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Synthesis and dye adsorption property of a vanadium (IV) complex of salicylaldimine and aromatic heterocycle

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ABSTRUCT

An oxidovanadium complex $[V^{IV}O(sal\text{-}Gly)(phen)]$ *(sal=salicylaldehyde, Gly=glycene, phen = 1,10-phenanthroline) was synthesized through reaction between glycene and salicylaldehyde followed by addition of* $VOSO_4$ *and 1,10-phenanthroline. The dye adsorption property of this structurally characterized oxidovanadium complex was studied to ascertain the efficacy in removal of toxic dye molecules from aqueous medium.*

***Keywords**: Brilliant blue, dye adsorption, oxidovanadium, methyylene blue.*

1. INTRODUCTION

Vanadium occurs as an “essential trace” element in diverse living organisms and has wide spread involvement in enzymatic and physiological activities [1]. The coordination chemistry of vanadium complexes are of immense interest due to their significance in various biochemical, pharmacological and catalytic activities [2-3]. Vanadium possesses the ability to assume various oxidation states ranges from -1, 0, +1, +2, +3, +4, +5 [4]. Under physiological conditions, *in vivo*, vanadium complexes are usually stable in their +4 and +5 oxidation states. The continuous upsurge of interest in vanadium is due to the important therapeutic role of vanadium as anticancer, antimicrobial and antidiabetic agents and their catalytic activity [5]. The pharmacological potential of vanadium complexes has been shown in the treatment of type I and type II diabetes and also as anti-tumor agents [6]. Schiff base compounds are ones of the most widely used ligands and played a central role in the development of coordination chemistry of transition metals [7]. In the area of bioinorganic chemistry, interest in Schiff base complexes with transition and inner-transition metals has focused on the role of such complexes in providing useful synthetic models for the metal-containing sites in metallo-proteins and enzymes [8]. Vanadium Schiff base complexes have been considered as new versatile catalytic reagents for a wide range of oxidation reactions like oxidation of olefins, alcohols, benzene/alkylaromatic compounds, and sulfides.

There is significant increase in global water pollution due to rapid industrialization, results in increase of toxic materials in industrial waste effluents. Organic dyes are one of the major pollutants discharged from paint, rubber, paper, leather industries. Organic dyes are difficult to degrade due to their xenobiotic properties and complex structure.The removal of these contaminants from industrial waste is highly demanded as their presence in very small or even trace amount is highly harmful [9, 10]. Herein, the dye adsorption properties of the complex were studied to ascertain the efficacy in removal of toxic dye molecules from aqueous medium.

2. EXPERIMENTAL

2.1. Materials and methods

$VOSO_4$ and 1,10-phenanthroline were purchased from Sigma Aldrich. Other materials were obtained from commercial sources and used as received. Solvents were purified by distillation prior to use. Electronic spectra were recorded on a Shimadzu 1800 spectrophotometer.

2.2. Preparation of the complex

Oxidovanadium complex [VO(sal-Gly)(phen)] was synthesized according to a previously reported procedure [11, 12] in water/alcohol mixtures. The amino acid glycene dissolved in water was mixed with an equimolar amount of salicylaldehdye in ethanol. The resulting solution was refluxed for 1h, followed by addition of equimolar aqueous solution of $VOSO_4$. To this mixture the equimolar heterocyclic base 1,10-phenanthroline in methanol was added. The resulting complex obtained had been previously reported [11] (Fig.1).

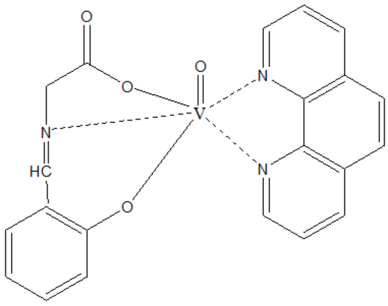

Fig.1. Structural formula of [VO(sal-Gly)(phen)]

2.3. Dye adsorption studies

The cationic and anionic dyes viz., methylene blue (MB) and brilliant blue (BB) were used for dye adsorption study at room temperature (25°C). The complex (0.01g) was dispersed in 10mL (0.02 mg/L) aqueous solution of methylene blue (MB), and the resulting solution was magnetically stirred. At definite time intervals, a 0.5 mL of the aliquot was sampled; the suspended particles were separated by centrifugation and diluted to 2.5 mL. Electronic absorption spectra of the samples were recorded immediately.

In case of anionic dye adsorption study similar procedure was followed. The complex (0.015g) was dispersed in 10mL (0.02 mg/L) aqueous solution of brilliant blue (BB), and the resulting solution was magnetically stirred. At definite time intervals, a 0.5 mL of the aliquot was sampled; the suspended particles were separated by centrifugation and diluted to 2.5 mL. Electronic absorption spectra of the samples were recorded immediately.

3. RESULT AND DISCUSSION

Considering the polymeric structure of compound, studies on dye adsorption property of the complex was planned. Removal of dyes by adsorption techniques is considered as a reliable method because of economic feasibility, simplicity of design and high efficiency [12]. Metallo-organic framework compounds (MOFs) have gained considerable attention as attractive dye-removal adsorbents [13,14]. Methylene blue (MB), a popular cationic thiazone dye, and brilliant blue (BB) an anionic dye were selected for the present study, as these represent one of the most common organic dyes in textile industrial waste water. On interaction of an aqueous solution of methylene blue and brilliant blue with the compound, both the solution turned colorless. The decrease in intensity of the characteristic absorption peaks of methylene blue at 664 cm-1 (Fig. 2) and brilliant blue at 554 cm-1(Fig. 3) on interaction with the compound indicates removal of the dyes from aqueous solutions.

