

Electroorganic Preparations

XVI. Polarography and Reduction of Quinazoline

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The polarographic behaviour of quinazoline and some of its derivatives was found to be consistent with a hydration of the nucleus of the mono-cation. The rate constant of the dehydration was determined from polarographic data, and the dehydration was found to be specific acid catalyzed.

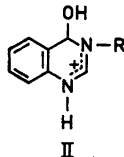
Quinazoline yields on controlled potential reduction both in acid and alkaline solution a dimerized product, which probably is dimerized at C-4. The product can be reoxidized to quinazoline with hexacyanoferrate(III) in alkaline solution.

The polarographic reduction of quinazoline (I) and its derivatives has not been investigated previously. Such an investigation of quinazoline seemed warranted by the abnormal properties of quinazoline with respect to spectrum and base strength which have been explained¹ by a hydration of the quinazoline nucleus of the mono-cation thus forming II, R = H. It was hoped that a polarographic investigation of these compounds might throw further light on the problem.

For some of the compounds the electrode reactions were established by controlled potential reduction.



I



II

RESULTS

The pH-dependence of the limiting current and the half-wave potentials of quinazoline are shown in Fig. 1. Below pH 0 the data are plotted against the acid function H_+ . The half-wave potentials in solutions more acid than

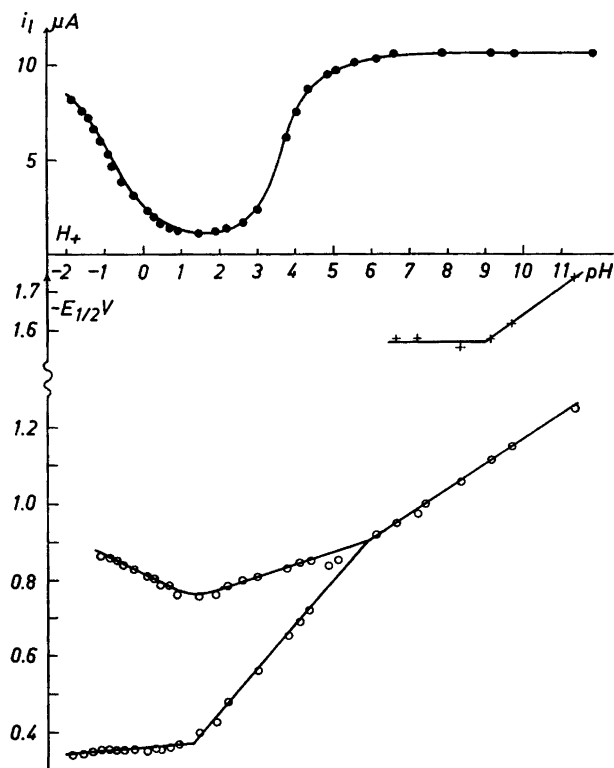


Fig. 1. pH-dependence of the limiting current (μA) (see text) and half-wave potentials (vs. S.C.E.) of quinazoline. Concentration 1.5×10^{-3} M.

pH 0 are of limited value as they include a liquid junction potential of un-negligible (*i.e.* several mV) value.

The limiting currents in Fig. 1 are in the acid region the sum of the two one-electron waves. In very strongly acid solution where the second wave is masked by the hydrogen wave the limiting current depicted is the double of that of the observed first wave.

The half-wave potentials of quinazoline are somewhat dependent on the concentration, becoming more negative with increasing concentrations. The wave height is not directly proportional to the concentration, but increases less than required by the simple relation. In 0.1 N potassium hydroxide the apparent electron consumption decreases from 2 at 10^{-4} M to around 1.5 at 5×10^{-3} M.

At pH 1, where the limiting current (i_l) is around 10 % of the limiting current at pH 5, i_l is independent of the height of the mercury reservoir (h), which is found for kinetically controlled waves, whereas $i_l = k \sqrt{h}$ at pH 5, which points to a diffusion controlled wave at this pH.

