DETECTION OF HEAVY METALS USING GOSSYPOL

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Abstract: In the modern era, the rapid development of technology has led to an increased demand for high-quality raw materials, especially heavy metals. Consequently, the continuous use of these metals has resulted in a growing amount of metallic waste. As a response, new, efficient, and cost-effective methods for extracting recyclable materials are continuously emerging. One such laboratory method involves the use of gossypol for the extraction of heavy metals.

Keywords: Heavy metals, Chromium, Gossypol, NY-I, Chromium (III) nitrate, Acetone, Universal buffer solution, Spectroscopy.

Introduction. The protection of the natural environment and natural resources has become one of the most pressing issues of the early 21st century. The expansion of industry, technology, and science, along with the growing global population, has significantly impacted the environment and contributed to climate change.

One of the main elements of sustainable development is to maximize the efficiency of processes while minimizing the loss of natural resources. Recycling is one of the easiest and most effective ways to achieve this. Heavy metals are typically defined as those with a density greater than 5 g/cm³. Most elements in this category are soluble in water, toxic, and carcinogenic. Even small quantities of these metals are highly toxic, which is why their removal from wastewater has recently gained significant attention due to strict environmental regulations

Research section. Currently, the biosorption method is widely used in the treatment of industrial wastewater to remove heavy metals. When examining the materials used as adsorbents in biosorption—such as Ulva rigida, Punctaria latifolia, Pyropia leucosticta, Callithamnion corymbosum, and Cladophora sericea (mostly marine algae)—it was found that their organic binding properties align with those found in the cotton plant. Gossypol, a natural compound derived from cotton roots, has several derivatives used in such processes.

An analysis of industrial wastewater revealed the presence of the following heavy metals:

- Zn^{2+} – 2.13 mg/L
- Cr^{3+} – 6.94 mg/L
- Cu^{2+} – 4.47 mg/L
- Fe^{2+} and Fe^{3+} – 9.81 mg/L

In the laboratory, biosorption was used to precipitate these metals from the wastewater. Gossypol’s NY-I derivative was utilized as the sorbent, and it was found to selectively interact with Cr^{3+} ions. The procedure was carried out as follows:

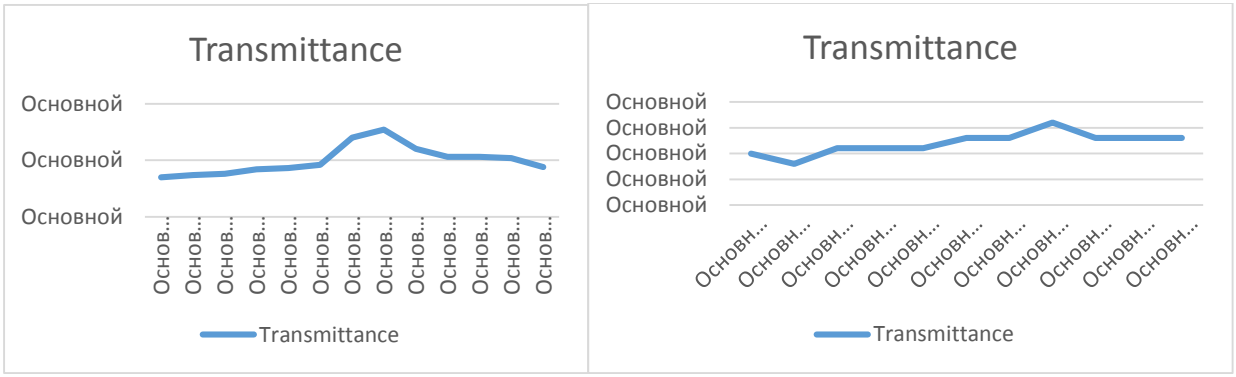
- Relative molecular mass of NY-I: 822.81272 g/mol
- Relative molecular mass of $Cr(NO_3)_3$: 237.9721 g/mol

Acetone was used as the solvent for NY-I, and distilled water for the chromium compound. Equal molar concentrations were prepared using the molar concentration formula:

To analytically confirm this reaction, a spectrophotometer was used. Two 5 mL cuvettes were prepared:

- Cuvette 1 (Standard solution): 2 mL of 0.01 M NY-I + 2 mL distilled water
- Cuvette 2 (Comparison solution): 2 mL of 0.01 M NY-I + 2 mL of 0.01 M $Cr(NO_3)_3$

The absorption of visible light (380–750 nm) was measured, and the following results were recorded:



The biosorption method demonstrated an efficiency of 96–98% in removing Cr^{3+} ions.

Conclusion: Sorption methods are widely used in the treatment of industrial wastewater. Using natural plant-based materials—particularly gossypol—as sorbents proves to be economically efficient. This study successfully demonstrates that 96–98% of Cr^{3+} ions can be removed from wastewater using NY-I, a gossypol derivative.

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