



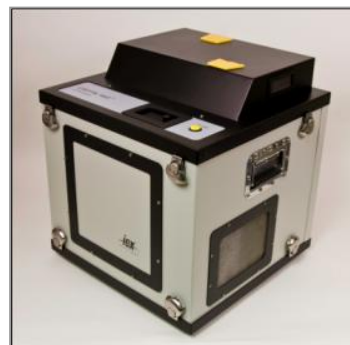
CONTINUOUS AIR MONITORING USING GRIFFIN 460 MOBILE GC/MS

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INTRODUCTION

Continuous air monitoring for the interior and exterior of buildings is of critical importance to government officials and major event administrators. Government buildings, subways, and major public venues (stadiums, concert halls, etc.) are potential targets for indoor and outdoor gas attacks. The loss resulting from a Chemical Warfare Agent (CWA) or Toxic Industrial Compound (TIC) attack is significant for these high consequence buildings. In an effort to allay fears, officials have been prompted to consider the addition of advanced chemical detection instrumentation to prevent such an attack. The critical need is for instruments that will positively identify and confirm the threat, with no false alarms.

The sensors currently used in the market place identify and confirm chemical threats by isolating a “fingerprint” of various chemicals. However, these sensors have high false positive alarm rates. The isolated fingerprint detected by the sensors changes based on uncontrollable external factors such as every-day changes in temperature and humidity swings. Ultimately, the sensor cannot differentiate between many common chemicals and the results are adversely affected. The sensor detects a chemical threat, when it is actually only a harmless perfume, automotive exhaust, diesel fuel, or other common chemical found in every day air. This technical limitation is called a false positive alarm, meaning the sensor alarms when no real threat is present. Responding to false positive alarms is expensive, time consuming, and reduces confidence in the ability of the system to protect assets.



Griffin 460 Mobile GC/MS

One solution for the demands of advanced chemical detection is the mass spectrometer. This instrument is considered the “Gold Standard” in chemical analysis. Used for field-based chemical forensics and environmental monitoring, the mass spectrometer is considered to be thousands of times more discriminatory than ordinary sensors. The critical difference between mass spectrometers and other sensors is the mass spectrometer’s high degree of selectivity - the ability to differentiate between similar chemical compounds in a complex mixture without interference. This strength comes from the fact that the mass spectrometer is physically identifying not only the whole of the sample, but also its individual components. Once all the components of the sample are identified by the mass spectrometer and then confirmed by matching it against its internal chemical library, the mass spectrometer has a significant reason to alarm, not just a fingerprint indicator.

This white paper demonstrates the use of the Griffin 460 Mobile Gas Chromatograph/Mass Spectrometer (“GC/MS”) to monitor indoor and outdoor air in an industrial office park. The dual tube sampling system in the Griffin 460 provides full-coverage continuous sampling to guarantee rapid response times. In order to simulate complex chemical mixtures, data is

presented that confirms the ability of the Griffin 460 to unequivocally identify multiple chemicals in one sample over an extended period of time. The data shows that the Griffin 460 positively identifies and confirms the presence of even the most common chemicals that can create false positive alarms with sensors. This white paper further demonstrates its ability to be selective regardless of temperature and humidity fluctuations. This information is highlighted by the outside air monitoring tests which were conducted in an office park. The effects of wide temperature fluctuations did not deter the mass spectrometer from differentiating materials. Nor did it create a scenario where false positive alarms were seen. The level of identification and confirmation provided by the Griffin 460 empowers officials to respond to incidents with confidence.

INSTRUMENTATION

- Griffin 460 GC/MS system
- Griffin System Software – GSS 3.7

Gas Chromatograph Operating Conditions: Temperature program is 40° C hold for 2 min, then increase at 60° C per minute to 240° C, hold for 1 min. Repeat GC Method for each sample analysis.

