CASE REPORT

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The Forensic Examination of a Fire-Damaged Vehicle

REFERENCE: Service AG, Lewis RJ. The forensic examination of a fire-damaged vehicle. J Forensic Sci 2001;46(4):950–953.

ABSTRACT: The Lothian and Borders Police Forensic Science Laboratory was asked to assist in the investigation of a suspected fraudulent insurance claim involving a fire-damaged motor vehicle. This case demonstrates the persistence of fire accelerants when confined, and the reproducible nature of volatiles created from the accelerated burning of a synthetic material.

KEYWORDS: forensic science, accelerant analysis, pyrolysis, carpet, gas chromatography

The owner of a right-hand drive Porsche motor vehicle claimed that, while driving his vehicle, he turned on the fan heater and sparks were emitted from the heating vents, igniting the dashboard. The fire was confined to the central area of the dashboard and console. A claim was made to the insurance company who, not suspecting a crime, settled the owner's claim and sold the car to a scrapyard. About three months later it was brought to the insurance company's attention that the claimant had confided in an associate that he had removed the car's stereo and set fire to the dashboard using lighter fluid. The police were contacted and the car was located in the scrapyard.

Scene Investigation

Because of the time delay from the incident (March 5 1998) until the car was located (June 11 1998) it was expected that the accelerant would no longer be detectable. However, the windows of the car were still intact, thereby restricting ventilation and "weathering" of volatiles and possibly retaining traces of any accelerant used.

On examination it was noted that the car was fire damaged around the dashboard and console. It was also apparent from the burning pattern that the damage was not consistent with the claimant's story of the fire having started by sparks emitted from the heating vents. The damage to the heating vents and dashboard was greatest on the left-hand side (U.K. nearside) whereas the damage to the floor mats was greatest on the right-hand side (U.K. offside) (Figs. 1*a*, 1*b*). If the offside of the dashboard had been severely damaged then the damage to the offside floor could be explained by melting plastic falling onto the floor. However, there did not appear to be any mechanism for the transfer of burning material from the heating vent to the offside floor. The pattern of burning was in fact consistent with flammable liquid having been splashed in more than one area. Debris samples from the burnt areas of the car were taken, packaged in nylon bags and their necks knotted to effect an airtight seal. The samples were labeled as follows:

Item (1): Pieces of burnt/melted plastic material.
Item (2): Piece of partially burnt carpet/mat.
Item (3): Control Packaging (nylon bag).

Experimental

Sampling

Dynamic headspace sampling was employed using the stainless steel tubes from the ATD 400 packed with Tenax® TA as the adsorbent. The debris samples were individually heated to 100°C in a convection oven for 10 min, then removed and a corner was cut from the bag to allow the insertion of one end of a stainless steel ATD adsorption tube. The other end of the tube was connected to a plastic syringe (150 mL) with a short length of rubber tubing (approximately 3 cm long). By withdrawing the plunger of the syringe a measured volume of the headspace was sampled and hydrocarbon volatiles present were trapped onto the Tenax® within the adsorption tube. A headspace sample (200 mL) was removed from each item for analysis.

Instrumentation

Items 1 to 3 were analyzed using a Perkin Elmer Automated Thermal Desorption system (ATD 400) interfaced with a Hewlett-Packard 5890 Series II Gas Chromatograph (GC) fitted with a flame ionization detector (FID). The following conditions were used:

a) Automated thermal desorption system (ATD 400)
The operating conditions for a two stage desorption process were as follows: The sample was first thermally desorbed from the Tenax® tube at 230°C under a flow of helium, for 5 min. The volatiles were concentrated in the cold trap at −30°C. Flash heating (3 to 4 s) of the cold trap to 300°C facilitated the trans-

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Received 31 May 2000; and in revised form 11 Sept. 2000; accepted 18 Sept. 2000.

A

B

FIG. 1*a,* 1*b*—*Areas of burning around front console of motor vehicle.*

fer of the volatiles via a heated transfer line (200°C) onto the gas chromatograph column as a sharp band. The trap was held at 300°C for 2 min to ensure complete removal of the volatiles. Inlet and outlet splits before and after the cold trap were set so that 1/40 of the sample was passed onto the column.

b) Gas Chromatograph (GC)

The operating conditions of the GC were as follows: Oven temp., 50°C for 2 min; ramp rate, 6°C to 230°C; final time, 10 min; injector temp., 250°C; detector temp., 250°C; carrier gas, helium 16 psi; FID gases, air 40 psi; hydrogen 20 psi. Chro-

matography was performed on a Restex Rtx-1 (30 m) capillary column with a 0.25 mm internal diameter. The data were collected using HP Chemstation software.

