2021_02: Automated High Throughput System for Heavy Metal Pollution Monitoring

Supervisor: Professor David Payne (d.payne@imperial.ac.uk)

Department: Imperial College London/Materials

a) Motivation for the project

Digestion of environmental samples is time consuming and dangerous, requiring strong hazardous acids that produce equally hazardous waste - the procedure itself is not green. We propose the use of green solvents for effective lead extraction coupled with an automated high throughput system that only requires very dilute nitric acid to rapidly prepare many samples for AAS/AES instruments.

b) Context and background

High throughput sampling and cleaner preparation will allow discretised sampling of an area to obtain concentration maps of pollutants, that can be overlayed with real-world data, without the environmental downsides of generating large quantities of hazardous waste, as incumbent methods currently do. This will allow studies to pinpoint the origin of pollutants in a fraction of the time that would otherwise be required with current sample preparation techniques. This has an application in environmental monitoring and enforcing pollution regulation where a suspected source can be mobile or unclear, due to covert or illegal activities.

c) Objectives and methodology

The primary objective of this project will be to build the automated high throughput sample preparation system that will digest and dilute environmental samples for AAS/AES techniques.

The focus of the current work is for monitoring lead pollution, and the digestion media are based around natural deep eutectic solvents (NADES) designed for recycling lead acid batteries as part of the EPSRC funded RELAB project (EP/P004504/1).

The prototype should demonstrate the capability to prepare 5 environmental samples simultaneously in under 5 minutes and will have modularity in design so it can be expanded. The prototype will be tested on real lead-contaminated landfill samples obtained from blast-furnace slag heaps at a lead recycling facility. To be disposed as non-hazardous waste the slag must be below the permissible limit of lead content. These samples have already been collected and will be tested with this system.

The student will work with the project team to assist in the design, construction, and verification of this prototype.

The initial 2-week period of the project will focus on prototype design, drafting a bill of materials and ordering components. During weeks 3-7 the ordered components will be sent to the student's residential address, where they can assemble and test components of the preparation prototype with non-hazardous substitute substances. In week 8 the completed subsystems will be delivered back to campus for final assembly in the lab. Finally, weeks 9-10 will be for system integration, verification and testing on environmental samples. The funded student will be responsible for writing a technical report on their system development process during this time.

Project Length: 10 Weeks