NEW GC / TWO-STAGE DIFFERENTIAL MOBILITY ANALYSER FOR THE SCREENING OF EXPLOSIVES IN CARGO

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Abstract
The capability to detect explosion vapours in the atmosphere is a long sought goal in the security area. Present state of the art is centered in two solutions: IMS, which is only practical for very volatile explosives (EDGN), and mass spectrometry, which is expensive and bulky. Our aim is to detect explosive vapours in the atmosphere through the coupling of a fast GC column with two Ion Mobility devices, in order to obtain a low cost, yet sensitive and discriminating, detector.

Two differential mobility analysers (DMA) as acting as narrow band mobility filters are coupled in series, with a thermal fragmentation cell placed in between, such that parent ions selected in DMA are fragmented in the cell at atmospheric pressure, and their product ions are analysed on DMA. A key feature of the tandem DMA is the short residence time (~ 0.2 ms) of ions in the analyzer, compared to tens of milliseconds in drift tube ion mobility spectrometers (IMS). Ion fragmentation within the analyzer and associated mobility tails are therefore negligible for a DMA but not necessarily so in conventional IMS. The presented technology has demonstrated Limits of Detection in the order of 1 pg for TNT for atmospheric samples of 500 L of air.

Methods
Blank Atmospheric Samples: comprised of 500 L of air sampled in Boecillo at the end of July, when the vapor concentration is maximum according to a previous study. Filters: Fiber glass/ stainless steel coated with Texan GR. Allows sampling flow rates in the range of 100 – 1000 L/min.

Thermal Desorber: The filter is inserted in the desorber and desorbed at a flow rate of 0.2 L/min and a fixed temperature of 200 °C.

Cold Trap: The vapors liberated in the desorber are condensed and retained in a cold trap at 0°C. The cold trap is built from a silica lined stainless steel tube 2/8.

Multicapillary Column GC (MCC-GC): 20 cm length, 1000 capillaries in parallel, 40 µm capillary diameter, 0.2 m of OV-5 Stationary liquid phase.

DMAs: Low residence time (200 µs), high transmission (~ 50 %), high resolution (up to 110). The DMA, selects the explosive parent ion which enters the fragmentor, whereas the DMA2 classifies the fragment ion generated.

Fragmentor: build from metal and ceramic is capable to reach temperatures up to 800 °C in order to better to the more resilient species. The ion transmission inside the fragmentor takes place by electric fields, minimizing ion losses against the walls.

Ion Detector: For the time being a Mass Spectrometer working in single quadrupole mode is being used. However the m/z separation is not being used, representing the Total Ion Current (TIC). Once fixed the configuration and optimized the parameters the MS will be replaced by an electrometer.

Results
The atmospheric background was evaluated for the following explosives: EDGN, NG, PETN, TNT and ROX. The analysis results are shown in Table 1.

Conclusions
• MCCGC-DMA-F-DMA technology has demonstrated atmospheric background in the order of 1 pg in samples of 500 L of air taken during the hottest days of summer (high content of nitroaromatic interferents).
• The performance of the GC system is still far from its optimum, so the room for improvement is remarkable.

• The time analysis takes 3 minutes and a half in the current configuration (1 minute for the desorption and trapping + 2.5 minutes for the analysis). After optimizing the GC performance, this analysis time can be further improved.

References