FINAL REPORT ABSTRACT
Forensic Analysis of Evidence from Clandestine Methamphetamine Laboratories

Submitted to
National Institute of Justice

By
Washington State Patrol Crime Laboratory Division

December 12, 2005

Project Title:	Capillary Electrophoretic Analysis of Clandestine Methamphetamine Laboratory Evidence
Project Subtitle:	Practical Application of CE Techniques to the analysis of samples from Clandestine Methamphetamine Laboratories
Authors:	Dr. David M. Northrop – Forensic Scientist Dr. Eric C. Person – Forensic Scientist Ms. Lori Knops – Forensic Scientist
Period:	July 1, 2003 to March 31, 2006
Budget Amount:	$316,222
Grant Number:	2003-LT-BX-K004

NIJ grant 2003-LT-BX-K004 Final Report

Capillary Electrophoretic Analysis of Clandestine Methamphetamine Laboratory Evidence

Three goals were outlined for this project:

1) To develop capillary electrophoresis (CE) methods that can be used to assist in the identification of inorganic chemical species from various methamphetamine manufacturing methods;
2) To develop a better understanding of methamphetamine manufacturing methods and the chemistry of popular and emerging reactions, so as to improve the evaluation of samples collected from illicit manufacturing facilities;
3) To provide training to forensic chemistry analysts, clandestine laboratory crime scene responders, and user agencies on what to look for when handling laboratories associated with popular and newly emerging methamphetamine manufacturing trends.

Goal 1 was achieved with the development of a dynamic coating CE method using CElixirOA™ 8.2 to separate inorganic anions including: acetate, azide, bromide, carbonate, chlorate, chloride, fluoride, hypophosphate, iodide, nitrate, nitrite, perchlorate, phosphate, phosphite, sulfate, sulfite, and thiocyanate. The developed method is capable of detecting these anions down to between 10 and 30 ppm and with a percent relative standard deviation for normalized migration times of less than 0.1%. This method was used to differentiate samples from various methamphetamine manufacturing methods for the purpose of identifying the manufacturing process that was utilized.

Goal 2 was accomplished in three primary ways. First, the phosphorus chemistry in the hydriodic acid method of methamphetamine manufacture was elucidated using the CE anion method (developed in Goal 1) and GC/MS analysis for organic species. Equations were developed to allow the chemist to predict starting materials based on the analysis of post-reaction materials. Using predicted, optimized reaction stoichiometry, methamphetamine was manufactured in less than 15 minutes. Second, methamphetamine was manufactured in a "One-Pot" environment using the in-situ generation of ammonia from fertilizer and lye combined with an alkali metal and pseudoephedrine in a single reaction vessel. Third, pseudoephedrine was demonstrated to be recoverable from multi-ingredient, liquid, and/or softgel over-the-counter (OTC) medications using commonly available extraction methods. These same OTC medications were shown to be converted to methamphetamine using the "One-Pot" method of manufacture.

Goal 3 included the publication of six papers, production of eight training videos, and oral presentations of results at twenty meetings with forensic scientists, clandestine laboratory responders, law enforcement officials, community leaders, legislators and user agency personnel. In addition, the CE methods have been successfully implemented in other crime laboratories within the Washington State Patrol Crime Laboratory Division.

FINAL REPORT SUMMARY
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2) To develop a better understanding of methamphetamine manufacturing methods and the chemistry of popular and emerging reactions, so as to improve the evaluation of samples collected from illicit manufacturing facilities;
3) To provide training to forensic chemistry analysts, clandestine laboratory crime scene responders, and user agencies on what to look for when handling laboratories associated with popular and newly emerging methamphetamine manufacturing trends.

This summary details the ways in which these goals were accomplished.

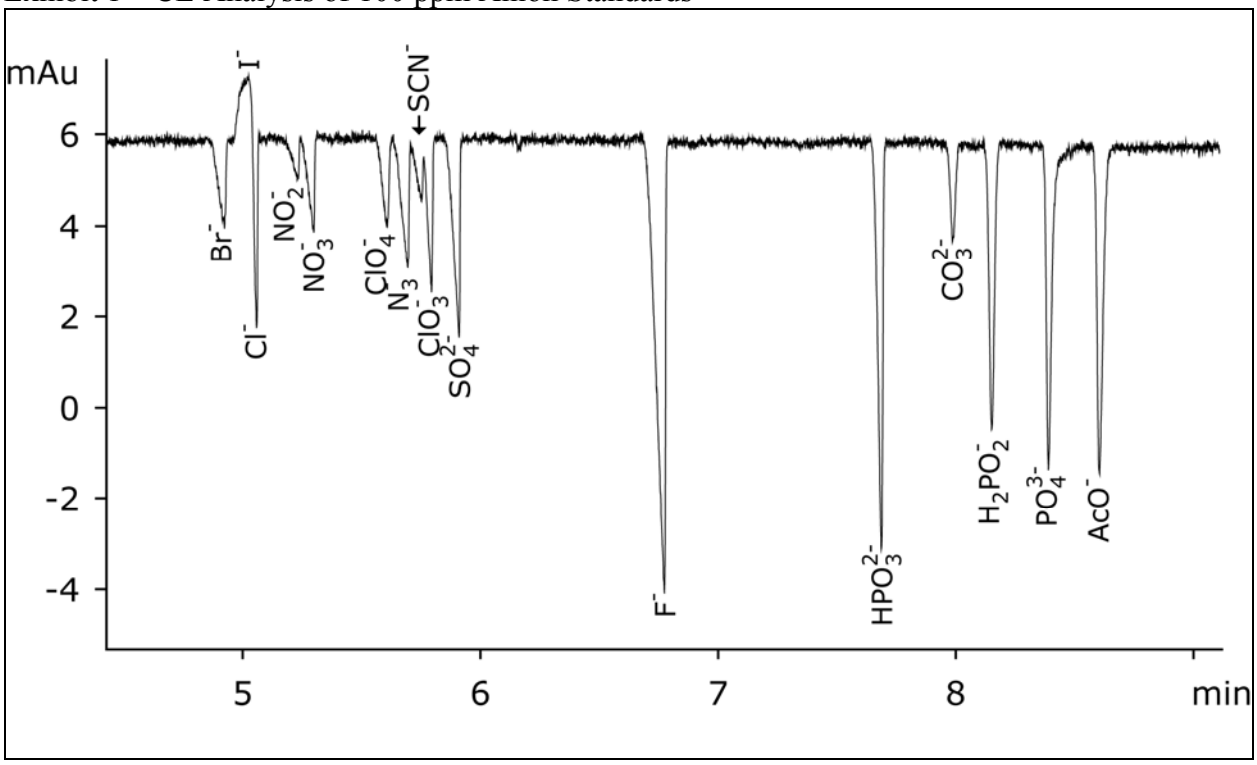
Goal 1 – *Capillary Electrophoresis Methods for Inorganic Ion Analysis of Samples from Clandestinely Manufactured Methamphetamine*