Column	Rtx-5ms, 30m X 0.25mm X 0.25µm
Carrier Gas	Helium, 1 mL/min

Mass Spectrometer Operating Conditions

Mass Scan Range	m/z 50-425
Analyzer Temperature	150° C

Preconcentrator Conditions

Tubes	Tenax TA/Carboxen 1017 Dual Bed
Desorption Temperature	250° C
Desorption Time	2 minutes

RESULTS AND DISCUSSION

RESULTING DATA FROM ROOM AIR IN LABORATORY

Figure 1 presents a plot of the continuous room air data. A D5 (decamethylcyclopentasiloxane) signal started to appear at about 6:19 am when people started to enter the laboratory. D5 is an odorless, colorless fluid and is used as a common ingredient in personal care products and dry cleaning fluids. At around 6:32 pm, the D5 signal declined as people left the laboratory for the evening.

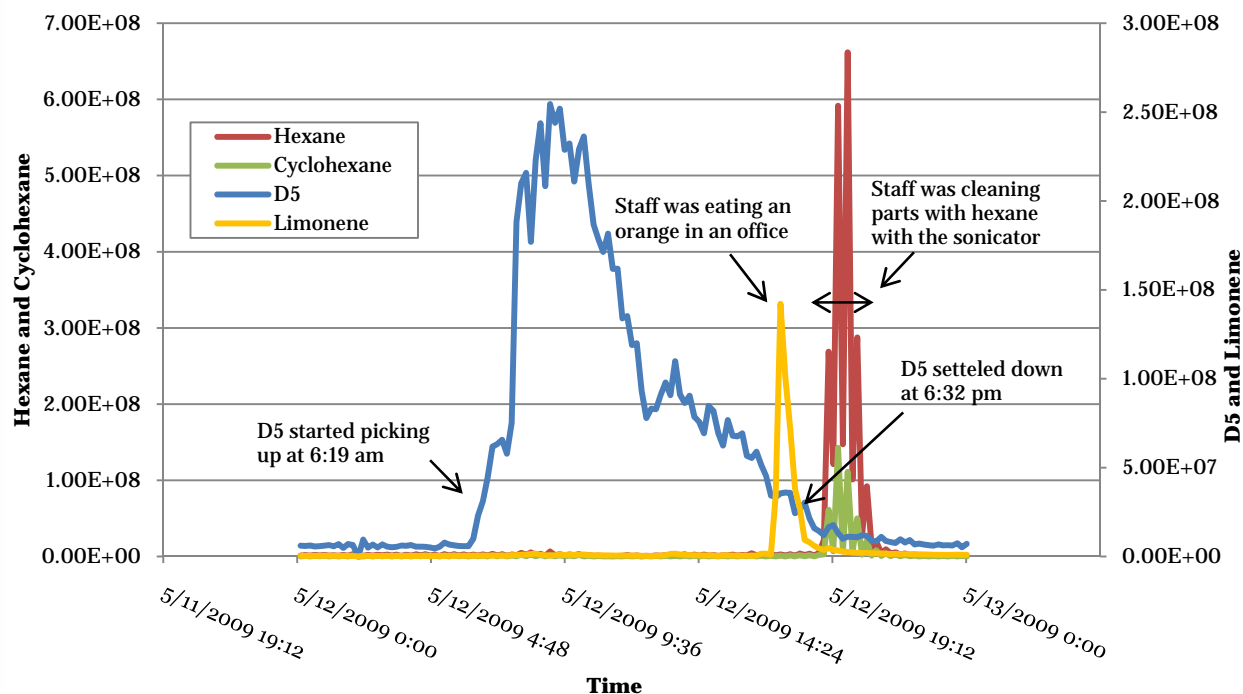


Figure 1: Continuous Room Air Data in a Lab

REAL WORLD APPLICATION:

The detection of CWA's and TIC's is dependent upon the concentration of the material. When exposed to these materials, a person carries their "scent" (trace) on their cloths, skin, and other personal items. As seen with the D5 and limonene, the presence of these materials lingers for a long time, and at very tiny quantities. If a person is carrying the trace CWA on their person, the mass spectrometer can be used to identify it.

