soluble crystals which were recrystallized from a mixture of ether and petroleum ether, m.p. 98~99°. *Anal.* Calcd. for $C_{11}H_{13}O_2NS$ : N, 6.3. Found : N, 6.1.

Phenylhydrazone; m.p. 147°. *Anal.* Calcd. for $C_{17}H_{19}ON_3S$ : N, 13.4. Found : N, 13.2.

**S-α-Carbethoxyacetonyl N-Dimethylthiocarbamate (XIX)**—Sodium chloride formed by mixing 8.05 g. of dimethylamine hydrochloride, 50 cc. MeOH, and 4 g. NaOH was removed by filtration and COS was bubbled through the filtrate for 30 mins. To this was added 5 g. of freshly prepared ethyl α-bromoacetoacetate and mixed thoroughly. After the completion of the reaction, water was added to the mixture and the syrupy substance thereby formed was taken up in ether. After washing with water, the ether extract was concentrated, petroleum ether added, and allowed to stand in an ice chest by which the crystals began to separate out gradually. The crystals were collected by filtration and washed thoroughly with petroleum ether. The methanolic solution of this substance gives a reddish purple coloration with ferric chloride. *Anal.* Calcd. for $C_9H_{15}O_4NS$ : N, 6.0. Found : N, 6.1.

**N-Benzyl-4-methyl-4-hydroxy-5-carbethoxythiazolidin-2-one (XXI)**—Carbonyl sulfide was bubbled through the solution of 5 g. of benzylamine dissolved in 50 cc. MeOH and to this mixture of the amine salt, 7 g. of ethyl α-bromoacetoacetate was added. By thorough mixing, the mixture became a clear solution and this was treated as in the case for (XVII). m.p. 82~83°. The methanolic solution of this substance failed to give any coloration with ferric chloride. *Anal.* Calcd. for $C_{14}H_{17}O_4NS$ : N, 4.7. Found : N, 4.4.

## Summary

N-Substituted thiocarbamates (VIII and XII) do not show any absorption for carbonyl in their infrared absorption spectra but show absorption of disubstituted amide that they were assumed to have the structure (IX and XIII) of an N-substituted thiazolidin-2-one. (XVII) which cannot undergo cyclization showed absorption for carbonyl. Although (XIX) gives coloration with ferric chloride, (XX) does not give any coloration due probably to the structure of (XXI) assumed for it.

(Received June 18, 1954)

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## 57. Takashi Isshiki, Toshio Kajima, and Shunsaku Noguchi : On the Polarography of *p*-Aminomethylphenyl Isopentyl Ketone.

(*Pharmaceutical Institute, Medical Faculty, University of Tokyo**)

Nowadays literatures on the polarography of ketones are voluminous[1]. It is well known that the reduction potentials of ketones at the dropping mercury electrode are more or less influenced by such factors as solvent, pH, supporting electrolytes, and others. The present study was undertaken to determine the polarographic constants of *p*-aminomethylphenyl isopentyl ketone, which had been prepared by Ishidate and Nambara[2] in order to test its antibacterial activities.

## Results

In a basic solution, under the condition which only aqueous buffer solution was used as a solvent, multiple wave was observed for the ketone. However, it was found that the tendency toward producing a single wave increased as the ratios of both isopropanol and tylose to buffer increased. Finally it became clear that the mixture of buffer and isopropanol in equal volume containing 0.05% of tylose as a whole, was the suitable solvent for the polarographic determination in basic medium. In neutral or acidic media, however, the wave is not so complicated as that in basic one. It is unnecessary for the neutral or acidic solvent composed of equal volumes of aqueous buffer and isopropanol

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* Hongo, Tokyo (一色 孝, 梶間俊男, 野口俊作).

[1] cf. Kolthoff, Lingane : "Polarography," Interscience Publishers, Inc., New York, 652(1952).

[2] M. Ishidate, T. Nambara : This Bulletin, **1**, 290 (1953).

to add any tylose.

