

Application Note # CA-270386

Refinery Gas Analysis with the Bruker Rapid RGA Analyzer

Introduction

The source and composition of refinery gases varies considerably. Typical sources include atmospheric or FCC (Fluid Catalytic Cracking) overheads, ethylene, propylene production, fuel gas, stack gas, and off gas from desulfurization. Measuring gas composition precisely and accurately is a significant challenge in today's refinery operations. Bruker's refinery gas analyzers (RGA) deliver superior, reliable results for a wide range of sources and analysis throughput requirements. This note describes the performance of the Rapid RGA Analyzer.

Instrumentation:

Bruker's Rapid RGA Analyzer is based on a 450-GC gas chromatograph and consists of three independent analytical channels. Figure 1 depicts a configuration scheme.

Data handling and GC control software: Galaxie™ Chromatography Software from Bruker.

Materials and reagents

A synthetic refinery gas obtained from Scott Specialty Gases is used. Composition and peak identification numbers are listed in Table 1.

Results and discussion

The Rapid RGA Analyzer is a 3-channel multi-valve, multi-column system. Each channel operates independently with the sample line connected in series. The sample is sent through the three sample loops feeding the three GC channels. In the first channel, a hydrocarbon channel, the sample is directed over a HayeSep Q column designed for hydrocarbons. The non-hydrogen part is back flushed. The hydrogen is directed through a Bruker Molsieve column to the detector.

The repeatability of this channel is very good (Table 2). The second channel analyzed the permanent gases, methane, the C2 hydrocarbons, and H₂S, using a HayeSep N column. The other components are back flushed to vent, while the components of interest are directed to the HayeSep Q column.

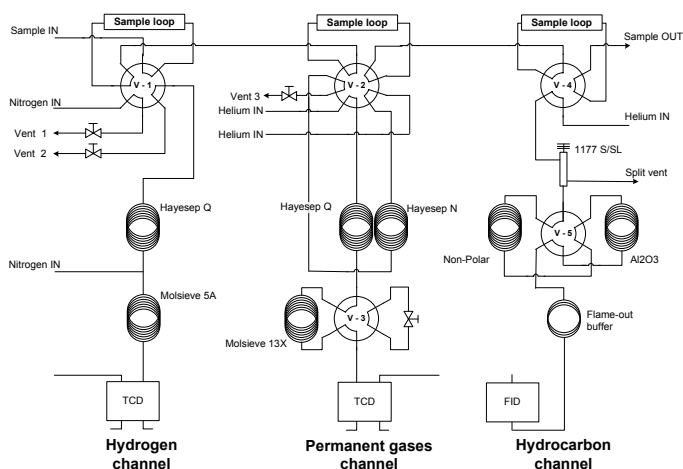


Figure 1: Plumbing scheme for the Rapid RGA analyzer.

Table 1: Composition of test gas.

Peak	Component	%	Peak	Component	%
1	Hydrogen	1.00	14	Propylene	5.00
2	Carbon Dioxide	1.00	15	iso-butane	0.50
3	Ethylene	24.90	16	n-Butane	1.02
4	Ethane	5.00	17	Propadiene	0.60
5	Acetylene	1.00	18	t-2-Butene	0.50
6	Hydrogen Sulfide	1.01	19	1-Butene	0.50
7	Oxygen	1.01	20	iso-Butene	1.01
8	Nitrogen	5.01	21	cis-2-Butene	0.50
9	Methane	24.90	22	iso-Pentane	0.50
10	Carbon Monoxide	0.51	23	n-Pentane	0.20
11	Hexane	0.20	24	1,3-Butadiene	1.00
12	Propane	5.10	25	Methyl Acetylene	1.01
13	Cyclopropane	0.50	26	Ethyl Acetylene	0.50

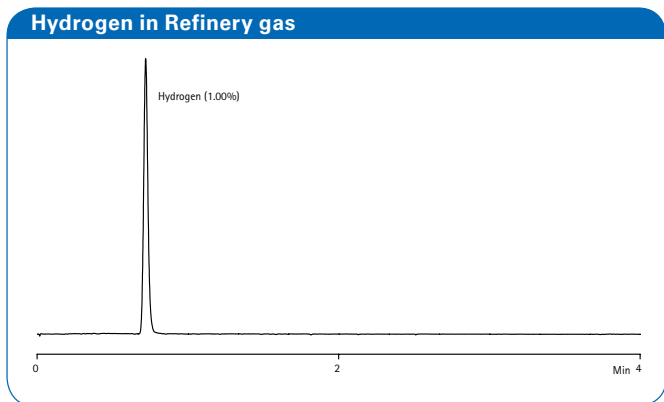


Figure 2: Hydrogen chromatogram of channel 1.