Flexible inorganic ion analysis techniques can be used to provide valuable data in the analysis of samples from clandestine methamphetamine manufacturing sites. Variations within a specific class of manufacturing methods can be difficult to differentiate without evaluating all of the chemical species present. Two primary achievements in using capillary electrophoresis for this purpose were accomplished.

1) Several capillary electrophoresis (CE) anion methods were evaluated for their suitability in the analysis of clandestine laboratory samples [1-4]. One specific goal was to find an analytical approach for identifying the various phosphorus oxyacids (hypophosphorous acid, phosphorous acid and phosphoric acid). The best results were obtained using modifications made to a commercially available dynamic coating CE anion analysis kit, CElixirOA™ 8.2 (Microsolv Technology Corp, Longbranch, NJ). To achieve the desired results, modifications were made to this kit including lowering the run temperature to 15°C and utilizing an acid flush of the column between runs. These modifications succeeded in creating a method that provides robust, reproducible results for the analysis a number of forensically significant anions. The anions that were resolved using this method included: acetate, azide, bromide, carbonate, chlorate, chloride, fluoride, hypophosphate, iodide, nitrate, nitrite, perchlorate, phosphate, phosphite, sulfate, sulfite, and thiocyanate. The developed method is capable of detecting these anions down to between 10 and 30 ppm and with a percent relative standard deviation for normalized migration times of less than 0.1%. A separation of 100 ppm standards is shown in Exhibit 1. This concentration range is useful for the analysis of samples from clandestine laboratories when they are diluted appropriately. Lowering the temperature to 15°C improved resolution for some closely migrating species (e.g. iodide and chloride). While the acid flush modification to the method alleviated a problem with severe phosphate peak tailing that had been observed initially. The peak tailing is believed to be from adsorption of phosphate in the system. The acid flush between runs removes any adsorbed materials. The recommended analysis parameters are shown in Exhibit 2. Anion analysis for iodide, hypophosphite, phosphite, and phosphate can be used to assist in the determination of which phosphorus – iodine methamphetamine manufacturing method was used. This method was successfully

employed to evaluate samples from the four phosphorus – iodine methamphetamine manufacturing methods described below in Goal 2. Following validation of the method, it was implemented successfully in two other laboratories (within the Washington State Patrol Crime Laboratory Division – WSP CLD) where clandestine laboratory evidence is evaluated. These labs have begun using the method in routine casework. Samples from adjudicated cases were provided to the WSP CLD Marysville Laboratory by the Greeley-Weld County Forensic Laboratory in Greeley, Colorado. The samples from Colorado were from methamphetamine labs suspected of using the hypophosphorous acid – iodine method of manufacturing. CE anion analysis of these samples has been successful in identifying anion species characteristic of this method of manufacture.

Exhibit 1 – CE Analysis of 100 ppm Anion Standards



The CE anion method developed during this project was also used to evaluate samples from other methamphetamine manufacturing methods. The determination of sulfate and/or nitrate can be useful in identifying what type of ammonium salt was used to generate liquefied ammonia for the alkali metal – liquefied ammonia methamphetamine manufacturing method.

In addition to the utility of this method for the analysis of samples from clandestine drug manufacturing cases, the developed CE anion analysis method is being used in other areas of forensic analysis within the WSP CLD including: explosives cases, poisoning cases and other chemistry cases involving inorganic anions.

