Solvation Interaction Parameters Between CuCl₂ and Orange G (OG) at 19.1°C Using Carbon Glassy Electrode (CGE) in KCl Aqueous Solutions

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Abstract

The redox mechanisms were examined for copper chloride in absence and presence of Orange G (OG) at 19.1°C cyclic voltammetry using carbon glassy electrode (CGE). The supporting electrolyte used is 0.1 M KCl effect of scan rate was also studies for the redox reactions for CuCl₂ alone and in presence of the ligand used orange G (OG). Stability constants for the complex formed from the interaction of CuCl₂ with Orange G (OG) were evaluated with the different thermochemical data. Effect of different scan rates were examined for cupric chloride in absence and presence of the ligand used Orange G (OG).

Keywords: Solvation parameters, Cyclic voltammetry, Copper chloride, Orange G (OG), Glassy carbon electrode (CGE)

Introduction

Extraction of metal ions as pollutants from aqueous solutions by use of electrochemical methods is very interesting for environmental aim [1-6]. Several metal ions in solutions can be recorded and examined by the reduction of the different cathode materials [6, 7]. In this work estimation and electrochemical voltammetric analysis of copper ions in 0.1 M KCl was studied to explain the characteristics for evaluating it in the environmental samples. Long exposure to copper cause many problems, irritation in eyes, nose, mouth, causes headaches, dizziness, vomiting and diarrhea. High uptake copper many cause kidney and liver damage [7]. Copper is vital dietary, small amount of metal is needed for wellbeing [8]. Copper [9] is most third abundant metal in the body [8-10]. In this work estimation and electrochemical voltammetric analysis of copper ions in 0.1M KCl was studied for explaining the characteristics for evaluating it in the environmental sample.

Experimental

The chemical used CuCl₂, KCl used are of high purity from Sigma Aldrich Co. Orange G (OG) is of the type Ranken (Ranbaxy). The volume of the experimental solution is 30 ml. Three electrode cell was used connected to potential DY 2100.Ag /AgCl, KCl sat., reference electrode, carbon glassy electrode (CGE) was used as working electrode, platinum wire was also used as auxiliary electrode. N₂ flow was done to ensure oxygen removal. The carbon glassy electrode (CGE) is prepared in our laboratory from pure carbon piece, polished with aluminum oxide on wool piece. Area of electrodes 0.502 cm².
Results and discussion

Electrochemical behavior of CuCl₂ in absence of Orange G (OG)

Studying electrochemical behavior for CuCl₂ in 0.1M KCl supporting at 19.1°C was done in the range from +1V to -1V. In range -1 to +1V oxidation took place, but scanning in the range of +1 and -1V permits and allows the copper reduction processes and ligand reduction if found. The change of Cu (II) to the Cu (III) state (δlow / δspin) involves the reduction of metal ion radius [11]. Cyclic voltammogram between 1 and -1V (Volt) show redox processes explaining C(II)/Cu(I) and Cu(I)/Cu(0) processes appearing in Fig.1.

Fig. 1: Cyclic voltammograms of different concentration of CuCl₂ in 0.1MKBr solutions at 19.1°C

Scan rate was also studied for 6.62x10⁻⁴ M of CuCl₂, at 0.01, 0.02, 0.05 and 0.1 V/S, and 100,50,20 and 10 mV/second. All redox waves were appeared to increase on increasing scan rate as shown in Fig. 2.

Fig. 2: Effect of scan rates on the cyclic voltammograms of CuCl₂ in 0.1M KBr at 19.1°C.

Electrochemical behaviour of complex formed from the interaction of CuCl₂ with Orange G was oxadied cyclic voltammetrically in the range of 1 to -1V.

The potential reduction of Cu([II])/Cu([I]) processes is studied. The electro chemical activity in range studied showed pattern at all CuCl₂ concentrations that may considered as sum of individual processes.

\[ \text{Cu ([II]) OG} + e^- \rightarrow \text{Cu([I]) OG} \]  \hspace{1cm} (1)

Reaction of CuCl₂ with gradual addition of ligand Orange G (OG) were recorded until 1:3 (ML/Ligand) molar ratio was reached. Change in color and in electrochemical behavior was clear from the first addition. The changes increase when the ligand additions increase. Wave Cu ([II])/Cu([I]) complexes appear at higher concentrations of orange G (OG). Analysis of the voltammograms were done as explained in literatures [10-19] and the obtained data are given in Table (1) for the interaction of CuCl₂ with Orange (G).

Table 1:
Table 1: Effect of concentration for ligand Orange G (OG)) at 0.1 scan rate at 19.1°C.

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<th>L x 10⁻³</th>
<th>Δαx10⁻⁸</th>
<th>Epc/2</th>
<th>uαac</th>
<th>KαC x 10⁻³</th>
<th>Γαx10⁻⁴</th>
<th>(+) Qα x 10⁺</th>
<th>-) Qα x 10⁻</th>
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Conclusion

Thermochemical parameters for complex interaction between CuCl₂ with Orange G (OG) prove the stability of the complex formed. All data given in text prove the reversible diffusion process of the system under consideration.

References
