source	GPA Standard 2145-09 (FPS)

## Calculated Values

Result	Value
Total BTU / Lb.	20965
Total BTU / Gal.	111068
Total Molecular Weight	75.246
Total Vapor Pressure (psia)	49.77
Total Specific Gravity at 60 DegF (Water=1)	0.6355
Total Lbs. / Gal. (Absolute Density)	5.298
Total Cu.Ft. / Gal. at 14.65 Psia, 60 DegF	26.8033
Total API Gravity at 60 DegF	91.17

## Component Results

Component Name	Mol%	Wt%	LV%
Nitrogen	0.3331	0.1240	0.0977
Methane	0.3283	0.0700	0.1483
Carbon Dioxide	0.3283	0.1920	0.1493
Ethane	1.0160	0.4060	0.7242
Hydrogen Sulfide	0.0000	0.0000	0.0000
Propane	3.9504	2.3150	2.9006
i-Butane	6.9702	5.3840	6.0788
n-Butane	6.9612	5.3770	5.8489
i-Pentane	19.8917	19.0730	19.3880
n-Pentane	19.8615	19.0440	19.1877
2,2-DMC4	0.2113	0.2420	0.2351
2,3-DMC4 + 2MC5	6.5382	7.4880	7.1392
3MC5 + CC6	6.7478	7.7280	7.3350
n-Hexane	7.6211	8.7280	8.3523
Heptanes Plus	19.2409	23.8290	22.4149
Total:	100.0000	100.0000	100.0000

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Agilent Technologies

Channel Partner