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Bio and Chemical Reagents (Methods of Preparation and Uses): Review

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Abstract

Among the organic compounds that are commonly used as chemical reagents in the field of pollution, removals of heavy metals from rivers, coordination chemistry and in various fields of life such as industry, medicine and pharmaceutical research are organic reagents such as oxime and imine azo reagents, Fehling and Tollen reagents and their derivatives. This type of reagent is characterized by high stability and rapid reaction with metal ions, as these ions bond with the organic reagent through donor atoms (S, O, N) to form colored complexes with high sensitivity and selectivity. The reason for the stability of this type of reagent is attributed to the double bond between the two nitrogen atoms of the azo bridge group, and it is also affected by the types of groups attached to the ends of the azo bridge group, whether aliphatic or aromatic., The use of chemical reagents ensures the accuracy and reliability of results, which is essential for scientific research and development. In general, chemical reagents are indispensable tools in laboratory analysis, enabling scientists to conduct experiments. Due to these features, azo compounds have received the attention of a large number of researchers in various fields of science.

Keywords: Reagent, detection, lab identification, synthesis, organic

INTRODUCTION

These organic chemical reagents have high efficiency compared to inorganic reagents as they have the ability to react with many metal ions, including transition elements and some representative elements to form complexes with stable cyclic rings [1]. They are also characterized by having high molecular weights. In addition, these reagents have been used to form colored complexes after reacting with metal ions and have been used in quantitative and qualitative estimation, including in spectroscopic studies to estimate small amounts of metal ions in different models of alloys, soil, water, and other models related to biochemistry such as industry, medicine and pharmaceutical research are organic reagents such as oxime and imine azo reagents, Fehling and Tollen reagents and their derivatives [2]. This type of reagent is characterized by high stability and rapid reaction with metal ions, as these ions bond with the organic reagent through donor atoms to form colored complexes with high sensitivity and selectivity. The reason for the stability of this type of reagent is attributed to the double bond between the two nitrogen atoms of the azo bridge group, and it is also affected by the types of groups attached to the ends of the azo bridge group, whether aliphatic or aromatic [3], The

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importance of chemical evidence analysis in laboratory science lies in identifying and confirming the presence of specific substances, materials, or components in a sample [4]. This process helps in understanding the composition and properties of a sample and can be used to solve crimes, identify unknown substances, determine the quality and safety of products, and ensure compliance with regulatory standards. Chemical evidence analysis allows scientists to gather accurate information, which can be used to make informed decisions and take appropriate action. It is an essential tool in a variety of fields, including forensic science, environmental science, and pharmaceutical research [5,6].

The Role of Chemical Reagents in Organic Reactions

Chemical reagents play a crucial role in laboratory analysis because they enable scientists to perform accurate, precise, and reliable tests. These reagents are specific compounds with unique chemical properties and are used to detect, identify, and quantify different substances in samples. They aid in the process of chemical reactions and can be used to create new compounds or modify existing ones. The use of chemical reagents ensures the accuracy and reliability of results, which is essential for scientific research and development. In general, chemical reagents are indispensable tools in laboratory analysis, enabling scientists to conduct experiments, test hypotheses, and develop knowledge in various fields of study [7], The chemicals used in chemical analysis vary according to the category of the analyzed and the type of result required, but in general the chemicals used in chemical analysis include the following:

1. Acidic and basic indicators, such as phenolphthalein, methyl orange, and phenol red.
2. Oxidizers and reductants, such as hydrochloric acid, nitric acid, and silver chlorate.
3. Various adhesives and solvents, such as alcohol, ether, benzene, ketones, acetone, and methanol.
4. Solutions designated for the determination of specific elements, such as barium chloride, copper sulfate, and iron metals.
5. Metal indicators, such as ethylene thiocarbamate and nitryl triacetate.

Preparation Methods of Some Chemical Reagents

Reagents are solutions of colored organic materials added to the reaction to determine the end point of the reaction as well as its starting point by changing the color of the solution. The added reagents do not enter into the reaction, but their color changes with the change in the medium., As we mentioned earlier, organic chemical reagents can be used to test the occurrence of a chemical reaction between the materials added to the reaction, and there are several types of them arranged in a table called the table of chemical reagents, we will mention some of them[8]:

Azo Reagents (Ar-N=N-)