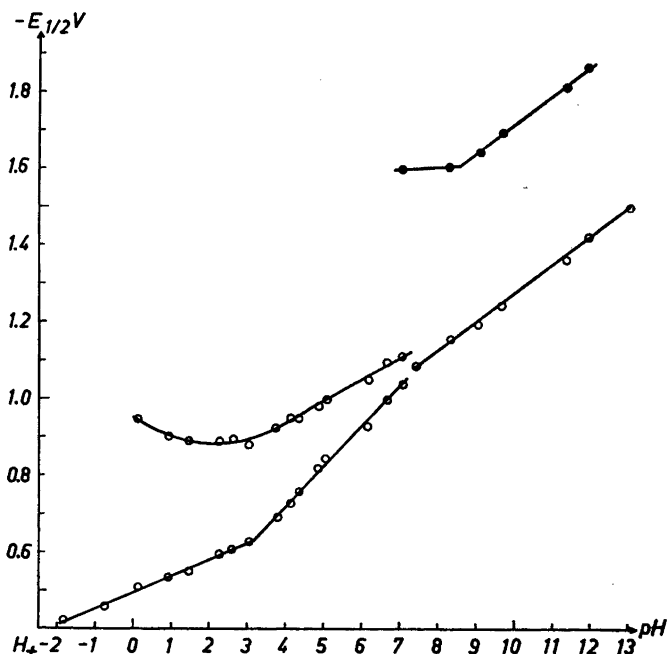


Fig. 2. pH-dependence of the half-wave potentials (vs S.C.E.) of 4-methylquinazoline. Concentration 0.7×10^{-3} M. 0.008% gelatine added as maximum suppressor.

The second wave of quinazoline resembles closely in half-wave potential, shape, and dependence of the limiting current on pH the wave of 3,4-dihydroquinazoline.

In Fig. 2 is depicted the pH-dependence of the half-wave potentials of 4-methylquinazoline. Only a small decrease in slightly acid solution of the limiting current of this compound is found. Before the first wave a concentration-independent prewave occurs in acid solution. This prewave and a maximum found on the second wave can be suppressed by gelatine.

The acidity function H_+ was determined by measuring the spectra of 3-aminopyridine ($pK_2 = -1.5^2$) at different acidity. The absorption band at $317 \text{ m}\mu$ is characteristic of the monoprotonated 3-aminopyridine, and the absorption of the doubly protonated compound is negligible at $317 \text{ m}\mu$. The acidity function H_0 was similarly determined using the absorption at $425 \text{ m}\mu$ as a measure of the concentration of the unprotonated form of 4-chloro-2-nitroaniline.

The acidity function H_+ rather than H_0 was chosen as it would better reflect the ability of the medium to protonate a positively charged species. However, no significant difference between H_+ and H_0 was found in the region 0 to -2 .

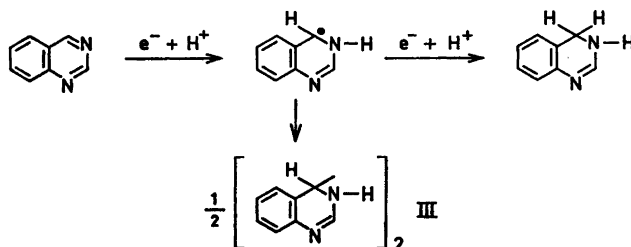
The electron consumption in the controlled potential reduction is dependent on the concentration. The slope of the curve obtained by plotting the concentra-

tion of quinazoline against electron consumption during a reduction of quinazoline in alkaline solution corresponds at 0.02 M quinazoline to $n = 1.2$ whereas at 0.001 M the slope suggests $n = 2$. At 0.05 M quinazoline the overall electron consumption was found to be 1.23 and at 0.1 M n was 1.1.

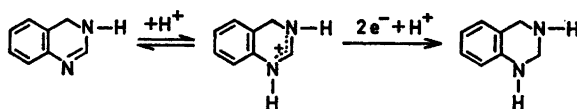
From the reduction both in acid and alkaline solutions of quinazoline was isolated a compound $(C_8H_7N_2)_n$, soluble in aqueous acid, but insoluble in most organic solvents.

