Training Guidelines for the Fire Debris Analyst

Lesson Plan (Module) 13

Date: November 2006 **Instructor:** Qualified Instructor

Subject: Classification, Interpretation and Identification **Total Time:** 40 hours

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Learning Objectives

- To understand the criteria for the classification of ignitable liquids
- To identify the limitations of GC/FID data per ASTM 1387
- To recognize the impact various substrates can have on data interpretation
- To properly identify a group of ignitable liquids in accordance with ASTM E1618

Suggested Reading

1. ASTM E 1387-01, "Standard Test Method for Flammable or Combustible Liquid Residues in Extracts from Fire Debris Samples by Gas Chromatography," ASTM International.
2. ASTM E 1618-01, "Standard Test Method for Ignitable Liquid Residues in Extracts from Fire Debris Samples by Gas Chromatography-Mass Spectrometry," ASTM International.
3. GC-MS Guide to Ignitable Liquids, Newman, R., Gilbert, M., Lothridge, K., CRC Press, 1998.
4. Accelerant Identification in Fire Debris by Gas Chromatography/Mass Spectrometry Techniques, Kelly, R.L., Martz, R.M., Journal of Forensic Sciences, Vol. 29 (3), pages 714-722, 1984.
5. GC/MS Data Interpretation for Petroleum Distillate Identification in Contaminated Arson Debris, Keto, R.O., Journal of Forensic Sciences, Vol. 40 (3), pages 412-423, 1995.
6. An Accelerant Classification Scheme Based on Analysis by Gas Chromatography/Mass Spectrometry (GC/MS), Nowicki, J., Journal of Forensic Sciences, Vol. 35 (5), Pages 1064-1086, 1990.
7. GC/MS Data from Fire Debris Samples: Interpretation and Applications, Wallace, J.R., Journal of Forensic Sciences, Vol. 44 (5), pages 996-1012, 1999.
8. Detection of Petroleum-Based Accelerants in Fire Debris by Target Compound Gas Chromatography/Mass Spectrometry, Keto, R.O., Wineman, P.L., Analytical Chemistry, Vol. 63 (18), pages 1964-1971, 1991.
9. Microbial Degradation of Gasoline in Soil, Mann, D.C., Gresham, W.R., Journal of Forensic Sciences, Vol. 35 (4), pages 913-923, 1989.

10. Microbial Degradation of Petroleum Hydrocarbons: Implications for Arson Residue Analysis, Kirkbride, K.P., Journal of Forensic Sciences, Vol. 37 (6), pages 1585-1599, 1992.
11. Turpentine in Arson Analysis, Trimpe, M.A., Journal of Forensic Sciences, Vol. 36 (4), pages 1059-1073, 1991.
12. The Petroleum-Laced Background, J.J. Lentini, J.A. Dolan, and C. Cherry, Journal of Forensic Sciences, 45 (5), pages 968-989, 2000.
13. Differentiation of Asphalt and Smoke Condensates from Liquid Petroleum Distillates Using GC/MS, Lentini, J.J., Journal of Forensic Sciences, 43(1), pages 97-113, 1998.
14. The Identification of Isopar H in Vinyl Flooring, Wells, S.B., Journal of Forensic Sciences, 50(4), pages 865-872, 2005.
15. Persistence of Floor Coating Solvents, Lentini, J., Journal of Forensic Sciences, 46(6), pages 1470-73, 2001.
16. Basic concept of pyrolysis for fire debris analysts, Stauffer E., Science and Justice, 43(1), pages 29-40, 2003.
17. Analysis and Interpretation of Fire Scene Evidence, J.R.Admirall & K.G. Furton, Editors. CRC Press LLC, 2004; Chapter 5 “Analytical Methods for the Detection and Characterization of Ignitable Liquid Residues from Fire Debris”, Julia A. Dolan; and Chapter 6 “ASTM Approach to Fire Debris Analysis”, Reta Newman.
18. The transfer and persistence of petrol on car carpets, K. Cavanagh-Steer, et al., Forensic Science International, 147(1), pages 71-79, 2005.
19. Pyrolysis Products of Structure Fires, J.D.DeHaan, K.Bonarius, Journal of Forensic Science Society, 28(5-6), pages 299-309, 1988.
20. Fire Investigation, Daéid, N.N. Editor, CRC Press, 2004; Chapter 5 “Modern laboratory techniques involved in the analysis of fire debris samples”, Reta Newman; Chapter 6 “Interpretation of laboratory data”, Reta Newman; and Chapter 7 “Sources of interference in fire debris analysis”, Eric Stauffer.
21. Background interference from car carpets – the evidential value of petrol residues in cases of suspected vehicle arson, K. Cavanagh, et al., Forensic Science International, 125, pages 22 – 36, 2002.
22. Aromatic Content in Medium Range Distillate Products – Part I: An Examination of Various Liquids, Dolan, J.A., Stauffer, E., Journal of Forensic Sciences, 49(5), pages 992 – 1004, 2004.
23. Effect of Background Interference on Accelerant Detection by Canines, Kurz, M.E., et al., Journal of Forensic Sciences, 41(5), pages 868 – 873, 1996.

