Full Refinery Gas Analysis in 200 seconds using the 19" Flash RGA

Wilco Agterhuis, Ronald Verbeek, G.A.S – Global Analyser Solutions.
Tinstraat 16, 4823 AA Breda, The Netherlands. T +31 (0)76 5411800. Email: info@gas-site.com. Website: www.gas-site.com

The Refinery Gas Analyser (RGA) analyses various streams of gases that are normally produced in an oil refinery. Examples are LPG, stack gases, flare gases, reformer gases and by-products of cracking and catalytic processes. The composition of these samples can vary considerably; it is a challenge to analyse different components like permanent gases, hydrocarbons and sulphur components in one sample correctly. An exact measurement is essential in reaching optimal control of refining processes and high product quality.

The Flash RGA delivers full analyses of a wide scope of sample streams in only 200 seconds. Complete characterisation is offered by fast analysis of 32 components. The instrument occupies little space, using the popular 19" standard industrial enclosure. The Flash RGA is based upon proven GC Technology like Valco® valves, robust GC detectors and standard available columns. The result is a very stable and reliable instrument.

Instrument Configuration

Refinery Gas Analysers can be found in many different configurations. The best approach is a no-compromise three channel instrument, because a wide range of components has to be analysed. One channel is dedicated to hydrogen, using TCD and argon or nitrogen as carrier gas. The thermal conductivity values of hydrogen and helium are almost identical and therefore the use of carrier gas helium would result in low sensitivity and a non-linear response curve for hydrogen. The second channel analyses all other permanent gases and C_2 hydrocarbons, using TCD and helium carrier gas. The third channel uses FID detection for detailed determination of hydrocarbons. A three-channel instrument might look complicated. But in practice it is more transparent compared to instruments with one detector and multi column switching. The three channels are simple and independent, making the setup for the instrument easy.

Several analysers based on CompactGC can be stacked in a 19" cabinet

Figure 1 shows the diagram of the Flash RGA. The analyser has 3 separate analysis channels; each channel has a back flush option to protect the separation column from high boiling components.

Channel 1 determines helium and hydrogen, using TCD detection.

On channel 2, the sample is injected on two columns. A delay column is added to prevent simultaneous eluting of both columns on TCD. Carbon dioxide, C_2-components and hydrogen sulfide are analysed, followed by oxygen, nitrogen, methane and carbon monoxide.

On channel 3, C_6+ is back flushed to the detector, eluting as the first peak in the chromatogram, before C_1-C_5 hydrocarbons. For this component group, FID is the preferred detector.

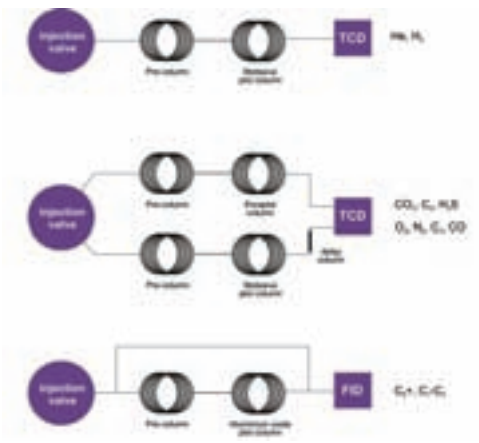

Figure 1: Flow diagram Flash RGA

Isothermal column temperatures are used for all channels. In this way, no additional cooling and conditioning time is needed, and the next analysis can be started immediately after the previous one. So cycle time equals run time.

All gas flows and pressures are digitally controlled. Robust Valco® valves are located in an independent heated valve compartment. Sample condensation is avoided in this way, and valve lifetime is enlarged. All channels have separate columns ovens, for optimal parameter setting, resulting in a short runtime. The analyser uses standard available capillary columns that can easily be changed by the user. The components are detected by standard GC detectors with a very reliable and robust instrument as a result.