Controlled Experiments

In order to explain our findings it was necessary to carry out a series of controlled experiments. The experiments were devised to determine the ease of ignition of the mats within the vehicle and to attempt to replicate the chromatographic profile produced by Item 2. Fortunately, because the fire had not been too severe, the floor mats in the rear of the vehicle (identical to those in the front) had not been damaged, and so one of these was taken as a comparison sample and labeled as:

Item 4 Comparison mat

The following tests were performed on Item 4 using the instrumental conditions previously outlined:

a) Item 4 was placed within a nylon bag and sealed prior to analysis by ATD 400/GC/FID to determine if it had become contaminated with accelerant.
b) A match was applied to the pile of Item 4 in an attempt to ignite it. When this failed a Bunsen flame (circa 1900°C (1)) was applied in order to cause burning similar to that in the case sample. Burning ceased when the heat source was removed. The partially burnt material was placed within a nylon bag and sealed prior to analysis by ATD 400/GC/FID.
c) Lighter fluid was sprinkled on the pile of Item 4 and ignited in an attempt to reconstruct an accelerated fire that could yield a chromatographic profile similar to that obtained with Item 2. Approximately 1 mL of "Swan" lighter fluid was sprinkled across the carpet pile and ignited. After burning for about 15 to 20 s the flame was extinguished. The piece of burnt mat was left exposed to the air for one week at room temperature (circa 22°C) before placing within a nylon bag and sealing prior to analysis by ATD 400/GC/FID.
d) A sample of the "Swan" lighter fluid was allowed to evaporate to 5% of its original volume, in a glass vial over a hot plate to examine the effect of "weathering" on its chromatographic profile.

Results

Case Items

Examination of the chromatogram (Fig. 2) obtained from the headspace of the debris sample from the car (Item 2) showed similarities to lighter fuel (Fig. 5), with some additional peaks.

Controlled Experiments

a) No significant peaks were obtained with the unburnt comparison mat (Item 4) confirming that it had not been previously contaminated with accelerant and was therefore suitable for the remaining tests.
b) A sample of Item 4 burned without accelerant was analyzed. Pyrolysis products generated yielded a different chromatographic profile (Fig. 3) to that obtained from Item 2.
c) The chromatogram resulting from Item 4 burned with the lighter fluid and left exposed for one week (Fig. 4), prior to analysis, showed a much greater resemblance to Item 2 than to the lighter fluid standard alone (Fig. 5). This suggested that the best way to reproduce the chromatogram from Item 2 was to ignite the com-

