# Sorption-Photometric Determination of Nickel and Cobalt Ions in Industrial Waste Using Diethyl 2,2'-((1,3,4-Thiadiazole-2,5-Diyl) Bis (Sulfandiyl)) Diacetate Organic Reagent

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ABSTRACT

Diethyl 2,2'-((1,3,4-thiadiazol-2,5-diyl) bis (sulfandiyl) for nickel and cobalt ions in industrial and environmental facilities of "Almaliq KMK" JSC ) diacetate was selected as an organic analytical reagent. Immobilization of 2,2'-((1,3,4-thiadiazol-2,5-diyl) bis (sulfandiyl)) diacetate organic reagent on various fibrous carriers, determination of nickel and cobalt metal ions, and also an express method of determination are shown. Analytical and metrological parameters of the method were evaluated, it was found that the limit of determination of nickel and cobalt ions increases 20 times in the immobilized state compared to the solution.

**Keywords:** nickel and cobalt ions, 2,2'-((1,3,4-thiadiazol-2,5-diyl) bis (sulfandiyl)) diacetate, analytical reagent, immobilization, sorption-photometric determination

## I. Introduction

Currently, sorption-photometric methods are widely used for the determination of toxic and highly active heavy metals. This method is of great importance due to its sensitivity, simplicity, and less time spent on analysis. Sorption-photometric methods, one of the most modern physical and chemical methods, are widely used. Sorption-photometry is based on measuring the light absorption of colored and colorless solutions in monochromatic light.

Currently, environmental pollution, the need for clean drinking water is one of the global problems, and year by year the level of pollution of the environment and water bodies continues to grow, causing concern to the world community. For example, from 1925 to 1986, water mineralization in the Zarafshan River increased from 0.46 g/l to 1.22 g/l. This means that the mineralization of river water increased by 2.2-6.8 times during the incomplete life of one generation [1].

In recent years, the use of sorbents in photometric analysis has gained practical importance. This makes it possible to create a new, highly sensitive, selective sorption-photometric method. This method of analysis also uses organic reagents known in photometric analysis. The sensitivity and accuracy of sorption-photometric methods is higher than that of test methods. As a result of the combined use of these two methods, it is necessary to determine the amount of toxic substances by the test method, and to measure the exact amount by the sorption-photometric method. The established test methods are mainly determined by the level of permissible limit value (PDK) [2].

Immobilization is derived from the Latin word "binding" which means "strengthening" and refers to the environment that is forcibly created to protect an injured limb for a certain period of time. In the language of chemistry, it is used in the sense of immobilizing compounds that do not exist stably or have low efficiency, to increase their activity or to maintain their stability, in general, absorption. There are mainly two ways to form groups on the surface of sorbents that allow obtaining complex compounds [3].

Is the modification of the sorbent with a covalently bound functional group, and the second is the immobilization of the organic reagent in the matrix as a result of intermolecular interaction. Although the sorbent created in the first way has some advantages, there are some difficulties in its preparation and synthesis of necessary substances. According to the second method, it is usually only required to select the necessary reagent for immobilization [4].

There are different types of immobilization of organic reagents into a polymer matrix: electrostatic, adsorptive, and covalent immobilization. Immobilization increases the resistance of organic reagent layers to leaching and eliminates photochemical degradation. A standard method for preparing such immobilized substances is to achieve absorption at the matrix level of a reagent chosen according to the objective being observed. Ion-exchange fibrous sorbents have an advantage over other granular sorbents due to their large surface area. This feature helps the sorption-desorption process to go well on its surface and absorb ions of very small concentration. The activity of the sorbent is increased by modifying the nitron fiber with hydroxylamine or similar substances to convert it into a chemical state.

The simplest and most widely used immobilization method is the adsorption of an organic reagent on the fiber. In this case, a new bond appears between certain groups in the fiber and the reagent. The nature of such a bond is greatly affected by slight changes in pH, ionic strength, temperature, and solvent nature of the solution during the analysis. Ignoring these effects can lead to desorption of the reagent from the fiber [5].

Reactions of complex formation of Ni and Co (II) with PVP were studied by sorption-photometric method. The optimal conditions were pH=8, λ =360 nm, and the lower limit of detection was determined to be 0.01 [6].

## II. General methodology of work

### *2. 1. Method of carrying out the reaction:*

1. 0.05 g of 2,2'- ((1,3,4- thiadiazol-2,5-diyl) bis(sulfandiyl)) diacetate was taken from the reagents on an analytical balance, placed in a 100 ml volumetric flask and made up to the mark with alcohol. The prepared solution was diluted and used for further work.

2. 0.05 g of 2,2'- ((1 ,3,4-thiadiazol-2,5-diyl) bis (sulfandiyl)) diacetate was taken from the reagents on an analytical balance, placed in a 100 ml volumetric flask and made up to the mark with alcohol. The prepared solution was diluted and used for further work.

3. To prepare a standard 1 mg/ml solution of Ni $^{+2}$ ion, 0.5 g of $Ni(NO_3)_2 \cdot H_2O$ salt was taken and placed in a 200 ml flask, 2 ml of nitric acid was also added and brought to the mark with distilled water. . This solution was used in subsequent work.

