Polarographic Study of the Interaction Between the Antimonyl Ion and Pyrazolone Derivatives

By JOSEPH L. ROOSEMONT

The antimonyl ion was examined by polarography with the dropping Hg electrode. The half-wave potential was found to be a function of the pH of the buffer systems. In the presence of antipyrine and aminopyrine complex formation was noticed. The differential behavior of Pb(II) and As(III) under identical working conditions was studied.

A SCOPE OF polarographic research is the investigation of the behavior of electro-active substances in the appropriate supporting electrolytes. The objective may be in this connection either to determine the formation of selective complexes between the additive and the ion or to deduce the nature of these compounds.

In this paper the polarographic behavior of the antimonyl ion, compared to Pb(II) and As(III) is studied with regard to possible complex formation. This preliminary study deals particularly with the influence of the pH on complex formation. It is evident that one buffer possessing buffering capacity over a rather large pH range is certainly more suitable than a series of buffers of different composition and a limited pH range. A "ternary" buffer mixture is therefore proposed covering the slightly acid, the neutral, and the alkaline ranges. For the acid side an ascorbate buffer is utilized. Ascorbic acid has been proposed by Šušić (1) as a supporting electrolyte. This buffer has been included in the author's research in order to study the polarographic behavior of the ions in the presence of the pyrazolone derivatives in the acid range.

EXPERIMENTAL

Test Solutions—Solutions of 0.01 *M* potassium antimonyltartrate, lead acetate, and arsenic trioxide were prepared in bidistilled water. The arsenic trioxide solution was prepared by dissolving the required quantity in a minimal volume of 2 *M* NaOH, adjusting the solution to pH 7, and making up to volume.

Supporting Electrolytes—The used ternary buffer is 0.5 *M* in succinic acid, glycocoll, and tris-(hydroxymethyl)aminomethane. By mixing with appropriate volumes of 0.5 *M* NaOH a buffering action was observed between pH 4.4 and 12. Mold growth was avoided by addition of 50 mg./L. thymol. The corresponding supporting electrolyte was prepared by mixing an equal volume of buffer and 1 *M* KNO_3.

The ascorbate buffer was obtained by neutralizing a solution of ascorbic acid (0.25 *M*) with NaOH (0.25 *M*). Only the buffer range between pH 3.6 and 4.8 was studied. The buffer functioned as the supporting electrolyte.

The electrolytes were inert in those areas where the ions concerned were polarographically active. Unless indicated, no maximum suppressor was added.

Complexing Agents—The pyrazolone derivatives (antipyrine and aminopyrine) used for this purpose were also inert in the interesting voltage ranges.

Instrumentation—A polarograph of the Metrohm E 261 R type with Ag/AgCl reference electrode and automatic registration was used. All determinations were made under identical working conditions and with the same capillary (rate of flow = 2.75_0 mg./sec. for a Hg pressure = 50 cm. $T = 25° \pm 0.1°$). The $E_{1/2}$ values refer to the saturated calomel electrode.

Procedure—A fixed volume (0.2 ml.) of a stock solution was diluted with the supporting electrolyte at the required pH to a total volume of 20 ml. Oxygen was removed from the solution by passing through pure nitrogen during 10 min. and the polarograms were registered. The complexes with the pyrazolone derivatives were examined by making the solutions 0.01 *M* with respect to these compounds. When using the ascorbate buffer appearance of disturbing maxima was avoided by adding 0.2 ml. gelatin solution (0.5 Gm.%).

RESULTS AND DISCUSSION

For the antimonyl ion the apparent $E_{1/2}$ values as a function of the pH are indicated in Fig. 1. From this figure it appears that the $E_{1/2}$ values become more negative as the medium becomes more alkaline. In the presence of antipyrine a complex formation was observed. The half-wave potentials were found to shift towards more negative values. In the

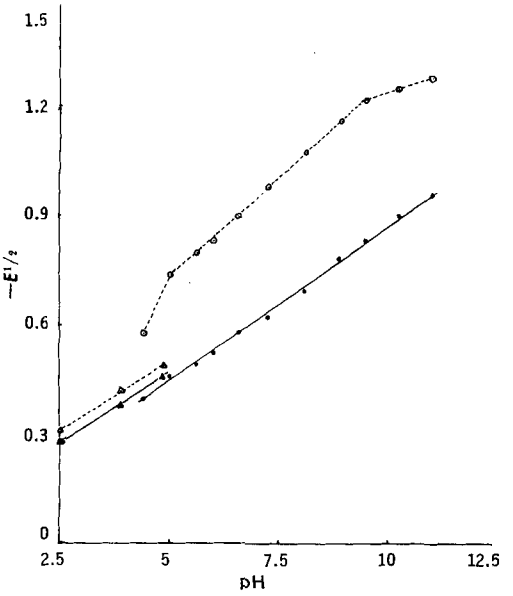

Fig. 1—Apparent half-wave potentials of the antimonyl ion as a function of the pH. Key: ●, in ternary buffer; ▲, in ascorbate buffer; ○, in ternary buffer with antipyrine; △, in ascorbate buffer with antipyrine.