Other chemical events were noticed during the same time period. At 4:50 pm, Limonene was detected when a staff member ate an orange in an office adjacent to the laboratory. Limonene is a colorless, liquid found in citrus fruits. The detection of limonene lasted about 3 hrs (long after the physical scent of orange had dissipated). Cyclohexane and hexane signals increased greatly when a staff member used cyclohexane to wash some machine parts in a sonicator at about 6:30 pm. As expected, the detection time of the hexanes was less than that of the limonene due to the more volatile nature of the hexanes.

Figure 2 is a screen capture from the Griffin System Software (GSS) Level II user interface for Developers. GSS also provides a Level 1 user interface for Operators that provides a more simplified view of the data. A representative example of the Level I interface is provided in **Figure 3**. Figure 2 displays the chromatograph (2a), original mass spectral results (2b), and library match (2c) from room air collected in the laboratory during normal working hours (06:00 – 18:00). The chromatograph displayed in the box labeled **2a** shows a major peak at the Retention Time (RT) of 4.67 minutes. This peak identifies decamethylcyclopentasiloxane (“D5”) as described earlier. The original mass spectrum is displayed in the box labeled **2b** and is a chemical fingerprint of the lab air at the 4.67 minute mark. The mass spectrum shows the presence of a multitude of other chemicals detected by the mass spectrometer.

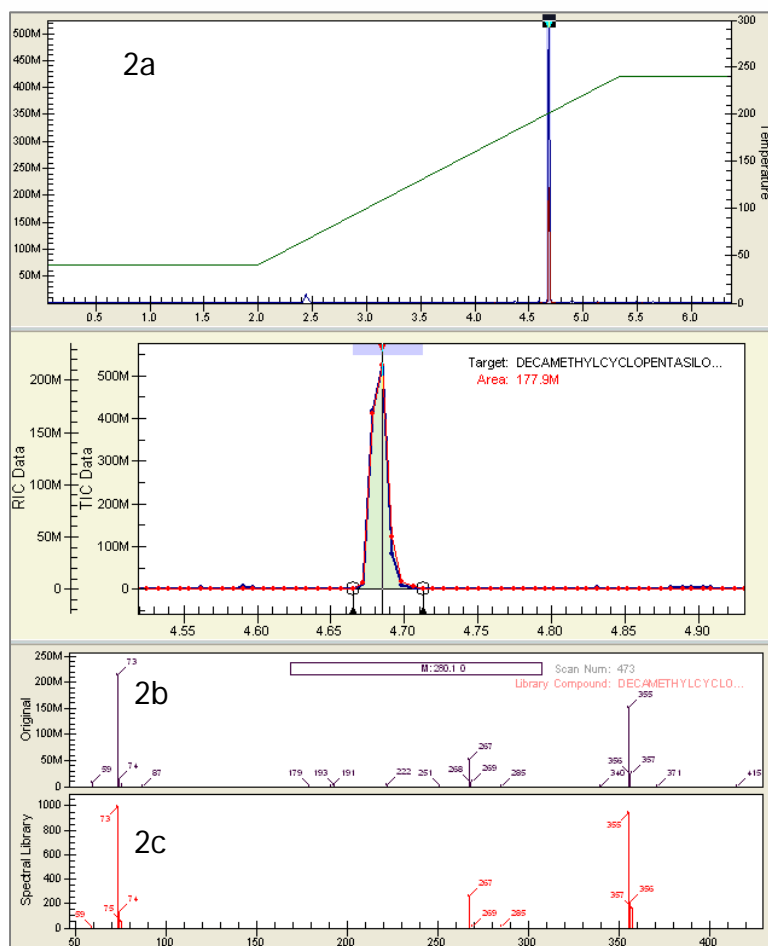


Figure 2 - Resulting Chromatograph and Mass Spectra from Room Air during Working Hours