Exhibit 2 – Recommended Instrument Conditions

Vial Summary

Position*	Buffer	Purpose
Vial 1	0.1 N HCl or 0.1 N HBr	Preconditioning
Vial 2	CE Grade Water	Preconditioning
Vial 3	CE Grade Water	Preconditioning
Vial 4	CElixerOA 8.2 Solution A – Initiator	Preconditioning
Vial 5	CElixerOA 8.2 Solution B – Accelerator	Preconditioning
Vial 6	CElixerOA 8.2 Solution B – Accelerator	Run Buffer
Vial 7	CElixerOA 8.2 Solution B – Accelerator	Run Buffer
Vial 8	CE Grade Water	Flush Waste
Vial 9	CE Grade Water	Stacking Injection

Column Preconditioning Flushes

Inlet (Vial #)	Outlet (Vial #)	Time†
HCl or HBr (1)	Waste (8)	30 seconds
Water (2)	Waste (8)	30 seconds
Water (3)	Waste (8)	30 seconds
Initiator (4)	Waste (8)	90 seconds
Accelerator (5)	Waste (8)	90 seconds
Initiator (4)	Waste (8)	90 seconds
Accelerator (5)	Waste (8)	120 seconds

Instrument Conditions

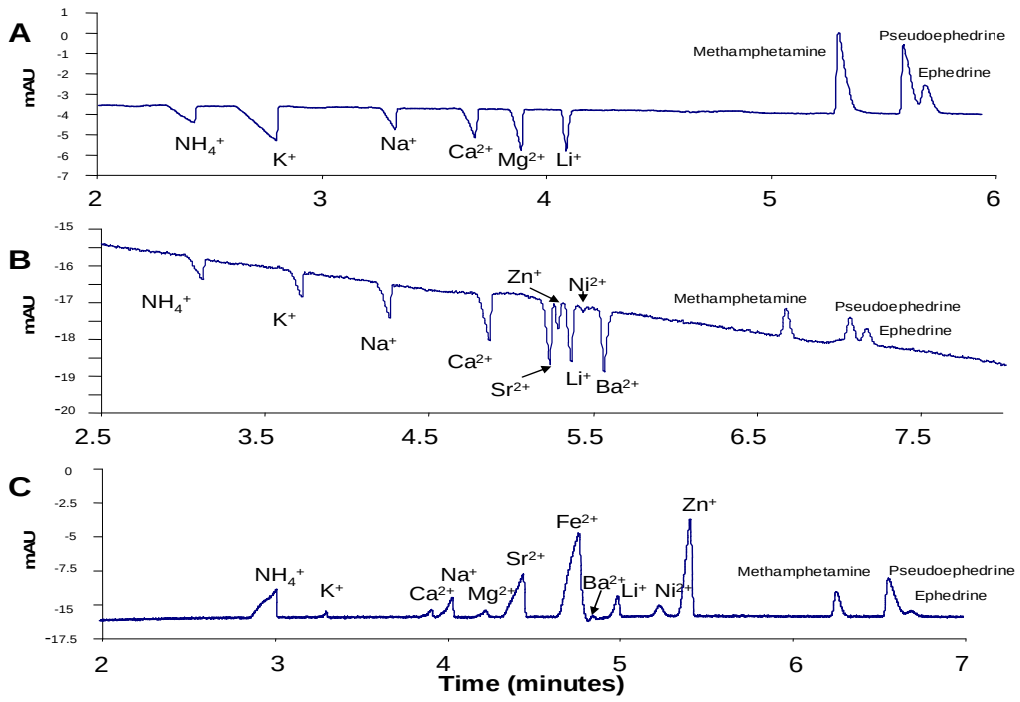
Cassette Temperature	15°C
Capillary	50 μM Inside diameter fused silica capillary, 80.5 cm actual length, 72 cm Effective length‡
Stacking Injection	50 mbar, 2 Seconds, sample vial to run buffer (7) 10 mbar, 2 Seconds, water (9) to run buffer (7)
Run Buffers	Inlet vial (6), Outlet vial (7)
Run Voltage	30 kV, Negative polarity
Run Time	11 Minutes (approximately 22 minutes including preconditioning)
Detection	Monitor at 233 nm, 20 nm bandwidth, no reference§

* Vial positions are included for subsequent reference, though the required buffers could be placed in any location so long as the method is adjusted accordingly.
† The instrument's standard flush pressure is used and will displace the volume of the capillary from the injection vial to the detector in approximately 90 seconds.
‡ This column dimension is commercially available or can be cut from a spool of capillary at a reduced cost. Capillary lengths of 64.5 cm were also found to provide acceptable results.
§ Other wavelengths may be useful for the detection of absorbing species, so it is recommended that the entire spectrum be saved.

2) Existing commercial CE methods for the analysis of inorganic cations were evaluated for their suitability in the analysis of clandestine laboratory samples. Two commercial CE

cations methods (from Agilent Technologies [5] and Waters Corporation [6]) provide good separation for ammonium, potassium, sodium, calcium, magnesium and lithium. However, cations of iron, barium, zinc, nickel, and strontium tend to migrate in a very narrow range close to the migration range of lithium. The addition of an organic modifier (methanol or acetonitrile) to the CE run buffer of either commercial kit examined improved the resolution of these cations listed above. Some organic cations (such as methamphetamine, pseudoephedrine and ephedrine) are also resolved using these standard commercial methods; however, the addition of the organic modifier did not improve resolution of any of the organic amines examined. An example of the types of data obtained is shown in Exhibit 3. Additional research is still needed to optimize these methods; however, valuable information about the cationic species in clandestine methamphetamine manufacturing samples is readily obtained using the current state of technology. Cation analysis was demonstrated to be useful in providing data to confirm the type of alkali metal and presence of ammonia in the alkali metal – liquefied ammonia method of methamphetamine manufacture.

Exhibit 3 – CE cation analysis



A – 100 millimolar standards, Capillary: 75 micron i.d., 64.5 centimeters long (56 centimeters to detection window), Agilent cation buffer, no organic modifier, detection – diode array UV monitored at 200 nanometers, temperature – 25°C.

