Employing the Power of Gas Chromatography/Mass Spectrometry in the Field

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Science doesn't just happen in a laboratory, behind closed doors in carefully climate-controlled labs, surrounded by scientists. Neither should scientific analysis. Gas Chromatography/Mass Spectrometry (GC/ MS) is the laboratory gold standard for chemical analysis. A highly-selective technology, it can differentiate between similar chemical structures in a single, complex sample mixture. This aids in the quick and accurate identification of harmful chemicals. With the recent introduction of new person-portable, fielded gas chromatography/mass spectrometers (GC/MS), the capability to conduct high-fidelity, conformational analysis at the scene of interest is a reality. Ignitable liquid residue analysis by fire investigators; HazMat team responses to chemical spills; forensic identification of suspected narcotics in clandestine labs; chemical agent threat surveying by military reconnaissance teams; and industrial process monitoring are just a handful of such high consequence applications which benefit from in field analysis.

Chemical identification is certainly not new, but advances in technology have shifted paradigms in data gathering and on-site detection. Traditionally, it was necessary to collect samples from a field site and then transport them back to a fixed laboratory for work-up and analysis. Challenges associated with this approach include maintaining sample integrity, and in some cases actively managing the chain of custody of said samples. Certain samples will begin to deteriorate once collected. This can be mitigated through preservation of the sample (freezing, refrigeration, added preservatives, and so forth) but ultimately, the best course of action to ensure a representative sample is to perform the analysis immediately after sample collection.

For some applications, the ability to obtain answers at the scene goes beyond ensuring sample integrity. While industrial process analyses may need a single stream characterised, forensic and environmental applications often necessitate a more investigative approach, meaning multiple samples collected. Receiving actionable information in near-real-time (minutes versus hours) streamlines the site investigation. Rather than collecting multiples of samples from across a scene to take away, in the hope of being thorough enough to catch the analyte(s) of interest in a shotgun approach, analysis on site helps direct the site investigation and identify the specific items of interest much more efficiently.

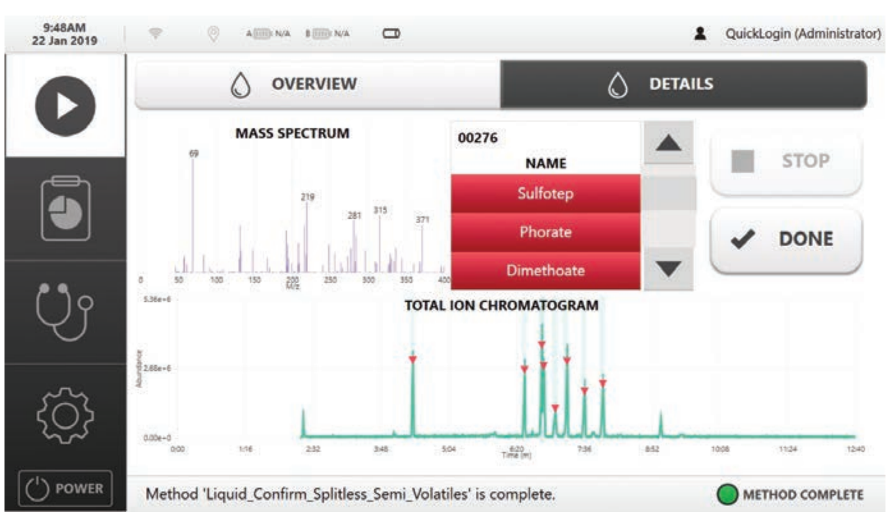

Figure 1: Simplified touchscreen user interface

What does it take to bring laboratory-grade analysis capability to the field? Traditional, lab-based GC/MS are large systems, requiring dedicated power and gas supplies, as well as external vacuum pumps and operating computers. The recent generation of person-portable, fieldable GC/MS goes beyond a simple Size, Weight, and Power (SWaP) reduction. Vacuum pumps that were traditionally large, heavy, noisy and fragile, have been replaced with smaller, quieter models that better handle the shock and vibration of being moved while under operation. The traditional convection ovens that house the chromatographic columns have been replaced with compact, low thermal-mass (LTM-GC) equivalents that reduce the physical and energy footprints, while improving the heating efficiency and reducing run time.

