DETERMINATION OF HEAVY METAL IONS IN WASTEWATER

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Abstract In this study, the efficiency of sorption processes and solid-phase immobilized reagents for determining ecologically hazardous heavy metal ions in wastewater was investigated. The sorption method was implemented using polymer ion exchangers, natural minerals, and modified nanoparticles, while the binding mechanisms of functional groups ($-COOH$, $-NH_2$, $-SO_3H$) with metal ions were analyzed. Immobilization of organic complex-forming reagents into a polymer matrix significantly increased the sensitivity of detecting trace metal ions. The use of immobilized sorbents enhanced preconcentration and enabled reliable determination of Cr(III), Cu(II), Mn(II), and Co(II) ions in the 10^{-5}–10^{-6} mol/L range. The results provide a scientific and practical foundation for monitoring industrial wastewater, developing selective sorbents, and automating analytical processes.

The presence of chromium(III) and manganese(II) ions in wastewater is common in industrial processes and significantly increases environmental risk. Reliable determination and monitoring of these ions is complicated by their oxidation states, coordination properties, and formation of stable complexes in solution. Chromium in the Cr(III) state exists as highly stable hydrated complexes, while manganese appears mainly in the Mn(II) form with high solubility, requiring specific reagents and sorbent systems for selective determination.

Sorption processes allow selective retention of Cr(III) and Mn(II) ions through mechanisms such as physical adsorption, ion exchange, or complex formation. Sorbents containing amino-functional groups form strong coordination bonds with Cr(III), improving analytical sensitivity. In contrast, Mn(II) forms weaker interactions and requires organic complex-forming reagents for differential detection.

Nitroso R-salt forms colored chelate complexes with metal ions and is highly selective toward Cr(III). Immobilized nitroso R-salt enables preconcentration and photometric determination of Cr(III) at low concentrations, while Mn(II) produces weak coloration and does not interfere with Cr(III) measurement.

Sorption–spectrophotometric determination Cr(III) complexes strongly with immobilized nitroso R-salt at pH 4.5–5.5. Electron density increases on ligand donor groups, producing a stable chelate with λ_max ≈ 520–540 nm. Preconcentration lowers detection limits to 10^{-5}–10^{-6} mol/L. Mn(II), forming weakly colored complexes, is better analyzed at pH 6–7. Sorption improves binding, and differential spectrophotometry allows accurate measurement. Preconcentration decreases detection limits to 10^{-4}–10^{-5} mol/L.

The nitroso R-salt based sorption–spectrophotometric method is effective, sensitive, and selective for Cr(III) and Mn(II) determination in wastewater. Cr(III) forms stable chelates with high color intensity, while Mn(II) can be quantified after preconcentration. The immobilized sorbent reduces reagent consumption, simplifies analysis, and allows reuse.

References:

1. Fedorova, N. A., & Klimov, V. P. Analytical Chemistry of Complex Compounds. Moscow: Khimiya, 2018.
2. Marczenko, Z. Spectrophotometric Determination of Elements. Wiley, 2000.
3. Skoog, D. A., Holler, F. J., & Crouch, S. R. Principles of Instrumental Analysis. Cengage Learning, 2017.
4. Lurie, A. A. Handbook of Analytical Chemistry. Moscow: Khimiya, 2010.
5. Kaneko, M., & Okura, I. Photochemistry of Metal Complexes. Springer, 2019.