Azo reagents have received the attention of many workers in the field of chemistry, as their effective role in many fields, including industrial and agricultural, has become clear, in addition to their biological effect, not to mention their use in the field of inorganic chemistry as ligands to prepare metal complexes for transition and representative ions. The predominant color characteristic of solutions of these ligands and their complexes has been exploited in most cases for the detection and spectral estimation of small quantities of ions, as well as in extraction and as ligands in the formation of complexes and as materials for removing pollution [9, 10]. They are used as blocking agents in environmental models in polluted river water and heavy water. The structural formulas of azo reagents show that they contain acidic groups, which lose their protons when they coordinate with metal ions, causing a reduction in the positive charge on the metal ion when they coordinate. The following two structural formulas show the process of binding of a homocyclic azo ligand to any ion. There is no harm in clarifying the importance of choosing the type of substituent groups in the coordination of azo ligands and the stability of their compounds [11, 12]. The number of these groups, their type and location in the ligand, and their ability to bind to the metal ion, especially in the ortho position of the ring or rings linked on both sides of the bridging azo group, to involve them in the coordination process with the metal ion and their effect on the type of rings formed, whether pentagonal or hexagonal, as the stability of the resulting complexes increases with the increase in the number of metal rings formed, in addition to the size of these groups and their basicity. There are other factors related to the metal ion, such as (charge, radius, and electronegativity). The presence of the hydroxyl group in the ortho position of the ring linked to the azo group has a great effect as it participates in coordination with the metal ions to form a five-membered ring [13-16]. It is considered one of the electron-donating groups because it contains two pairs of non-contiguous electrons that can be linked to the metal ions through covalent or coordination bonds, Figure 1.

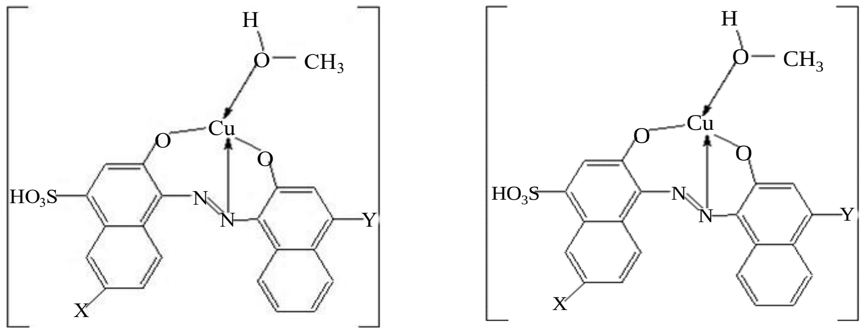

Figure 1. (a, b) Azo Reagents.

The presence of the hydroxyl group in the para position relative to the azo group in some organic ligands leads to the formation of complexes [17] with less stability than when it is in the ortho position, Figure 2.

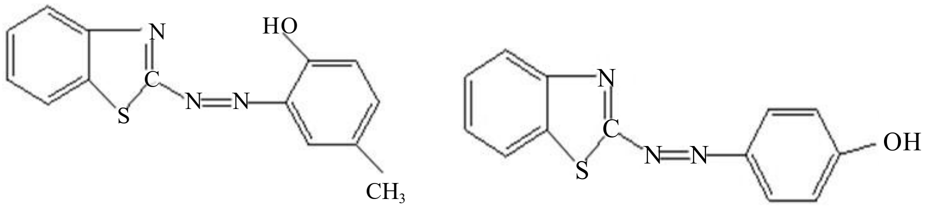

Figure 2. Azo Reagents via ortho more stable than para-position

Preparation of Azo Reagents (Ar-N=N-)

It has been shown by browsing the literature that there are many common preparation methods, including, for example, the traditional preparation method of diazonium salt, which is one of the important materials for preparing a large number of pure organic compounds and materials [18-20]. As a result of diazonium salts having electrophilic properties, they have the ability to couple with many compounds with high electron density and therefore have analytical benefit for estimating these compounds. Diazonium salts also play an effective role in dye chemistry, as they are linked with phenols, naphthol and naphthylamine, giving many types of colors. Diazonium salts are formed by treating the primary aromatic amine with the nitrite ion in an acidic environment (usually using a mineral acid) at a temperature of 0-5°C. This reaction is called nitrogenating Process and can be represented by the equation in Figure 3:

$$ArNH_2 + NaNO_2 + 2HX \xrightarrow[(0\text{-}5)^{o}C]{Cold} Ar\overset{+}{-}N{\equiv}\bar{N}X + NaX + 2H_2O$$