The IR-spectrum contained a band at 3200 cm^{-1} , suggesting the presence of a nitrogen-hydrogen bond. The compound gave in alkaline solution (borate buffer) a cathodic wave near the potential where 3,4-dihydroquinazoline does and in strongly alkaline solution an anodic wave which 3,4-dihydroquinazoline does not. The UV-spectrum in neutral and alkaline solution was similar to that of 3,4-dihydroquinazoline.¹

From these results and the polarographic evidence the following reaction route in alkaline solution is probable:



The second wave of quinazoline is a reduction of the 3,4-dihydroquinazoline formed in the first reduction at low concentrations of quinazoline. 3,4-Dihydroquinazoline was reduced in borate buffer to 1,2,3,4-tetrahydroquinazoline according to:



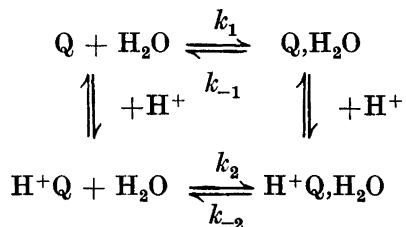
The dimeric reduction product of quinazoline (III) can be rapidly reoxidized to quinazoline in good yield (85 %) by adding it to a boiling alkaline solution of hexacyanoferrate(III).

DISCUSSION

The $E_{1/2}$ -pH-curves of the two one-electron waves of quinazoline show a change in slope around pH 1.3 (Fig. 1) and the two-electron wave of 3,4-dihydroquinazoline (2nd wave of quinazoline) shows a change around pH 9. The pK_A of 3,4-dihydroquinazoline is 9.16.¹ 4-Methylquinazoline ($pK_A = 2.5$ ¹) changes its slope of the curve at pH 2.5. This suggests³ that pK_A of the reducible, normal cation is around 1.3; the evidence is, however, not conclusive as

3-methylquinazolinium ion also shows a similar, but much smaller change in the slope of the $E_{1/2}$ -pH-curve around pH 1.3.

The abnormal pH-dependence of the limiting current of quinazoline can be explained by hydration of the protonated quinazoline nucleus if it is assumed that only the normal cation and not the hydrated cation is polarographically reducible. The polarographic behaviour of quinazoline (Q) would thus be determined by the equilibrium and rate constants of the following equilibria:



with the four equilibrium constants:

$$K_1 = (\text{Q},\text{H}_2\text{O})/(\text{Q})(\text{H}_2\text{O})$$

$$K_2 = (\text{H}^+\text{Q},\text{H}_2\text{O})/(\text{H}^+\text{Q})(\text{H}_2\text{O})$$

$$K_3 = (\text{Q})(\text{H}^+)/(\text{H}^+\text{Q})$$

$$K_4 = (\text{Q},\text{H}_2\text{O})(\text{H}^+)/(\text{H}^+\text{Q},\text{H}_2\text{O})$$

A polarographic behaviour similar to that of quinazoline is found for certain aldehydes, *e.g.* pyridine aldehydes,^{4,5} and the phenomenon has been interpreted as a reversible hydration of the reducible aldehyde group to the non-reducible aldehyde hydrate.

Besides the spectroscopic and potentiometric arguments in favour of a hydration of the quinazoline cation the polarographic behaviour of 4-chloroquinazoline strongly supports the hypothesis. 4-Chloroquinazoline is, as are other cations of 4-substituted quinazolines, not hydrated in acid solution. The compound is, however, rapidly hydrolyzed in acid solution, unless the temperature is kept low. At -10°C the compound is sufficiently stable for a polarographic investigation in 40 % alcohol. In acid solution the two-electron reduction of the carbon-chlorine bond is followed at more negative potentials by two one-electron reductions of the quinazolinium ion thus formed, and the sum of the wave-heights of the two one-electron waves is equal to the height of the two-electron wave. The interpretation is that the normal quinazolinium cation formed in the reduction of the unhydrated 4-chloroquinazoline is reduced as soon as it is formed. The polarography of 4-chloroquinazoline thus reveals the polarographic behaviour of the undisturbed, normal cation.

The independence at pH 1 of the wave-height on the height of the mercury reservoir suggests that the wave height in this region is not determined by diffusion, but by the rate of a reaction which here is the dehydration of the abnormal cation (II, R = H).

