Determination of the Stability Constant of the Bismuth-DCTA Complex

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1,2-Diaminocyclohexanetetra-acetic acid (DCTA) forms stable complexes with many metal ions. The complexes are in general more stable than the corresponding EDTA complexes.

In the present communication the composition and the stability constant of the complex formed between bismuth(III) and DCTA have been determined polarographically. No information on these data were found in the literature.

A displacement method, previously applied by Schwarzenbach *et al.* [1], was used. The method is based upon the displacement in the complex of one metal ion by another, according to the equilibrium:

$$MR + M' \rightleftharpoons M'R + M$$

$$K = \frac{K_{M'R}}{K_{MR}} = \frac{[M'R] \cdot [M]}{[MR] \cdot [M']}$$

where [] represent molar concentration, R the chelating agent and K the displacement equilibrium constant. K is equal to the ratio of the stability constants.

Pribil *et al.* [2] suggested a polarographic method by which it was possible to determine the concentrations of bismuth- and copper-DCTA complexes in the presence of each other. The stability constant of the copper-DCTA complex was determined by Schwarzenbach [1] to be $10^{21.36}$.

Experimental. Polarograms were recorded with an Atlas Tast-polarograph, Selector D. A conventional type of dropping mercury electrode was used. A saturated calomel electrode (S.C.E.) served as a reference electrode. Oxygen-free nitrogen was bubbled through the solution for 10 min in order to remove dissolved air.

Solutions containing varying amounts of bismuth, DCTA and copper, were prepared. A constant pH of 4.30 and an ionic strength of about 0.1 was maintained by the addition of acetic acid/sodium acetate buffer.

Polarographic measurements were carried out after different times of standing. The concentrations of copper and bismuth complexes were found from the polarograms. All experiments were performed at 20.0 ± 0.2°C.

Results. Amperometric titrations showed that the composition of the bismuth-DCTA complex was 1:1.

The stabilities of the copper- and bismuth-DCTA complexes are of the same order. Because of this, copper will displace some bismuth from the complex. The equilibrium was indicated by constant diffusion currents.

A mean value of the stability constant was found to be: $K_{Bi\text{-}DCTA} = 1.3 \times 10^{24}$.

1. Schwarzenbach, G., Gut, R. and Anderegg, G. *Helv. Chim. Acta* **37** (1954) 937.
2. Pribil, R., Roubal, Z. and Svatek, E. *Collection Czechoslov. Chem. Communs.* **18** (1953) 43.

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Table 1. Determination of the stability constant of the bismuth-DCTA complex.

Total molar concentrations × 10^4			Molar concentrations found × 10^4				log $K_{Bi\text{-}DCTA}$
DCTA	Bi	Cu	Bi-DCTA	Bi	Cu-DCTA	Cu	
3.6	3.00	3.52	2.86	0.14	0.19	3.33	23.9
2.3	2.00	5.28	1.77	0.23	0.09	5.19	23.9
4.8	4.00	7.04	3.67	0.33	0.27	6.77	23.7
4.7	3.00	7.04	2.76	0.24	0.07	6.97	24.4
4.2	4.00	7.04	3.72	0.28	0.06	6.98	24.5