PAC | Application Note

Alternative Carrier Gasses for AC Hi-Speed Refinery Gas Analyzer

- Lower Cost of Operation
- Easy switch on existing systems
- No Hardware changes
- Same system performance

Keywords: Carrier, Hydrogen, Nitrogen

INTRODUCTION

Nowadays labs chromatographers are more and more likely to choose alternative carrier gas instead of helium like hydrogen and nitrogen. This decision is driven by increasing helium prices and supply shortage issues. Helium prices on average are approximately 6 times that of hydrogen and multiple times for nitrogen, and with the price for helium expected to increase with an estimated 10-15% year over year, the benefits are easy to see. An average lab employing 5 to 10 GC systems may save thousands of dollars per year in operating cost just by changing carrier gas to nitrogen or hydrogen. This application note describes the use of nitrogen and hydrogen as carrier gas for the AC Hi-Speed analyzer without any hardware modifications and a runtime within 8 minutes.

HIGH SPEED REFINERY GAS ANALYSIS

Refinery gas streams vary considerably in composition. Determining individual components of each gas stream is a challenge. An exact measure of stream components is essential in achieving optimum control and assuring product quality. AC Analytical Controls offers the Hi-Speed Refinery Gas Analyzer, the high speed solution that determines and reports the composition of refinery gas streams

The AC Hi-Speed RGA system contains six columns and is subdivided into three separate analytical channels:

- The first channel separates the hydrocarbons on the PLOT column, using the FID for detection
- The second channel determines helium and hydrogen, using the TCD for detection
- The third channel is used to determine the permanent gasses: oxygen, nitrogen, carbon monoxide and carbon dioxide (and hydrogen sulfide), using a second TCD for detection GAS^{XLNC} software is used for its advanced calibration and reporting options

Figure 1. AC Hi-Speed analyzer

Alternatives for helium carrier gas on AC Hi-Speed Analyzer

In the standard configuration helium carrier is used on the first (hydrocarbons) and third channel Perm. Gases). The second channel (H2/He) uses nitrogen as carrier gas.
In the Alternative configuration, the “hydrocarbon” channel carrier is changed to Nitrogen, and the Perm Gases channel the carrier gas is changed to hydrogen. The second channel remains on Nitrogen Carrier, there is no real benefit in change.

		Description	Standard carrier	Alternative carrier	Remarks
Channel	1	Hydro-carbons	Helium	Hydrogen	• Possible Hydrogenation of Olefins • Faster
				Nitrogen	• Slightly Longer runtime (± 8 minutes). • Good separation
	2	Hydrogen / Helium	Nitrogen	n.a.	• No need to change the carrier gas
	3	Permanent gasses	Helium	Argon	• Possible as carrier, but sensitivity for hydrogen affects nearby eluting component oxygen. • Need hardware changes to achieve the same lower detection limits
				Hydrogen	• Good alternative. • No changes to system • Minimum risk in safety as micro packed columns are used. The column and valve box are housed in a in a ventilated left side. • TCD on hydrogen is very sensitive to surrounding atmospheric changes (people walking by). TCD vent needs to be stabilized • Total vented hydrogen flow is ± 45 ml/min. Good ventilation of the surrounding is a must

Table 1. Alternatives for helium carrier gas on AC Hi-Speed Analyzer

First Channel - Hydrocarbon Analysis on Nitrogen Carrier

Channel Performance Parameters
- Resolution: > 2.0
- Linear dynamic range: 0.01 – 100 mol%
- Repeatability: < 1%

Nitrogen is used as carrier gas. Nitrogen has a lower efficiency compared with helium under the same conditions. With nitrogen the runtime is increased from 5 minutes to 8 minutes with a minimum decrease in efficiency. All components are baseline separated