Diazonium salt

$X = Cl^-, Br^-, NO^-_3, HSO^-_4$

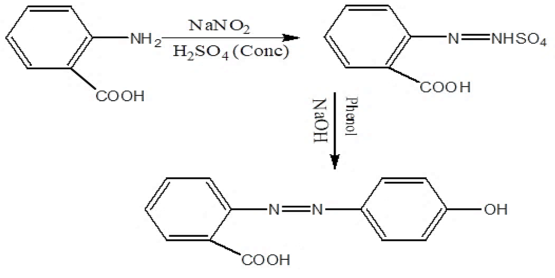

Figure 3. Preparation Method of Azo Reagent

Imine (Anil) Reagents (Ar-CH=N-)

Imine-azomethane reagents have many advantages, the most important of which is their relatively high stability. This stability is related to the raw materials needed to prepare these bases (carbonyl and amine compounds) in terms of aromatic properties. Compounds containing aryl substituents are characterized by their high stability compared to Schiff bases derived from aliphatic compounds [21-24]. They are often solid and have relative thermal stability, while Schiff bases derived from aliphatic compounds are characterized by being less stable, Figure 4.

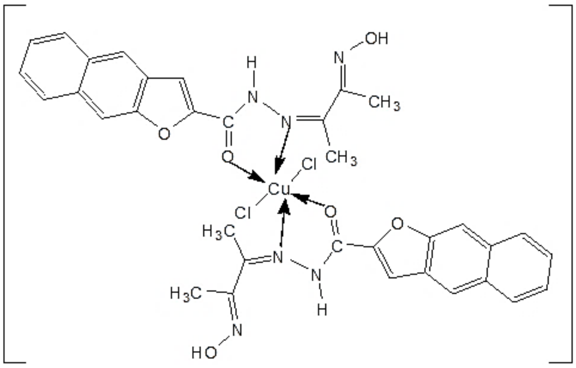

Figure 4. Imine Reagents.

Phenolphthalein Reagent

For example, phenolphthalein: red in a basic medium, colorless in an acidic medium. Phenolphthalein Reagent

Grignard Reagent

Many organic derivatives of magnesium are represented by the general formula (RMgX) where R represents hydrocarbons such as CH_3, C_2H_5, and C_6H_5, while X represents halogen atoms that represent the seventh group in the periodic table such as chlorine, bromine, and iodine, named after its French discoverer Victor Grignard, and these reagents are prepared by the reaction of halogen with magnesium in an atmosphere of nitrogen, since the reagent reacts strongly with oxygen and moisture, halogen compounds differ greatly in their reaction with magnesium, for example, alkyl halides react quickly while aryl chloride reacts very slowly [24-26].

Tollens' Reagent

It is a chemical reagent used to determine the presence of aldehydes and aromatic aldehydes. This reagent consists of a solution of ammonia and silver nitrate, named after its discoverer Bernhard Tollens. A positive test for this reagent in the table of chemical reagents indicates the presence of silver, as a distinctive silver mirror is formed on the inner surface of the reaction. This reagent has no chemical formula.

Fenton’s Reagent

It is a reaction of hydrogen peroxide and iron catalyst, used to reduce levels of organic pollutants through chemical oxidation to produce hydroxyls. This reagent allows the safe removal of chlorinated organics and similar organic pollutants [28].

Collin’s Reagent

A mixture of chromium oxide with pyridine in dichloromethane, its chemical formula is $C_{10}H_{10}CrN_2O_3$, used to selectively oxidize primary alcohols to aldehydes [29].

Fehling’s Reagent

This reagent listed in the table of chemical reagents consists of a mixture of copper sulphate, which is blue in color, and potassium sodium tartrate. This reagent is used by a chemical to distinguish between water-soluble carbohydrates and ketones and is used to reduce reducing and non-reducing sugars. The disadvantage of this reagent is that it cannot distinguish between benzaldehyde and acetone [30].

