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Interaction of naphthalene acetic acid with dipositive metalions and
the characterization of the complexes
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Abstract

Research shows that carboxylic acids' coordination chemistry has been investigated extensively, as shown by a survey of the relevant literature. However, the current study was prompted by the dearth of published information on the coordination chemistry of modified acetic acid moieties. In this study, we used elemental analysis, UV-Vis, FT-IR, and ¹H-NMR spectroscopy, and magnetic susceptibility to characterize naphthalene acetic acid (NAA), a base moiety. Cobalt (II), copper (II), nickel (II), and mercury (II) were explored and their interactions with the base NAA in non-aqueous environments such as ethanol were investigated. Characterization of the solid-state synthesized metal complexes of cobalt (II), copper (II), nickel (II), and mercury (II) ions with NAA included chemical analysis, electrical conductivity, elemental analysis, and spectrum measurement (UV-visible, FT-IR, and ¹H-NMR).The complexes synthesized have also had their magnetic susceptibility evaluated.

Key-Words: Naphthalene acetic acid, Bivalent metal ions.

INTRODUCTION:

The chemical subfield of "coordination" is expanding quickly. Many other fields may benefit from it. Co-ordination compounds are common in nature and include things like chlorophyll (the green pigment of plants) and haemoglobin (the coloring component of blood). Since transition metals contain an abundance of unoccupied d orbitals, they are able to create stable metal-ligand complexes by sharing electrons with their

ligands via dative bonds [6]. Iron, cobalt, and nickel are more prone to forming complex compounds among the transition metals. Popular plant growth regulators [13, 14] include indole-3-acetic acid, naphthalene-acetic acid, and 2,4-dichlorophenoxyacetic acid. It was discovered that these hormones and their derivatives regulated plant development and had other biological actions .

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The Stuff and How We Did It In this chapter, we briefly describe the various analytical approaches that were used to get these results. The synthesized compounds were characterized by their molecular conductance, magnetic susceptibility, infrared spectral measurement, ultraviolet spectral measurement, ¹H NMR spectral measurement, elemental analysis, and chemical analysis. Conductivity of electricity The concentration was estimated to be approximately 103 M. KBr pellets were used to record the infrared spectra of the ligand NAA and the complexes in the standard range of 4000-400 cm⁻¹. The ¹H-NMR spectra was obtained at 300 K using DMSO-D₆ and CHCl₃-D as solvent and TMS as the internal standard. The organic ligand NAA and its mercury (II) complex have been studied using ¹H-NMR spectroscopy in order to shed light on their structure. Lambda 35 double beam UV - visible spectrophotometer was used to measure the electronic spectra of the current ligand and the colored metal complexes in DMF or DMSO solutions. The instrument's usable wavelength range ranged from 350 to 1100 nm. We used a Gouy magnetic balance to take the magnetic readings. Hg[Co(SCN)₄] was used for the Gouy tube's calibration,

and Pascal's constants were used for the diamagnetic corrections. Curie's formula, $\chi = 2.84[XM \text{ corr.} T]^{1/2} / B.M.$, was used to determine the effective magnetic moments, where T is the absolute temperature at which the observations were taken. was completed. Naphthalene acetic acid metal complexes metal content by dissolving them with concentrated nitric acid. Nickel, and cobalt (II) The weight percentages of cadmium (II) and mercury (II) were calculated. Iodometric titration was used to identify copper (II). Analyzing carbon and hydrogen content helped elucidate the ligand naphthalene acetic acid's chemical make-up. The Vario EL III analyzer was used to count the number of carbon and hydrogen atoms. Naphthalene acetic acid: a characterization. In the current investigation, naphthalene acetic acid, which is commercially

accessible and chemically pure, was bought and employed as the ligand. Methods of Experimental Research Naphthalene acetic acid metal complex synthesis.

Complex Cobalt (II) Preparation

Cobalt (II) chloride (0.01 M), weighing 2.38g, was dissolved in 25ml of hot distilled water in a 100 ml beaker. Another 100 ml beaker was used to dissolve 5.58 g of NAA (0.03 M) in 25 ml of boiling ethanol. After agitating the metal salt solution for 10 minutes, the clear solution of the ligand was slowly added. A solid complex, colored pink, precipitated out of the solution. After being filtered, it was washed several times in ethanol and then in solvent ether. To preserve the complex, it was dehydrated and placed in a desiccator.