The rate constant of this reaction (k_{-2}) can be calculated from the ratio K between the hydrated and unhydrated form and the polarographic results

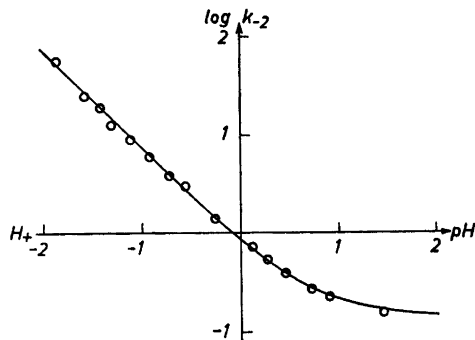


Fig. 3. The dependence of the rate of dehydration (k_{-2}) of the abnormal quinazolinium cation (II, R = H) on the acidity. The solid line is drawn according to:
 $k_{-2} = 0.70(H^+) + 0.16$.

according to Koutecky.⁶ The currents used in the calculation are the instantaneous currents obtained with an undamped polarograph. The dependence of k_{-2} on pH and H_+ is depicted in Fig. 3 and the relevant results are given in Table 1.

The polarographic data include the measurable limiting current i_l and the drop time t . It is also necessary to know the diffusion current i_d which would have been found if the wave were diffusion controlled and all the molecules were in the reducible form. In the present case i_d can be estimated fairly well from the diffusion current of the unprotonated, non-hydrated quinazoline in neutral solution. The error in i_d by assuming the same diffusion coefficient in alkaline and moderately acid solution is probably less than 5%. In strongly acid solution the changes of the viscosity of the medium becomes of importance for i_d . This influence has been estimated both from the viscosity of hydrochloric acid solutions,⁷ by assuming Stoke's law to be applicable, and by the influence of

Table 1. Polarographic results (instantaneous currents, kinetically (i_l) and diffusion (i_d) controlled) and the ratio K between hydrated and unhydrated forms used in the calculation of k_{-2} . Concentration of quinazoline 1.5 mM.

pH (H_+)	i_l μ A	i_d μ A	K	k_{-2} sec ⁻¹
-1.87	9.40	11.1	13.9	56
-1.58	8.65	11.45	18.9	25
-1.42	8.25	11.55	21.8	19
-1.30	7.60	11.7	24.0	12.5
-1.11	7.00	11.8	26.7	9.1
-0.92	6.25	11.9	30.0	6.1
-0.72	5.33	12.1	34.4	3.9
-0.55	4.60	12.25	39.2	3.0
-0.25	3.80	12.4	45.0	1.45
0.12	2.72	12.6	48	0.74
0.28	2.40	12.6	50	0.53
0.45	1.96	12.6	54	0.39 ₅
0.69	1.68	12.6	55	0.27 ₅
0.91	1.52	12.6	53	0.23
1.45	1.32	12.6	55	0.16

the medium on the diffusion current of quinoxaline in hydrochloric acid solutions. As both estimates give fairly equal results no significant error is probably introduced by the estimation of the effect of the viscosity changes.

The ratio K has been estimated from spectroscopic results. The normal cation has an absorption maximum at $333\text{ m}\mu$, the unprotonated quinazoline one at $305\text{ m}\mu$, whereas the abnormal cation absorbs only slightly above $300\text{ m}\mu$. The extinction coefficient of the normal cation is, however, not known. The extinction coefficient of the normal cation at $333\text{ m}\mu$ is taken, as a first approximation, to be equal to that of quinazoline at $305\text{ m}\mu$ from a comparison of the spectra of quinazoline and 4-methylquinazoline in anhydrous dichloroacetic acid¹ and of the unprotonated and protonated quinoxaline and 4-methylquinazoline in water. The latter has been found¹ to contain 19 % hydrated cation in acid solution.

Another estimate of K can be made from potentiometric data. The $\text{p}K_{\text{A}}$ of pyrazine and quinoxaline are 0.6 and 0.7, respectively,⁸ and those of pyridazine and cinnoline are both 2.3.⁸ From the $\text{p}K_{\text{A}}$ of pyrimidine (1.3) the $\text{p}K_{\text{A}}$ of the normal quinazoline cation has been estimated to 1.5.¹ From this value and $\text{p}K_4$, K can be calculated.⁹ The estimates of K from the spectroscopic and potentiometric data agree within 20 % in slightly acid solution.

In the estimation of the ratio K necessary for the calculation of k_{-2} the total concentration of the unhydrated form is used. The concentration of the unprotonated form is calculated using $\text{p}K_3 = 1.5$. The protonation is fast compared to the dehydration, and when the protonated, anhydrous form is removed from the equilibrium by reduction, the unprotonated, anhydrous form will be protonated (and reduced) so fast that all the anhydrous molecules which diffuse to the electrode will be reduced.