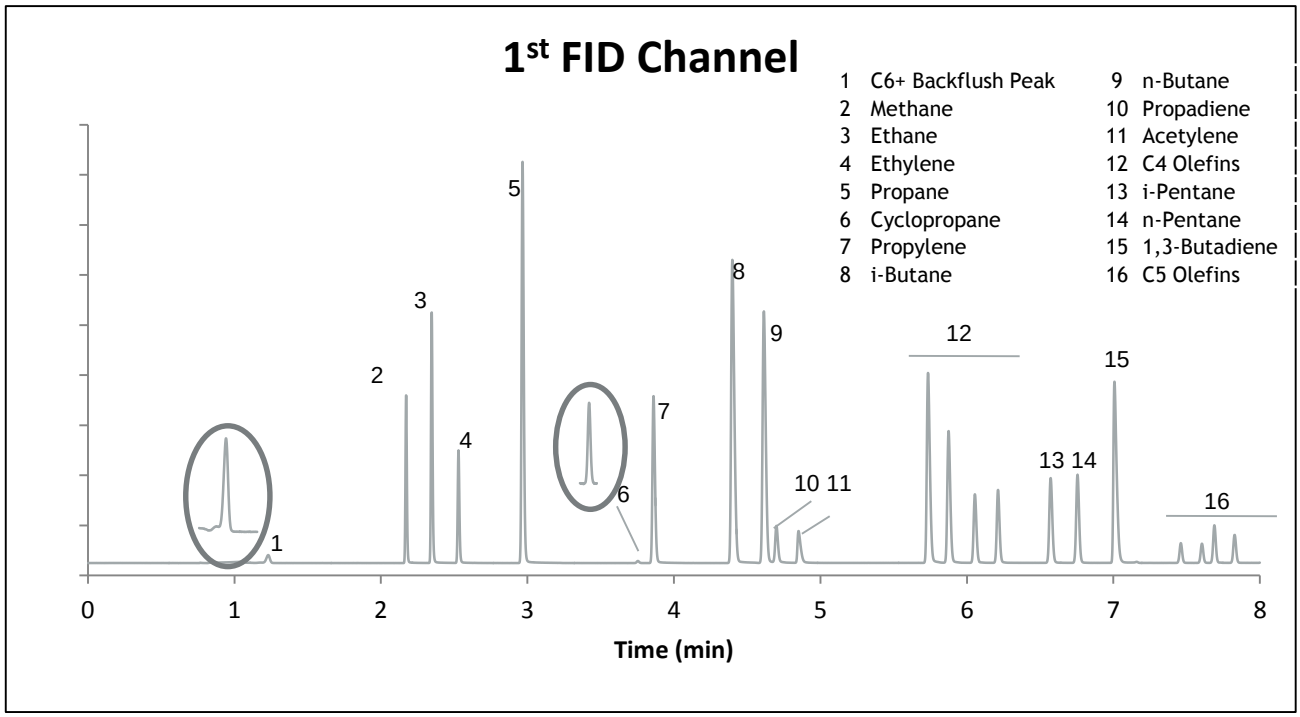

Figure 2 Chromatogram : Hydrocarbons on 1st FID channel

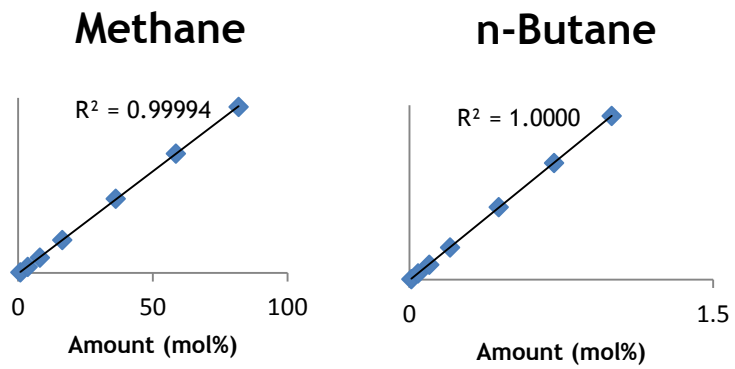

Figure 3 Linearity and resolution on 1st FID channel

RT	Compound	$R_{nitrogen}$	R_{helium}
1.231	C6+ Backflush Peak	-	-
2.172	Methane	29.7	27.5
2.347	Ethane	9.1	8.4
2.529	Ethylene	8.9	8.3
2.967	Propane	17.7	17.2
3.752	Cyclopropane	26.4	29.4
3.859	Propylene	3.3	3.7
4.399	i-Butane	14.5	15.3
4.613	n-Butane	5.3	5.9
4.697	Propadiene	2.2	4.2
4.844	Acetylene	4.0	6.1
5.732	t-2-Butene	22.2	20.7
5.872	1-Butene	3.6	3.8
6.051	i-Butylene	4.8	5.3
6.209	c-2-Butene	4.5	4.5
6.57	i-Pentane	9.8	9.6
6.754	n-Pentane	4.8	5.3
7.002	1,3-Butadiene	6.4	7.5
7.455	t-2-Pentene	12.1	11.7
7.599	2-methyl-2-Butene	4.2	4.5