Introduction

Upon completion of this lesson the analyst will be able to interpret chromatographic data from fire debris samples to (a) determine whether an ignitable liquid is present and to (b) identify and classify the ignitable liquid.

Outline

1. Why classification is necessary
    a. the products with similar chemical composition are marketed for different uses
    b. the products with different chemical composition are marketed for the same usage

2. Evolution of Ignitable Liquid Classification
    a. ATF & IAAI (1983)
    b. ASTM E 1387-90
    c. ASTM E 1387-95
    d. ASTM E 1387-01
    e. ASTM E 1618-01
    f. ASTM E 1618-06

3. Data Analysis: GC/FID
    a. visual comparison/pattern recognition
    b. limitations

4. Data Analysis: GC/MS
    a. compound identification
    b. visual comparison (TIC)
    c. extracted ion chromatography (EIC)
        i. major ions present in MS of common ignitable liquids (single ions)
        ii. summed ions
    d. target compound chromatography (TCC)
        i. target compounds in different classes of ignitable liquids

5. Ignitable Liquid Classification Scheme
    a. criteria for the identification of gasoline
        i. general TIC profile
        ii. presence and or absence of types of hydrocarbons
    b. criteria for the identification of distillates
        i. general TIC profile
        ii. presence and or absence of types of hydrocarbons
        iii. de-aromatized and re-aromatized distillates
    c. criteria for the identification of isoparaffinic products
        i. general TIC profile
        ii. presence and or absence of types of hydrocarbons
    d. criteria for the identification of aromatic products
        i. general TIC profile
        ii. presence and or absence of types of hydrocarbons
    e. criteria for the identification of naphthenic paraffinic products
        i. general TIC profile
        ii. presence and or absence of types of hydrocarbons
    f. criteria for the identification of normal alkane products

i. general TIC profile
ii. presence and or absence of types of hydrocarbons

g. criteria for the identification of oxygenated products
   i. presence of ignitable oxygenated compounds
h. light, medium and heavy range
   i. carbon range

6. Interference from Substrate Materials
   a. carpet and carpet padding
   b. wood
   c. paper products
   d. shoes and clothing
   e. polymers
   f. condensates
   g. vehicle fires
   h. others

Teaching Aids

Practical exercises (interpretation of analytical data)
Handout
PowerPoint presentation

Summary

Classification of ignitable liquids is essential since products with similar composition are marketed under different brand names for different uses. The ignitable liquid is classified by its chemical nature and by its boiling point range.

Test Questions

1. Which of the following are bacteria more likely to degrade in a gasoline sample?
   a. certain aromatics
   b. cycloalkanes
   c. naphthalenes
   d. indanes

2. How do you distinguish between a distillate and a de-aromatized distillate?
   a. relative abundance of extracted ion profiles for aromatic compounds
   b. GC/FID data
   c. total ion chromatogram
   d. the profile of 128, 142, 156 ions

3. What fresh petroleum distillate elutes primarily between C8 and C12?
   a. light
   b. medium
   c. heavy
   d. gasoline

4. A chromatogram has a series of homologous triplets from C10-C16. What does this commonly represent?
   a. heavy petroleum distillate
   b. medium petroleum distillate
   c. polystyrene
   d. polyethylene

5. What type of an ignitable liquid has similar summed extracted ion profiles for ions (57+71+85) and (55+69+83)?
   a. isoparaffinic product
   b. naphthenic paraffinic product
   c. petroleum distillate
   d. aromatic product

6. Which of the following does not fall under the ASTM classification of oxygenate?
   a. acetone
   b. petroleum ether
   c. isopropyl alcohol
   d. diethyl ether

7. Kerosene falls into which ASTM classification?
   a. heavy petroleum distillate
   b. medium petroleum distillate
   c. mid-heavy petroleum distillate
   d. none of the above

8. Gasoline identified in fire debris can be readily associated with a particular gasoline source. True or **False**

9. Detection of terpenes is conclusive proof that turpentine was used as an accelerant. True or **False**