Identification of Arson Accelerants by Gas Chromatography

Purpose
Arson is an insidious crime that annually claims the lives of hundreds of Americans and costs billions of dollars. Scientists and criminal investigators use a variety of analytical techniques to determine the type of accelerants used to start the fire. In this laboratory, you will use gas chromatography (GC) to determine the composition and/or structure of the flammable material used as the accelerant found at a crime scene.

Introduction
Fires generally burn from a point of origin upward and outward; therefore, if a liquid accelerant has been used to start a fire, some of it will probably have soaked downward and not have been entirely consumed. The fire investigator attempts to trace the fire to its point or points of origin and then digs down and collects samples. To prevent the evaporation and loss of volatile liquids, samples must be placed in air-tight containers. Frequently, new quart or gallon paint cans are used, as are quart fruit jars. Once the samples arrive at the laboratory, the forensic chemist may use any of a number of procedures to recover and identify the accelerants from the collected debris. One popular method is the headspace technique. In this method, a portion of the debris is placed in a glass jar or empty paint can which has a small hole punched in the lid. The hole is covered with a silicon septum glued on with Super-glue. When the container is heated, any volatile residue present in the debris will be driven off and trapped in the container's enclosed airspace. A few millimeters of the vapor is removed with a syringe and analyzed by gas chromatography. If investigators are extremely lucky and find the accelerant, they can also analyze the remaining liquid.

Gas chromatography is an analytical tool used by forensic scientists to identify all types of organic materials including poisons, drugs, and alcohol in blood or urine samples. It is a rapid, simple, and specific procedure, assuming the availability of standards. Gas chromatography involves a sample being vaporized and injected onto the head of the chromatographic column. Once the sample (liquid or gaseous) is injected onto a heated column packed, the sample is transported through the column by the flow of inert, gaseous mobile phase. The column itself contains a liquid stationary phase which is adsorbed onto the surface of an inert solid. This packing material is determined by reference to the literature or by the analyst, who tries various materials and determines the best one for use by examining the results of a series of trials. In this experiment, GC will be used to identify the recovered accelerant, such as gasoline, kerosene, etc.
Crime Scene

The fire department has been called out to the scene of a fire at a motel in Crawford County. The fire marshal suspects that the fire was started with the use of accelerants. An investigator at the scene collected some partially burned wood from the site where the fire appears to have started. She placed the pieces of wood into a paint can, which was immediately sealed in order to prevent loss of any potential accelerant due to evaporation. After completing the standard headspace technique, the vapors were condensed (to obtain a liquid sample) and analyzed using gas chromatography.

PART A: Analysis of Possible Accelerants

1. Obtain a sample of the accelerant found at the crime scene from your instructor.
2. Your instructor or laboratory assistant will provide general instructions on the use of the GC.
3. Using a 10 microliter (ÎL) syringe, insert the syringe needle into the liquid sample. Pump the plunger a few times to fill the barrel of the microsyringe. Finally withdraw about 1 ÎL sample. (Try to avoid air bubbles.)
4. Inject the 1 ÎL sample into the gas chromatograph.

PART B: Identification of Suspect Accelerant

1. Identify the number of organic compounds in the unknown accelerant sample.
2. Using the standard (known) chromatograms, identify the accelerant by comparison with the patterns obtained from each of the four possible accelerants.

Results

Number of organic compounds: ________________
Identify your accelerant: ________________

Attach GC trace to end of report.

Questions

1. Would the GC analysis alone be able to convict a suspect of arson? What other type of evidence might be necessary?

2. Was the accelerant used at the crime scene a mixture or a pure compound? If the sample was a pure compound provide a chemical formula and structure.
GC Traces of Known Accelerants

Figure 2: GC trace of toluene (found in gasoline).

Figure 3: GC trace of MTBE (tert-butyl methyl ether) gasoline additive.
Figure 4: GC trace of nail polish remover (acetone based).\textsuperscript{4}

Figure 5: GC trace of rubbing alcohol (2-propanol).\textsuperscript{4}
Figure 6: GC trace of mineral spirits (turpentine).

References

2. http://www.shu.ac.uk/schools/sci/chem/tutorials/chrom/gaschrm.htm
4. GC Conditions: detector injector temperature 250°C, injector temperature 250°C, rate 10°C/min, range 80-250°C, 1 µL injection, flow set at 80, hold time 2 minutes.