7.684	1-Pentene	2.5	2.7
7.823	c-2-pentene	3.9	4.2

Second Channel - Hydrogen Analysis on Nitrogen Carrier

Channel performance Parameters
- Linear dynamic range: 0.01 – 100 mol%
- Repeatability: < 1%

There are no changes on this channel compared to the standard configuration in AC Hi-Speed analyzer

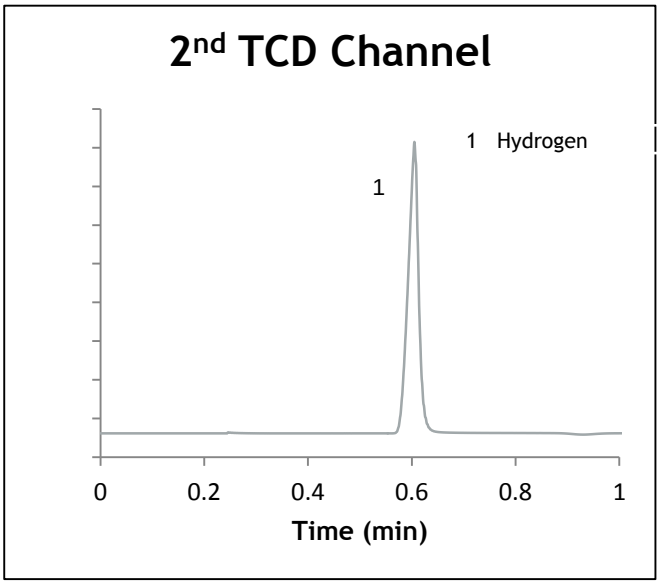

Figure 2 Chromatogram : Hydrogen on TCD channel

Third Channel – Permanent Gasses Analysis on Hydrogen Carrier

Channel performance Parameters
- Linear dynamic range: 0.02 – 100 mol%
- Repeatability: < 1%

On this channel hydrogen is used as carrier gas. With Hydrogen as carrier gas, the same performance parameters are achieved as when Helium is used as carrier gas