B – 100 millimolar standards, Capillary: 75 micron i.d., 64.5 centimeters long (56 centimeters to detection window), Agilent cation buffer, 10% acetonitrile modifier, detection – diode array UV monitored at 200 nanometers, temperature – 20°C.

C – 100 millimolar standards (ammonium at 200 millimolar), Capillary: 75 micron i.d., 64.5 centimeters long (56 centimeters to detection window), Waters IonSelect™ Low Mobility Cation Electrolyte, 10% acetonitrile modifier, detection – diode array UV monitored at 240 nanometers with a 214 nanometer reference, temperature – 25°C.

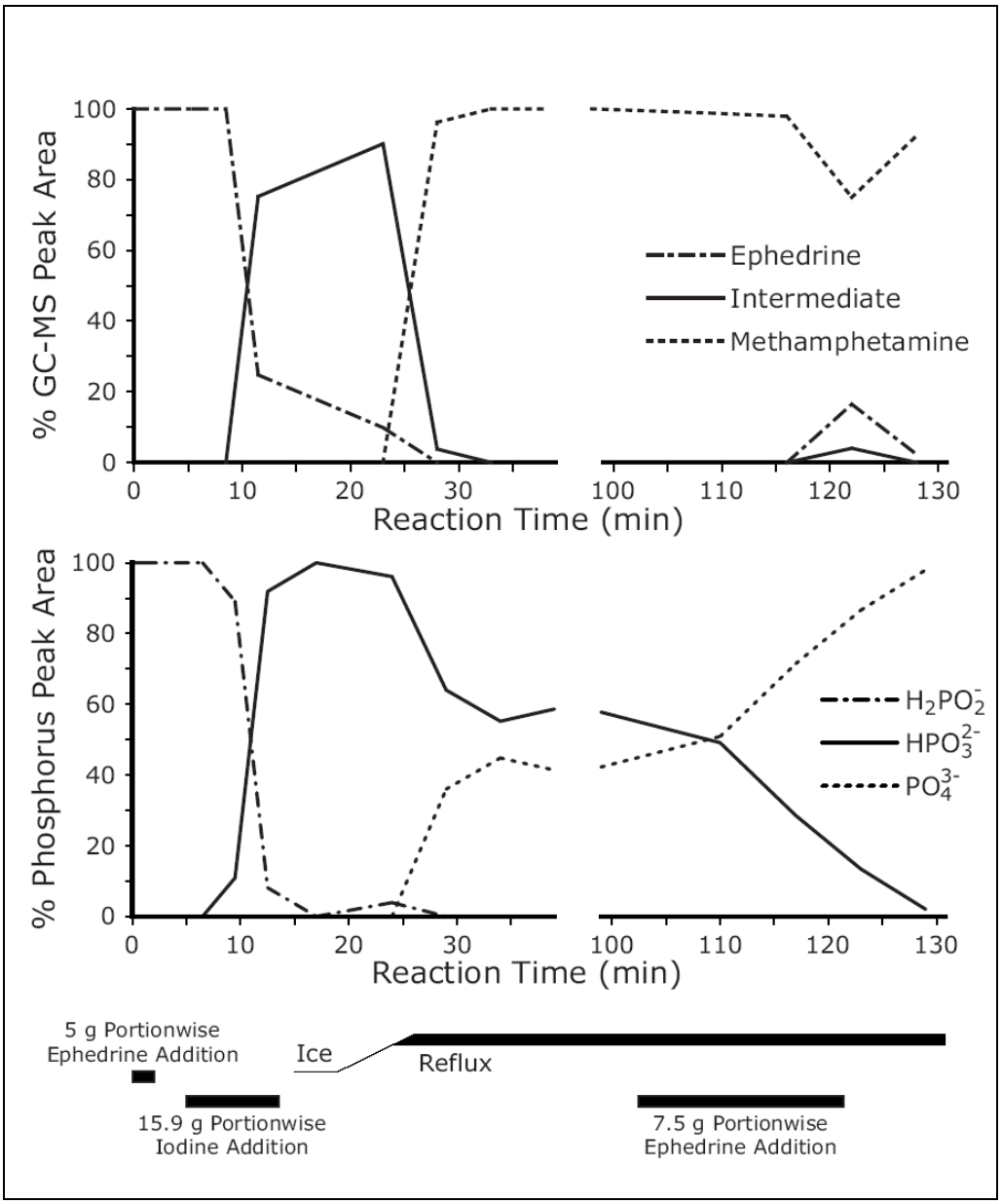
Goal 2 – *Chemistry of Popular and Emerging Clandestine Methamphetamine Manufacturing Methods*

Three primary achievements were accomplished with regards to the chemistry of methamphetamine manufacture.