Chromatograms And Results

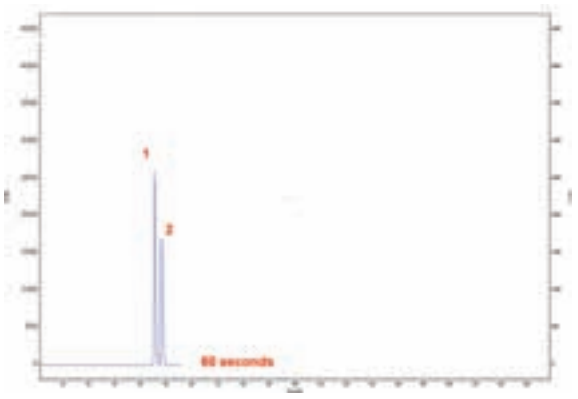

Figure 2: Chromatgram channel 1, TCD

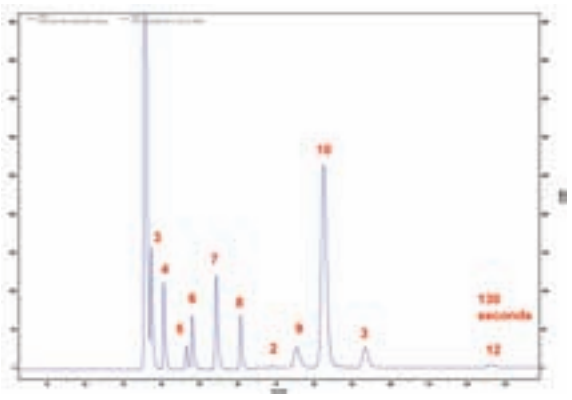

Figure 3: Chromatogram channel 2, TCD

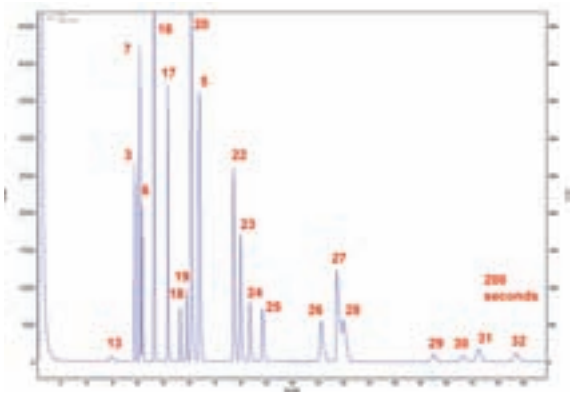

Figure 4: Chromatogram channel 3: FID

Component identification:

1 Helium	18 iso-Butane
2 Hydrogen	19 n-Butane
3 Methane	20 Propadiene
4 Carbon dioxide	21 Acetylene
5 Acetylene	22 t-2-Butene
6 Ethylene	23 1-Butene
7 Ethane	24 Isobutylene
8 Hydrogen Sulfide	25 c-2-Butene
9 Oxygen	26 Isopentane
10 Nitrogen	27 n-Pentane
12 Carbon monoxide	28 1,3-Butadiene
13 C_6+	29 t-2-Pentene
14 Ethane	30 2-me-2-Butene
16 Propane	31 1-Pentene
17 Propene	32 c-2-Pentene

