Y12 Visualizing and Detecting Explosives Through the Use of High-Performance Thin-Layer Chromatography (HPTLC)

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Learning Overview: After attending this presentation, attendees will have gained a basic understanding of how to use an HPTLC system to detect explosives.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing a novel way to detect explosives in any criminal instance, such as acts of terrorism. This method allows for explosives to be detected and differentiated with the hope of one day being able to trace the components back to an initial source and identify a potential suspect.

As terrorist attacks involving the use of explosives persist around the globe, the development of novel methods for the detection and identification of explosive residues continues to be an important pursuit. Thin Layer Chromatography (TLC) is one of the many analytical methods commonly used to detect explosives. As an extension of the capabilities of TLC, it is proposed that HPTLC in conjunction with chemical development can provide valuable information when attempting to detect explosives.

The goal of this project was to evaluate different mobile phase systems in an attempt to identify which system would provide the best HPTLC separation of explosives. Many different solutions were employed to visualize the explosive solutions such as: a horseradish peroxidase solution, N,N-dimethyl-1,4-phenylenediamine dihydrochloride solution, potassium iodine-starch solution, ammonium thiocyanate-ferrous sulfate solution, ferrous hydroxide solution, modified Griess reagent, 1% diphenylamine solution, 0.02% diphenylbenzidine solution, and 0.2% diphenylbenzidine solution. Out of these nine solutions, 1% diphenylamine in hexane provided the most promising results. The plates were spotted using an automatic sampler. After spotting, the samples were developed in a developing chamber. During development, appropriate solvent phases were investigated to ensure proper separation. To this end, two mobile phases were compared. The first mobile phase tested was an 8:4:3 ratio of toluene, hexanes, and acetone. The second mobile phase explored was an 8:4:3 ratio of toluene, hexanes, and ethyl acetate. After comparison of these two mobile phases, it was determined that a mixture of toluene, hexanes, and ethyl acetate provided the best separation.

Due to the fact that nitroaromatics and nitramine compounds can be detected after irradiating with 254nm Ultraviolet (UV) light; pictures of the plate were taken under white light, 254nm, and 366nm light using a visualizer. The plates were then treated with 1% diphenylamine in hexane by vertically dipping the plates into the solution and allowing them to dry before photographing again under the same conditions. Treating the plates with the 1% diphenylamine solution allows for the identification of nitrite esters. Last, measurements were taken using a scanner, and an overall report of the measurements was generated. At this point in the project; 1,2-dinitrobenzene, 3,4-dinitrotoluene, Ethylene Glycol Dinitrate (EGDN), nitroglycerin, nitroguanidine, Pentaerythritol Tetranitrate (PETN), and picric acid have been examined using this procedure. All the explosives tested, with the exception of nitroguanidine and picric acid, were separated using this method. In the future, this method could be used to detect single-component explosives or explosive mixtures.

Forensic Science, Explosives, High-Performance TLC

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