The typical waves observed in various pH solutions are shown in Fig. 1. It was seen that the wave at pH 3.08 was scarecely discernible owing to the overlapping of the depolarization wave of supporting electrolytes.

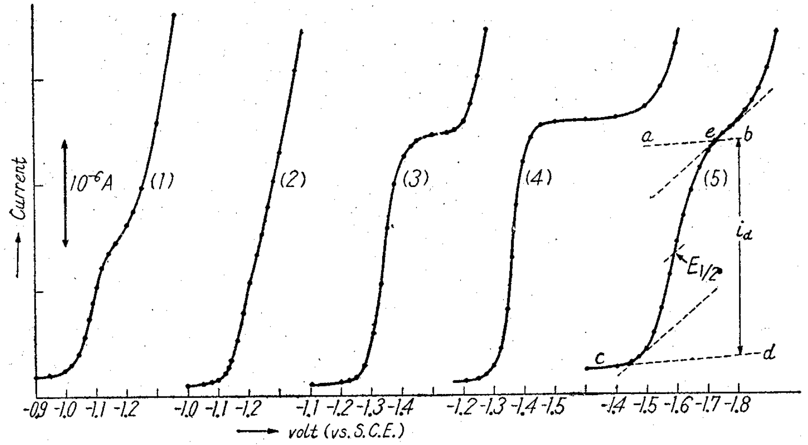

Fig. 1.

Current Potential Curves at Various pH

(1) 1.68; (2) 3.08; (3) 4.6; (4) 6.85; (5) 9.65

Concentration : $10^{-3}$ mol./L.

Half-wave potentials in various pH solutions are listed in Table I. It is clear that the half-wave potential shifts to a more negative value by increasing the value of pH, as might be expected.

The height of wave at pH 6.85 was linear function of the molar concentration of the ketone. This is diagrammatically shown in Fig. 2. Similar results were also obtained at pH 9.65.

Table I. Half-Wave Potential at ca. $10^{-3}$ mol./L. (vs. S.C.E.)

| pH | $E_{1/2}$ |
|---|---|
| 1.68 | −1.08 |
| 3.08 | — |
| 4.6 | −1.32 |
| 6.85 | −1.36 |
| 9.65 | −1.59 |

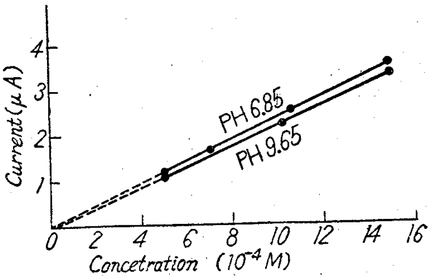

Fig. 2.

Calibration Curve

The diffusion current constants ($i_d$/cm$^{2/3}$t$^{1/6}$) at various pH were calculated from the above data. These are given in Table II. The height of wave in basic solution was about twice that in acidic one (pH 1.68).

Table II. Diffusion Current Constants ($i_d$/cm$^{2/3}$t$^{1/6}$) at Various pH

| pH | $i_d$/cm$^{2/3}$t$^{1/6}$ | pH | $i_d$/cm$^{2/3}$t$^{1/6}$ |
|---|---|---|---|
| 1.67 | 0.876* | 6.85 | 1.82** |
| 3.08 | — | 9.65 | 1.72** |
| 4.6 | 1.75* | | |

* These values were measured at $10^{-3}$ mol./L.

** These were the mean values at various concentrations.

## Mechanism

The number of electrons involved per molecule in the reduction process was calculated from the following Gilbert-Rideal's equation[3] by measuring the amount of electrolytic reduction from the change in diffusion current.

$$n=\frac{-1}{2.303\times F\times v}\times\frac{i_d}{C}\times\frac{dt}{d(\log h)}$$

where $C$ is the initial molar concentration of the ketone, $i_d$ is the corresponding diffusion current in ampere, $v$ is volume in liter of the solution in the electrolysis cell, $F$ is the Faraday, $t$ is reduction time in seconds, and $h$ is wave-height measured in arbitrary terms. In Fig. 3 the logarithms of wave-heights determined from polarographic records taken at intervals during electrolysis, are plotted against time. Value of $d(\log h)/dt$ which corresponds to the tangent of the slope in Fig. 3 and

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3) Gilbert, Rideal: Trans. Faraday Soc., **1951**, 396.

the other data necessary for the calculation of $n$ are listed in Table III.