Complexes of copper(II), nickel(II), and mercury(II) were all prepared using the same method.

Cobalt Estimation

A weight-based estimate of cobalt was made. Ammonium thiocyanate and mercuric chloride were added to the cobalt solution at the right concentrations. The Hg[Co(SCN)₄] combination was isolated as a solid, resulting in a bluish hue. The amount of cobalt was determined by comparing the complex's weight to known values.

Copper price prediction

Copper was determined using iodometry. A bluish-white precipitate was formed when ammonium hydroxide was added to the copper solution. The iodine that was freed was titrated against a standard sodium thiosulfate solution after being dissolved in acetic acid and combined with roughly 2g of solid potassium iodide. The final result was achieved by adding 2 ml of starch solution. The last stage was the loss of all blue hues. The quantity of copper was determined using the titre value.

The following is a gravimetric approximation of nickel. After diluting the clear solution with distilled water to a volume of 100ml, 5ml of 1:1 HCl was added. The solution was then warmed to about 80 degrees Celsius. A 1% alcoholic solution of dimethyl glyoxime reagent was added to the heated solution drop by drop, bringing the total volume to around 20 ml. continuous shaking metal content by dissolving them with concentrated nitric acid. Gravimetric analysis was used to identify cobalt (II), nickel (II), and mercury (II). Iodometric titration was used to identify copper (II). Analyzing carbon and hydrogen content helped elucidate the ligand naphthalene acetic acid's chemical make-up. The Vario EL III analyzer was used to count the number of carbon and hydrogen atoms. Naphthalene acetic acid: a characterization. In the current investigation, naphthalene acetic acid, which is commercially accessible and chemically pure, was bought and employed as the ligand.

Methods of Experimental Research

Naphthalene acetic acid metal complex synthesis. Complex Cobalt (II) Preparation Cobalt (II) chloride (0.01 M), weighing 2.38g, was dissolved in 25ml of hot distilled water in a 100 ml beaker. Another 100 ml beaker was used to dissolve 5.58 g of NAA (0.03 M) in 25 ml of boiling ethanol. After agitating the metal salt solution for 10 minutes, the clear solution of the ligand was slowly added. A solid complex, colored pink, precipitated out of the solution. After being filtered, it was washed several times in ethanol and then in solvent ether. To preserve the complex, it was dehydrated and placed in a desiccator. Complexes of copper(II), nickel(II), and mercury(II) were all prepared using the same method.

Cobalt Estimation

A weight-based estimate of cobalt was made. Ammonium thiocyanate and mercuric chloride were added to the cobalt solution at the right concentrations. The $Hg[Co(SCN)_4]$ combination

was isolated as a solid, resulting in a bluish hue. The amount of cobalt was determined by comparing the complex's weight to known values.

Copper price prediction

Copper was determined using iodometry. A bluish-white precipitate was formed when ammonium hydroxide was added to the copper solution. The iodine that was freed was titrated against a standard sodium thiosulfate solution after being dissolved in acetic acid and combined with roughly 2g of solid potassium iodide. The final result was achieved by adding 2 ml of starch solution. The last stage was the loss of all blue hues. The quantity of copper was determined using the titre value.

Nickel Cost Projection

The following is a gravimetric approximation of nickel. After diluting the clear solution with distilled water to a volume of 100ml, 5ml of 1:1 HCl was added. The solution was then warmed to about 80 degrees Celsius. A 1% alcoholic solution of dimethyl glyoxime reagent was added to the heated solution drop by drop, bringing the total volume to around 20 ml.

always mixing things up. The solution was quickly made alkaline by adding a weak ammonia solution, drop by drop. The nickel dimethyl glyoximate combination precipitated out as a bright red color. After settling for approximately an hour in a water bath, the precipitate was digested. The precipitate was weighed after it was filtered, washed with hot water, dried in an air oven, and then chilled in a desiccator. Nickel's mass was determined by comparing it to that of the dimethyl glyoximate complex.

Discussion and Results

The novel naphthalene-derived base, naphthalene acetic acid (NAA), has two oxygen atoms that might serve as donor atoms. Investigating the

NAA's interaction with a transition metal salt is important because it provides insight into how the NAA bonds with the metal atom. As a result, the novel base NAA was procured for ligand usage.

