World Academy of Science, Engineering and Technology
International Journal of Chemical and Molecular Engineering
Vol:16, No:08, 2022

Simultaneous Electrochemical Detection of Chromium(III), Arsenic(III), and Mercury (II) In Water Using Anodic Stripping Voltammetry

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Abstract : This study involves a single element and simultaneous electrochemical detection of heavy metal ions through square wave anodic stripping voltammetry. A glassy carbon electrode was used to detect and quantify heavy metals such as As(III), Hg(II), Cr(VI) ions in water. Under optimized conditions, peak separation was obtained by varying concentrations, scan rates, and temperatures. As (III), Hg (II), Cr (III) were simultaneously detected with GCE. Several analytical methods, such as inductively coupled plasma mass spectroscopy (ICP-MS), atomic absorption spectroscopy (AAS), were used previously to detect heavy metal ions, which are authentic but are not good enough for online monitoring due to the bulkiness of the equipment. The study provides a good alternative that is simple, more efficient, and low-cost, involving a portable potentiostat. Heavy metals having different oxidation states can be detected by anodic stripping voltammetry. This method can be easily integrated with electronics. Square wave Anodic stripping voltammetry is used with a potential range of -2.5 V – 2.5 V for single ion detection by a three-electrode cell consisting of silver/silver chloride(Ag/AgCl) as reference and platinum (Pt) counter and glassy carbon (GCE) working electrodes. All three ions are optimized by varying the parameters like concentration, scan rate, pH, temperature, and all these optimized parameters were used for studying the effects of simultaneous detection. The procedure involves preparing an electrolyte using deionized water, cleaning the surface of GCE, depositing the ions by applying the redox potentials obtained from cyclic voltammetry (CV), and then detecting by applying oxidizing potential, i.e., stripping voltage. So this includes ASV techniques such as open-circuit voltage (OCV), chronoamperometry (CA), and square wave voltammetry (SWV). Firstly, the concentration of the ions varied from 50 ppb to 5000 ppb, and an optimum concentration was determined where the three ions were detected. A concentration of 400 ppb was used while varying the temperatures in the range of 25°C – 45°C. Optimum peak intensity was obtained at a temperature of 30°C with a low scan rate of 0.005 $V\text{-}s^{-1}$. All the parameters were optimized, and several effects have been noticed while three ions As(II), Cr(III), Hg(II) were detected alone and simultaneously.

Keywords : Arsenic(III), Chromium(III), glassy carbon electrode, Mercury (II), square wave anodic stripping voltammetry
Conference Title : ICACAC 2022 : International Conference on Advanced Computational and Analytical Chemistry
Conference Location : Kuala Lumpur, Malaysia
Conference Dates : August 30-31, 2022