1) A series of experiments were conducted to elucidate the chemical processes involved in the popular hydriodic acid – phosphorus method[7] of reducing pseudoephedrine (or ephedrine) to methamphetamine. Four primary variations of this method were investigated to determine what phosphorus species would be present in samples collected from these types of reactions. The variations investigated included:
    a. red phosphorus with iodine
    b. phosphorous acid with iodine
    c. hypophosphorus acid with iodine
    d. phosphorus triiodide

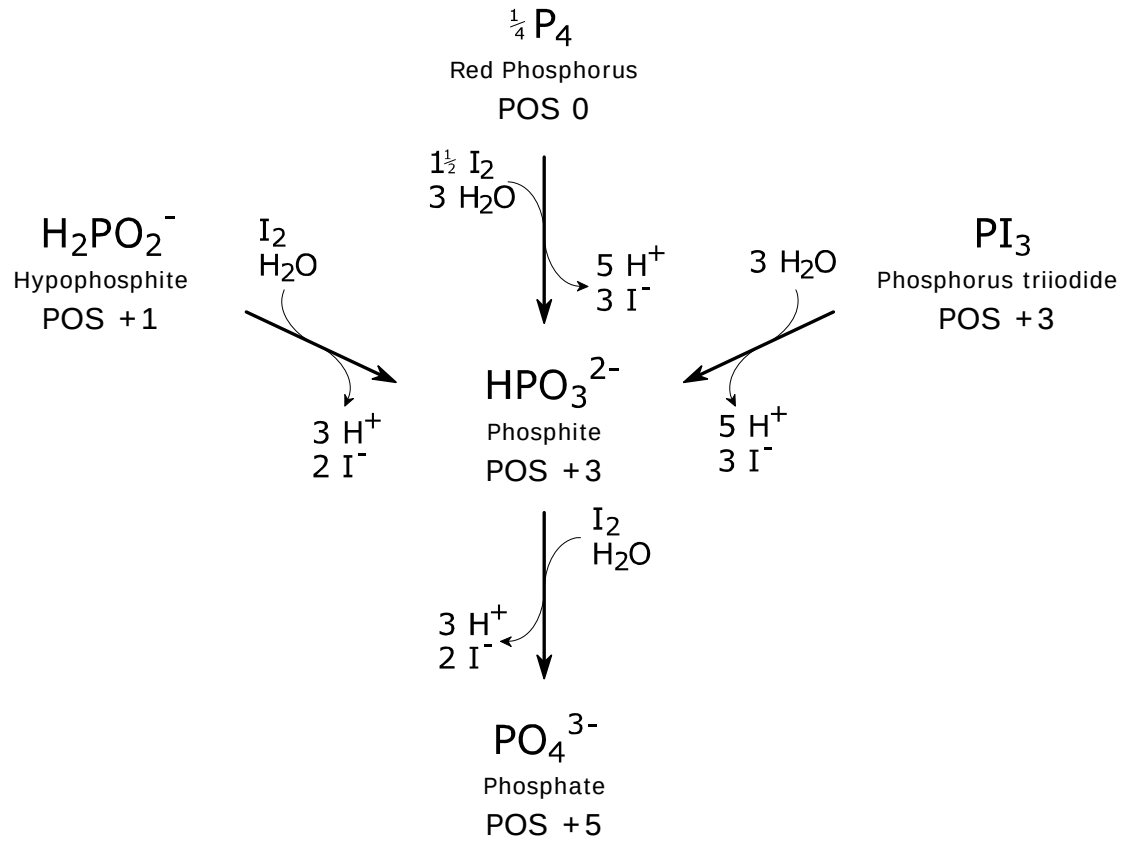
    All four phosphorus-containing reducing agents were found to successfully reduce pseudoephedrine (or ephedrine) to methamphetamine. Samples from each of the experiments were collected at sequential time points throughout each experiment. These samples were analyzed using the CE anion analysis method developed in Goal 1 and established gas chromatography / mass spectrometry (GC/MS) methods. Exhibit 4 shows an example of the data generated for a hypophosphorous acid / iodine reaction.

    Exhibit 4 – CE and GC/MS data for Hypophosphorous Acid/Iodine Reaction



The data from each of the reactions was used to confirm mechanistic pathways and show the interconnections between all four variations. Exhibit 5 shows the relationships between the various phosphorus containing reducing agents and the final product phosphate.

Exhibit 5 – Phosphorus-Containing Reducing Agent Oxidation Pathways



A graphical schematic of likely oxidation pathways for common phosphorus-containing reducing agents in the presence of water and iodine. The oxidation state assigned to the phosphorus atom (POS) is shown below each species, illustrating the reactions that include oxidation of the phosphorus atom.

The data also was used to develop a detailed set of equations to describe the processes. Net reaction equations for the four reactions are shown in Exhibit 6.

Exhibit 6 – Net Reaction Equations

Red Phosphorus :	$P_4 + 6\,H2O + 10\,\text{Pseudoephedrine}^{*} \xrightarrow{HI} 10\,\text{Methamphetamine} + 4\,PO_4^{3-} + 12\,H^+$
Phosphorous Acid :	$H_3PO_3^{2-} + \text{Pseudoephedrine} \xrightarrow{HI} \text{Methamphetamine} + PO_4^{3-} + H^+$
Hypophosphorous Acid :	$H_2PO_2^{-} + 2\,\text{Pseudoephedrine} \xrightarrow{HI} 2\,\text{Methamphetamine} + PO_4^{3-} + 2\,H^+$
Phosphorus Triiodide :	$PI_3 + H_2O + \text{Pseudoephedrine} \rightarrow \text{Methamphetamine} + 3\,I^- + 6\,H^+$

* Note Ephedrine can be substituted in the above equations for pseudoephedrine.

These equations show the appropriate stoichiometric balance of reactants for the efficient manufacture of methamphetamine. Methamphetamine was manufactured in under 15 minutes using conditions that the equations predict to be optimal[8], thus demonstrating that methamphetamine manufacture can be done rapidly using these processes if the reaction conditions are appropriately controlled. These equations can be used to calculate

relationships between the quantities of reactants used and the quantities of products produced[9]. This allows the chemist to evaluate sample data to assist in the determination of which manufacturing process was used. CE data obtained from case samples was evaluated using the relationships described above. Exhibit 7 lists some of the conclusions that can be determined from this data.