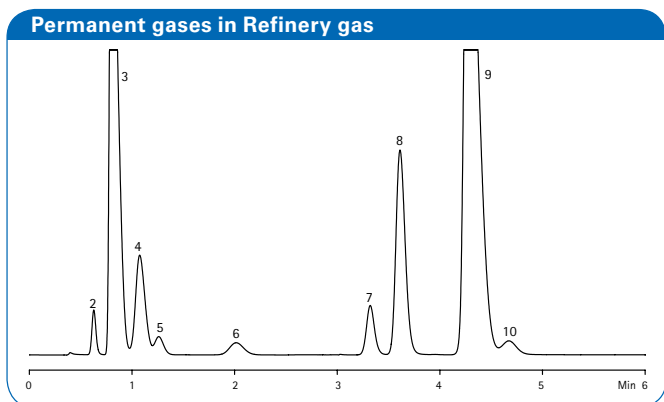


Figure 3: Permanent gases chromatogram from Channel 2.

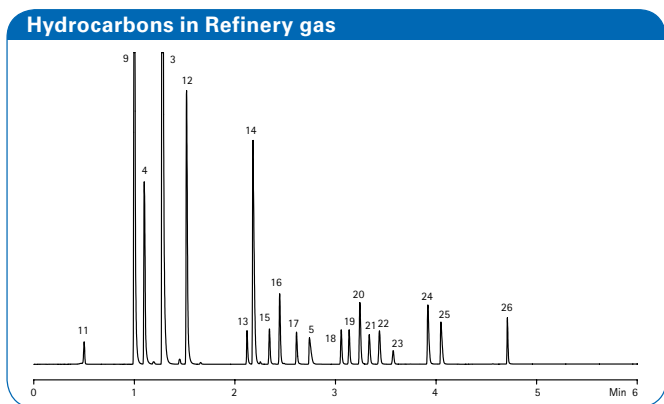


Figure 4: Light hydrocarbon chromatogram from Channel 3.

The first eluting components, oxygen, nitrogen, methane, and carbon monoxide, are directed onto the Molsieve column which is set in stop-flow. The C2 hydrocarbons and carbon dioxide are bypassed to the detector. After this, the Molsieve is set in flow and the oxygen, nitrogen, methane, and carbon monoxide are separated and analyzed. Figure 3 shows a chromatogram of the permanent gas channel. Repeatability figures of the hydrogen and permanent gas channel are presented in Table 2. With relative standard

Table 2: Repeatability figures of the hydrogen and permanent gas channel.

Run #	H ₂ S	O ₂	N ₂	CH ₄	CO
1	329758	460861	2164257	8802505	233196
2	330095	460963	2164781	8802455	233441
3	330213	460785	2164470	8800442	233281
4	331244	461228	2165522	8805445	234043
5	331026	461098	2164774	8802743	233449
6	331519	461323	2166141	8807302	233714
7	331707	461413	2166541	8808801	233359
8	332148	461180	2165513	8805236	233150
9	332013	461238	2166438	8808114	233668
10	331928	461227	2165983	8805622	233510
n	10	10	10	10	0
Avg.	331165	461132	2165442	8804866	233481
St.Dev.	866	203	832	2759	270
RSD	0.26%	0.04%	0.04%	0.03%	0.12%

