STUDYING THE REAGENT PROPERTIES OF INDIGO

[1]Mazhidov Sardor Abdujalil ugli, [2]Abdurakhmanova Ugilai Kokhhorovna
[1]Doctoral student at the Department of Chemistry
[2]Head of the Department, Doctor of Biological Sciences, Prof.
[1,2]Gulistan State University
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Abstract. *New and modern areas of analytical chemistry in the field of detection of non-ferrous metals are currently being developed. This article presents methods for the spectrophotometric determination of manganese ion, one such metal. It is important to note that the colored substance indigo, which belongs to the class of organic compounds, was used as a reagent. The optimal conditions for analysis were found , the composition and stability constants of the manganese complex (+ 2) with the analytical reagent indigo were determined.*
Keywords: *analysis, solvent, indigo, dye, analytical reagent, manganese ions (+2), optical density.*

Today, the substance Indigo, extracted from the *Indigofera plant tinctoria L* is used as a dye in many major research centers around the world, and its derivatives in various forms are used industrially. Because these dyes are natural, stable and have high quality indicators, as well as their negative impact on living organisms and the environment is practically unknown. Taking these features into account, some research centers are working on the use of Indigo as an organic reagent in analytical chemistry, obtaining its complexes with heavy metals and studying the physicochemical constants of these complexes [1-2] .

Advances in the field of analytical chemistry have a significant impact on the progress of world science. because this area is inextricably linked with industry, manufacturing, agriculture, medicine, pharmaceuticals, food and other important sectors

One of these achievements is the development of spectrophotometric methods for the detection of heavy and non-ferrous metal ions, including the manganese ion .

Because manganese ions are used in large quantities in manufacturing and agriculture. Therefore, one of the pressing problems is ecology and environmental protection, as well as assessing the impact on a living organism [3] .

Various analytical methods have been developed for the determination of manganese (II) , including spectrophotometric methods that allow the determination of various forms of manganese in minerals, natural samples, water, and biological objects using analytical reagents [4-5]. However, most of these methods do not fully meet the requirements of the analysis, due to their lack of sensitivity or selectivity [6].

Some organic natural compounds may have effective reaction properties compared to heavy metal ions. n because they contain some functions. in addition, natural compounds are important to meet the demand for raw materials. therefore their use is effective

Analytically, the most valuable, as a rule, are those organic substances containing complexing groups of atoms that make it possible to form complex compounds with metal ions [7-8].

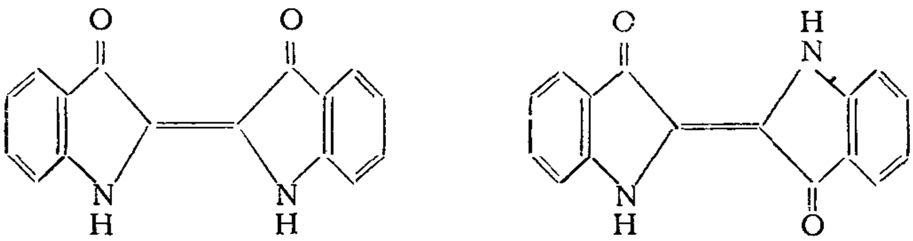
These types of organic substances include indigo

The goal of the work was to develop a new photometric method for detecting manganese in various alloys of industrial samples using indigo. For this purpose, systematic studies were carried out on optimal conditions, the nature of their interaction with metrological characteristics (normality, reproducibility, selectivity).

Due to the presence of electron-donating atoms and groups in indigo, it has good reactivity, and as a result of its sulfonation reaction, indigo carmine is obtained, which has acid-base indicator properties that are highly soluble in water. Indigo carmine changes color from blue to yellow within the pH range = 11.6-14.0 [9].

It is known from the literature that since the indigo molecule is linked by a double bond of two indoxyl groups, the molecule should theoretically exist in two different geometric isomers (cis and trans forms), but the mode of formation of indigo is unknown. However, it is always produced when converting.

sis-isomer, trans-isomer



Natural sources of indigo have been sufficiently studied, and at present they are mainly isolated from Indigofera plants tinctoria L and isatis tinctoria [10].

