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Synthesis and Characterization of Two Azo Complexes

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Abstract

Azo dyes are organic compounds. In this study two complexes were prepared. The infrared spectrum of the compound under study showed a set of distinct bands that confirm its chemical structure. An absorption band was recorded at 3085 cm^{-1}, attributed to aromatic C–H bond stretching vibrations, proving the presence of aromatic rings in the structure. A clear band also appeared at 1542 cm^{-1}, attributed to aromatic C=C stretching vibrations. A clear band appeared at 1542 cm^{-1} attributed to aromatic C=C stretching vibrations, strengthening the evidence for the aromatic character of the compound. Also, a band was observed at 1434 cm^{-1} attributed to the N=N bond stretching vibration, a confirmatory sign of the presence of the azo group characteristic of azo dyes. In addition, the spectrum showed a band at 1380 cm^{-1} attributed to the N–C bond stretching vibration, indicating the attachment of nitrogen to the aromatic rings. These results are consistent with the spectroscopic references for azo dyes, which typically show bands in approximately the same frequency ranges, supporting the hypothesized structure of the compound and confirming it as a suitable azo aromatic compound for dye applications.

Keywords: Organic chemistry; 4-hydroxyazobenzene; Hydroxyphenyl-azo-benzoic; Chemical complexes

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1. Introduction

Azo dyes are organic compounds that contain the chromophore group (-N=N-) [1]. The colors of azo dyes vary depending on their composition and the nature of the substituent groups. An increase in chromophore groups (which carry the color) or an increase in the molecular weight increases the intensity of the color. The groups exposed to the benzene ring carrying the chromophore group affect the intensity of the color. These solutions are called exochromic groups, meaning color enhancers. They are electron-repelling groups and are arranged according to the strength of their effect. Azo compounds were used as dyes for textiles and carpets [2]. Studies have shown that azo dyes prepared from nitrogen derivatives of thiophene amino2- and their combination with various types of Arylmaleimides-N, shown in the formula below, are suitable for polyester fabrics, as they have a carnation-red color and are characterized by their resistance to heat and washing [3]. The presence of the azo bridge group (-N=N-) is of great importance in imparting color (82) to these compounds. This property has been widely exploited in spectroscopic studies to produce complexes that are often chelate and colored. Therefore, we find that azo compounds have become widespread and have found wide-ranging applications and uses in industrial, biological, and medical fields [4].

2. Methods

2.1 Preparation of 4-hydroxyazobenzene ($C_6H_5–N=N–C_6H_4–OH$)

This compound is prepared according to the general method by dissolving 1.35 g of amino 6-O purine in 4 µl of distilled water and 4 ml of HCl. The mixture is cooled to 0-5 °C. Then, 0.69 g of sodium nitrite solution is added to it gradually, while stirring for 20 minutes at 0-5 °C. We added the diazonium salt formed above to a mixture of 0.68 g (naphthol-1) dissolved in 50 ml of ethanol and 2 ml of a 5% NaOH solution. We left the mixture for an hour with continuous stirring. During this time, we observed the formation of an orange precipitate. We left the precipitate to dry until the next day, filtered it, and washed it with distilled water. We left it to dry and then measured its R.I.

2.2 Preparation of hydroxyphenyl-azo-benzoic acid ($COOH-C_6H_5–N=N–C_{12}H_{10}OH$)

This compound was prepared by dissolving 1.4 g of amino 6-benzoic acid in 40 ml of distilled water and 4 ml of HCl. The mixture was then left to cool. Then 30 ml of sodium nitrite (0.69 g) solution was added gradually, stirring continuously for 20 minutes at 0-5 °C.

We added the diazonium salt formed above to a mixture of 69 g of napthol in 50 ml with ethanol and 20 ml of a 5% NaOH solution. We left the mixture for an hour with continuous stirring. During this time, a red precipitate was observed to form. We left it until the next day, then filtered it, washed it with distilled water, let it dry, and measured its R.I.

3. Results and Discussion

3.1 Composite diagnosis 4-hydroxyazobenzene by IR-F spectrum

The compound 4-hydroxyazobenzene was identified spectroscopically using IR-FT and gave the following bands: The compound spectrum showed an absorption band at a frequency of 3085 cm. A band at 3085 cm^{-1} This band corresponds to the aromatic C–H stretching vibration. Its presence clearly indicates an aromatic benzene ring in the compound's structure. A band at 1542 cm^{-1} as shown in Fig. (1).

