

# SYNTHESIS AND STUDY OF COBALT COMPLEXES

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## Abstract

The origin of the name Cobalt is thought to stem from the German kabold for "evil spirits or goblins", who were superstitiously thought to cause trouble for mines, since the cobalt minerals contained arsenic that injured their health and the cobalt ores did not yield metals when treated using the normal methods.

Metal ion complexes are playing an increasing role in the development of antimicrobials. In this research paper we study the antimicrobial properties of cobalt coordination complexes in oxidation state 3+. All complexes are found active when screened for their antimicrobial activity.

In UV-Vis spectrophotometric study it is found that the, Hexamine cobalt (III) chloride absorbs at 240nm, Hexanitro cobaltate (III) absorbs at 228nm and hexanitro Co(III) absorbs at 222nm.

Thermogravimetric analysis of Co(III) complex of Hexamine cobalt (III) chloride shows mass loss at 80°C to 100°C is due to water lattice weight losses upon decomposition point shows thermal stability. In sodium hexanitro cobaltate (III) shows maximum weight losses at 200°C and above it weight losses continuously up to 650°C. In hexamine Co(III) and hexanitro Co(III) weight losses maximum at 500°C and shows thermal stability up to 650°C.

In X-ray Diffraction studies of Co(III) complex of Hexamine cobalt (III) chloride, Sodium hexanitro cobaltate(III), hexamine Co(III) and hexanitro Co(III) shows the nature of the compound is crystalline in nature.

*Index Terms -Cobalt complex, X-ray diffraction, Antimicrobial activity, UV- visible.*

## **Introduction**

Metals have been used in the treatment of diseases of humans since ancient times. The Chinese were using elemental gold for the treatment of diseases, a practice known as chrysotherapy, as far as 2500 BC [1]. In more recent times, a stable metal coordination complex based on the element platinum, cis-[PtCl<sub>2</sub>(NH<sub>3</sub>)<sub>2</sub>] (cisplatin), has become the most well known of all metal based drugs and hundreds of articles have been published on the synthesis and activity of complexes derived from the parent cisplatin molecule. The mechanism of action of cisplatin at the molecular level, involving interaction of the labile Pt(II) ion with DNA, is included in undergraduate inorganic chemistry curricula in the United States, and introductory college level inorganic textbooks describe the coordination chemistry of Pt(II) with nitrogen containing bases of nucleic acids, and use cisplatin to illustrate the hard-soft relationship between metal ions and ligand donor atoms. Since Rosenberg's initial discovery of cisplatin in 1969 [2], many more examples of metal-containing drugs have been reported in the literature. Gold containing complexes such as auranofin are commonly used to treat rheumatoid arthritis [3], radiopharmaceuticals based on metals such as technetium and rhenium are used in imaging and radiotherapy[4], and ruthenium complexes have had some success as anticancer drugs [5]. Complexes containing gadolinium, cobalt, lithium, bismuth,

iron, calcium, lanthanum, gallium, tin, arsenic, rhodium, copper, zinc, aluminum and lutetium have all been used in medicine. More recently, cobalt(III) based ligand complexes have been found to possess both antiviral and antibacterial activities.

### Experimental Method

#### Synthesis of Hexamine cobalt (III) Chloride:

Add 4.8g of  $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$  and 3.2 g of  $\text{NH}_4\text{Cl}$  to 20 mL of water in a 125 ml flask. Gently agitate the flask until most of the salts are dissolved. Then add 0.5g of fresh activated decolorizing charcoal and 10 ml concentrated ammonia. Next, connect the flask to the vacuum line and draw air through the mixture until the red solution becomes brown. If the bubbling is too vigorous, ammonia will be lost from the solution and the solution will stay red instead of becoming brown. In this case, add more ammonia to finish the experiment, though your yield will likely be low. The air inlet tube should be fairly large bore (~10mm) to prevent clogging by the precipitated  $\text{Co}(\text{NH}_3)_6^{3+}$  salt.

Filter the crystals and charcoal on a Buchner funnel using double filter paper, scraping down the sides so you transfer the entire slurry. Then pour a solution of 3ml conc. HCl in 40 ml of water over the charcoal. Heat the filtrate on a hot plate to affect complete solution and filter hot. Crystallize the hexamminecobalt (III) chloride by cooling to  $0^\circ\text{C}$  while adding dropwise 8 ml conc. HCl. Filter the crystals, rinsing with 60% ethanol and then 95% ethanol, then dry at  $80\text{-}100^\circ\text{C}$ . Place the product on a watch glass, cover with a second watch glass labeled with your lab section and name and warm until next lab period in an  $80^\circ\text{C}$  oven.

$[\text{Co}(\text{NH}_3)_6]^{3+}$  is a component of some structural biology methods to help solve their structures by X-ray crystallography or by nuclear magnetic resonance. In the biological system, the counterions would more probably be  $\text{Mg}^{2+}$ , but the heavy atoms of cobalt provide anomalous scattering to solve the phase problem and produce an electron-density map of the structure.

#### Synthesis of Sodium Hexanitrocobaltate (III)

Dissolve the sodium nitrite in 3ml of water in the test tube. Cool the solution to  $50^\circ$  and add the cobalt (II) nitrate, shaking to dissolve the solid. Clamp the test tube onto a ring stand and connect its side-arm to an aspirator using thick-walled rubber tubing. Turn on the aspirator slowly, until air starts to bubble gently through the solution. Then add 1ml of 50% acetic acid, drop by drop. After the addition of acetic acid is complete, increase the water flow for the aspirator and draw air through the solution for about 30 minutes to remove  $\text{NO}_2$  as the excess nitrous acid decomposes.

Now transfer the contents of the test tube to a small beaker, washing the tube with not more than 0.5 ml of water. Cool the solution in ice and while stirring, slowly add 6ml of 95% ethanol dropwise using a pipette. As soon as crystals begin to form, slow the addition and add the rest of the ethanol over a period of at least 5 minutes. Leave the mixture to stir for about 10 minutes and collect your product in a pre-weighed sintered glass crucible.

Wash the product with a small volume of 95% ethanol and air dry the solid in your locker. Determine the mass of product collected and calculate a percent yield. Transfer your dry product to a sample vial. This compound is used as a qualitative test for potassium and ammonium ion. Potassium and ammonium ions are insoluble in water, while sodium is. Hence potassium and ammonium salts are precipitated as a yellow solid.

#### Synthesis of Hexa-amine cobalt (III) hexanitro cobalt (III):

Dissolve 1.0 gm of hexamine cobalt (III) chloride in minimum amount of hot water. To this stirred hot solution add drop wise a solution hexanitrocobaltate (III). Cool the resulting solution in ice bath. Collect the precipitated solid on Buchner Funnel and dry it in vacuum desiccator. Weight the dry solid compound and record the yield.

All above synthesised complexes were screened for their antimicrobial activity by paper disc method

#### Conclusion:

Hexamine cobalt (III) Chloride, Sodium hexanitrocobaltate (III) and hexa-amine cobalt (III) hexanitro cobalt (III) complexes have been synthesized and characterized by using UV visible spectroscopy, XRD. All complexes show excellent antimicrobial activity.

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