EXPERIMENTAL PART

Research methods. pH-metry, spectrophotometry, methods of direct quantitative determination using spectrophotometric measurements (calibration curve method).

Chemical reagents, materials and equipment. Chemical grade reagents were used in this work . and ch.d.a. _

Preparation of solutions : Working solutions of manganese prepared by dissolving precise weighed amounts of salt MnSO 4 (reagent grade) in distilled water, then transferred to a 250 ml volumetric flask and diluted to the mark.

Indigo dye is obtained from the leaves, " Indigofera" tinctoria L ", for use as an analytical reagent . Identification was carried out using thin layer chromatography.

An indigo solution was prepared by dissolving an accurately weighed portion of the reagent in dimethylformamide . The purity of the reagent was checked by thin layer chromatography .

Chemically pure organic solvents were used . or pre-purified by distillation, purity was controlled by boiling point.

Absorption spectra of solutions of the Me - R complex was recorded on an SP - UV 1100 spectrophotometer. The acidity of solutions was monitored with a glass electrode on a KSL-1100-1 pH meter .

RESULTS AND ITS DISCUSSION

To study the spectrophotometric reaction of complexation of iron with indigo , first of all, optimal conditions were selected. The optical density of solutions (reagent and ionic associate of the reagent with iron) ($Mn - R_{\text{реагент}}$) was measured respectively at $\lambda_{reagent}$ =610nm and λ_{comp} = 71 0 nm $(l = 1см)$ on the spectrophotometer relative to a blank solution (Fig. 1) .

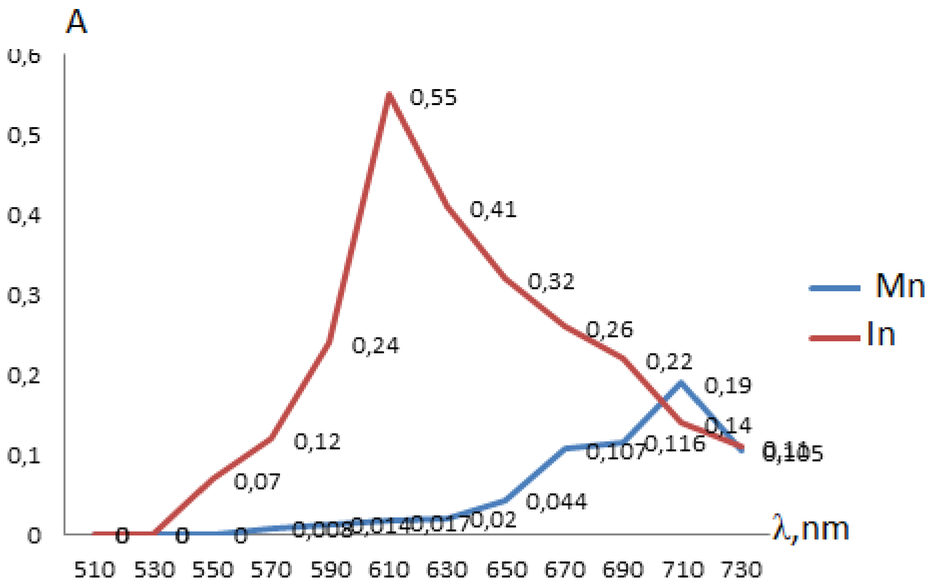


Fig.1. Dependency graph absorption wavelengths of solutions of reagents and complexes from the optical density of the solution

One of the main conditions for the complexation reaction is the acidity of the medium. Therefore, to obtain reproducible results, buffer solutions with different pH values are used.
For the optimal pH value, pH values with different pH values and different compositions of buffer mixtures were prepared. The optical density of the complex increases with increasing pH of the solutions.