Preparation of Parfoid Reagent

Dissolve 33 g of copper acetate in 500 ml of 1% acetic acid

Preparation of Benedict's reagent

1. Dissolve 10 g of sodium citrate with 8 g sodium carbonate in 50 ml of hot distilled water
2. Dissolve 1 g of copper sulfate in 10 ml of distilled water
3. Add B to A gradually while stirring and if the solution is not clear, filter it

Preparation of Resorcinol Reagent

Dissolve 8 g of it in 400 g of diluted sulfuric acid 10%

Preparation of Salvanoff Reagent

Add 100 ml of diluted hydrochloric acid 10% to 900 ml of distilled water, then add 0.5 g of Resorcinol

Preparing of Silver Nitrate Reagent

Dissolve 107 g of silver nitrate in a liter of distilled water

Preparation of Ammonium Molybdate Reagent

1. Insert 40 ml of ammonium hydroxide to 60 ml of distilled water
2. Add 45 g of ammonium molybdate
3. Insert 250 ml of concentrated nitric acid
4. Add 500 ml of water while continuing to stir
5. Fulfilled the solution to a liter with distilled water
6. Leave for a day and then use the clear solution

Chemical Reagents

After we mentioned some types of chemical reagents and what distinguishes them and their most important characteristics, we must know what is the difference between catalysts and reagents: Catalysts differ from the table of chemical reagents as catalysts work to change the reaction rate, meaning that it increases or decreases, but they are not consumed and reappear after the end of the reaction, unlike the reagent that is consumed during the reaction, although the catalyst accelerates the reaction [31-33], it is not consumed during the reaction, while the reagent is added for the purpose of testing the occurrence of the reaction, and accordingly it is consumed during the reaction and does not reappear after the end of the reaction in its original form as it was added, while the catalyst works to cause a change in the reaction rate and is not consumed, so it reappears after the end of the reaction [34-36].

Preparation of Alcoholic Iodine Solution Reagent

1. Dissolve 6 g of iodine in 500 ml ethyl alcohol and a concentration of 95%
2. Disperse 30 g of mercuric chloride in 500 ml ethyl alcohol with a concentration of 95%
3. Insert 1 to 2 and mix well and place in a tightly closed container

Preparation of the Iodine Solution

Dissolve 20 g of potassium iodide in 30 ml of distilled water, then add (7 and 12) of pure iodine and complete with distilled water to a liter while stirring [37].

Preparation of Lime Water

Saturate the water with calcium hydroxide, then filter and store in tightly capped bottles

Preparation of Bromine Water

Put 11 ml of bromine with a liter of distilled water

Preparation of Fehling’s Reagent

Fehling's solution A: Dissolve 34 g of sulfate copper in 500 ml distilled water

Fehling's solution B: Dissolve 173 g of Rochelle salt "sodium potassium tartrate" with 52 g of sodium hydroxide in 500 ml distilled water [38].

Note: In the absence of Rochelle salt, the tartrate solution is replaced by the following: 121 g of sodium hydroxide and 39.1 g of tartaric acid dissolved in 400 ml distilled water, then complete the solution to 500 ml

Preparation of The starch Reagent

Mix 2 g of starch with a little cold water and stir until we get a soft dough, add 150 ml of boiling water and continue boiling for 5-10 minutes, leave the solution to cool, then separate the clear solution

Preparation of the phenolphthalein Reagent and Indicator (ph.ph)

Add 2 g of phenolphthalein to 600 ml of ethyl alcohol and complete with distilled water to a liter

Preparation of the methyl orange indicator

Dissolve 1 g of methyl orange in a little ethyl alcohol, then complete to a liter with alcohol diluted with distilled water (1:1 ratio)

Preparation of the methyl red Indicator

Dissolve 1 g of methyl red in a liter of hot water or dissolve 1 g of it in 600 ethyl alcohol and complete to a liter with distilled water [39-41].

Preparation of the borax Indicator

Add 5 g of sodium tetraborate "borax" to a liter of distilled water [42].

Preparation of the Nessler solution Indicator

1. Dissolve 50 g of potassium iodide in 50 ml of distilled water
2. Gradually add a saturated solution of chloride Mercury (60 g/L distilled water) and continue stirring until a clear precipitate is formed.
3. Add only 400 ml of calcium hydroxide solution.
   The preparation is prepared by adding (248 g) of calcium hydroxide to 500 ml of distilled water.
4. The solution is completed to a liter with distilled water and placed in a dark-colored bottle and left for a day before use [43,44].

Preparation of Ferric Chloride Reagent

Dissolve 135 g of it in a liter of distilled water containing 30 ml of hydrochloric acid [45-47].

CONCLUSIONS

Chemical reagents are important tools in laboratory analysis because they allow for precise and accurate measurements of chemical and physical properties. They are used to distinguish, identify, and measure different substances in a sample. Reagents can be used to carry out specific chemical reactions, allowing scientists to study and understand the properties and behavior of different compounds. The use of chemical reagents is crucial to ensuring accurate and reliable results in laboratory analysis, which can be used to guide scientific research and develop new technologies.

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