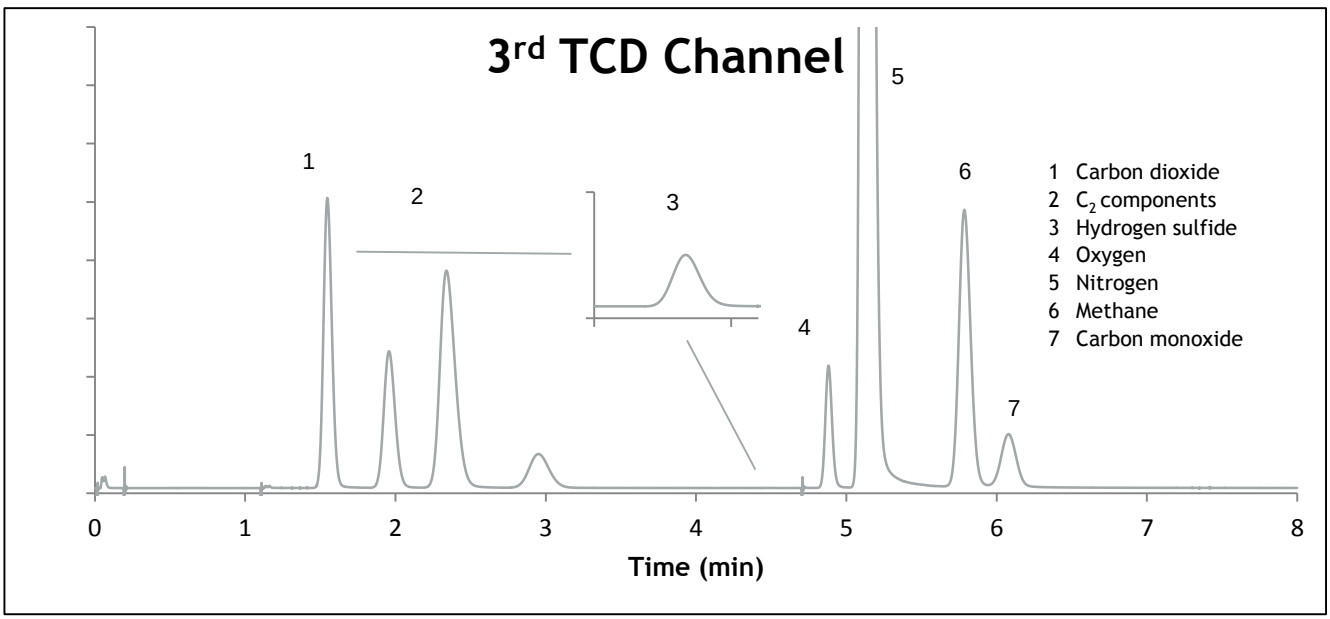

Figure 2 Chromatogram : permanent Gases on 3rd TCD channel

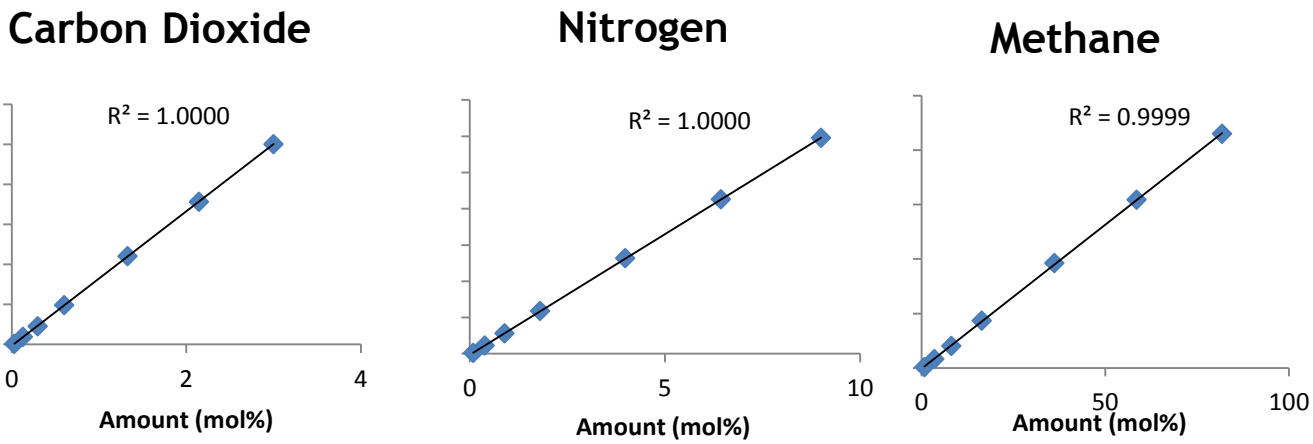

Figure 3 Linearity and resolution on 1st FID channel

Area	HS-RGA on H2/N2							
	1	2	3	4	5	6	Average	RSD%$_{n=6}$
C6+	12.6	12.4	12.6	12.6	12.6	12.8	12.6	**1.13**
Methane	115.9	116.6	116.2	116.2	116.2	116.0	116.2	**0.21**
Ethane	186.3	187.4	186.8	187.6	186.8	186.5	186.9	**0.28**
Ethylene	91.7	92.1	91.8	92.3	91.8	91.7	91.9	**0.25**
Propane	416.4	418.7	417.4	419.1	417.5	416.8	417.7	**0.25**
Cyclopropane	2.4	2.5	2.5	2.5	2.4	2.5	2.5	**0.67**
Propylene	206.3	207.5	206.9	207.6	206.8	206.5	206.9	**0.25**
i-Butane	464.8	467.4	466.0	467.9	466.1	465.3	466.3	**0.26**
n-Butane	376.6	378.7	377.7	379.1	377.7	377.0	377.8	**0.26**
Propadiene	53.1	52.9	52.6	52.8	52.7	52.5	52.7	**0.42**
Acetylene	49.7	49.8	49.7	49.9	49.8	49.6	49.8	**0.19**
t-2-Butene	280.1	281.6	280.7	281.9	280.7	280.3	280.9	**0.25**
1-Butene	187.6	188.5	188.0	188.7	188.0	187.7	188.1	**0.25**
i-Butylene	92.4	92.8	92.6	93.0	92.6	92.5	92.6	**0.23**
c-2-Butene	95.9	96.4	96.2	96.4	96.0	96.0	96.2	**0.23**
i-Pentane	122.1	122.7	122.4	122.9	122.3	122.1	122.4	**0.25**
n-Pentane	123.1	123.8	124.0	124.4	123.8	123.5	123.8	**0.36**
1,3-Butadiene	280.5	281.9	281.1	282.2	281.0	280.6	281.2	**0.24**
t-2-Pentene	24.7	24.9	24.9	25.0	24.8	24.8	24.9	**0.43**
2-methyl-2-Butene	24.2	24.3	24.3	24.4	24.3	24.3	24.3	**0.23**