Conclusions from Analyses

Table 4.1 provides the elemental analysis findings for NAA and its compounds. NAA and its complexes may be empirically formulated based on their percentage compositions.

NAA: A Descriptive Analysis

Pure NAA was characterized by measuring its melting point, elemental composition, infrared, ultraviolet, and ¹H-NMR spectra. In (Table 4.1), you'll find the results of an elemental analysis of NAA. (Table 4.2) details the crucial vibrational frequencies. Resonance signals from ¹H-NMR spectroscopy are shown in (Table 4.3). The OH group of the carboxylic acid may be traced to a moderately high absorption band in the IR spectra located at 3434 cm⁻¹. An aromatic C-H vibration is responsible for the 3060 cm⁻¹ absorption band, whereas an aliphatic C-H vibration is responsible for the 2916 cm⁻¹ band. Possibly both the aromatic C=C stretch and the carboxylic carbonyl group are responsible for the absorptions seen between 1696 and 1510 cm⁻¹. Multiplet signals for the free ligand NAA were seen at 7.966 GHz. The signal at 4.073 ppm is attributable to the protons of the CH₂ group, whereas the signal at 7.246 ppm is attributable to the aromatic protons. We anticipate a 10–14ppm chemical change owing to the carboxylic proton (COOH). Given that the spectrum was scanned at, There was no trace of this signal between -0.5 and 9.5ppm. C12H9O2·2.2H₂O: Chemical Description Cobalt in its +2 oxidation state may be present in this pink-colored complex with a 1:2 metals:ligand stoichiometry. The carboxylic acid in NAA may have been ionized during the CoII chloride-NAA interaction, resulting in the carboxylate anion, which then combined with Co²⁺ to form the pink complex Co(C12H9O2). The conductivity measured in a 103M DMF solution and the elemental analysis (Table 4.1) both corroborate this. The free acetate ion (CH₃COO⁻) shows

absorption at 1560 and 1416cm⁻¹ which are attributed to ν_a (COO⁻) and ν_s (COO⁻) respectively. Considering the NAA⁻ ion, the band at 1410 cm⁻¹ may be due to symmetric ν_s (COO⁻) vibrations. In the case of the cobalt (II)

complex these respective absorption bands are observed at 1511 and 1410 cm⁻¹. The difference (Δ) between the asymmetric and symmetric bands of free NAA⁻ is at a much higher value of 189cm⁻¹ where as in the complex spectrum, Δ is much lower at 100cm⁻¹ indicating bidentate chelation of the carboxylate ligand to CoII ion. A perusal of the electronic spectrum of the CoII complex shows several bands due to d-d transition, charge transfer and ligand origin. A very weak absorption at 524.7nm (ie19058 cm⁻¹) may be attributed to 4T_{2g} (F) → 4T_{1g} (P) transition. Another weak absorption band found at 651.2nm (15356cm⁻¹) is attributed to 4T_{2g} (F) → 4A_{2g} (F) transition. A strong band found at 297nm (33670cm⁻¹) may be due

to charge transfer transition. The effective magnetic moment measured at room temperature for the CO₂⁺ ion is 4.8 B.M. Hence on the basis of chemical analysis, infrared and electronic spectra and magnetic moment the cobalt (II) complex is proposed to have an octahedral stereochemistry. Characterization of Ni (C12H9O2)₂·2H₂O The green coloured nicked (II) complex on elemental analysis is found to have 1:2 stoichiometry. Very low electrical conductivity value indicate the complex to be a non- electrolyte. An examination of IR spectrum of this shows the appearance of ν_a (COO⁻) at 1510 cm⁻¹ and that ν_s (COO⁻) at 1410 cm⁻¹. The difference between the symmetric and anti symmetric absorption is at 100 cm⁻¹ which much less than the free ion (NAA⁻) value (189cm⁻¹) this spectral feature indicates the bidentate chelation of the carboxylate ligand. Also the far IR absorption band seen at 540cm⁻¹ may be due to ν (Co-O). The IR spectrum also shows bands at 3391(lr), 1631, 801, and 625 cm⁻¹ which are attributed to the presence of

water molecules. The band found at 540 cm^{-1} is ascribed to the (Ni- O) stretching vibration.

