The 1:1 Copper(II)-alizarin Red S Chelate in Aqueous Solution

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With 2 Figures

Abstract

Formation of a 1:1 pink coloured chelate (λ_{max} 500 mμ) between copper(II) and Alizarin Red S using the mole ratio and slope ratio methods by absorbance studies have been reported. The value of stability constant as determined by the mole ratio method is 4.5×10^5 at 25°.

Introduction

MUKHERJI and DEY[1]) reported the formation of a 1:1 complex between copper(II) and Alizarin Red S (abbrv. ARS) by the absorbance measurements using only the method of continuous variations[2]). In order to confirm the results of the prior workers the study of the composition and stability of the copper-Alizarin Red S chelate was further continued using the spectrophotometric measurements by the mole ratio method and the slope ratio method and the present communication reports the results of this study.

Experimental

Instruments: A Unicam SP 500 spectrophotometer and a L & N direct reading pH indicator was used for absorbance and pH measurements.

Materials. Copper sulphate (B.D.H. Anala R) and Alizarin 3 sulphonate (B.D.H. indicator) was dissolved in distilled water for making stock solutions.

Conditions of experiments: All experiments were performed in an air conditioned room at 25°. The pH of all the solutions was maintained at 4.0 by adding HCl or NaOH. Total volume was kept 25 ml in each case.

Results and Discussion

Composition of the chelate: The nature of the complexes formed was ascertained by MUKHERJI and DEY[1]) using the method of VOSBURGH

[1]) A. K. MUKHERJI and A. K. DEY, J. Ind. chem. Soc. **34**, 461 (1957).

[2]) P. JOB, Compt. rend. **180**, 928 (1928); Ann. Chim. (X) **9**, 113 (1928).

and COOPER[3]) and it was found that only one chelate was formed under the conditions of study which has a λ_{max} at 500 mμ. Studies were made at 500 mμ for the determination of composition by the mole ratio[4]) and slope ratio[5]) methods. The results of the two methods show the ratio of copper to the reagent to be 1:1 (Fig. 1 and 2) which is in agreement with the results of the previous workers.

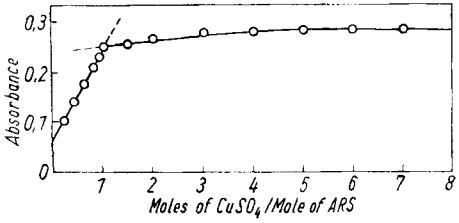

Fig. 1. Composition of the chelate by the mole ratio method at 500 mμ, pH 4.0. Final concentration of the Alizarin Red S 2.0×10^{-4} M

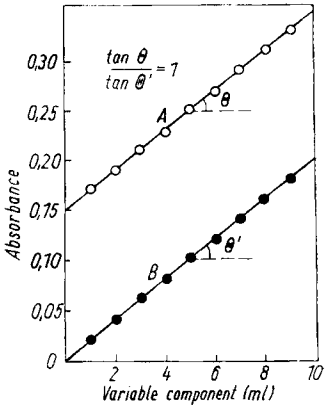

Fig. 2. Composition of the chelate by the slope ratio method at 500 mμ, pH 4.0. 10 ml (5.0×10^{-4}M) excess component + x ml (1.66×10^{-1} M) variable component + (15-x) ml H_2O. Curve A ARS excess, Curve B $CuSO_4$ excess

Determination of the stability constants: The stability constant has been determined by the mole ratio method through a calculation of the degree of dissociation of the chelate using the following expression:

$$Kd = (\alpha\, c)\,(n\,\alpha\ c)^n / c(1 - \alpha).$$

The values of stability constants as determined by the previous workers and the present work are given in Table 1. The free energy change of formation has also been calculated with the help of the expression

$$\Delta F^\circ = -RT \ln K,$$

the terms having their usual meaning.

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[3]) W. C. VOSBURGH and J. R. COOPER, J. Amer. chem. Soc. **63**, 437 (1941).
[4]) J. H. YOE and A. L. JONES, Ind. Engng. Chem. Analyt. Ed. **16**, 111 (1944).
[5]) A. F. HARVEY and D. L. MANNING, J. Amer. chem. Soc. **72**, 4488 (1950).

Table 1
Stability constants

Method employed	stability constant	$\Delta F°$ at 25° (K. Cals)
Dey et al	$3.5 \pm 0.4 \times 10^5$	— 7.63
Mole ratio	$4.5 \pm 0.2 \times 10^5$	— 7.92 (present work)

The values of stability constant in the present work and by the previous workers are in close agreement with each other.

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