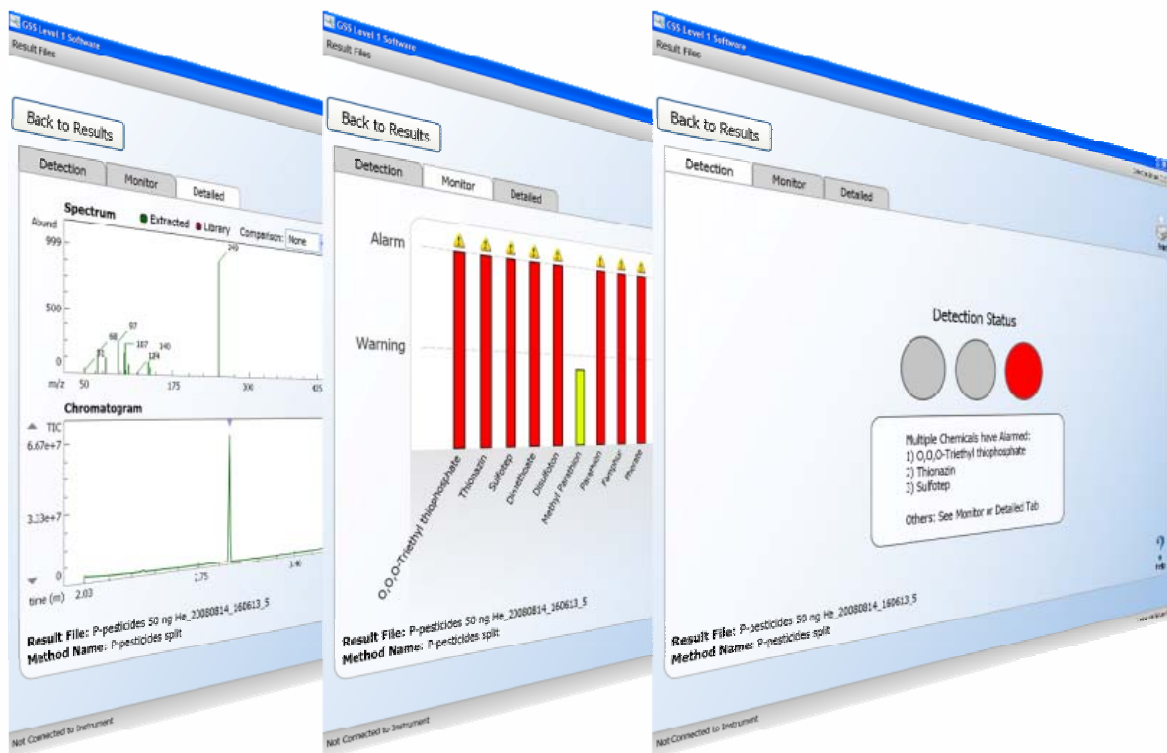


Figure 3 - The GSS Level I interface provides real-time Data and Result files in a 3-tab format (Detection, Monitor, Detailed). In Detection mode, when an alarm chemical is detected at or above the alarm threshold, the status indicator will transition to red, yellow or green. In the event that a chemical is detected and alarms (red), a list of chemical targets is provided.

The data presented in **Figure 1** and **Figure 2** is significant proof that the GC/MS is capable of differentiating and identifying numerous chemicals in a complex atmosphere, such as the air in a chemical laboratory. Complex air samples can cause interference for other sensors. When presented with a sample containing many different chemicals, other sensors could have difficulty positively detecting the appropriate chemicals. This data proves the GC/MS can differentiate between many chemicals in the same complex sample and positively identify them. Further, being that D5 is odorless and colorless, it is a very important example of the ability of the mass spectrometer to be used as both a confirmation and alarming device. There is further indication that the GC/MS will successfully track the presence of chemicals over a continuous period of time. The utilization of multiple GC/MS instruments throughout a facility creates a network of systems that are continuously monitoring for chemical threats. Such data can provide a significant early warning system for buildings which have exposure to potentially dangerous chemicals.