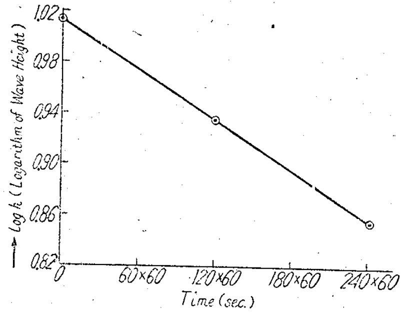
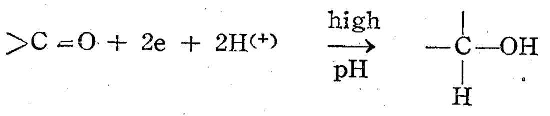


Fig. 3. Electrolytic Reduction at the Dropping Mercury Electrode (Applied voltage : $-1.7$ V) (A new capillary having the "m" value of 1.022 mg./sec. at a mercury level of 514 mm. was used)

Table III.

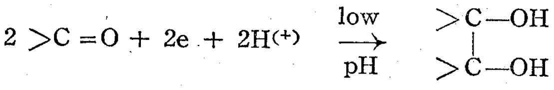
| $C$ | $i_a$ | $v$ | $d(\log h)/dt$ | $n$ |
|---|---|---|---|---|
| $1.20\times10^{-4}\,M$ | $3.37\times10^{-7}$ A | $5\times10^{-4}$ L. | $-1.10\times10^{-5}$ | 2.3 |

The result for the ketone at pH 6.25, namely two electrons per molecule, is in accord with the following mechanism proposed by Pasternak⁴⁾.



$$>C=O + 2e + 2H^{(+)} \xrightarrow[\text{pH}]{\text{high}} -\overset{|}{\underset{\underset{H}{|}}{C}}-OH$$

At a low pH (1.68) one-electron reduction with the formation of pinacol may be involved, because the wave-height at pH 1.6 is one-half that of high pH of 9.65.



$$2>C=O + 2e + 2H^{(+)} \xrightarrow[\text{pH}]{\text{low}} \begin{array}{l} >C-OH \\ \quad | \\ >C-OH \end{array}$$

The behaviors are mostly in accord with that of general aromatic ketones.

The authors wish to express their sincere appreciation to Prof. Ishidate for his direction and advice. They are also grateful to Messrs. Nambara and Kimura for valuable assistance.

## Experimental

**Apparatus**—Most of the data were obtained using a hand-made, manually operated polarograph⁵⁾. Some of the current-voltage curves were determined by Yanagimoto Polarograph which had been improved in our laboratory. Both galvanometers were calibrated according to the method of Kolthoff and Lingane⁶⁾. The former had the maximum sensitivity of $1.515\times10^{-8}$ A/mm. and internal resistance of 135 ohms. The latter had constants of $3.420\times10^{-9}$ A/mm. and 400 ohms.

The electrolysis cell was the H-type improved in our laboratory⁵⁾ and the anode arm contained a saturated calomel electrode having a mercury surface of about 10 cm². No correction was made for IR drop or junction potentials. Ordinary cells employing a mercury pool as an anode were occasionally used for the confirmation of wave-heights obtained by the above H-type cells*. The electrolysis experiments were carried out at constant temperature of $25°\pm0.2°$.

At a mercury level of 641 mm., the "m" value for the capillary was 1.056 mg. per second in distilled water. Drop time t (average 4.06 sec.) was determined at $-1.35$ V (near $E_{1/2}$ at pH 6.85) in each run. The capillary constant, $m^{2/3}\,t^{1/6}$, was, therefore, 1.31 as the mean value.

**Reagents**—*p*-Aminomethylphenyl isopentyl ketone hydrochloride was prepared in our laboratory according to the method of Ishidate, *et al.*²⁾.