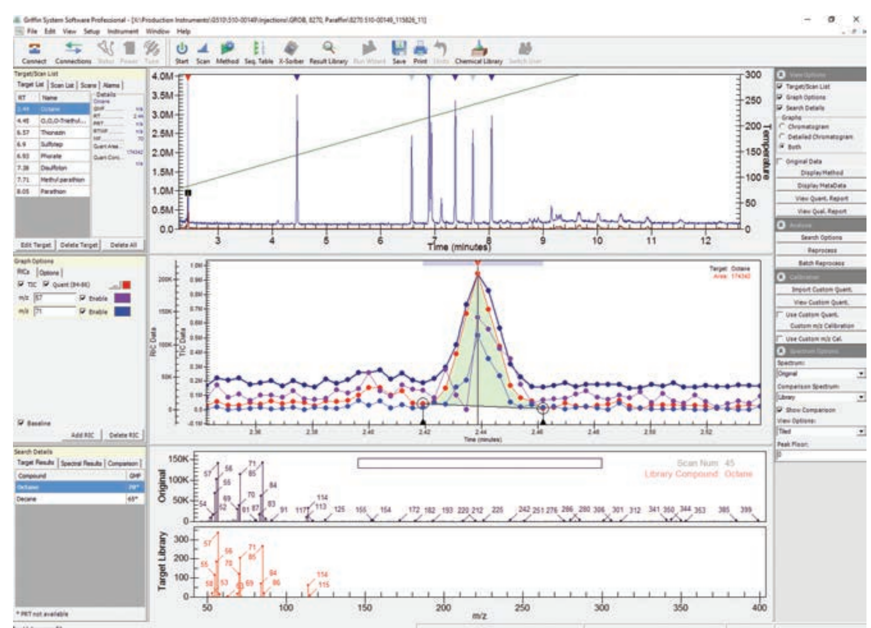

Figure 2: Laboratory quality data is still available for full review

It's fair to note that fieldable GC/MS with the SWaP reduction, LTM-GC and smaller pumps have been available on the market for some time now, but up until recently they have come with limitations that have restricted application to full transition from laboratory-based analyses. Early models of fielded GC/MS have been limited to air and vapour-based sampling only due to pump technology. On some models the mass-analyser was designed such that industry standard libraries such as NIST were not fully compatible, thus limiting the application to proprietary libraries, negatively impacting application to unknown sample matrices.

The current generation of fielded GC/MS unit now truly challenge their laboratory brethren. Perhaps the biggest gain in capability is the inclusion of industry standard split/splitless injection ports on some models. Improved vacuum pumps now support the introduction of condensed phase samples (i.e. liquid and solid injection). Such samples have historically been the bread-and-butter of laboratory-based GC/MS, and the biggest limitation of previous generations of fielded GC/MS. Combined with industry standard quadrupole mass analysers, and their compatibility with NIST libraries, fielded GC/MS now has the ability to go head to head with their larger, laboratory-based siblings.

Analytical performance alone however, will not win over the field user. Substituting the challenges of transporting samples back to a laboratory, for the challenges of deployed operations is not a winning solution. Expect fast startups, substantial battery life, and the

ability to hot-swap batteries without losing instrument uptime. Expect the ability to easily switch from an external gas supply on board a response vehicle to an internal gas tank, and readily available gas replacements. Ease of operation wearing personal protective equipment (up to a full Level A suit) should be standard, as well as the ability to protect and decontaminate the equipment from use in 'hot zone'. Data collected in the field should be easy to interpret, especially when relying on a smaller on-board display versus a computer screen. That same data however, should be readily available for a closer look when exported to a traditional computer.

Taking environmental application as an example, the data below was collected on a Griffin G510 GC/MS. EPA Method 8270 references a number samples preparation and analysis methods of volatile and semi volatile organic compounds (VOCs/SVOCs) in air, water, or soil matrices, that could be present from a chemical spill or wastewater contamination. While the Griffin G510 is capable of sampling and preconcentrating an air sample for VOCs, the standard method is solvent extraction; a water or soil sample is washed with a solvent, which is then collected for analysis. Traditionally, the original sample would need to be collected and transported to back to the laboratory. Standard practice would be to refrigerate the sample for transport. If a suspect leak into a body of water was suspected, multiple samples would need to be collected, perhaps working their way back up a river, to aid in the determination of source. Instead of collection a substantial number of samples and returning to a fixed laboratory, a fieldable GC/MS such as the Griffin G510 could be running samples as the team moves from collection point to collection point. This results in a faster Go/No Go result, and guides a drilling down on potential sources in a single mission, versus sample collection followed by analysis at a later date.

Modern GC/MS technology now permits laboratory calibre analysis where it matters. The science is out there, happening in real time. Now the scientists can be out there too, observing and responding with actionable data.

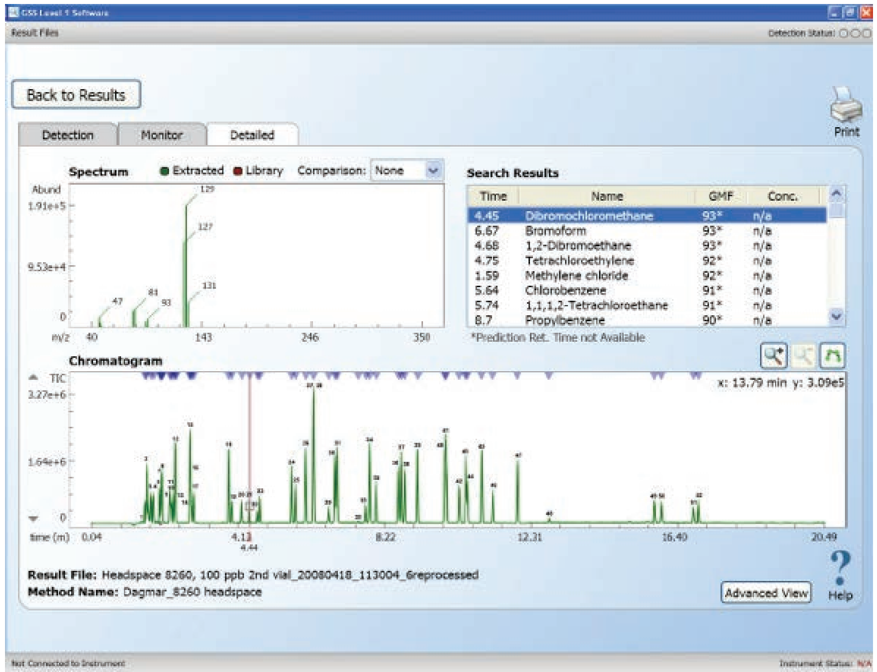

Figure 3. Representative data collected on a Griffin G460 Field Portable GC/MS for an EPA 8260 method utilising manual headspace analysis.