Training Guidelines for the Fire Debris Analyst

Lesson Plan (Module) 10

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

Subject: Recovery and Separation of Ignitable Liquids **Total Time:** 30 hours

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Learning Objectives

- To understand the advantages and disadvantages of the different methods for the recovery and separation of ignitable liquid residues in fire debris and to learn to use these methods.

Suggested Reading

1. ASTM E 1385-00 "Standard Practice for Separation and Concentration of Flammable or Combustible Liquid Residues from Fire Debris by Steam Distillation," ASTM International.
2. ASTM E 1386-00, "Standard Practice for Separation and Concentration of Ignitable Liquid Residues from Fire Debris Samples by Solvent Extraction," ASTM International.
3. ASTM E 1388-00, "Standard Practice for Sampling of Headspace Vapors from Fire Debris Samples," ASTM International.
4. ASTM E 1412-00, "Standard Practice for Separation of Ignitable Liquid Residues from Fire Debris Samples by Passive Headspace Concentration With Activated Charcoal," ASTM International.
5. ASTM E 1413-00, "Standard Practice for Separation and Concentration Ignitable Liquid Residues from Fire Debris Samples by Dynamic Headspace Concentration," ASTM International.
6. ASTM E 2154-01 "Standard Practice for Separation of Ignitable Liquid Residues from Fire Debris Samples by Passive Headspace Concentration with Solid Phase Microextraction (SPME)", ASTM International.
7. Kirk's Fire Investigation, J. D. DeHaan, Ed., 5th Ed., 2002. Chapters 4 and 14.
8. The Use of Activated Charcoal Strips for Fire Debris Extractions by Passive Diffusion. Part 1: The Effects of Time, Temperature, Strip Size, and Sample Concentration, Newman, R.T., Dietz, W.R., Lothridge, M.S.M., Journal of Forensic Sciences, Vol. 41 (3), pages 361-370, 1996.
9. Improved Charcoal Packaging for Ignitable Liquid Recovery by Passive Diffusion, Dietz, W.R., Journal of Forensic Sciences, Vol. 36 (1), pages 111-121, 1991.

10. A Comprehensive Sample Preparation Scheme for Accelerants in Suspect Arson Cases, Ren, Q., Bertsch, W., Journal of Forensic Sciences, Vol. 44 (3), pages 504-515, 1999.
11. The Concentration and Analysis of Volatile Hydrocarbons in Fire Debris Using Tenax-GC, Russell, L.W., Journal of the Forensic Science Society, Vol. 21, page 317-326, 1981.
12. The Detection and Analysis of Ignitable Liquid Residues Extracted from Human Skin Using SPME/GC, Amirall, J.R., Wang, J., Lothridge, K., Furton, K.G., Journal of Forensic Sciences, Vol. 45 (2), pages 453-461, 2000.
13. Solid Phase Micro-Extraction, Zhang, Z., Yang, M., Pawliszyn, J, Analytical Chemistry, Vol. 66, pages 844a-853a, 1994.
14. A Novel Method for the Analysis of Gasoline from Fire Debris Using Headspace Solid Phase Micro extraction, Furton, K., Almirall, J., Bruana, J., Journal of Forensic Sciences, Vol. 41 (1), pages 12-22, 1996.
15. Fire Investigation, Daéid, N.N. Editor, CRC Press,2004; Chapter 5 "Modern laboratory techniques involved in the analysis of fire debris samples", Reta Newman.
16. Analysis and Interpretation of Fire Scene Evidence, J.R.Admirall & K.G. Furton, Editors. CRC Press LLC, 2004. Chapter 4 "Essential Tools for the Analytical Laboratory: Facilities, Equipment, and Standard Operating Procedures", Carl E. Chasteen; 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.

Introduction

Ignitable liquids are rarely presented to the laboratory in pure form. They must therefore be isolated from the fire debris prior to analysis. This lesson plan will cover the various methods of ignitable liquid residues recovery and separation.

Outline

1. Headspace
    a. Room Temperature and Heated
    b. Equipment needed
    c. Advantages
    d. Disadvantages
    e. Reference ASTM E 1388

2. Steam Distillation
    a. Equipment needed
    b. Advantages
    c. Disadvantages

d. Reference ASTM E 1385

3. Solvent Extraction
    a. Equipment needed
    b. Advantages
    c. Disadvantages
    d. Reference ASTM E 1386

4. Passive Headspace Concentration (charcoal sampling)
    a. Equipment needed
    b. Advantages
    c. Disadvantages
    d. Reference ASTM E 1412

5. Dynamic Headspace Concentration
    a. Equipment needed
    b. Advantages
    c. Disadvantages
    d. Reference ASTM E 1413

6. Solid Phase Micro Extraction (SPME)
    a. Equipment needed
    b. Advantages
    c. Disadvantages
    d. Reference ASTM E 2154

Teaching Aids

Handout
PowerPoint presentation
Practical exercises using the various recovery techniques

Summary

The choice of the best extraction procedure is an important aspect of fire debris analysis. No single method is ideally suited for all types of samples recovered from fire scenes. Understanding the advantages and disadvantages of each separation technique will help the analyst in the selection of the appropriate method or methods.

Test Questions

1. Which of the following techniques is best for recovery of traces of ignitable liquid from a burned intact metal gas container?

a. solvent extraction
b. steam distillation
c. heated headspace
d. SPME

2. What is the preferred adsorbent for non-polar hydrocarbons?
   a. diatomaceous earth
   b. silicon dioxide
   c. activated carbon
   d. glass wool

3. What solvent should not be used for extraction of charcoal strips?
   a. petroleum ether
   b. pentane
   c. diethylether
   d. carbon disulfide

4. What solvent should not be used for solvent extraction?
   a. petroleum ether
   b. pentane
   c. diethylether
   d. carbon disulfide

5. Which technique is preferred for the isolation of lighter volatiles?
   a. steam distillation
   b. solvent extraction
   c. headspace
   d. passive adsorption

6. Which of the following techniques does not use a volatile solvent?
   a. SPME
   b. steam distillation
   c. passive headspace concentration/solvent elution
   d. solvent extraction

7. Which of the following techniques is best to distinguish between kerosene and diesel?
   a. steam distillation
   b. solvent extraction
   c. headspace
   d. passive adsorption