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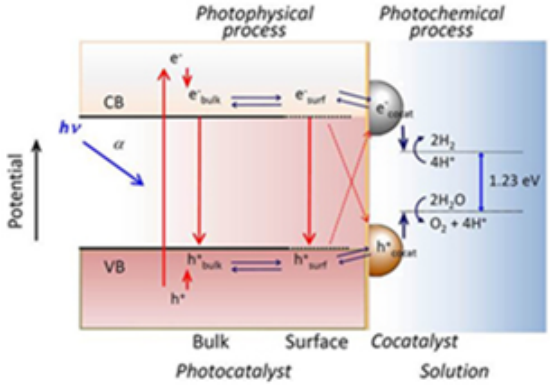
#G05

Photo Catalysis Reaction Monitoring Analyser

Authors - G. Rawlinson & R Tulloch

Abstract

Photo catalysis is a promising science for future applications which combines the topics of materials science, nanotechnology, energy research, environmental science, photonics and chemical analysis. The motivation for the current interest in this topic stems from the challenges science and society face from climate change and energy supply. One goal is to produce useful chemical products such as H2 for the "hydrogen economy" and other solar fuels. It is a simple, renewable, clean and cost effective technology which will play an ever more important role as the science progresses.



There is a high activity of research in this area using nanotubes, catalysts and titanium oxide. The photo catalysis gases and fuels produced can range from hydrogen, carbon dioxide, methane to methanol, C1-C3 aldehydes ketones and acids.

Introduction

JSB's challenge was to design a sampling system and analyser to record accurate and reliable results based around the four main criteria below:

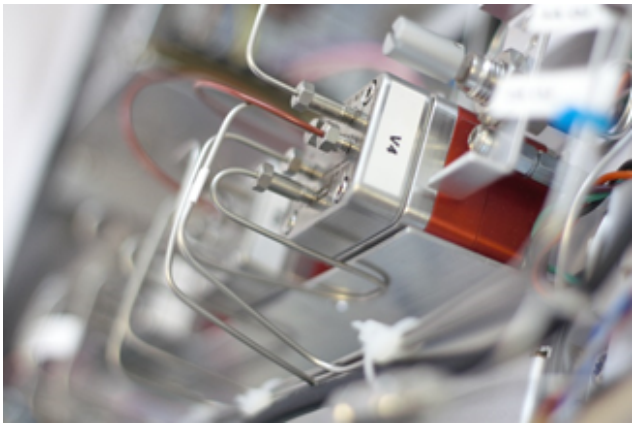
- Analysis – Determination of both the vapour and liquid phase of the reaction mixture.
- Calibration – Without disconnection of fittings.
- Vessel purging – Automatic efficient purging of the sample reaction vessel <0.02% air
- Sampling – A minimum sample volume taken and replacement with Argon if necessary, whilst still reaching the limits of detection required and non-introduction of air into the sampling system.

Instrumentation

JSB's customised gas chromatograph (based on Agilent 7890) fitted with rotor and diaphragm valves, split/splitless injector, dual Thermal Conductivity Detector (TCD), methaniser and Flame Ionisation Detector (FID). Pneumatically actuated valves are used to introduce the gaseous sample simultaneously across the two channels.
Liquid samples were introduce through the split/ splitless injector.