RESULTING DATA FROM OUTDOOR AIR

Figure 4 shows a comparison of the chromatographic and mass spectral results for D5 collected outdoors and indoors at midnight, when the concentration is lowest in the lab air. It is clear that the D5 in outside air is much smaller in intensity, even compared to the room air at midnight. The data proves that the mass spectrometer is able to identify a tasteless, odorless chemical in an uncontrolled environment where the concentrations are much lower. The data is important for another reason. The presence of D5 was confirmed in a complex outdoor air sample that also contained chemicals such as benzene, toluene, xylenes, and naphthalenes.

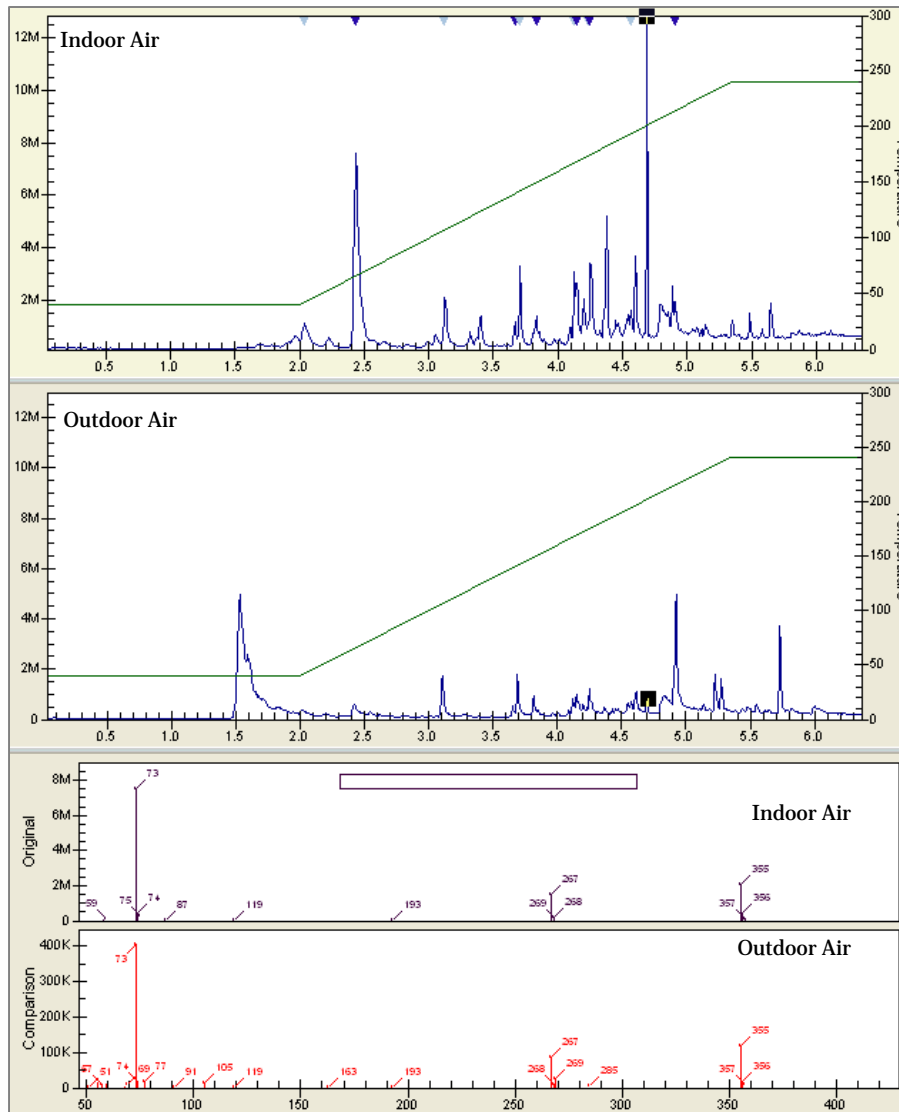


Figure 4: Room Air vs. Outdoor Air

REAL WORLD APPLICATION:

The air composition found outside of buildings can change dramatically both when the temperature changes and as human intervention waxes and wanes. Utilization of a mass spectrometer can help differentiate complex materials and quickly identify the presence of airborne CWA's and TIC's, regardless of the effects of temperature and humidity.