Exhibit 7 – CE anion analysis interpretation

CE Results	Interpretation
Liquid Samples	
hypophosphite	• unreacted hypophosphorous acid • hypophosphite salt
phosphite	• unreacted phosphorous acid • dissolved phosphite salt
phosphate	• phosphoric acid • diluted phosphoric acid • dissolved phosphate salt
iodide and phosphate	• May be from any methamphetamine manufacturing method using iodine and a phosphorus-containing reducing agent†
iodide, phosphite and phosphate	May be from the following methamphetamine manufacturing methods where the quantity of reductant was insufficient to consume all of the reducing agent: • iodine and hypophosphorous acid • iodine and phosphorous acid • phosphorus triiodide • iodine and red phosphorus reactions may exhibit trace quantities of phosphite in some samples (Quantitative analysis of the anions may be used to suggest ratios of precursors)
iodide, phosphite and hypophosphite	• May be from a methamphetamine manufacturing method using iodine and hypophosphorous acid ▪ prior to the addition of reductant ▪ atypically low amount of iodine and reductant used
iodide and hypophosphite	• Stabilized commercial hydriodic acid (small amounts of hypophosphorous acid may be used as a stabilizing agent)
† Phosphorus containing reducing agents included: Red phosphorus (presumably white phosphorus also), hypophosphorous acid, phosphorous acid, and phosphorus triiodide.	
Red Solid Samples – Aqueous Extracts	
phosphate, phosphite, and hypophosphite	• likely unused red phosphorus with oxyacids resulting from air oxidation
iodide, phosphate, phosphite and hypophosphite	• likely used red phosphorus • confirmed with elemental analysis for phosphorus • GC/MS may show methamphetamine and/or other organic byproducts)

CE Results	Interpretation
no significant phosphorous anions observed	• red phosphorus with glues remaining on the surface preventing oxidation (may show slow reaction rates as a result, data not shown) • freshly washed or extracted red phosphorus that has not had time to oxidize
Other Anionic Species	
Chloride ions	• counter ion from precursor materials • muriatic acid added to the reaction or used in a prior process (e.g. from the precipitation of iodine from tincture)
Sulfate ions	• counter ion from precursor material • sulfuric acid added to the reaction or used in a prior process (e.g. from the precipitation of iodine from tincture)
Carbonate ions	• absorbed carbon dioxide (typical for highly basic pH reaction materials – usually from the addition of NaOH)

2) Successful experiments were conducted that demonstrated the viability of a new variation on the alkali metal – liquefied ammonia method of methamphetamine manufacture[10]. This variation is termed the "'One-Pot' method of manufacture" because all of the reaction materials are combined in a single reaction vessel. The variation involves the in-situ generation of ammonia from an ammonium salt and sodium hydroxide[11]. The generated ammonia is captured in a suitable organic solvent to which an alkali metal (e.g. sodium or lithium) has been added. Ephedrine placed in the reaction vessel is converted to methamphetamine in a single reaction step. The experiments were conducted demonstrating that various ammonium salts (e.g. ammonium sulfate, ammonium nitrate etc.) can be used with the "One-Pot" method, and that ephedrine does not need to be purified prior to use in the experiment. Additional experiments also showed that other alkali metals could be used as well. CE cation analyses of materials from these reactions show high concentrations of sodium (from the sodium hydroxide) in addition to ammonium and lithium. CE anion analysis will typically show the ammonium salt counter ion (e.g. nitrate, sulfate, phosphate etc.) and any counter ions for pseudoephedrine and any other tablet ingredients (e.g. chloride, sulfate, bromide, etc.).
3) Pseudoephedrine is a highly popular precursor for the manufacture of methamphetamine and often is obtained from commercial over-the-counter (OTC) cold and/or allergy preparations. Legislative restrictions on OTC pseudoephedrine preparations are being implemented and vary from state to state[12]. Some pharmaceutical industry representatives have insisted that multi-ingredient, liquid and/or softgel preparations are not suitable for use in methamphetamine manufacture[13]. As a result, many jurisdictions have chosen to exempt these preparations from control[14]. Experiments were undertaken to determine the viability of these exempt preparations in the manufacture of methamphetamine. Three sets of experiments were conducted:
    a. A series of extraction techniques were applied to five representative multi-ingredient, liquid and softgel OTC pseudoephedrine preparations to determine if pseudoephedrine could be extracted from the other pharmaceutical ingredients[15]. Simple, readily available extraction methods were shown to be successful in the isolation of pseudoephedrine from the five OTC products examined.

b. Pseudoephedrine extracted from each of the selected multi-ingredient, liquid and softgel OTC pseudoephedrine preparations was successfully converted to methamphetamine via the Red Phosphorus – iodine reduction method[15].
c. Four selected multi-ingredient, liquid and softgel OTC pseudoephedrine preparations were successfully converted to methamphetamine using the "One-Pot" lithium – ammonia reduction method without any pre-extraction (or separation) of the pseudoephedrine from the other pharmaceutical ingredients[16].

