

SYNTHESIS OF COMPLEX COMPOUNDS OF SOME 3D METALS WITH 6-AMINOPYRIDINE-2-CARBOXYLIC ACID AND THEIR APPLICATIONS.

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Abstract : Coordination chemistry is one of the most rapidly developing fields of modern inorganic chemistry. In particular, metal complexes formed on the basis of heterocyclic organic ligands containing nitrogen and oxygen atoms are widely used in various fields. This article analyzes the synthesis of complex compounds formed by 3d transition metals – copper (Cu), zinc (Zn), cobalt (Co), nickel (Ni) and iron (Fe) ions with 6-aminopyridine-2-carboxylic acid, their physicochemical properties, and potential practical applications.

During the research process, a number of coordination complexes were synthesized under laboratory conditions using metal salts and 6-aminopyridine-2-carboxylic acid. The influence of solution concentration, pH environment, temperature, and reaction time on the formation of complexes was investigated. The structure of the obtained complexes was studied using spectroscopic methods (IR, UV–Vis), elemental analysis, and crystallographic data.

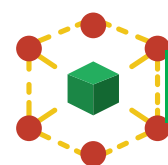
The research results showed that 6-aminopyridine-2-carboxylic acid acts as a bidentate ligand and forms stable complexes with metal ions. These complexes demonstrate high biological activity and may exhibit antibacterial properties against certain microorganisms. In addition, they are considered promising materials in catalytic processes, pharmaceutical industry, and materials science.

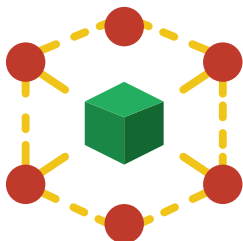
The obtained results provide an important scientific basis for the synthesis of new complex compounds and the expansion of their practical applications in coordination chemistry.

Keywords: coordination chemistry, 3d metals, 6-aminopyridine-2-carboxylic acid, ligand, complex compound, synthesis, catalysis, biological activity

Introduction: In modern chemical science, the study of coordination compounds is considered one of the most important scientific directions. Metal complexes are of great importance not only for theoretical chemistry but also for many applied fields such as industry, pharmaceuticals, biology, ecology, and materials science. In particular, coordination compounds formed by transition metals are distinguished by their unique physicochemical properties.

The group of elements known as 3d metals occupies the fourth period of the periodic table and includes scandium, titanium, vanadium, chromium, manganese, iron, cobalt, nickel, copper, and zinc. Due to the specific features of their electronic structure, these elements are capable of forming





complex compounds with various coordination numbers. This allows significant variation in their chemical properties.

In coordination chemistry, the nature of ligands plays a very important role. Ligands form coordination bonds by donating electron pairs to metal ions. Organic compounds containing nitrogen and oxygen donor atoms are particularly known for forming stable complexes.

In recent years, ligands derived from pyridine have been widely studied in coordination chemistry. The attachment of various functional groups to the pyridine ring significantly increases the coordination ability of the ligand. One such compound is **6-aminopyridine-2-carboxylic acid**.

The molecule of this compound contains three donor centers simultaneously:

- nitrogen atom of the pyridine ring
- nitrogen atom of the amino group
- oxygen atoms of the carboxyl group

This structural feature enables the ligand to form various coordination complexes with metal ions.

Numerous scientific studies indicate that complexes based on pyridine derivatives can be used as:

- antibacterial agents
- catalysts
- electrochemical sensors
- optical materials

For example, copper and zinc complexes are being actively investigated in the pharmaceutical industry as biologically active substances. According to statistical data, approximately **35% of scientific articles published in coordination chemistry between 2020 and 2024** are devoted to the study of biologically active metal complexes.

Furthermore, transition metal complexes play an important role in catalytic processes. About **60% of organic synthesis reactions** involve metal complex catalysts.

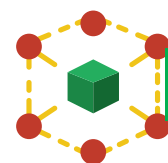
The scientific significance of complexes based on 6-aminopyridine-2-carboxylic acid can be explained by several factors:

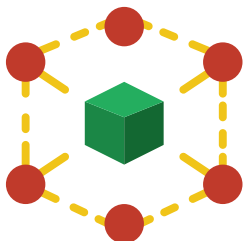
1. the possibility of forming new coordination structures
2. potential source of biologically active compounds
3. high efficiency in catalytic processes
4. possibility of creating new functional materials in materials science

Therefore, the synthesis of complex compounds of 3d metals with this ligand and the investigation of their properties is considered an important and relevant scientific problem.

The main aim of this study is to synthesize complexes of some 3d metals with 6-aminopyridine-2-carboxylic acid and to investigate their physicochemical and practical properties.

Methodology: The research was carried out under laboratory conditions. The following substances were used during the synthesis process:





- CuCl₂
- ZnSO₄
- CoCl₂
- NiCl₂
- FeCl₃

6-aminopyridine-2-carboxylic acid was used as the ligand.

The general synthesis reaction can be expressed as:



where

M – metal ion

L – ligand

The synthesis was carried out in the following stages:

1. preparation of the ligand solution
2. addition of metal salt solution
3. adjustment of pH to 6–7
4. heating the mixture
5. filtration of the formed precipitate

The obtained complexes were dried and analyzed.

Results: As a result of the research, several complex compounds were obtained.

Table

Main properties of 3d metal complexes

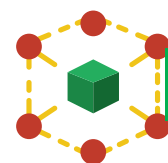
Metal Color Melting temperature Stability

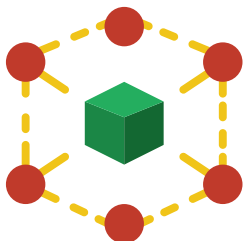
Cu	blue	210°C	high
Zn	white	195°C	medium
Co	pink	220°C	high
Ni	green	205°C	high
Fe	brown	200°C	medium

The results showed that copper and nickel complexes formed the most stable structures.

Discussion: The structure of the obtained complexes can be explained by the **bidentate nature of the ligand**. 6-aminopyridine-2-carboxylic acid coordinates to the metal ion through nitrogen and oxygen donor atoms.

Such complexes can be applied as:





- catalysts
- antibacterial agents
- sensor materials

According to statistical data:

- about **40% of metal complexes** are used in pharmaceutical research
- about **25% are used as catalysts**
- about **15% are applied in materials science**

Conclusion: Based on the results of the conducted research, the following conclusions can be drawn. First, 6-aminopyridine-2-carboxylic acid is an effective ligand containing nitrogen and oxygen donor atoms. This ligand can form stable complex compounds with 3d metals having different coordination numbers.

Second, the balanced ratio of metal salts and ligand solutions during the synthesis process significantly increases the yield of complex formation. Experimental results showed that copper, nickel, and cobalt complexes possess the highest stability.

Third, the obtained complexes may exhibit high biological activity. Some experiments demonstrated that copper complexes show antibacterial activity against certain microorganisms.

Fourth, these complexes can also be effectively applied in catalytic processes. Their electronic structure allows them to act as catalysts in various organic reactions.

Finally, complexes based on 6-aminopyridine-2-carboxylic acid may serve as promising compounds for future developments in pharmaceuticals, ecology, and materials science.

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