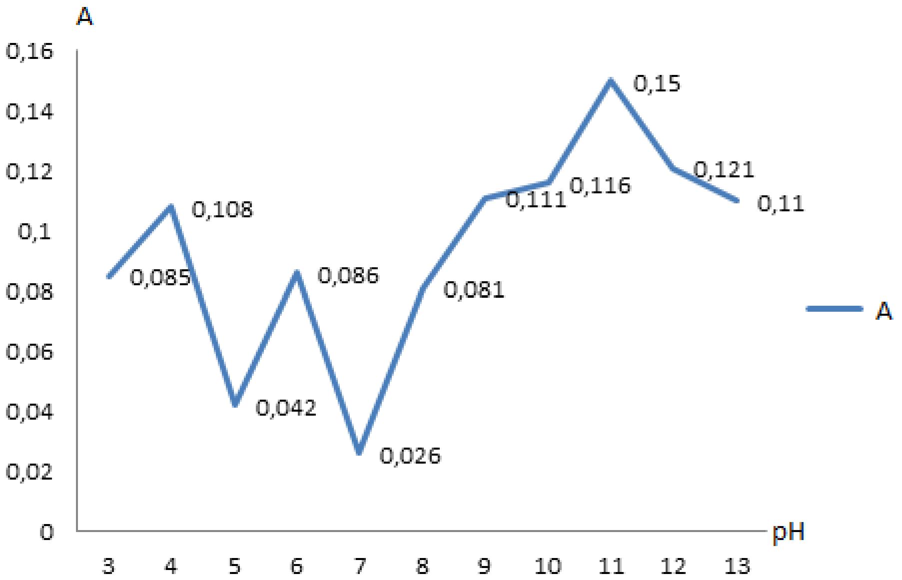
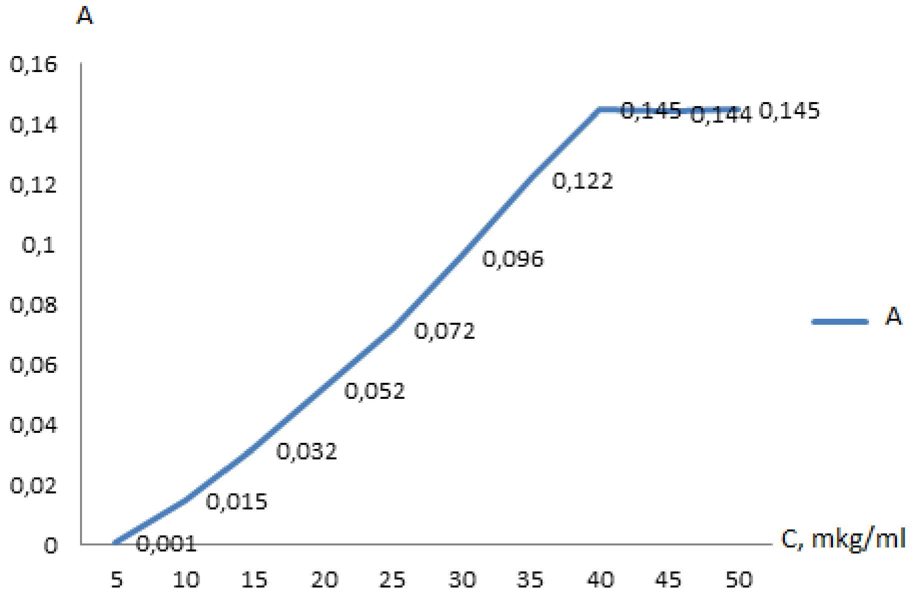


Fig.2. Graph of the dependence of the optical density of a complex compound ($Mn - R_{\text{реагент}}$) on the solution environment.

The maximum light absorption of the resulting complex, i.e., the optical density of the solution medium

Observed over short periods of time (pH = 11.98-12.00). Based on this, pH = 12.0 is optimally selected, and according to the experimental results, the maximum yield of the complex is observed when using an ammonia buffer solution used in further studies (Fig. 2).

Then the molar attenuation coefficient is analyzed and the Sendel sensitivity is determined (Table 1). Under optimal conditions, a calibration graph is constructed, which is drawn in the range of metal concentrations of 5.0-40.0 MCG/25 ml (Fig. 3.).