Goal 3 – *Training of Forensic Chemistry Analysts, Clandestine Laboratory Scene Responders, and User Agencies*

The final goal of the project was to disseminate the results of the research in a manner that would provide practical and beneficial information to a number of different audiences. Three general groups of people were initially targeted as the recipients of the research results. These were:

1. Forensic chemists directly involved in the analysis of samples and interpretation of data obtained from clandestine laboratories;
2. Clandestine laboratory scene responders responsible for scene interpretation, safety, and sample collection at clandestine laboratory scenes. These may include forensic chemists, clandestine laboratory trained law enforcement officers and others;
3. User agency personnel including law enforcement officers, evidence officers, prosecutors, defense attorneys, emergency response personnel, health department personnel, and other individuals directly or indirectly involved in clandestine laboratory work. Although not originally identified as belonging to this last group, it was found necessary to provide information concerning this project to legislators and other regulatory personnel.

Dissemination of the grant project results to the groups listed above has been done through written papers, training videos (produced in cooperation with the Snohomish Regional Drug Task Force and Detective Shawn Sheridan), professional meeting presentations, formal and informal training sessions, and legislative testimony[17]. Exhibits 8, 9 and 10 below list the products that have been generated as a result of the work done on this grant. In addition, numerous requests have been received for copies of the videos and the executive summary on the multi-ingredient tablet extraction results.

Acknowledgements

The authors would like to thank the following people for their contributions to this project. Much of the practical street level drug intelligence data (including recipes and manufacturing trends) were provided by Detective Shawn Sheridan of the Snohomish Regional Drug Task Force. He was also responsible for shooting, producing and editing the videos that were put together during this project. Mr. Ira Lurie, DEA Special Testing, Sterling, VA provided valuable assistance with the CE methods development work. Mr. Jeff Jagmin (WSP Crime Lab, Tacoma) and Mr. Martin McDermot (WSP Crime Lab, Seattle) also assisted with the implementation of the new CE anion method in other laboratories. A special thanks to Mr. Larry Pederson of the Greeley-Weld County Forensic Laboratory, Greeley, CO, who graciously provided adjudicated case samples for evaluation using the methods developed during this project. Ms. Drexie Malone (WSP Crime Lab Librarian) provided extensive assistance with literature searches. The authors would also like to acknowledge the support of the Washington State Patrol and the many individuals within the organization that supported this project and made it a success.

Exhibit 8 – Products Resulting From Grant Research	**Audience**
Publications	
Knops, Lori A.; Northrop, David M.; Person, Eric C., "Capillary Electrophoretic Analysis of Phosphorus Species in Clandestine Laboratory Samples," Journal of Forensic Sciences, 51(1), 2006.	Forensic Chemists
Heegel, Robert A., Knops, Lori A., Northrop, David M., and Person, Eric C., "Abbreviated Reaction Times In the Red Phosphorus – Iodine Manufacturing Method", Journal Of The Clandestine Laboratory Investigating Chemists Association, Volume 14 Number 3 – July 2004, p. 11.	Forensic Chemists
Person, Eric C.; Knops, Lori A.; Northrop, David M.; Sheridan, Shawn P., " 'One-Pot' Methamphetamine Manufacture," Journal of Clandestine Laboratory Investigating Chemists Association, Volume 14, Number 2, April, 2005, pp. 14-15.	Forensic Chemists
Northrop, David M.; Knops, Lori A.; Person, Eric C., "Methamphetamine Manufacture From Cold and Allergy Medications Containing Pseudoephedrine in Multi-ingredient, Liquid, and Softgel Preparations," Journal of the Clandestine Laboratory Investigating Chemists Association, Volume 15, Number 2, April, 2005, pp. 11-19.	Forensic Chemists
Heegel, Robert A.; and Northrop, David M., "'One-Pot' Methamphetamine Manufacture via the Lithium-Ammonia Method with Multi-Ingredient, Liquid, and/or Soft-gel Pseudoephedrine Preparations," Submitted to Journal of the Clandestine Laboratory Investigating Chemists Association, November, 2005, In Press	Forensic Chemists
Person, Eric C.; Knops, Lori A.; Northrop, David M.; and Heegel, Robert A.; "Phosphorus-Containing Reducing Agents: A review of their chemistry and use in the manufacture of methamphetamine and the significance of observed phosphate, phosphite, and hypophosphite in clandestine laboratory casework," to be submitted to the Journal of the Clandestine Laboratory Investigating Chemists Association, January 2006.	Forensic Chemists
Multi-Ingredient Cold Medicines Used to Produce Methamphetamine, Narcotics Digest, Volume 4, Number 17, April 26, 2005.	Law-Enforcement Personnel
Northrop, David M.; Knops, Lori A.; Person, Eric C., "Methamphetamine Manufacture From Cold and Allergy Medications Containing Pseudoephedrine in Multi-ingredient, Liquid, and Softgel Preparations," – Executive Summary	Non – law enforcement Personnel

Exhibit 9 – Products Resulting From Research	**Audience**
Training Videos	
"One-Pot" Methamphetamine	Forensic Chemists, Clandestine Lab Scene Responders, Law Enforcement Personnel
"Manufacturing Methamphetamine Using Hypophosphorous Acid"	Forensic Chemists, Clandestine Lab Scene Responders, Law Enforcement Personnel
"Manufacturing Methamphetamine Using the Red Phosphorus / Hydriodic Acid Method"	Forensic Chemists, Clandestine Lab Scene Responders, Law Enforcement Personnel
"Extracting Ephedrine"	Forensic Chemists, Clandestine Lab Scene Responders, Law Enforcement Personnel
"Red Phosphorus from Matchbook Strikers"	Forensic Chemists, Clandestine Lab Scene Responders, Law Enforcement Personnel
"Iodine Extraction"	Forensic Chemists, Clandestine Lab Scene Responders, Law Enforcement Personnel
"Stripping Lithium Batteries"	Forensic Chemists, Clandestine Lab Scene Responders, Law Enforcement Personnel
"Acid and Matches – A Bad Combination"	Forensic Chemists, Clandestine Lab Scene Responders, Law Enforcement Personnel

