Study on Distribution of Gasoline Combustion Dust Components

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Abstract

The application of High Performance Liquid Chromatography (LC) to the analysis of gasoline combustion dusts Components is studied in this article. The results show that sample of gasoline combustion dusts contains 20 kinds of components, distribution of the components are obtained at different times, it could be a promising technique for the confirmation of the gasoline combustion dusts, meanwhile the effects of temperature, on the timeliness of gasoline combustion dusts analysis adsorbed on the glass has been investigated, the corresponding data of timeliness, derived equations and correlation are provided. Pattern recognition was useful for the detection and characterization of gasoline combustion dusts.

Keywords: gasoline; glass; dust; high-performance liquid chromatography

1. Introduction

Combustion dusts are one of very important evidences in fire, it not only contains a variety of combustion products, but also it contains a large number of fire information. It is one of the most important fire scene "signs" reflecting the process of fire. Incomplete combustion of ignitable liquids produce amounts of dust because of lacking oxygen early in the fire, they will be adsorbed on the surface of glass, walls and other objects. These dust samples are extracted as evidence identification, and determine whether they contain ignitable liquid fire, so as to provide technical support for fire Cause Determination.

Liquid chromatography (LC) method has been developed for the analysis and identification of selected gasoline combustion dusts target compounds in highly contaminated extracts of fire debris. However, in practice, it is often seen that the time interval between the occurring of the fire to the evidence extraction and submission is too long, some for days, others more than ten days or even more than six months, without realizing the timeliness of such evidence eligible for forensic analysis, which barely provides any related data for reference and brings a great deal of difficulty in extracting such fire evidence on the fire scene. In this article, we apply LC to the detection of gasoline combustion dusts, often referred to as accelerants, and present new data. Groups of characteristic compounds and Distribution of components were clearly observed in the sample. it could be a promising technique for the confirmation of the gasoline combustion dusts. The timeliness of gasoline combustion dusts analysis adsorbed in glass carrier, offering the timeliness of such fire evidence eligible for forensic analysis, providing a reference for timely extraction of such evidence by fire scene investigators.
2. Experimental

2.1. Analysis method

Combustion dusts of gasoline products and their residues were analysed on HPLC using C-18 reverse phase column. Mobile phase of Methanol: Water (8:2) at the flow rate of 1 ml/min and UV absorption detection at 275 nm and 285nm were used.

2.2 Specimen preparation

Gasoline(50ml,90#) were placed in sample cell of burning stove, then closing stove door and igniting gasoline until the flame went out naturally. Combustion dusts of gasoline were collected in flue of height 1.5m. After cooling 5min, Samples were kept in incubators at 40°C, 100°C and -10°C, and calm wind conditions and analyzed at regular intervals, and each repeated three times.

2.3 Extraction preparation

Reagent grade N-hexane was used as diluent for dust samples and extracting solvent, glass adsorbed gasoline residues were cleaned repeatedly, and placed in breaker (20mL) until soaked maintained for 30min by N-hexane. Filtrate were filtered and concentrated to 1ml.

3. Results and Discussion

3.1. components of gasoline combustion dusts

![Fig.1 LC for gasoline combustion dusts](image)

Table 1 ID file for gasoline combustion dusts target compounds

| Target compounds | Retention time(min) | Target compounds | Retention time(min) |
|------------------|---------------------|------------------|---------------------|
|                  |                     |                  |                     |
| 1                | 3.298               | 11               | 9.057               |
| 2                | 4.956               | 12               | 10.809              |
| 3                | 5.406               | 13               | 11.434              |
| 4                | 5.636               | 14               | 11.857              |
| 5                | 5.878               | 15               | 15.365              |
| 6                | 6.372               | 16               | 16.211              |
| 7                | 6.932               | 17               | 18.853              |
| 8                | 7.827               | 18               | 19.529              |
| 9                | 8.310               | 19               | 21.812              |
Liquid chromatograms and the corresponding target compound for gasoline combustion dusts are shown in Figure 1 and Table 1. 25 kinds of target compounds were detected in 25 min and marked in the experimental conditions. Several kinds of compounds for 6.372 min, 1.434 min, 6.211 min, and 19.529 min content were relatively high, and characteristic of compounds. Target compound analysis is a useful approach to the identification of residual gasoline products in fire debris. Target compound patterns for gasoline combustion dusts are sufficiently specific to allow their identification in high-background arson samples.

![Figure 2 LC for gasoline combustion dusts at different time](image)

| NO | Time (h) | NO | Time (h) |
|----|---------|----|---------|
|    | 0       | 1  | 2       |
| 1  | 0       | + | +       |
| 2  | 8.0     | + | +       |
| 3  | 16.0    | + | +       |
| 4  | 24.0    | + | +       |
| 5  | 30.0    | + | +       |

Curves for LC for gasoline combustion dusts at different time for tests are shown in Figure 2. The 20 kinds of target compounds for gasoline combustion dusts at different time are shown in Table 2. With the development of time, content of gasoline combustion dusts all components decreased gradually in Figure 2. Most of the components were disappear when the time reaches 30 hours. For gasoline combustion dusts, compounds 1 and 9 were significantly more volatile than other compounds include 3, 4, 12, 7, 19, 20, 10, 11, and 17 compounds, compounds 6, 8, 13, 14, 15, 16, and 18 were relatively stable as in table 2. The variables to be considered were distribution of the gasoline combustion dusts components which were different under different time conditions. Different time to extract the evidence were detected in the laboratory which requires different criterion for avoiding false positive results.

3.2. Effect of temperature on timeliness of gasoline analysis in cotton cloth carrier

The graph of the timeliness of gasoline combustion dusts on the glass at 100°C, 40°C and -10°C, and calm wind conditions is shown in Fig 3. It can be seen from the figure that the timeliness of gasoline analysis on the glass at 100°C, and calm wind conditions is 5160 min; the timeliness of gasoline analysis on the glass at 40°C and calm wind conditions is 7200 min; the timeliness of gasoline analysis on the cotton cloth at -10°C and calm wind conditions is 18600 min. This clearly indicates that the effect of temperature on the timeliness of gasoline analysis is the most significant, the higher the temperature, the faster gasoline residue adsorbed on the carrier evaporates, and the shorter timeliness of analysis. The timeliness was 5160 min at 100°C, but extended to 18600 min at -10°C, giving a difference of 3.6 times in the timeliness. Therefore, in the hot summer weather, gasoline residues on the carrier at the scene is more volatile and evidence extraction must be performed as soon as possible in order to prevent the evidence from losing its validity and identifying value; while in winter, fire scene evidence extraction time may be appropriately extended.
It can be seen from the graph that temperature and timeliness are of exponential relationship, the equation of the curve is $y=11652X^{-7.6342}$, where $X$ represents temperature, $y$ for timeliness. Given the temperature of weather, fire scene investigators can use this equation to calculate timeliness of gasoline analysis on the glass carrier, and carry out sampling in a timely manner so as not to miss the best time for sampling and submission of evidence for testing.

![Fig.3 Temperature versus timeliness](image.png)

4. Conclusion

The use of LC analyzed the compositions of gasoline dusts used in a fire. An excellent pattern can be obtained. LC is an invaluable analytical technique in suspected arson cases, meanwhile study has been carried out on the timeliness of gasoline combustion dusts analysis adsorbed in glass carrier under different temperature conditions, providing basic data and reference for fire scene investigators to extract such fire evidence in a timely manner. We will continue to research the project and improve the quality of all aspects of ignitable liquid residue analysis.

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