

DEVELOPMENT OF A NOVEL OPTICAL DEVICE FOR RAPID DETECTION OF HEAVY METALS IN WATER USING CHARACTERISTIC ISO-PATHLENGTH POINT

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It is essential for human health to have access to clean water. However, inorganic fertilisers such as triple superphosphate (TSP) that contain high quantities of Cd between 39 mg L⁻¹ and 46 mg L⁻¹ contaminate surface water bodies in Sri Lanka. Overuse of inorganic fertilisers has been associated with heavy metal concentrations, particularly Cd and Pb, higher than WHO-recommended values for surface water bodies. Real-time pollutant identification employing sensitive, quick, and economical detection techniques is thus required to guarantee water purity. Many current technologies are expensive, necessitating sophisticated pre-treatment procedures and skilled personnel, and further, they are not suitable for real-time monitoring. In this study, contaminated water samples were analysed using a newly developed optical instrument designed to measure the intensity-angular distribution of light scattering over 180° range and identify unique iso-pathlength (IPL) points associated with specific heavy metal species. An IPL point is defined as the scattering angle at which the measured intensity becomes independent of particle concentration, given a constant absorption coefficient in the medium. A phosphate buffer solution at pH 7.4 was employed to maintain a stable absorption coefficient, with its suitability verified through UV-visible spectroscopic analysis. Instrument calibration was performed using reference water samples contaminated with Fe, Cd, As, and Pb in the (5 – 50) mg L⁻¹ range, representing the single-intermediate scattering regime, yielding calibrated IPL points at 5°, 8°, 17° 46', and 4° 36', respectively. The reproducibility of these IPL points was confirmed across repetitive independent trials for each metal under the same conditions. Application of this method to chemical waste sample that was composed with 1.0 mol L⁻¹ CdSO₄ and saturated with TeO₂ successfully detected Cd through a distinct IPL point at 8°. However, when analysing samples containing combinations of heavy metals, the previously determined IPL points were not observed, indicating increased complexity and interference in multi-component systems. Future work will improve the device's reliability for detecting heavy metals in complex water samples, establishing a new, efficient methodology for accurate on-site monitoring in field applications.

Keywords: Contaminated, Detection, Heavy metals, IPL point, Scattering