C3 Initial Evaluation of Negative Temperature Ramping in Gas Chromatography

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This presentation will discuss the development and evaluation of a low thermal mass (LTM) gas chromatograph potentially capable of laboratory quality analyses in the field including rapid positive and negative temperature programming.

Law enforcement, defense, and private industry personnel involved in on-site hazardous material testing or monitoring are faced with a critical challenge: the analysis of samples when decisions as to public safety or regulatory compliance need to be made quickly and accurately. Laboratory-based analysis using gas chromatography coupled with mass spectrometry (GC-MS) has long been the workhorse of confirmatory testing for the majority of these situations.

Traditionally, temperature programming in gas chromatography has involved heating the analytical column within a convection oven. This approach limits heating rates due to the combined thermal masses of the column and oven. The low thermal mass (LTM) GC described here encases the column within a highly thermal efficient toriod wrap that can be temperature programmed at high speed while maintaining low power consumption. With a total mass of less than one ounce, this combined oven and column can be heated as well as cooled at rates considerably higher than traditional GC configurations while maintaining reproducibility.

Field as well as laboratory GC-MS systems are limited due to size, power consumption, and a narrow range of temperature programming rates. A resistively heated low thermal mass GC system has been developed that can overcome most of these limitations, offering laboratory-level performance, or better, in a small, lightweight package. Using a sixteen-component custom chemical warfare GC-MS performance test mixture and a sixteen-component PAH standard, a prototype LTM GC was evaluated for speed and quality of analysis through application of pressure and temperature tuning.

This work reports the application of both positive and negative-going rapid temperature ramps resulting in more efficient separations compared to more traditional isothermal and positive-going temperature programs with regards to resolution and analysis time. The data presented illustrates resolution improvements for targeted critical pairs upon application of a temperature program including a rapid negative going temperature ramp; this includes a modest decrease in analysis time over a previously optimized separation.

This work also shows that the advantages provided by rapid temperature programming, including negative temperature ramping, are available to those who do not wish to depart from a conventional 15 meter by 0.25 mm ID GC column or the injection techniques commonly used in their applications. The LTM GC, when combined with MS detection, has the potential to offer significant analysis and economic benefits to forensic laboratories while maintaining a high level of performance and method flexibility.

Field GC-MS Analysis, Fast GC, Portable GC

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