# Screening for Dioxin/Furan Using a Fast GC and SAW Detector

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## Introduction

A new fast GC/SAW analyzer (Ref. 1) has been used to characterize dioxin and furan contamination in less than 10 seconds. Applications include screening of flyash and stack emissions where these compounds can have a detrimental effect on the environment. Using a new type of Surface Acoustic Wave (SAW) detector with picogram sensitivity, it is now possible to analyze air, water, or soil samples with precision and speed in the field. The system is portable allowing measurements to be taken at environmental sites without the need for time consuming and costly laboratory analysis. The speed of the GC/SAW analyzer has recently been validated by the US EPA using polychlorinated bi-phenyls (PCBs) and volatile organic compounds (VOCs). This paper will discuss the linearity, minimum detection limits (TEQ), and potential applications of this new screening tool.

## System Description

The GC/SAW is fully contained within a handheld sensor connected to a traveling support case as shown in Figure 1. An open tubular desorber (OTD) is attached to the inlet of the system and can reach temperatures as high as 300°C. The OTD is used to desorb soil samples as well as liquid injections of stock or extract solutions. The GC/SAW has an internal sampling pump for collecting vapors from the desorber.

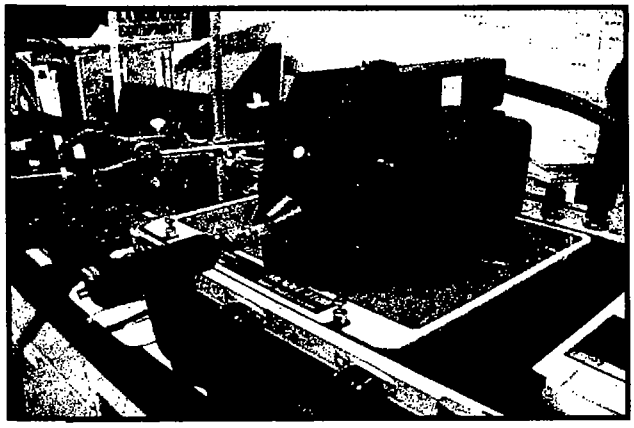


*Figure 1- Desorbtion tool attached to fast GC/SAW.*

## Test Method

Toluene stock solutions with known concentrations of dioxin and furan were used to calibrate the instrument with response factors for all analytes. The following two stock solutions containing five dioxin and five furan analytes were used in this study:

Solution No. 1- 5 ng/μliter each of 2,3,7,8 TCDD; 1,2,3,7,8 PCDD; 1,2,3,4,7,8 HexCDD; 1,2,3,4,6,7,8 5 HepCDD; and OctaCDD.

Solution No. 2- 5 ng/μliter each of 2,3,7,8 TCDF; 1,2,3,7,8 PCDF; 1,2,3,4,7,8 HexCDF; 1,2,3,4,6,7,8 5 HepCDF; and OctaCDF.

Each solution contained a tetra, penta, hexa, hepta, and octa member from the respective dioxin or furan congener group.

## Experimental Results

The linearity of the SAW detector was measured using 2,3,7,8 tetrachlorodibenzo-p-dioxin (TCDD). The 2,3,7,8 TCDD had a retention time of approximately 5 seconds as shown in Figure 3.

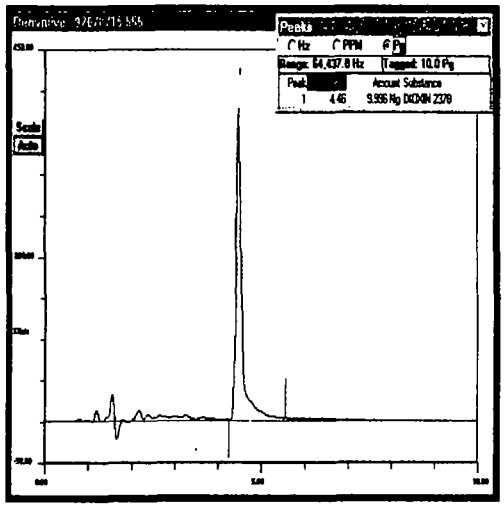


*Figure 3- Calibration with 2,3,7,8 TCDD.*

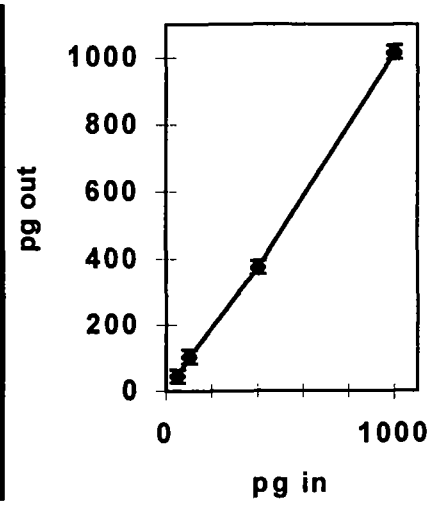



*Figure 2- Plot showing linearity for 2,3,7,8 TCDD.*

An 5-point calibration using serial dilutions was performed over the range 50 to 5000 picogram and the results are plotted in Figure 2. Accuracy and precision were quite good even at 1 pg levels.

Calibration of the instrument with solutions containing the five primary dioxin and furan cogeners produced the two overlaid 10 second chromatograms shown in Figure 4. The dioxins show higher retention times but lower response factors compared to the background (red) furan peaks. After entering the appropriate response factors (in Hz/pg) for each analyte, the instrument was able to display the concentration of each analyte directly in picograms.