Run #	CO ₂	C ₂ H ₄	C ₂ H ₆	C ₂ H ₂	H ₂
1	363151	8921956	1983567	312922	280554
2	363299	8921906	1983580	313761	280886
3	363371	8924268	1984014	313895	280755
4	362922	8923608	1983538	313380	280354
5	362936	8920738	1983399	312814	280739
6	363522	8924792	1984413	312555	281104
7	363492	8926882	1985327	313424	281072
8	363277	8926176	1984306	312911	280647
9	363649	8924905	1990275	312290	280694
10	363387	8924671	1990670	312348	280681
n	10	10	10	10	10
Avg.	363301	8923990	1985309	313030	280749
St.Dev.	240	1954	2783	565	226
RSD	0.07%	0.02%	0.14%	0.18%	0.08%

deviations of 0.3% and lower, the system is perfectly capable of analyzing these types of components. Light hydrocarbons are analyzed on the 3rd channel. When, upon injection, the C1 to C5 hydrocarbons elute from the non-polar column, the back flush valve is switched. The C6+ hydrocarbons are directed as a composite to the detector and the C1 to C5 hydrocarbons are flushed onto the Al₂O₃ column and separated as individual components. Repeatability figures for the hydrocarbon channel are shown in Table 3. With relative standard deviations around 0.3% for all components, the system is very capable of analyzing these components under these concentrations.

Conclusion

This note describes in detail the analysis scheme of the Bruker Rapid RGA Analyzer and the results obtained. With a relative standard deviation for most components around 0.3%, the Bruker Rapid RGA Analyzer is perfectly suited for the analysis of refinery gases of different sources.

Table 3: Repeatability figures of the hydrocarbon channel.

Run #	C6+	Methane	Ethane	Ethene	Propane	Cyclo-Propane	Propene
1	37740	775106	339487	1541087	458563	47210	452729
2	37686	775185	339404	1540138	458351	47187	451967
3	37646	773980	339005	1538039	458055	47101	451467
4	37667	774502	339063	1538985	458140	47183	451980
5	37601	772305	338081	1534779	456846	47000	450221
6	37673	773508	338623	1536998	457369	47091	451402
7	37668	773151	338617	1536325	457449	47108	451357
8	37627	774386	338898	1538160	457963	47114	451644
9	37734	773775	338656	1536893	457553	47096	451563
10	37647	773966	338863	1537935	457904	47146	451838
n	10	10	10	10	10	10	10
Avg.	37669	773986	338869	1537934	457819	47124	451617
St.Dev.	41	832	389	1746	488	58	602
RSD	0.11%	0.11%	0.11%	0.11%	0.11%	0.12%	0.13%

Run #	iso-Butane	n-Bu-tane	Propa-diene	Acety-lene	t-2-Butene	1-Butene	iso-Butene
1	58582	119725	49978	58422	58062	58657	117724
2	58465	119531	49956	58263	58029	58635	117613
3	58379	119470	49883	58135	57983	58650	117599
4	58548	119530	49840	57961	58018	58630	117651
5	58208	119116	49705	57948	57857	58481	117357
6	58443	119401	49802	57755	57923	58549	117423
7	58458	119389	49787	57516	57927	58545	117444
8	58475	119471	49773	57360	57982	58602	117510
9	58421	119388	49787	57396	57929	58528	117472
10	58519	119539	49776	57518	57934	58561	117486
n	10	10	10	10	10	10	10
Avg.	58450	119456	49829	57827	57964	58584	117528
St.Dev.	98	148	82	357	58	56	109
RSD	0.17%	0.12%	0.16%	0.62%	0.10%	0.10%	0.09%

Run #	cis-2-Butene	iso-Pentane	n-Pentane	1,3-Butadiene	Propyne	Butyne
1	58186	73064	28769	116795	85373	58636
2	58179	73027	28783	116764	85365	58665
3	58109	72968	28733	116638	85267	58574
4	58165	72911	28708	116683	85267	58566
5	57997	72789	28653	116411	84976	58450
6	58042	72902	28661	116631	85188	58559
7	58044	72816	28666	116608	85100	58536
8	58110	72934	28684	116706	85188	58563
9	58050	72823	28668	116548	85068	58522
10	58058	72914	28678	116609	85149	58531
n	10	10	10	10	10	10
Avg.	58094	72915	28700	116639	85194	58560
St.Dev.	63	85	44	104	121	57
RSD	0.11%	0.12%	0.15%	0.09%	0.14%	0.10%

Keywords

refinery gas
gas composition

Instrumentation & Software

Bruker's Rapid RGA Analyzer
Galaxie™ Chromatography Software

For research use only. Not for use in diagnostic procedures.

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