The adsorption activity of the compound was calculated using the following expression **(I)** [15]

$$D = (C_0-C_t)/C_0x100\% =(A_0-A_t)/A_0x100 \quad (1)$$

Where, D is the decoloration rate, and C_0, A_0 and C_t, A_t are the concentration and absorbance of the dye solution at 664 nm (absorption maxima, MB) and 554 nm (absorption maxima, BB) before and after adsorption, respectively. The dye adsorption amounts within time t (min), qt (mg/g), were calculated using equation (2) [16,17].

$$q_t = (C_0 - C_t)V/m \quad (2)$$

Where C_0 (mg/L) and C_t(mg/L) are the liquid-phase concentrations of the dye at the beginning and after equilibrium time t [min], V (L) is the volume of the solution and m (g) is the mass of the complex used. The decolouration rates for MB and BB were found to be 44.78% (ca. 4.887 mg/g) and 42.70% **(**ca. 1.085 mg/g) per hour respectively.

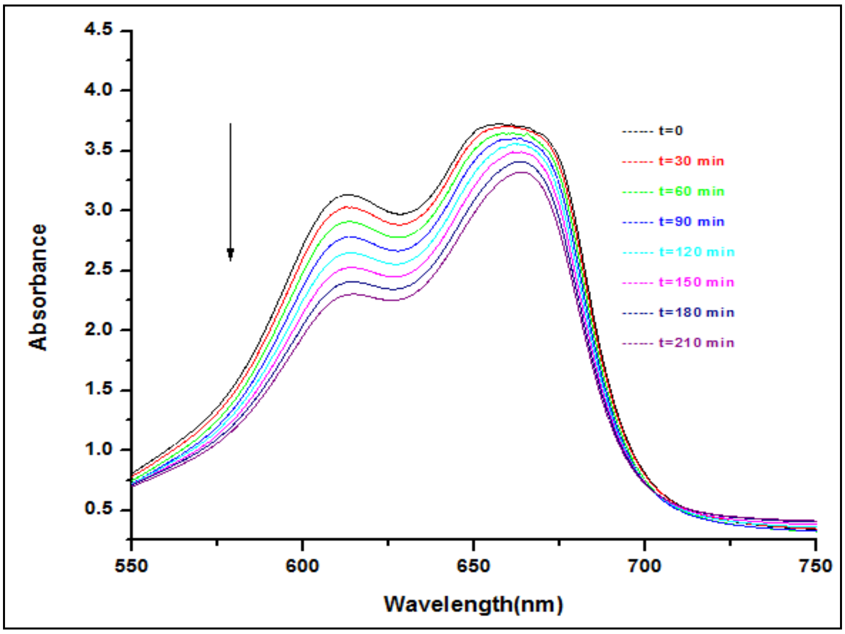

Fig.2. UV-visible spectra of the aqueous MB dye solution during adsorption study with the compound.

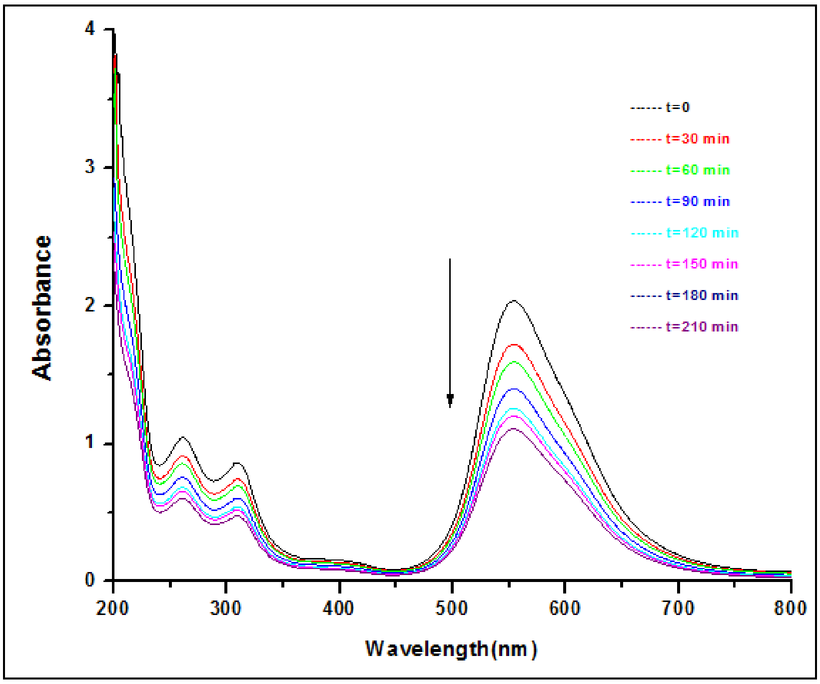

Fig.3. UV-visible spectra of the aqueous BB dye solution during adsorption study with the compound.

4. CONCLUSSIONS

The compound exhibits moderate dye adsorption properties towards the chosen cationic and anionic dyes namely Methylene blue (MB) and Brilliant blue (BB) from aqueous medium. The compound shows higher adsorption efficiency towards Methylene blue (MB) compared to that of Brilliant blue (BB).

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