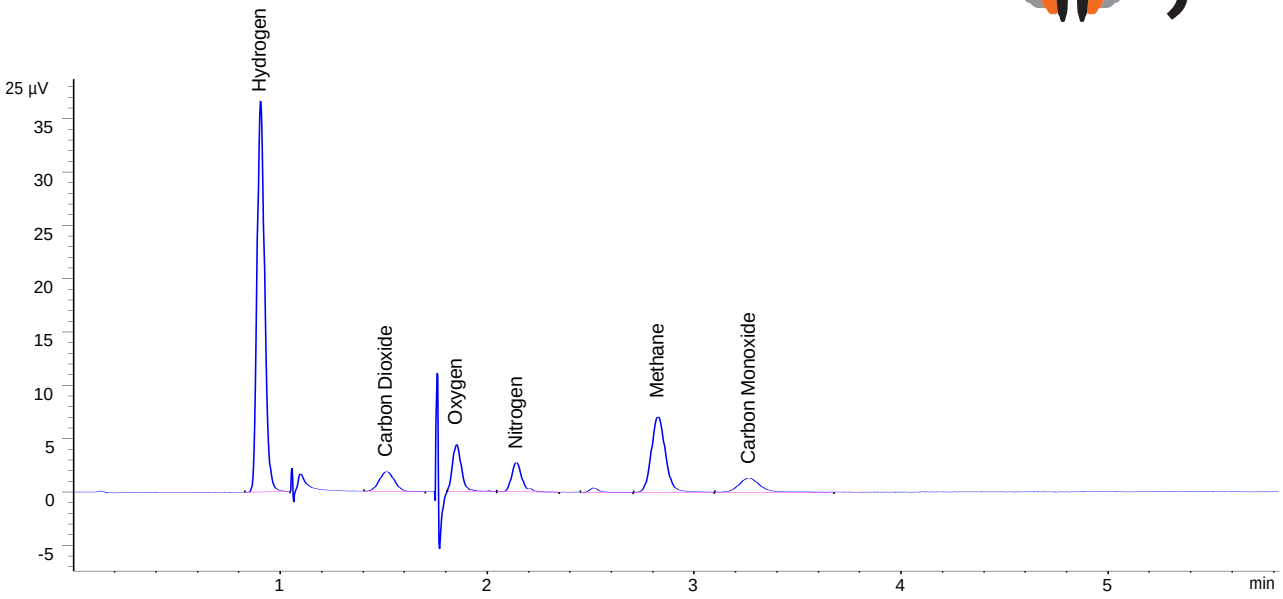
Specialist Valving

Without disconnecting the sampling vessel automatic calibration, purging of the system was carried out by a stream selector and two divert valves. This eliminates oxygen and nitrogen ingress and gives more accurate reliable data.

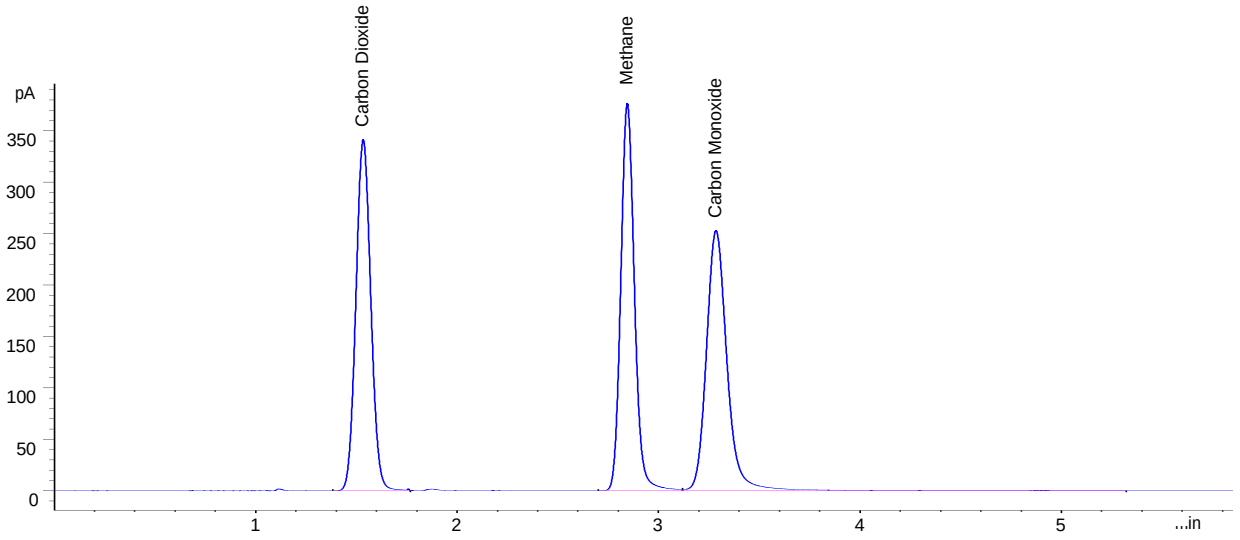


Chromatograms

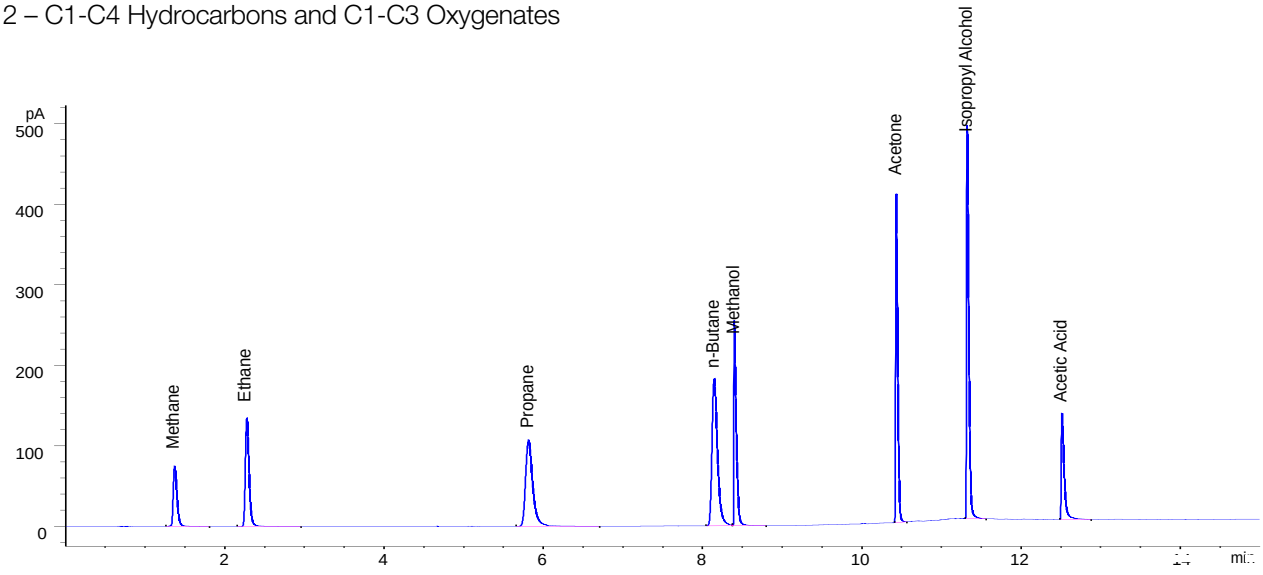
TCD Channel 1 – H2, CO2, O2, N2, CH4 and CO, backflush of >C1