This band corresponds to the stretching vibrations of the C=C groups in the aromatic ring (aromatic C=C stretching). Its appearance supports the presence of a multi-bonded aromatic core in the compound. The band at 1434 cm^{-1} is interpreted as an azodiazine bond stretching vibration (N=N stretching). This is a good confirmation of the presence of an N=N azo group, the characteristic feature of azo chains (azo Dys).The band at 1380 cm^{-1} is attributed to an N–C bond stretching (especially the N–aryl or nickel-aromatic ring). This period occurs when nitric oxide is attached to an aromatic ring or is prohibited for membership. The infrared spectrum of the compound shows the presence of distinct aromatic rings (bands at 3085 and 1542 cm^{-1}) and the presence of an azo group (N=N) confirmed by a band at 1434 cm^{-1}, in addition to N–C vibrations at 1380 cm^{-1} that support nitrogen bonding to the aromatic rings. These results are consistent with the structure of an azo-aromatic compound containing N–N bonds and nitrogen bonds to the aromatic rings. To check for the presence of –COOH and –OH groups it is recommended to check for the presence of the C=O band at ~1700 cm^{-1} and the O–H bond between 2500–3600 cm^{-1}. These results are consistent with other studies. In the study, IR bands were recorded for azo dyes, including a band for –N=N- in the range of approximately 1411-1458 cm^{-1}, bands for C–N in the range of 1350-1049 cm^{-1}, as well as bands related to aromatic ions (C–H, C=C) in similar ranges [5]. The results were also similar to those of a study involving IR-FT spectroscopy of new azo dyes, which showed bands confirming the presence of azos and bands confirming aromatic structures. Although they may not give the exact same numbers, the presence of aromatic C–H and C=C azos appears in similar bands [6]. Another study showed that in aromatic azo, N=N bands appear within similar ranges, as well as the presence of aromatic bands (C–H, C=C)[7].

3.2 Identification of hydroxyphenyl-azo-benzoic acid by IR-FT spectrum

The prepared compound 2 was characterized spectroscopically by IR-FT spectrum and gave the bands shown. The IR spectrum of the compound exhibited an absorption band at 2850 cm^{-1}, which can be attributed to the stretching vibrations of the C–H groups. An additional absorption band was observed at 1689 cm^{-1}, corresponding to the stretching vibrations of the C=C groups within the aromatic system. A characteristic band appeared at 1411 cm^{-1}, which is assigned to the stretching vibration of the azo linkage (–N=N–) as shown in Fig. (2).

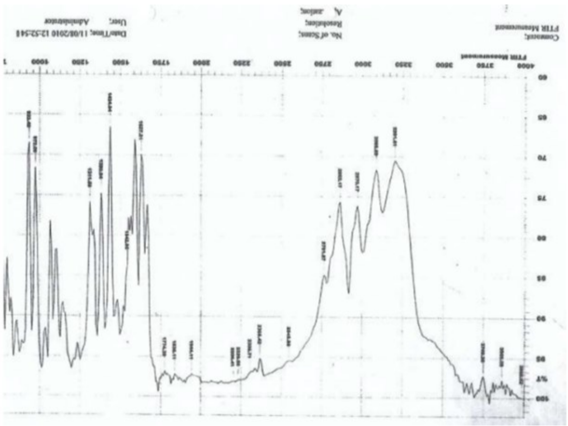

Fig. (1) 4-hydroxyazobenzene identified by IR spectrum

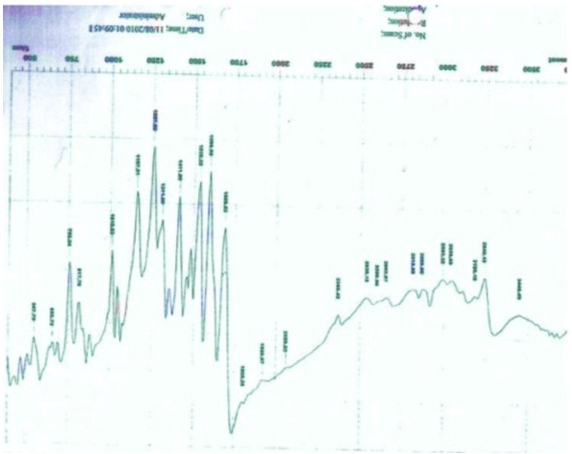

Fig. (2) hydroxyphenyl-azo-benzoic acid identified by IR spectrum

These results are consistent with the typical ranges reported in the literature: aromatic C–H stretching usually appears at ~3000–3100 cm^{-1}, aromatic C=C vibrations in the region of ~1600–1500 cm^{-1}, N=N absorptions are predominantly observed at ~1450–1400 cm^{-1}, and N–C stretching vibrations occur around ~1350–1250 cm^{-1}. The recorded values therefore fall within the expected spectral ranges, supporting the proposed structure of the compound. Furthermore, a previous study on azo dyes reported an N=N absorption band near 1460 cm^{-1}, which is in close agreement with the observed band at 1411 cm^{-1}, further confirming the presence of the azo functional group. These values support your numbers as being within the normal range. A previous study shows an N=N absorption band around ~1460 cm^{-1} for azo dyes, which is very close to the band you mentioned (1434 cm^{-1}) [8].

4. Conclusion

In concluding remarks, Azo dyes are synthetic organic compounds used to create colors in textiles, leather, inks, and other products. They are characterized by the presence of one or more azo groups (R−N=N−R′) in their chemical structure, which provides the vibrant color. The colors of azo dyes vary depending on their composition and the nature of the substituent groups. The spectrum showed a band at 1380 cm^{-1} attributed to the N–C bond stretching vibration, indicating the attachment of nitrogen to the aromatic rings. These results are consistent with the spectroscopic references for azo dyes, which typically show bands in approximately the same frequency ranges, supporting the hypothesized structure of the compound and confirming it as a suitable azo aromatic compound for dye applications.

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