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TABLE I—APPARENT $E_{1/2}$ VALUES OF Pb(II)

Buffer	pH	$-E_{1/2}$[a]
Ascorbate	2.5	0.39
	3.7	0.41
	4.2	0.42
	4.8	0.43
Ternary	4.5	0.47
	6.5	0.48
	8.0	0.49
	8.9	0.52
	11.0	0.58

[a] With reference to the saturated calomel electrode.

ascorbate buffer a nearly constant shift is observed and the slope of the straight lines is about 0.08_2 v./pH. In the ternary buffer a nearly identical slope (0.08_5 v./pH) was found for the antimonyl ion. In presence of antipyrine however three breaks were noticed, the slope of the middle part ($5 \leqslant$ pH $\leqslant 9.5$) being about 0.11_2 v./pH. Aminopyrine showed a similar effect on the polarographic behavior of the antimonyl ion.

With regard to Pb(II) the apparent $E_{1/2}$ values are indicated in Table I. Generally for lead a rather slight shift of the half-wave potentials is observed as a function of pH. The pyrazolones show a practically negligible shift of the $E_{1/2}$ values.

The As(III) behaves in an entirely different way: the reduction waves only originate sufficiently with a pH $\leqslant 2.5$. Beyond this limit value they are badly shaped or even absent. Adding antipyrine causes distortion of the waves. The same effect occurs with aminopyrine.

Polarograms registered in the alkaline range show beside the accustomed cathodical waves polarographic currents emerging from potential zero. It concerns apparently anodic waves. These anodic waves have been shown to be generated for Sb and As in a strongly alkaline medium (0.1 to 1 *M* in KOH) by Kolthoff and Probst (2). These waves begin to appear at about pH 9. A shift of the $E_{1/2}$ values seems also to appear when the pH values increase.

CONCLUSION

Apparently the antimonyl ion distinguishes itself from Pb(II) and As(III) by the values of the half-wave potentials in the described buffers and furthermore also by the interaction with pyrazolone derivatives. Only the antimonyl ion shows a definite tendency to complex formation.

For the As(III) the occurrence of waves is limited to a determined pH range; the waves are distorted in the presence of the pyrazolones. The described data will be further developed with regard to possible analytical applications.

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Keyphrases

Pyrazolone derivatives
Antimonyl ion—pyrazolone derivative interaction
Buffer system—"ternary"
Polarographic study—complex formation

Stability of Prednisolone in an Organic Vehicle

By W. H. BOWLES

Prednisolone (0.7042 Gm.) was dissolved in 35 ml. of a vehicle (CMP) composed of 50 percent camphor, 25 percent *m*-cresyl acetate, and 25 percent *p*-chlorophenol, a mixture used in dentistry as a pulp-capping agent to reduce sensitivity in dental restorations. This preparation was assayed by the blue tetrazolium reaction and compared with an identically treated sample of USP reference standard prednisolone. The prednisolone–CMP mixture was then incubated at 60° with aliquots collected for assay at intervals of 24 hr., 5 days, 1 week, 2 weeks, and 6 weeks. At the end of 2 weeks of incubation, 99.3 percent of the prednisolone still remained; after 6 weeks' incubation, the prednisolone concentration had dropped to 72.4 percent of the preincubation concentration. Compared to literature values on the thermal stability of aqueous preparations of prednisolone, these results indicate that prednisolone in CMP is quite stable.

THE WIDESPREAD use of natural and synthetic steroids as anti-inflammatory agents in recent years has led to some concern as to the stability of these compounds in various preparations. Most of these preparations are suspensions of the steroid in aqueous or buffered aqueous media. Granulation procedures used in the manufacture of such preparations often involve exposure of the steroid to moisture and elevated temperatures (1).

Studies of prednisolone in aqueous suspensions of solid buffering agents, such as magnesium oxide, magnesium trisilicate, aluminum hydroxide, and calcium carbonate, have shown that agents which

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