B24 Magneto-Archimedes Levitation (MagLev) Separation of Drugs

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Learning Overview: This presentation will inform the attendees on the process of MagLev and the application to separation of drugs of abuse. Attendees will identify the benefits associated with the use of MagLev to recover analytes sufficient for spectrophotometric analyses.

Impact on the Forensic Science Community: This presentation will impact the forensic science community as this novel technique avails analysis of low-concentration drugs, in particular fentanyl and fentanyl-related substances.

Currently, forensic drug chemists face a challenge in identifying controlled substances in complex mixtures containing multiple drugs, adulterants, diluents, and other drug-related substances. Many forensic drug labs have formed a great deal of reliance upon chromatographic separations and identification, such as Gas Chromatography/Mass Spectrometry (GC/MS), which has relegated spectrophotometric techniques, such as infrared or Raman, to a minor role in day-to-day analysis with certain classes of drugs. In light of the complex mixtures typically encountered, the rise in fentanyl and fentanyl-related substances, particularly at low concentrations, necessitates the availability of additional separation techniques. Higher potency of this class of drugs, at times, dictates lower concentration in samples recovered by law enforcement and submitted to forensic labs. This method would enable recovery suitable for spectrophotometric evaluation for low-concentration drugs.

MagLev affords separation of hydrophilic drugs and related substances with little effort. The MagLev device is composed of like-facing NdFeB magnets mounted in 3D-printed brackets that are positioned above and below a polycarbonate cuvette. With the use of a non-polar solvent mixture of tetrachloroethylene and hexanes providing a solution of a gadolinium complex, hydrochloride salts of drugs and other water-soluble-related substances remain suspended within the cuvette in a vertical column. In the time span of 5 minutes to 30 minutes, these substances levitate according to their densities, which affords separation into discreet crystal masses in a restorative process. These crystal masses were then recovered via Pasteur-pipette while still under magnetic forces using a specially designed access port through the top of the device chassis. These crystal masses are then transferred to laboratory filter paper and dried of residual paramagnetic solution with acetone and vacuum dried in preparation for spectrophotometic examination via infrared or Raman spectrophotometry. These crystal masses were then successfully characterized via Fourier Transform Infrared (FTIR). Experimental separations were performed on methamphetamine HCl, cocaine HCl, heroin HCl, fentanyl HCl, acetylfentanyl HCl, and benzylfentanyl HCl. In addition to these reference materials, the technique was applied to commonly encountered mixtures with adulterants and diluents. One such example is a mixture composed of 1.3% fentanyl HCl, 2.6% heroin HCl, and 96.1% lactose. Due to the differing densities of each substance, the crystal masses of each levitated to a different height presenting separation. These were then recovered using a Pasteur-pipette for spectrophotometric characterization. MagLev provides a resilient separation of hydrochloride salts of drugs and most respective adulterants and diluents based upon their densities while suspended in non-polar solvents. This technique is amenable for a great many commonly encountered drugs of abuse, requires no electricity, is low cost save for modest solvent purchases, and has a very small bench footprint.

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