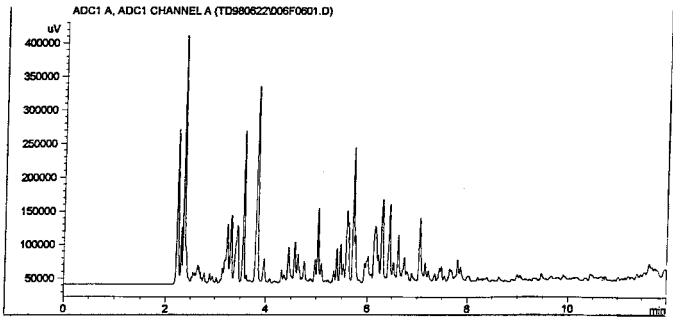

FIG. 2—*Gas chromatogram of headspace from Item 2 Debris from car.*

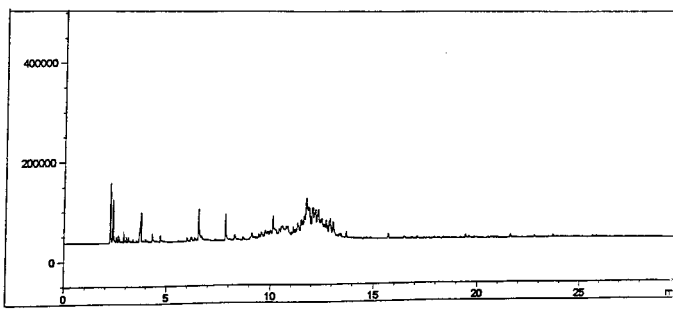

FIG. 3—*Gas chromatogram of headspace from Item 4 Control mat.*

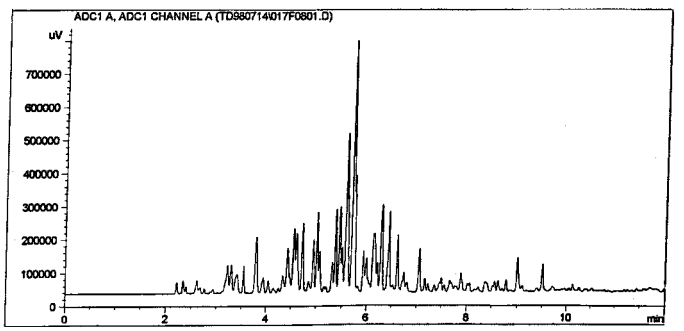

FIG. 4—*Gas chromatogram of headspace from Item 4 Control mat burned with lighter fluid.*

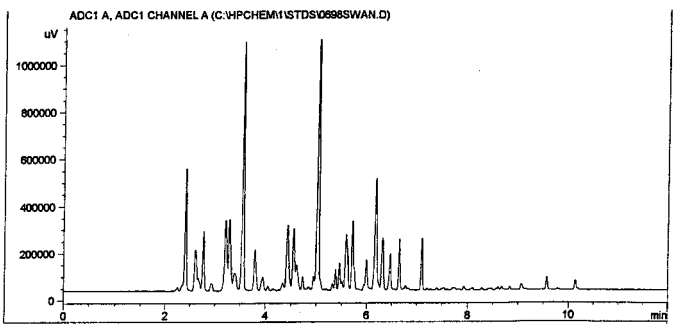

FIG. 5—*Gas chromatogram of "Swan" lighter fluid.*

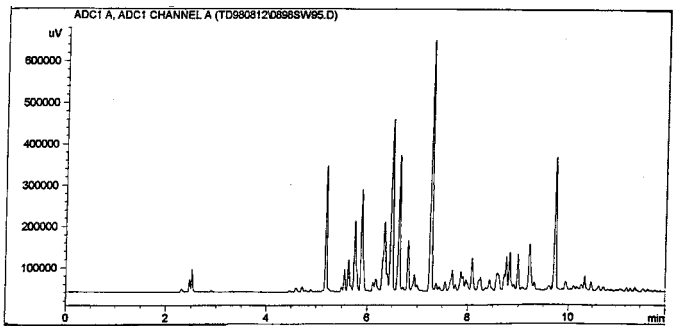

FIG. 6—*Gas chromatogram of "Swan lighter fluid" (95% weathered).*

parison mat (Item 4) using the lighter fluid and exposing it to the atmosphere for a period of time prior to analysis.

d) As expected, the profile of the 95% evaporated lighter fluid was found to have the early volatiles missing and the later fractions becoming more prominent (Fig. 6). However, the additional peaks that were found with the carpet burnt with lighter fluid were not present. This showed that these additional peaks did not occur as a result of the "weathering" process.

Conclusions

Difficulty in igniting the carpet with a match suggests that it would be unlikely to catch fire as a result of sparks being emitted from the heater. Melting plastic falling from the dashboard could have caused the damage but as the photographs reveal, there is no obvious mechanism for the transfer of the melting plastic from the heat damaged nearside vent to the offside floor.

Analysis of the burnt carpet from the scene yielded a chromatographic profile similar to "Swan" lighter fluid but with additional peaks (pyrolysis products) also present. Laboratory tests showed that this profile was best reproduced by burning the carpet with "Swan" lighter fluid and allowing it to "weather." Although it has been previously reported as not being possible to reproduce pyrolysis conditions of foam backed carpets in the laboratory (2), this case demonstrates the worth in recovering comparison samples for experimental burning.

Acknowledgments

The authors wish to express their appreciation to Dr. Allan Jamieson, Head of Forensic Sciences at the Lothian and Borders Police Forensic Science Laboratory for his encouragement during this work and for his assistance in reproducing the photographic images.

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