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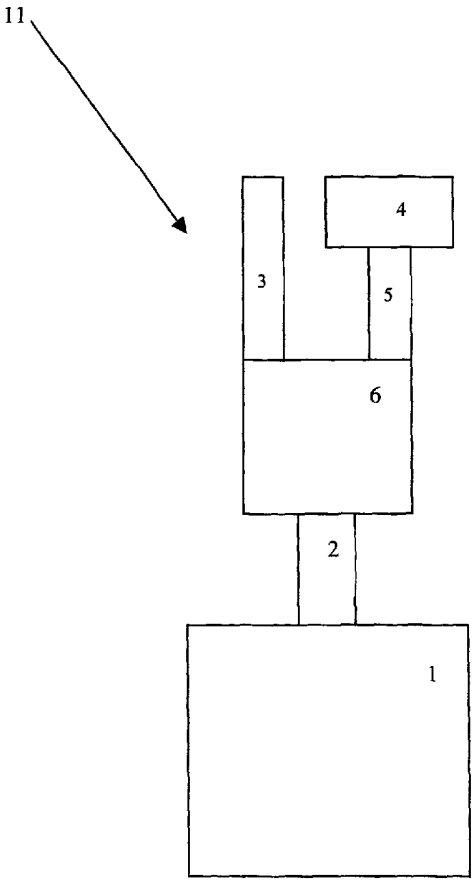
(54) Title: ION IMPROVED MOBILITY SPECTROSCOPY DETECTOR

(57) Abstract: An ion Mobility Spectroscopy (IMS) detector that achieves reliable dilution of vapour analyte by switching the intake of the detector between a filtered intake and an unfiltered intake in a controlled periodic fashion.



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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

ION MOBILITY SPECTROSCOPY DETECTOR

The current invention concerns the analytical technique of Ion Mobility Spectroscopy.

Ion Mobility Spectroscopy (IMS) has been in use for a number of years in applications such as the detection of explosives and narcotics or for detection and monitoring on contaminated land sites. It has several advantages over other techniques such as good sensitivity, the ability to detect a wide range of materials and simple, easily transportable equipment.

It does, however, suffer from the drawback of having a limited dynamic range. This problem can limit the ability to detect 'hotspots' (i.e. areas of relatively high concentration of contaminant) within a contaminated area.

Moreover if an IMS based detector is exposed to high concentrations of analyte vapour, it will take a long time to clear down once it is removed from the source unless some form of action is taken, for example manual intervention or operation of a reverse inlet flow protection system.

In the laboratory, vapour concentration is reduced by mixing it with air or other gas and most types of vapour generator, used to test detection devices, are based on this method.

To obtain the required dilution factor, the ratio of vapour laden air mixed with clean air is carefully controlled either manually or with valves and flow meters or mass flow controllers. Although this method works well under laboratory conditions it is too complex and difficult to control under field conditions.

Most IMS based detectors and monitors currently in use are designed to respond to a vapour challenge in approximately one second. The one second time limit takes into account the time to draw vapour sample into the inlet system, through any membrane interface that may be employed and into the IMS cell. Added to this is

the signal processing time, particularly at low vapour concentrations where signal averaging techniques are employed.

The current invention provides an improvement to a standard IMS detector that gives rise to increased dynamic range and reduced likelihood of saturation.

According to the invention, an IMS detector having a detector inlet is characterised by means for switching the detector inlet between a non-filtered intake and a filtered intake in a periodic fashion.

Preferably, the times within each period that the detector inlet is connected to each intake (the valve dwell times) are substantially the same, or smaller, than the response time of the detector.

According to a second aspect of the invention, a method of analysing a vapour analyte in an ambient gas comprises the step of detecting the vapour analyte using an IMS detector having a detector inlet and is characterised by the step of switching the detector inlet between a non-filtered intake and a filtered intake in a periodic fashion.

The invention will now be described by way of example, with reference to the following figures in which:

figure 1 is a schematic representation of an IMS detection system according to the invention;

figure 2 shows the output of a detector according to the invention at two valve switching time ratios and

figure 3 shows the output of a vehicle mounted detector according to the current invention.

Referring to figure 1, a detector of the current invention, generally designated 11, comprises a standard IMS detector 1 having a detector inlet 2 which is switchable between a non-filtered intake 3 and an intake 4 having a filter 5 (a filtered intake) by means of a solenoid operated valve 6.