	RT (min)	NORM CONC (mol/100mol)	Molar Mass (g/mol)	Mass Fraction (g)	Carbonfraction (gC/g)	Carbon Content (gC/100g)	Calorific Value (kJ/100g)
TCD R							
H2	1.302	12.59	2.016	25.369	0	0	81.64
TCD L							
CO2	1.348	3.012	44.01	132.558	0.2729	1.09	0
Oxygen	2.993	0.106	31.998	6.272	0	0	0
Nitrogen	3.377	39.161	28.013	1096.736	0	0	0
Carbonmonoxide	4.762	0.999	28.01	27.982	0.4286	0.361	8.61
FID Aux							
Methane	1.777	5.056	16.043	81.113	0.7487	1.83	122.26
Ethane	1.842	3.93	30.07	118.175	0.7989	2.844	165.19
Ethene	1.882	2.012	28.054	56.445	0.8563	1.456	60.21
Propane	2.043	5.947	44.097	262.244	0.8171	6.455	306.11
Propylene + Cyclopropane	2.267	3.015	42.081	126.878	0.8563	3.273	174.96
Propadiene	2.363	0.959	40.065	38.424	0.8994	1.073	55.21
Acetylene	2.53	0.999	26.038	26.012	0.9228	0.723	37.63
Iso-Butane	2.677	4.065	58.123	236.29	0.8266	7.196	306.19
N-Butane	2.873	3.994	58.123	232.143	0.8266	6.791	319.75
Trans-2-butene	3.116	2.999	56.108	167.706	0.8563	4.336	227.06
1-Butene	3.18	1.986	56.108	111.43	0.8563	2.875	152.04
Iso-Butylene	3.278	0.996	56.11	55.895	0.8563	1.442	75.75
Cis-2-butene	3.395	1	56.108	56.108	0.8563	1.447	76.35
Iso-Pentane	3.863	0.997	72.15	71.933	0.8324	1.904	99.06
1,3-Butadiene	3.93	2.997	54.092	162.113	0.8992	4.336	217.49
n-Pentane	4.006	0.99	72.15	71.428	0.8324	1.791	97.69
Trans-2-Pentene	4.503	0.199	86.177	17.149	0.8363	0.432	23.31
2-Methyl-2-Butene	4.657	0.199	86.177	17.149	0.8363	0.432	23.31
1-Pentene	4.67	0.399	86.177	34.395	0.8363	0.866	46.73
Cis-2-Pentene	4.795	0.299	86.177	25.767	0.8363	0.649	35.02
n-Hexane	5.595	0.095	86.177	8.195	0.8363	0.206	11.14
TOTAL		**100**				**52.687**	**2986.463**
						Total Carbon	**Calorific Value**

Figure 5: Additional report for CO_2 emission measurement according to DIN 51.666

Repeatability is better than 1% RSD at 1% concentration level for all specified components. The linearity is 4 decades. Minimum detectability is better than 0.01% (0.05% for H_2S). High levels of H_2S are handled without affecting the instrument, because inert Sulfinert® treated materials are used.

Data Handling and DIN 51666 Reporting

The EZChrom data system is used for data handling for the three analysis channels, providing all needed processing, reporting and quality control features.

Refinery Gas Analysers are also used for CO_2 emission measurements according to DIN 51.666. For this analysis, additional reporting of calorific value and carbon content is needed. EZChrom was extended with a report template for the necessary calculations. This template combines concentration values for three detectors to normalised results, and multiplies each concentration with the appropriate factor to obtain the needed emission values.

Benefits:

- Full Refinery Gas Analysis in only 200 seconds
- Including reporting according to DIN 51.666
- Meets requirements of UOP539, DIN51.666, ASTM D2163
- No additional cooling time: run time=cycle time
- Proven GC technology: reliable and robust instrument
- Full digital control

Note: The 19" Flash RGA from G.A.S follows the proven three channel setup that is found in larger laboratory analysers like the Fast RGA based on Thermo Trace GC (see figures 6 and 7).

Figure 6: laboratory Refinery Gas Analyser

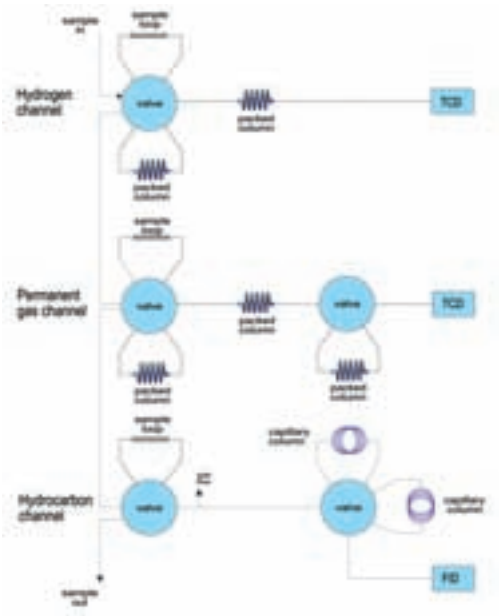

Figure 7: flow diagram laboratory Refinery Gas Analyser