Additional continuous outdoor air monitoring studies were conducted over a three day period. **Figure 5** is a plot showing naphthalenes detected over the three day monitoring period. The intensities of the naphthalenes are higher on sunny days when the temperature is higher. This is expected and likely due to the asphalt heating up and off-gassing a higher intensity of naphthalenes into the atmosphere.

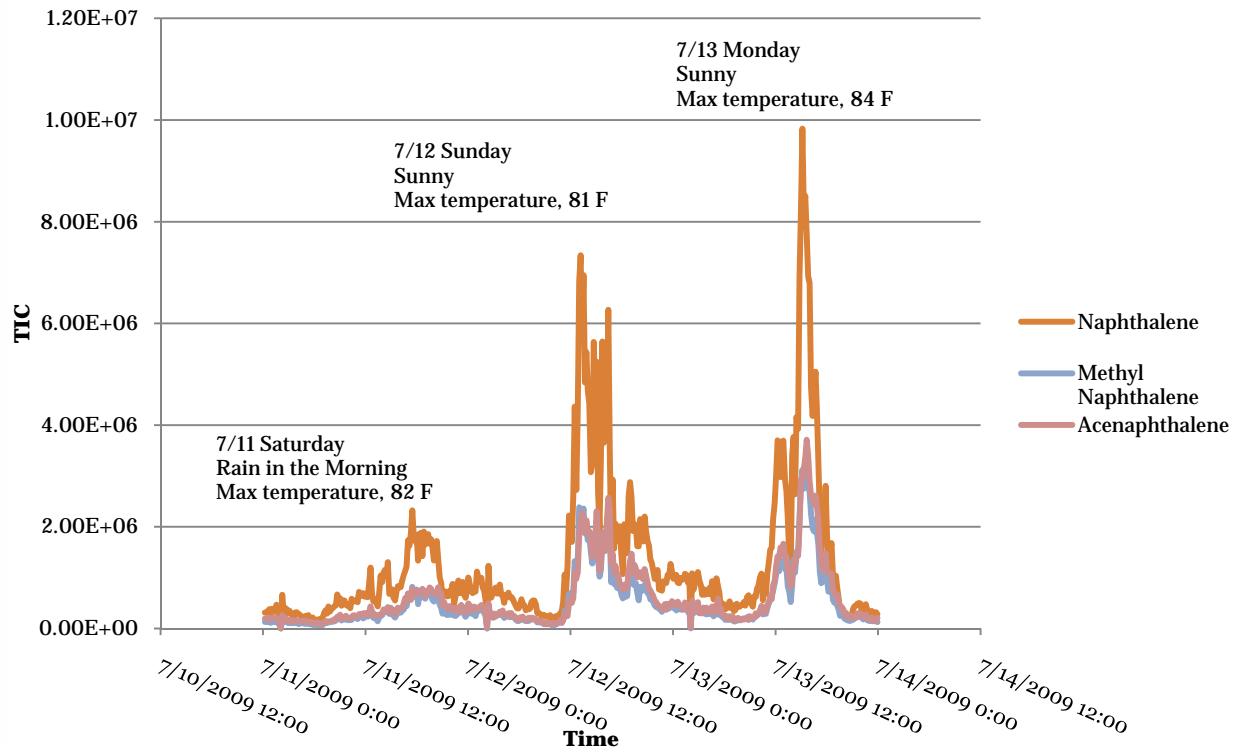


Figure 5: Outside Air Data Collected July 11-13, 2009, Naphthalenes

Figure 6 is a plot showing toluene and xylenes detected over the same three day monitoring period. Unlike the naphthalenes, the intensities of toluene and xylenes are not affected by temperature and weather conditions (sunny or rain). Instead, the intensities of toluene and xylenes are higher on working days (Monday) than the weekend. This is anticipated because the source of toluene and xylenes are likely from the car exhaust, which is higher on work days when more traffic is present outside.