During operation detector inlet 2 is rapidly switched between intakes 3 and 4. Switching is effected in a periodic fashion whereby during each period, the detector inlet 2 is connected to the unfiltered inlet 3 and the filtered inlet 4 for a respective pre-determined time. Thus, instead of trying to mix two flows of air as in the prior art (an analogue approach) the detector either draws in ambient air (containing vapour) or filtered clean air. In theory, the vapour concentration is effectively diluted by the same ratio as the time spent sampling ambient air to that spent sampling filtered air (a digital approach).

In a particular set up, the IMS detector 1 used was a Chemical Agent Monitor (CAM) manufactured by Graseby Dynamics, 765 Finchley Road, London NW11 8DS.

The filter 5 was a standard British military respirator filter. Use of such a low resistance filter allows reliance on the internal air inlet pump of the detector rather than having additional pumps or other means of pressurising the inlet air.

The two way solenoid valve 6 used is supplied by Production Techniques Ltd (part no. SV1D-3-11T) and was chosen to have low vapour adsorption properties at those parts with which vapour comes into contact.

Control of the valve 6 was achieved by monitoring the serial output of the detector 1 using a laptop PC (not shown) programmed in Microsoft® Qbasic®. The parallel port of the PC was used for control of the solenoid valve; the control programme turns the solenoid valve on once the output from the IMS 1 exceeds a predetermined value. This was initially set at 7 bars on the CAM display.

The control programme then pulses the valve on and off in a periodic fashion wherein the times that the valve is on and off (the valve dwell times for filtered air

and unfiltered air respectively) are selected to achieve the desired dilution factor. The pulsing continues until the IMS output falls to 3 bars on the CAM display.

The process repeats if the IMS output reaches 7 bars again.

In order to characterise the operation of the dilution system, the detector 1 was connected to a vapour generator (Graseby model GI10) to determine its response to undiluted vapour. Vapour samples were also collected on to PoraPak® tubes to determine vapour concentration using gas chromatography techniques.

The detector 1 was next connected to the dilution unit and various valve dwell times were investigated at two concentrations of methyl salicylate (MS) namely 1.77 mgm^{-3} and 21.4 mgm^{-3}.

The results are shown in the tables below.

Valve on (s)	Valve off (s)	Calculated Dilution Factor	Calculated Concentration ($mg\ m^{-3}$)	Measured Conc. ($mg\ m^{-3}$)
0	1	1	1.77	1.77
1.0	0.10	11	0.16	0.39
1.5	0.05	31.3	0.06	0.24
5.0	0.5	101	0.02	0.16

Table 1 Dilution System Characteristics at 1.77 mg m^{-3} of MS vapour

Valve On (s)	Valve Off (s)	Calculated Dilution Factor	Calculated Concentration ($mg\ m^{-3}$)	Measured Conc. ($mg\ m^{-3}$)
1.5	0.05	31.3	0.68	1.06
5.0	0.05	101	0.21	0.38

Table 2 Dilution System Characteristics at 21.4 mg m^{-3} of MS vapour

The results shown in the two tables indicate that the dilution factor achieved is less than calculated. It is also concentration dependent: the higher concentration giving

approximately 60% of the calculated value and the lower concentration giving between 10% and 40%.

Referring to figure 2, detector output at two valve dwell time ratios are shown. The upper trace represents data obtained with dwell times of 1.5s on and 0.05s off and the lower trace represents data obtained with dwell times of 5s on and 0.05s off. These data indicate that dwell times similar to, or smaller than, the detector response time achieve a more stable output.

To test the system under field conditions, it was fitted to the front of an off road vehicle which was driven over an area where MS had been sprayed on the ground (road and grass). Initial tests were carried out with the dilution system switching on at 7 bars and off at 3 bars.

Although the system worked, improvements were made by switching on at 8 bars and off at 6 bars. Further improvements were made by using the ion mobility peak height value from the detector (serial data output) which allowed for finer control of the system.

A typical set of data is shown in figure 3. The dilution system was on in the region of the graph where the horizontal line is at the top of the graph.

Claims

1. An IMS detector having a detector inlet, characterised by means for switching the detector inlet between a non-filtered intake and a filtered intake in a periodic fashion.

2. The detector of claim 1 wherein the valve dwell times substantially the same, or smaller than, the response time of the detector.

3. A method of analysing a vapour analyte in an ambient gas comprising the step of detecting the vapour analyte using an IMS detector having a detector inlet and characterised by the step of switching the detector inlet between a non-filtered intake and a filtered intake in a periodic fashion.