The ratio K is dependent on the medium, and the decrease of K is greater than would be expected from the diminished activity of water calculated from the osmotic coefficient of aqueous hydrochloric acid.¹⁰ Possibly ion-pair formation with chloride ions is responsible for the more pronounced decrease of the activity coefficient of the normal cation compared to that of the hydrated form.

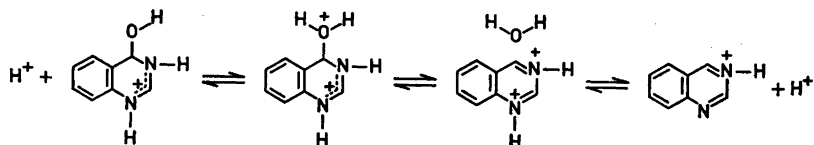
The treatment of Koutecky also assumes that the ratio K is independent of the potential gradient in the electrical double layer; the extent to which this is justified is not known.

From the polarographic data k_{-2}/K can be determined. An error in the estimate of K is reflected accordingly in k_{-2} . The form of the curve $\log k_{-2}$ vs pH (Fig. 3) will, however, not change.

k_{-2} is dependent on the acidity. Several measures of acidity in strongly acid solutions exist. In the present case Hammett's acidity function H_+ was chosen as a plot of $\log k_{-2}$ vs H_+ yielded a straight line with the slope -1 .

The data on Fig. 3 show that the dehydration rate constant k_{-2} is composed of two rate constants corresponding to a "spontaneous" (pH-independent) dehydration and an acid catalyzed dehydration. The dependence of k_{-2} on the acidity can thus be expressed by: $k_{-2} = k'(H^+) + k_0$, or below pH 0: $k_{-2} = k'(h_+) + k_0$ (5) where h_+ is defined by $-\log h_+ = H_+$. The curve in Fig. 3 is drawn using eqn. (5) with $k' = 0.70$ and $k_0 = 0.16$.

The linear dependence of k_{-2} on H_+ , which is a measure of the ability of the medium to protonate a molecule carrying a positive charge, suggests a specific acid catalysis. Such a catalyzed reaction can be visualized as shown:



The rate of the dehydration of the abnormal cation has not been followed polarographically at $\text{pH} > 1.5$ because the concentration of the unprotonated quinazoline no longer is negligible, and possibly a deprotonation followed by a dehydration can play a role in this region. The rate of the dehydration of the unprotonated, hydrated quinazoline has been found at $\text{pH} 10$ by means of a flow technique⁹ to 0.077 sec^{-1} .

4-Hydroxy-3-methyl-3,4-dihydroquinazoline (II, $\text{R} = \text{CH}_3$) is in dehydration-hydration equilibrium with 3-methylquinazolinium ion. The polarographic behaviour of the compound is very similar to that of quinazoline in acid solution, but in the former case the positive charge is retained in neutral and alkaline solution. At pH higher than 9 the compound is hydrolyzed, probably by ring-opening.

The rate constant k of dehydration of 4-hydroxy-3-methyl-3,4-dihydroquinazoline can be calculated from the polarographic results when a series

Table 2. Polarographic results (instantaneous currents, kinetically (i_i) and diffusion (i_d) controlled) and the ratio K between hydrated and unhydrated 3-methylquinazolinium cation used in the calculation of k . Concentration of 3-methyl-4-hydroxy-3,4-dihydroquinazoline 1.3 mM

$\text{pH} (H_+)$	$i_i \mu\text{A}$	$i_d \mu\text{A}$	K	$k \text{ sec}^{-1}$
-1.87	6.0	8.9	13.1	8.7
-1.58	5.0 ₅	9.1 ₅	17.5	4.5
-1.42	4.4 ₈	9.2 ₅	20.7	3.2
-1.30	3.8 ₄	9.4	22.7	2.0
-1.11	3.1 ₆	9.4 ₅	27.5	1.31
-0.92	2.5 ₂	9.5	31.6	0.83
-0.72	2.1 ₂	9.7	36.2	0.58
-0.55	1.7 ₆	9.8	42.5	0.43
-0.25	1.3 ₆	9.9	53	0.28 ₅
0.12	1.00	10.1	55	0.14 ₅
0.28	0.92	10.1	64.5	0.13 ₈
0.45	0.81	10.1	67.5	0.11
0.69	0.78	10.1	72	0.11
0.91	0.76	10.1	72	0.10 ₈
1.45	0.70	10.1	72	0.092
1.90	0.68	10.1	72	0.084
2.20	0.62	10.1	72	0.070
4.25	0.64	10.1	72	0.074
6.10	0.68	10.1	72	0.084