FID Channel 1 – CO2, Methane and CO, backflush of >C1



Channel 2 – C1-C4 Hydrocarbons and C1-C3 Oxygenates

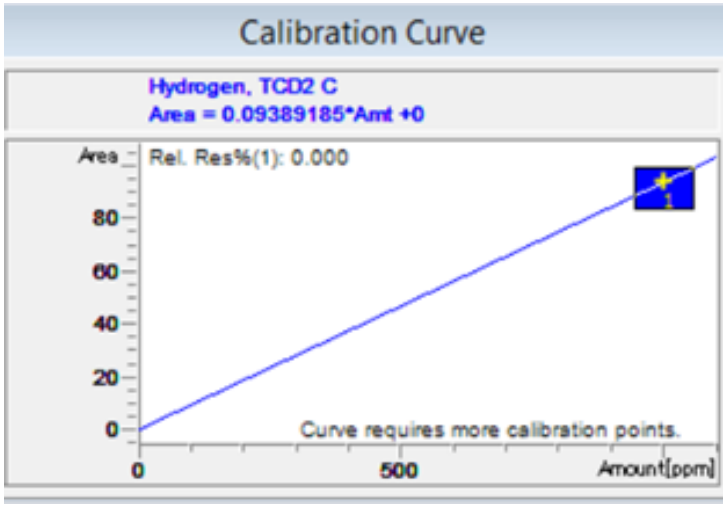


Results Summary

- Minimum air ingress (<0.02% air).
- Simplicity of calibration.
- Accurate analysis of gaseous reactants.
- Additional liquid C1-C4 analysis.

The analyser can be tuned to analyse a variety of gaseous and liquid samples with the minimum of interference and carry over from previous injections.

#	RT	Signal	Compound	Lvl	Amt[ppm]	Area	Rsp.Factor
1	0.905	TCD2 C	Hydrogen	1	1000	93.892	10.651
2	1.369	FID1 A	Methane	2	1000	245.670	4.071
3	1.514	TCD2 C	Carbon Dioxide	1	1000	10.039	99.611
4	1.549	FID3 B	Carbon Dioxide	1	1000	1774.400	5.6358e-1
5	1.859	TCD2 C	Oxygen	1	1000	13.626	73.388
6	2.145	TCD2 C	Nitrogen	1	1000	9.737	102.710
7	2.275	FID1 A	Ethane	2	1000	439.010	2.278
8	2.840	TCD2 C	Methane	1	1000	33.499	29.852
9	2.859	FID3 B	Methane	1	1000	1774.900	5.6340e-1
10	3.265	TCD2 C	Carbon Monoxide	1	1000	9.298	107.550
11	3.285	FID3 B	Carbon Monoxide	1	1000	1803.700	5.5442e-1
12	5.820	FID1 A	Propane	2	1000	669.860	1.493
13	8.151	FID1 A	n-Butane	2	1000	880.170	1.136
14	8.408	FID1 A	Methanol	3	1000	525.630	1.902
15	10.439	FID1 A	Acetone	3	1000	737.540	1.356
16	11.331	FID1 A	Isopropyl Alcohol	3	1000	954.060	1.048
17	12.521	FID1 A	Acetic Acid	3	1000	337.010	2.967



Conclusion

As an Agilent premium partner provider JSB offer a comprehensive and robust single vendor GC based solution for the analysis photochemical reactions. The hardware, software, columns, application, documentation, installation are all supplied by JSB. The analyser designed offers superior results and is backed by a team of sales and support specialists.

INTERNATIONAL

JSB Group
Tramstraat 15
5611 CM Eindhoven
T +31 (0) 40 251 47 53 F +31 (0) 40 251 47 58

INFO@GO-JSB.COM
WWW.GO-JSB.COM

SALES AND SERVICE

NETHERLANDS
Apolloweg 2B
8239 DA Lelystad
T +31 (0) 32 087 00 18
F +31 (0) 32 087 00 19

GERMANY, AUSTRIA, SWITZERLAND
Max-Planck-Strasse 4
D-47475 Kamp-Lintfort
T +49 (0) 28 42 9280 799
F +49 (0) 28 42 9732 638

BELGIUM
Grensstraat 7, Box 3
1831 Diegem
T +32 (0) 27219211
F +32 (0) 27207622

UK & IRELAND
Cedar Court, Grove Park Business Est. White Waltham, Maidenhead, Berks, SL6 3LW T +44 (0) 16 288 220 48
F +44 (0) 70 394 006 78

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