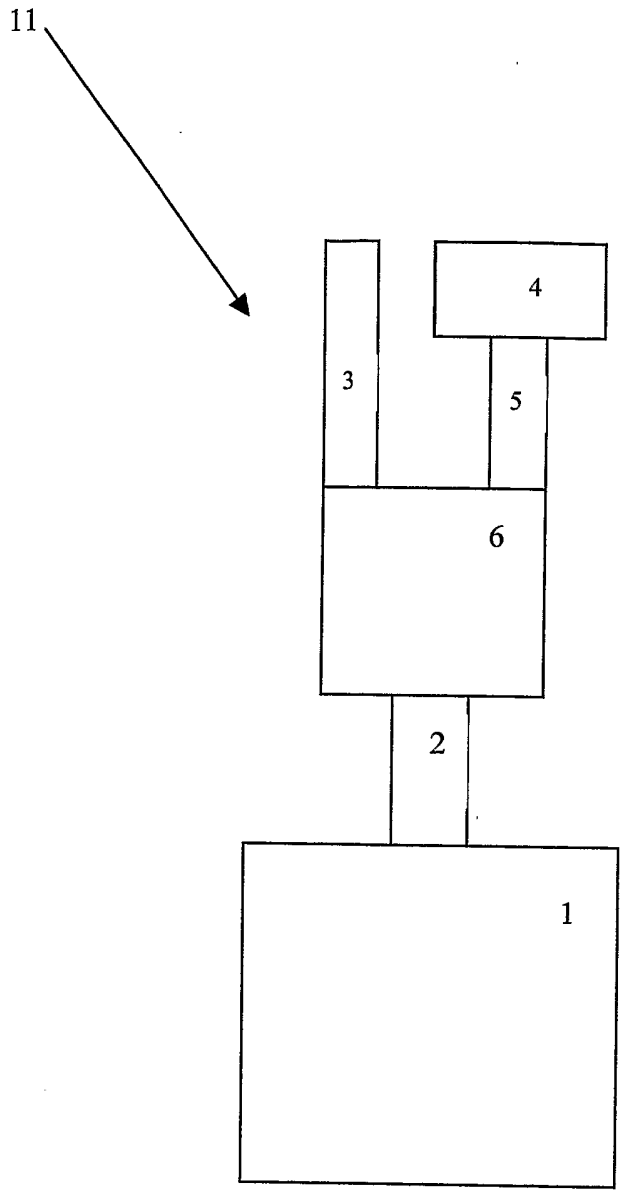

Figure 1

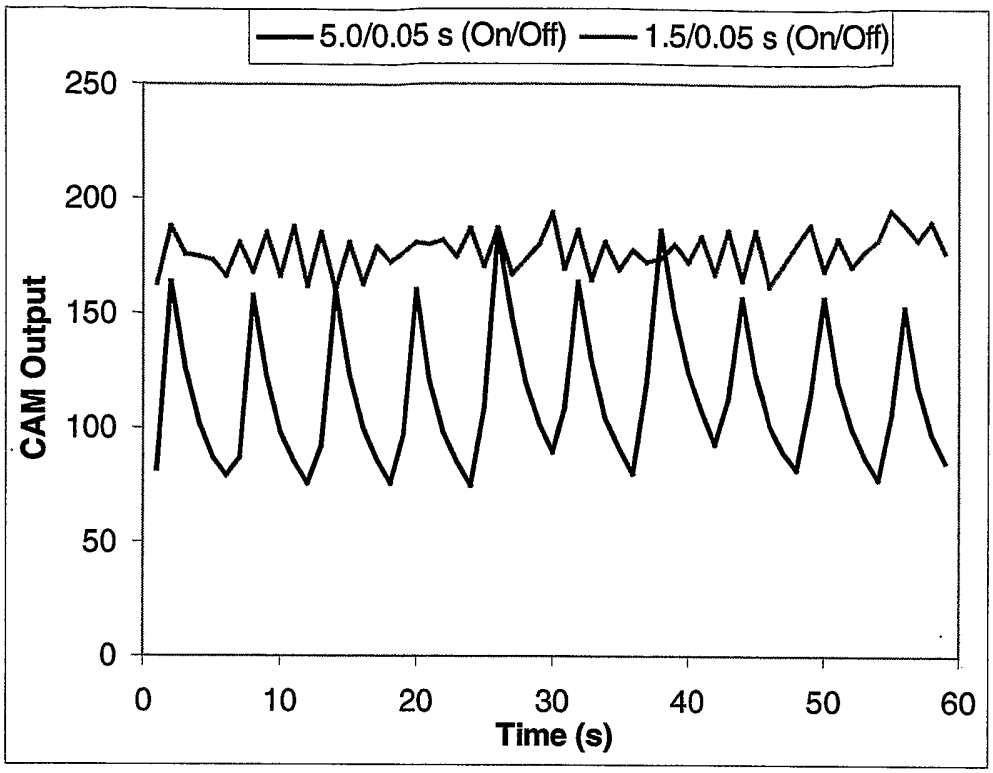
5.0/0.05 s (On/Off)
1.5/0.05 s (On/Off)
CAM Output
250
200
150
100
50
0
0
10
20
30
40
50
60
Time (s)