Rice. 3. Subordination of the manganese-indigo complex Beer's law

Table 1

Some analytical characteristics of the Mn (II) complex with indigo

	Analytical characteristics	$Mn{-}R_{\text{реагент}}$
1	Optimal volume of 0.0 5 % reagent solution, ml	5
2	Optimal solution environment, pH	1 2 .0
3	Stability of the complex over time, min.	6 0.0
4	Sendel sensitivity – μg/cm ^{2}	0.00 32 μg/cm ^{2}
5	The maximum absorption length of the color solution of the complex is λ, nm	710

The molar ratio of the manganese complex with the reagent was determined by the following methods: the Ostromyslensky-Job method (isomolar series method) and the Asmus straight line method. When determining the composition of the complex by the Ostromyslensky-Job method, equimolar concentrations of solutions of the metal ion and reagent are used: $C_{Mn2+} = C_R = 4.53 \cdot 10^{-5}$ mol/l.

To improve the reliability of the results recorded using this method, Asmus was redesigned using the straight-line method. From the results obtained, we can conclude that the content of the complex in the molar ratio me: R is 1: 2, i.e. the molar ratio of manganese to the reagent, detected by two methods, shows the same results: r = 1:2.

The accuracy and reproducibility of the method for determining manganese (+2) ions with the indigo reagent was checked by the “introduced-found” method, the results are presented in Table 2.

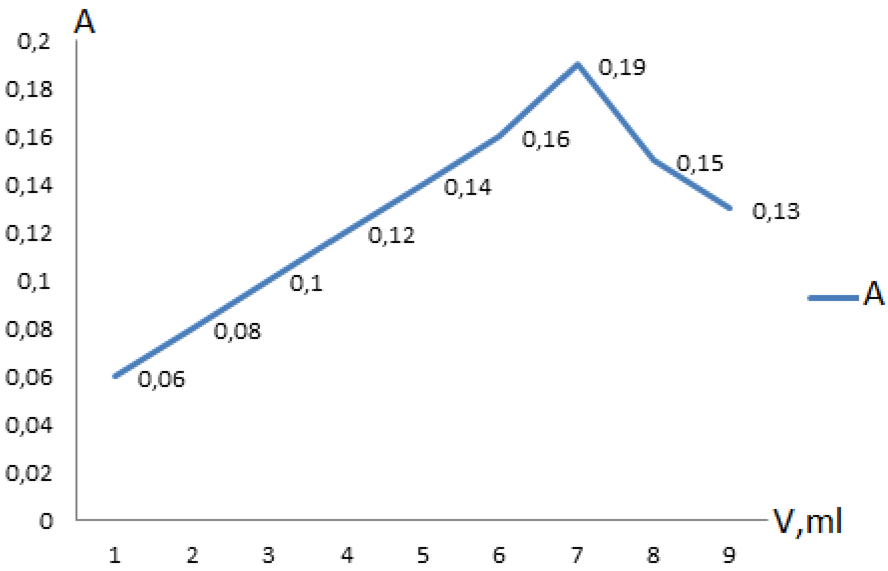


Fig.4. Determination of the molar ratios of the manganese complex with indigo using the isomolar series method

table 2

Results of testing the method for determining manganese (+2) in model solutions (n=3, P=0.95)

Introduced manganese, mg/l	Found manganese, mg/l	s	s_r
5,00	5,08 5.07 5.05	0.179	0.038

Note: n - number of parallel determinations, P - confidence probability, s - standard deviation, s_r - relative standard deviation.

Thus, the proposed method for determining manganese (+2) ions, high selectivity, fast productivity and ease of analysis make it possible to use them in the practice of chemical analysis when detecting manganese (+2) ions in various objects.

Thin layer chromatography of complexes

Initially, a solvent system (eluent) for Indigo was chosen for this purpose. It is known from the literature that a typical system for Indigo is a mixture of chloroform- hexane -methanol in a ratio of 7:4:1 (Rf = 0.88).

To control the result of the experiment, the method of thin layer chromatography (TLC) was used, for which Silufol plates (Czech Republic) were used. Dimethylformamide was used as a solvent to dissolve indigo and complexes (see Table 9).