The electronic spectrum of the Ni II complex shows an absorption at 24814 cm^{-1} (403 nm) which is attributed to $3A_{2g}(F) \rightarrow 3T_{1g}(P)$ transition, another band at 13405 cm^{-1} (746 nm) due to $3A_{2g}(F) \rightarrow 3T_{1g}(F)$ and a third band at 9814 cm^{-1} (1019 nm) due to $3A_{2g}(F) \rightarrow 3T_{1g}(F)$ transition. These absorption bands are indicative of an octahedral symmetry of Ni II in the complex. The μ_{eff} value measured at 2.84 B.M is also supportive of octahedral geometry. Hence based on analytical conductivity and magnetic data and IR and UV-visible spectroscopy a bidentate chelation of the organic ligand and octahedral stereochemistry is proposed to this complex. Characterization of $\text{Cu}(\text{C}_{12}\text{H}_9\text{O}_2)_2 \cdot 2\text{H}_2\text{O}$

On the basis of chemical and elemental analysis this complex is given 1:2 stoichiometry. The very electrical conductance measured for this complex reveals that the complex is non-ionic. The IR spectrum indicates the presence of $\nu_a(\text{COO}^-)$ and $\nu_s(\text{COO}^-)$ vibrational frequencies at 1511 and 1329 cm^{-1} respectively. The difference between these two is much higher than expected for bidentate chelation mode of coordination of NAA- ligand. Presence of water in the coordination sphere is indicated by IR bands at 3466 (br), 1599, 79 (split) and 625 cm^{-1} . The band at 511 cm^{-1} also points to the binding of Cu and O atoms. The green coloured CuII complex measures an electronic absorption band at 11509 cm^{-1} (868.86 nm) which is attributed to $2E_g \rightarrow 2T_{2g}(F)$. It also exhibits another band at 32159 cm^{-1} (310.95 nm) which may be due to charge transfer transition. The complex has a μ_{eff} value of 1.45 B.M per Cu atom at room temperature. The very low value of μ_{eff} may be due to a coupling of the unpaired electrons one on each Cu II ion. Hence based upon the chemical and elemental analysis, conductivity, magnetic moment, IR and electronic absorption spectra, this complex is given a carboxylato bridged binuclear structure where there is antiferromagnetic interaction between two copper ions. Characterization of Hg

$(\text{C}_{12}\text{H}_9\text{O}_2)_2 \cdot 2\text{H}_2\text{O}$ analysis shows that the mercury complex has 1:2 stoichiometry. The electrical conductivity measurement shows that it is a non-electrolyte. Investigation of its IR spectrum points to the fact that the carboxylato anion acts as a chelating bidentate ligand. The $\nu_a(\text{COO}^-)$ appears at 1511 cm^{-1} and the $\nu_s(\text{COO}^-)$ appears at 1410

cm^{-1} . The difference between the two is 101 cm^{-1} which is very low indicating bidentate chelation to the metal ion. Also the appearance of bands at 3448, 1599, 801 and 625 cm^{-1} are attributed to the presence of coordinated water molecules. Further, the far IR absorption at 400 cm^{-1} which is due to Hg-O stretching vibration may also indicate the coordination of the carboxylate anion and H₂O molecules. There is no magnetic and electronic spectral criterion for the bonding in d¹⁰ system. Hence, on the basis of other physico-chemical data a 6 – coordinated structure is proposed for this complex also. Co(II), Ni(II), Cu(II), Hg(II) are all examples of transition metals. This article discusses the biological significance of naphthalene

Carboxylates and related compounds, including information on transition metal ion complexes with regard to cobalt (II), nickel (II), copper (II), and mercury (II) ions. The experimental methods used to characterize the structures of the isolated complexes are described in detail. Electrical conductivity and magnetic measurements, infrared (IR), ultraviolet (UV), and nuclear magnetic resonance (1H NMR) spectroscopy, and elemental and chemical analysis are all part of the experimental methods. The findings obtained are discussed in detail in this study. All of the complexes have their bonding atoms fixed and their stereochemistry ascribed based on the physicochemical data collected. The stoichiometry of all of the complexes is 1:2. Two water molecules are coordinated in each of them. The carboxylate ligand serves as a bridging bidentate in the CuII complex and as a chelating bidentate in the CoII, NiII, and HgII complexes. A binuclear bridging structure is suggested by the very small magnetic moment measured for the



CuII complex. In every compound examined, the metal ions are arranged in octahedra.

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