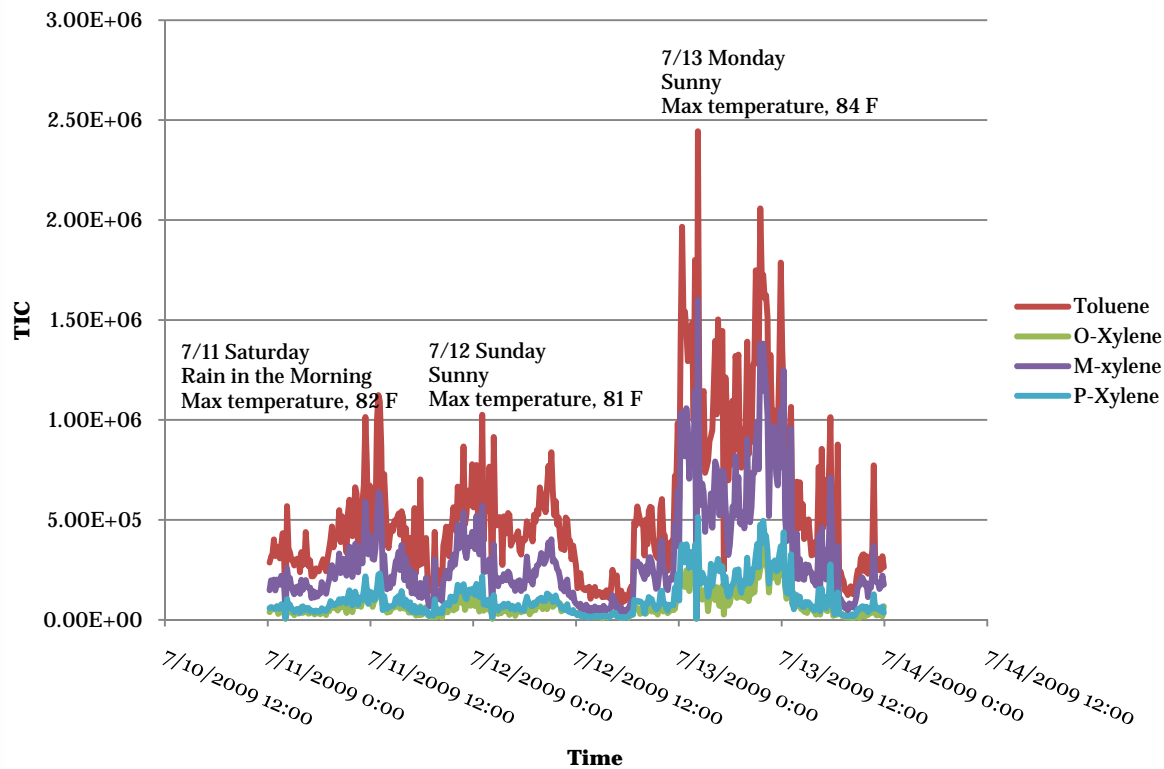


Figure 6: Outside Air Data Collected July 11-13, 2009, Toluene and Xylenes

CONCLUSION

The paper indicates that the Griffin 460 will be able to successfully monitor for and identify multiple chemicals in complex air samples both indoors and outdoors. This selectivity indicates that the mass spectrometer will not incur the false positive alarms found in other technologies. The dual tube pre-concentrator system in the Griffin 460 allows for full coverage, continuous air monitoring. The room air data related the events happening in a lab and in an office. Correlation of weather conditions and traffic activities were found in the outside air data. The data from the laboratory provides significant proof that this method of air monitoring will provide improved operational security without the false positive alarm issues experienced by other sensors.

It is important to note that the Griffin 460 Mobile GC/MS provides a full range of analytical flexibility. The instrument is equipped with multi-modal sampling capabilities for liquid, solid, and air monitoring. The Griffin 460 can also conduct complete “MS/MS” (multi-dimensional) analysis for differentiating and identifying trace levels of chemical compounds in complex chemical environments. These features make the Griffin 460 the world’s only GC/MS with integrated full-coverage air sampling and automated liquid injection that can also perform MS/MS analysis.

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