Exhibit 10 – Products Resulting From Research	**Audience**
Presentations	
"One-Pot" Methamphetamine Manufacture – Northwest Association of Forensic Scientists' Spring Meeting, Missoula, MT, April 2004	Forensic Chemists
"One-Pot" Methamphetamine Manufacture – Washington State Patrol Crime Laboratory Chemistry Functional Area Meeting, May 2004	Forensic Chemists, Clandestine Lab Scene Responders
The Clandestine Manufacture of Methamphetamine: Chemistry and Trends – Snohomish County Meth Watch Group and the Snohomish County Meth Action Team, June 2004	Law Enforcement Personnel, Community Business Leaders
The Chemistry of Methamphetamine Manufacture – The Snohomish County Bar Association, July 2004	Law Enforcement Personnel, Social Workers
"One-Pot" Methamphetamine Manufacture – Clandestine Laboratory Investigating Chemists' 14th Annual Technical Training Seminar, September 2004	Forensic Chemists, Clandestine Lab Scene Responders, Law Enforcement Personnel
Evaluation of Samples from Phosphorus Methods of Methamphetamine Manufacture using Capillary Electrophoresis and GC/MS – Clandestine Laboratory Investigating Chemists' 14th Annual Technical Training Seminar, September 2004	Forensic Chemists, Clandestine Lab Scene Responders, Law Enforcement Personnel
Training videos (Exhibit 8) presented – Washington State Patrol Crime Laboratory Chemistry Functional Area Meeting, October 2004	Forensic Chemists
Training videos (Exhibit 8) presented – Washington State Patrol SWAT, November 2004	Clandestine Lab Scene Responders
Capillary Electrophoretic Analysis of Inorganic Species in Clandestine Laboratories – American Academy of Forensic Sciences 57th Annual Meeting, February 2005	Forensic Scientists
CE Anion Analysis – Washington State Patrol Crime Laboratory Chemistry Functional Area Meeting, April 2005	Forensic Chemists
Methamphetamine Manufacture From Cold and Allergy Medications Containing Pseudoephedrine In Multi-Ingredient, Liquid, and Softgel Preparations – Washington State Patrol Crime Laboratory Chemistry Functional Area Meeting, April 2005	Forensic Chemists

Exhibit 10 – Products Resulting From Research	**Audience**
Presentations	
Methamphetamine Manufacture From Cold and Allergy Medications Containing Pseudoephedrine In Multi-Ingredient, Liquid, and Softgel Preparations – Oregon State Legislature, June 2005	Legislators
Methamphetamine Manufacture From Cold and Allergy Medications Containing Pseudoephedrine In Multi-Ingredient, Liquid, and Softgel Preparations – Clandestine Laboratory Investigating Chemists' 15th Annual Technical Training Seminar, September 2005	Forensic Chemists, Clandestine Lab Scene Responders, Law Enforcement Personnel
'One-Pot' Methamphetamine Manufacture via the Lithium-Ammonia Method with Multi-Ingredient, Liquid, and/or Soft-gel Pseudoephedrine Preparations – Clandestine Laboratory Investigating Chemists' 15th Annual Technical Training Seminar, September 2005	Forensic Chemists, Clandestine Lab Scene Responders, Law Enforcement Personnel
Phosphorus Containing Reducing Agents – Clandestine Laboratory Investigating Chemists' 15th Annual Technical Training Seminar, September 2005	Forensic Chemists, Clandestine Lab Scene Responders, Law Enforcement Personnel
'One-Pot' Methamphetamine Manufacture via the Lithium-Ammonia Method with Multi-Ingredient, Liquid, and/or Soft-gel Pseudoephedrine Preparations – Washington State Patrol Crime Laboratory Chemistry Functional Area Meeting, November 2005	Forensic Chemists
Methamphetamine Manufacture From Cold and Allergy Medications Containing Pseudoephedrine In Multi-Ingredient, Liquid, and Softgel Preparations – Washington State Patrol SWAT, November 2005	Clandestine Lab Scene Responders
Training videos (Exhibit 8) presented – Washington State Patrol SWAT, November 2005	Clandestine Lab Scene Responders
Methamphetamine Manufacture From Cold and Allergy Medications Containing Pseudoephedrine In Multi-Ingredient, Liquid, and Softgel Preparations – Northwest Association of Forensic Science Fall Meeting, Seattle, WA, November 2005	Forensic Scientists
The Chemistry of Phosphorus-Containing Reducing Agents and the Significance of Phosphate, Phosphite, and Hypophosphite in Clandestine Laboratory Casework – American Academy of Forensic Science 58th Annual Meeting, Seattle, WA, February, 2006	Forensic Scientists

References

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2. Hargadon, Kelly A. and McCord, Bruce R., "Explosive Residue Analysis by Capillary Electrophoresis and Ion Chromatography" *Journal of Chromatography* 602 (1992): 241-247.
3. Romano, Joe; Jandik, Petr; Jones, William R.; Jackson, Peter E; "Optimization of Inorganic Capillary Electrophoresis for the Analysis of Anionic Solutes in Real Samples" *Journal of Chromatography* 546 (1991): 411-421.
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