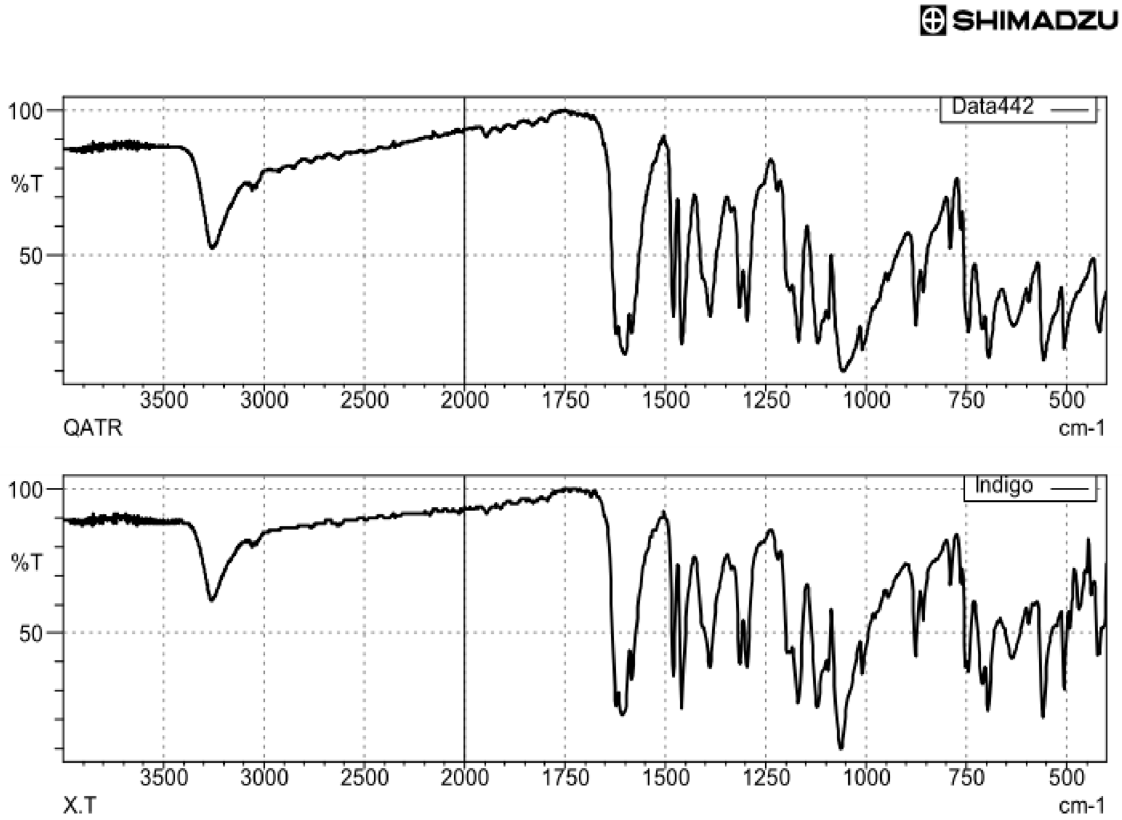
Table 9

Results of TLC analyzes of indigo complexes
(System – chloroform: gexane:methanol (7:4:1))

No.	Substance name	Spot color	Solvent	R_f value
1	Indigo	Brown	DMF	0.88
2	Indigo + Mn	Inky	DMF	0.78

Research results confirm that heavy metal ions react with Indigo, thereby forming a complex.

IR analysis of Indigo complexes with heavy metals



The IR spectrum of the metal complex during the formation of indigo with heavy metals was compared with the spectrum of indigo, with the formation of an amino group at 2313.57 cm^{-1} and the presence of absorption in the range of 1800-2000 cm^{-1} , and this absorption is characteristic of the interaction of metal atoms with the carbonyl group of the molecule indigo

Conclusions

Thus, we can conclude that a new spectrophotometric method for determining manganese using indigo has been developed. The optimal conditions for the determination of manganese (III) were found, the composition of the manganese - indigo complex was determined .

The developed method was used to determine manganese in model solutions. The value of s in all cases did not exceed 0.185.

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