1-Pentene	48.4	48.6	48.5	48.7	48.5	48.4	48.5	**0.26**
c-2-pentene	37.0	37.1	37.1	37.2	37.0	37.0	37.1	**0.24**
Hydrogen	2226.0	2218.6	2217.5	2218.0	2216.7	2217.2	2219.0	**0.16**
Carbon Dioxide	988.6	985.6	982.9	983.4	981.9	980.6	983.8	**0.29**
Oxygen	328.7	328.6	328.9	328.9	328.9	328.9	328.8	**0.04**
Nitrogen	12188.0	12176.8	12175.7	12174.4	12170.7	12167.6	12175.5	**0.06**
Carbon Monoxide	342.2	341.8	341.6	340.2	342.6	340.9	341.6	**0.25**

Table 2 Repeatability of Hi-Speed RGA with Hydrogen and Nitrogen carrier

CONCLUSION

Nitrogen (front channel) and Hydrogen (aux channel) can be effectively used as alternative to Helium on the AC Hi-Speed Refinery gas analyzer. Chromatography is a slightly slower, but data quality is comparable.

Changing carrier gasses to Nitrogen and/or Hydrogen can significantly lower the cost of operation. As demonstrated this may be done without compromise to data quality.

AC Analytical Controls® has been the recognized leader in chromatography analyzers for gas, naphtha and gasoline streams in crude oil refining since 1981. AC also provides technology for residuals analysis for the hydrocarbon processing industry. Applications cover the entire spectrum of petroleum, petrochemical and refinery, gas and natural gas analysis; ACs Turn-Key Application solutions include the AC Reformulyzer® , DHA, SimDis, NGA, Hi-Speed RGA and Customized instruments.