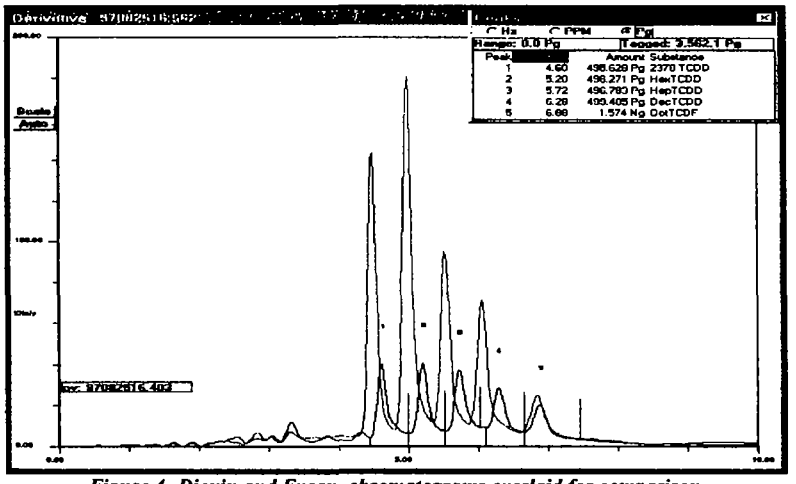
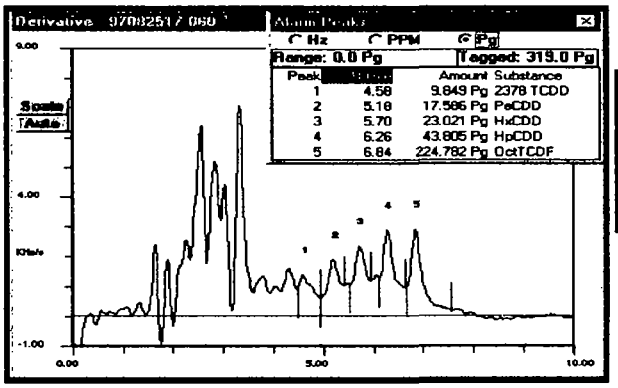



*Figure 4- Dioxin and Furan chromatograms overlaid for comparison.*

## Minimum Detection Limits (MDL)

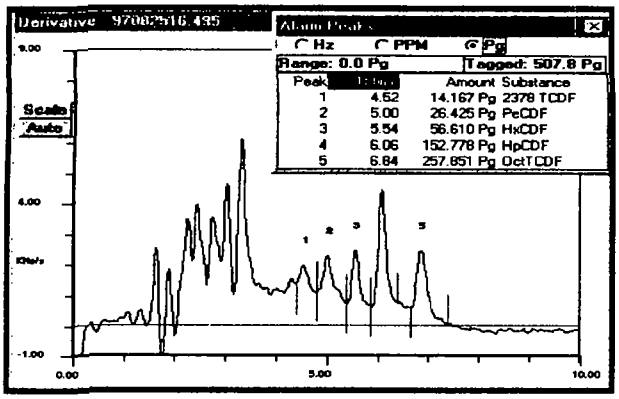
Minimum detection limits for the GC/SAW were determined by signal to noise and replicate measurements using 10-20 picogram samples . At this level the signal to noise ratio is approximately 4 to 1. A typical low level chromatogram result for dioxins is shown in Figure 5. In the accompanying table the measurement results are converted to TEQ picogram units using the appropriate TEQ (Ref. 2) factors. Lower limit of detection for dioxins was estimated to be 2.5 TEQ picograms.




| | |
|---|---|
| 9.849*1.00 | 9.85 |
| 17.586*0.50 | 8.79 |
| 23.021*0.1 | 2.30 |
| 43.805*0.01 | 0.44 |
| 224.78*0.001 | 0.22 |
| TEQ = | 21.6 pg |

*Figure 5- Testing GC/SAW with dioxins at low pgm levels.*

Similar results were obtained with furans in Figure 6. For furans, with their higher response factor, the lower limit of detection was approximately 1.0 picogram TEQ.




| | |
|---|---|
| 14.167*0.1 | 1.42 |
| 26.425*0.05 | 1.32 |
| 56.61*0.10 | 5.66 |
| 152.778*0.01 | 1.53 |
| 257.851*0.001 | 0.26 |
| TEQ = | 10.19 pg |

*Figure 6- Testing GC/SAW with furans at low pgm levels.*

## Summary of Results

The results discussed in this paper show that it is possible to provide on-site screening for the presence of dioxins and furans at the picogram level. Because chromatography alone cannot positively identify analytes there is still a need for laboratory validation. However, the new GC/SAW technology is able to provide very fast chromatography with sufficient resolution to identify and quantify likely dioxin/furan congener groups. Elimination of unneeded laboratory testing by screening may well prove more useful in reducing the cost associated with current site survey methodologies. The speed and accuracy of the new technology is also well suited to real time monitoring and control of stack emissions and other vapor generators. Using open tubular desorbers it is also possible to screen for dioxin/furan in soil and liquid matrices surrounding the source of dioxin/furan emissions (e.g. incinerators). In these cases the dioxin/furan concentrations can be much higher because they have built up over time.

## References

1. E.J. Staples, T. Matsuda, and S Viswanathan, "Real Time Environmental Screening of Air, Water and Soil Matrices Using a novel Field Portable GC / SAW System," Environmental Strategies for the 21st Century, Asia Pacific Conference, 8-10 April 1998, Singapore

2. TEQ levels from "Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated dibenzo-p-dioxin and Dibenzofurans (CDDs and CDFs), (USEPA/625/3-89/016, March 1989)