To prepare a standard 1 mg/ml solution of So $^{+2}$ ion, 0.5 g of $SoSO_4$ salt was taken and placed in a 200 ml flask, 2 ml of sulfuric acid was also added and brought to the mark with distilled water. This solution was used in subsequent work.

4. It was prepared by diluting concentrated hydrochloric acid in the preparation of 1.0·10-1 M hydrochloric acid solution.

5. A 0.04 M ($H_3BO_3$, $H_3PO_4$, $CH_3COOH$) 0.2 M NaOH solution was added to the universal buffer mixture with different pH (1-12) .

6. To prepare disks, 0.2 g of fibers synthesized at the department of polymer chemistry were taken. It was washed with distilled water until it became neutral. It was kept moist in a Petri dish.

7. The rN of the solutions was measured using the universal ionomer EV-130 and the rN-meter rN/mV/TEMR Meter P25 EcoMet developed in Korea.

8. Absorption and reflection spectra of solutions were used spectrocolorimeter called "IV-Vis Specord M-40".

9. The absorption spectrum of aqueous solutions of the reagent and the complex was measured in a spectrophotometer-46.

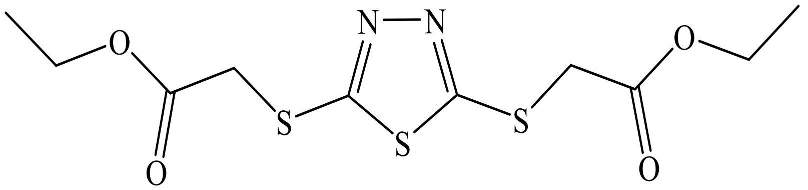
### 2.2. Selection of a new organic reagent for the determination of nickel (II) ion

For the determination of various metal ions as a result of organic reagents or their reactions, sorption- was examined using the spectrophotometric method.

As an organic reagent, we considered 2,2'-((1,3,4-thiadiazol-2,5-diyl) bis (sulfandiyl)) diacetate reagent to be the most suitable for nickel (II) ion, and most of the reagents used in the experiment are from the Department of Analytical Chemistry of UzMU was studied. This reagent has been shown to exhibit good metrological properties, high sensitivity and selectivity.

Considering all the information on the use of 2,2'-((1,3,4-thiadiazol-2,5-diyl) bis (sulfandiyl)) diacetate reagent in the analysis of the detected metal ion and their valuable chemical and analytical properties, 2,2 '-((1,3,4-thiadiazol-2,5-diyl) bis(sulfandiyl)) diacetate reagent allows us to accept it as a promising reagent for the determination of nickel (II) ion. There are a number of methods for the determination of nickel (II) ion, therefore, in its determination, 2,2'-((1,3,4-thiadiazol-2,5-diyl) bis (sulfandiyl)) diacetate reagents sorption- we considered the spectrophotometric possibilities and based on this, we studied the structure of the 2,2'-((1,3,4-thiadiazol-2,5-diyl) bis (sulfandiyl)) diacetate reagent, and based on preliminary studies, the result was selected for the given object It is given in table 1.

Table 1
Structural formula and designation of the studied reagent.

| | | |
|---|---|---|
| Structural formulas |  | Total: 8.5242 |
| Gross formula | $C_{10}H_{14}N_2O_4S_3$ | Charges<br>N 0.628<br>**S 0.294**<br>**[S( 1 )]**<br>**N -0.363**<br>**[N(4)]**<br>**S -0.503** |
| Naming according to systematic nomenclature a | diethyl 2,2'-((1,3,4-thiadiazole-2,5-diyl) bis (sulfandiyl)) diacetate | |

Judging from Table 1, 2,2'-((1,3,4-thiadiazol-2,5-diyl) bis (sulfandiyl)) diacetate organic reagent was selected for its high ability to be used as a reagent in the experiment, taking into account its analytical properties.

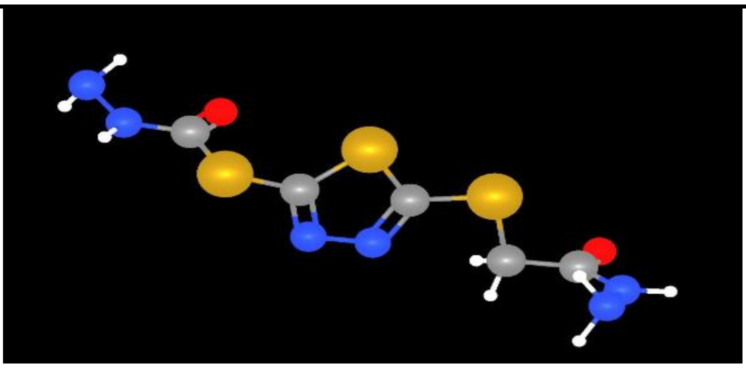


Figure 1. Quantum-chemical structure of the reagent in the Gaussian program.

As can be seen from this table, complexation of nickel (II) ion with immobilized organic reagent occurs mainly through -S and -N- groups, and to the reagent fiber through -O-SN 3 groups.

= 364 nm for the 2,2'-((1,3,4-thiadiazol-2,5-diyl) bis(sulfandiyl)) diacetate reagent shows a maximum wavelength at λ max = 670 nm for the immobilized complex , these wavelengths will be used in further work.

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