**Buffer Solution**—The buffer solutions used in this investigation were made according to Clark-Lubs. Measurements of pH were carried out using Towa-Dempa glass electrode pH meter.

**Cell Solution**—The weighed ketone was dissolved in the definite quantity of pure isopropanol and there was added the same volume of buffer solution (if necessary the buffer solution may contain 0.1% of tylose). No measurement of pH was made for this final cell solution containing isopropanol. Mol. ratio of the ketone and the total supporting electrolytes in the final cell solution was about 1 : 30 at the highest concentration of the ketone.

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4) Pasternak : Helv. Chim. Acta, **31**, 755 (1948).
5) T. Isshiki, Y. Mashiko : J. Japan. Chem., 8, 116 (1954).
6) Kolthoff, Lingane : "Polarography," Interscience Publishers, Inc., New York, 320, 323 (1952).
* See Fig. 4 in this Bulletin, **2**, 268 (1954).

**Procedure**—The solution was brought to 25°±0.2° by immersing in a constant temperature bath and made free from oxygen with hydrogen saturated with the solvent for 10~15 minutes. Then current-voltage relationship was plotted or recorded.

**Drawing**—$E_{1/2}$ and $i_d$ were determined on each polarogram according to the drawing shown in Fig. 1, curve 5.

In this figure, the straight line ($\overline{ab}$) parallel to the gently sloping residual current ($\overline{cd}$), was drawn through the starting point (e) of the more steep diffusion current plateau.

## Summary

Half wave potentials and diffusion current constants of *p*-aminomethylphenyl isopentyl ketone at various pH were determined. They are summarized in the accompanying Tables. The electrons per molecule, namely two, contributing for the polarographic reduction of the ketone in neutral medium were also calculated from the decrease of diffusion current after the prolonged electrolytic reduction at the dropping mercury electrode.

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## 58. **Takashi Isshiki, Yasushi Mashiko, and Mioko Ninomiya** : On the Polarography of 2-Acetamido-5-nitrothiazole.

(*Pharmaceutical Institute, Medical Faculty, University of Tokyo**)

Though a few procedures have been applied to the reduction of 5-nitro derivatives of thiazoles, no fruitful result has been obtained up to date[1].

Owing to the +M effect of the nuclear sulfur atom, thiazole is very stable to reducing reactions and no polarographic wave was obtained for 2-acetamidothiazole (below pH 9.65). It was, however, found that 5-nitro derivative of this compound was reducible at the dropping mercury electrode and this really gave distinct polarographic waves.

In basic solution where the solvent was composed of equal volumes of buffer solution (pH 9.65) and isopropanol, tylose was added to make 0.025% concentration. One pre-step was recorded before the main wave was developed. Similar phenomenon was also observed with the cell solution, where only pH of aqueous buffer solution (pH 7.85), differed from that mentioned.

Finally, the typical one-step wave as shown in Fig. 1 was obtained when equal volumes of buffer solution (pH 3.08) and isopropanolic solution of the nitro compound were mixed to form the cell solution containing 0.025% of tylose, as the maximum surpressor.

Half-wave potential in this cell solution is −0.32 V vs. S.C.E. The diffusion current is a linear function of the molar concentration of the compound as shown in Fig. 2. The value of diffusion current constant $i_d/\mathrm{cm}^{2/3}t^{1/6}$ in each concentration is also given in Fig. 2. The diffusion current constant as the mean value was calculated from these data and was found to be $4.11_1$.

The number of electrons contributing for the polarographic reduction can be calculated from the following Gilbert-Rideal's equation[2],

$$n=\frac{-1}{2.303\times F\times v}\times\frac{i_d}{c}\times\frac{dt}{d(\log h)}$$

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* Hongo, Tokyo (一色 孝, 益子 安, 二宮美保子).

[1] e.g., Ochiai, Nagasawa : J. Pharm. Soc. Japan, 58, 1048 (1938).

[2] Gilbert, Rideal : Trans. Farad. Soc., **1951**, 396.