Figure 2

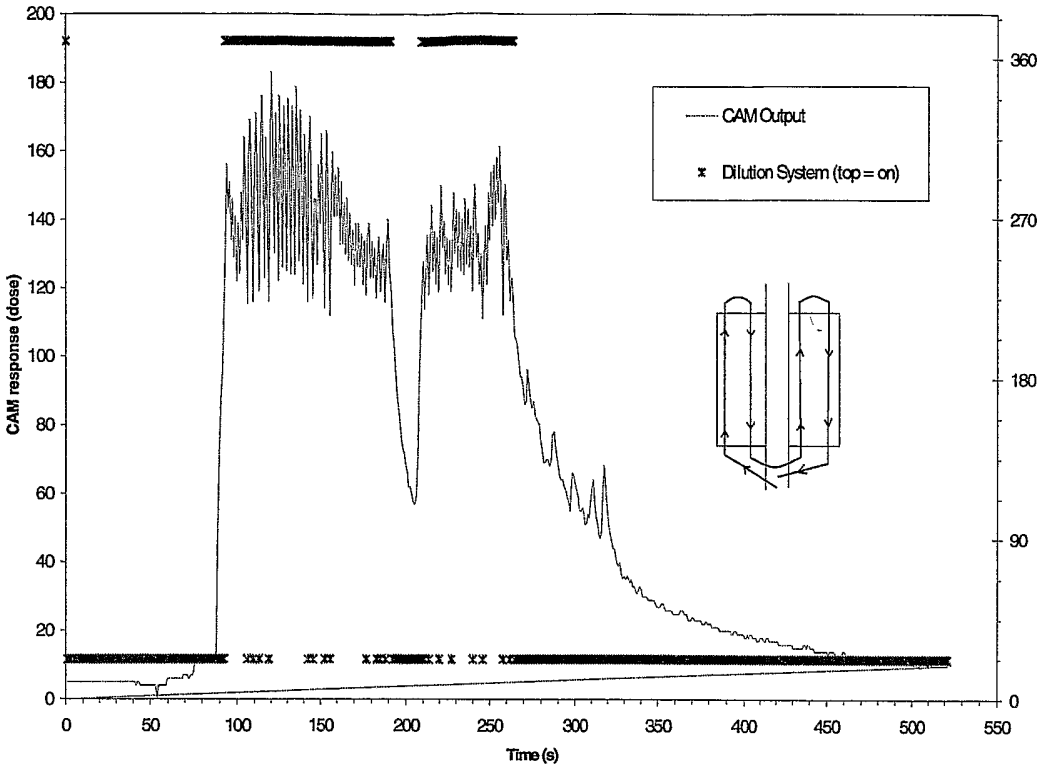
CAM Output
Dilution System (top = on)
CAM response (dose)
Time (s)
0
20
40
60
80
100
120
140
160
180
200
0
50
100
150
200
250
300
350
400
450
500
550
0
90
180
270
360

Figure 3

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 03/03214

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G01N27/64

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 5 736 739 A (KOUZNETSOV VIKTOR ET AL) 7 April 1998 (1998-04-07) abstract column 2, line 65 -column 3, line 19; figure 1 ---	1-3
A	US 5 345 809 A (CORRIGAN COLIN ET AL) 13 September 1994 (1994-09-13) abstract column 7, line 56 -column 8, line 20; figure 1 --- -/--	1-3

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 November 2003	27/11/2003

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Kempf, G

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International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 5 283 199 A (BACON JR ALLAN T ET AL) 1 February 1994 (1994-02-01) abstract; figure 1	1-3
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Information on patent family members

International Application No
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