of assumptions and estimates as those applied above for quinazoline are made. The diffusion coefficient is assumed to be the same as that of quinazoline and the same estimate of the influence of the viscosity changes on i_d is made. 3-Methylquinazolinium iodide has an absorption maximum at $340\text{ m}\mu$ and as a first approximation the molecular extinction coefficient is taken to be equal to that of the normal quinazolinium ion; 4-hydroxy-3-methyl-3,4-dihydroquinazoline does not absorb at $340\text{ m}\mu$. An estimate of the ratio of the two forms can thus be made. This ratio is dependent on the medium in the same way as that of quinazoline (Tables 1 and 2), but is assumed to be independent of the potential gradient at the electrode. The values obtained are found in Table 2.

Fig. 4 is a plot of $\log k$ vs pH (H_+). A curve according to (5) $k = 0.10(H^+) + 0.08$ (or $k = 0.10(h_+) + 0.08$) is drawn, and the experimental results fit the curve satisfactorily. Eqn. (5) can in this case be verified up to pH 9, above which pH the compound is hydrolyzed.

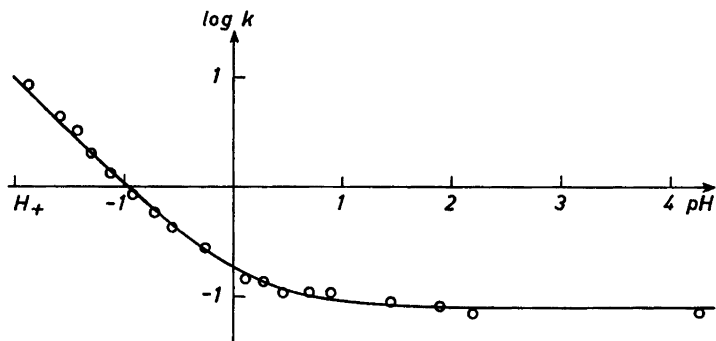


Fig. 4. The dependence of the rate of dehydration of 4-hydroxy-3-methyl-3,4-dihydroquinazoline (II, R = CH₃) on the acidity. The solid line is drawn according to $k = 0.10(H^+) + 0.08$.

A dehydration mechanism which reflects the specific acid catalysis suggested by (5) similar to that depicted above is probable.

From spectroscopic and potentiometric data¹¹ quinazoline-3-oxide has been shown to form a hydrated cation. The polarographic results are in accordance with this finding as judged from the following facts. The wave height diminishes in solutions more acid than the pK of the compound (1.52¹¹) and the wave height becomes independent of the height of the mercury reservoir, which is found for waves whose height is determined by the rate of a chemical reaction. The two-electron reduction of quinazoline-3-oxide does not yield quinazoline, but takes probably place in the nucleus.

It has been found from spectroscopic evidence that 4-substituted quinazolines generally show none or only a slight hydration, which has been ascribed to steric factors. The polarographic results are in agreement with this as no evidence of medium or strong hydration has been found in 4-chloro-, 4-methoxy-,

4-mercapto-, 4-methylmercapto-, 4-amino-, 4-methyl-, 2,4-dimethylquinazoline or 3,4-dimethylquinazolinium iodide.

The nucleus of 6-aminoquinazoline is hydrated in acid solution according to spectroscopic and polarographic evidence. As to 6-nitroquinazoline, the problem is not so simple.⁹ The nitro group absorbs too strongly in the relevant region to offer any straightforward spectroscopic evidence.

6-Nitroquinazoline shows in strongly acid solution a six-electron reduction to 6-aminoquinazoline and no wave corresponding to a reduction of this compound. Around pH 1 the six-electron wave splits up in a four-electron reduction to the hydroxylamine and a two-electron reduction further to 6-aminoquinazoline. In slightly acid and neutral solution the four-electron reduction of the nitro group is followed by a two-electron wave around the potential where 6-aminoquinazoline shows a wave. Further is found a drawn-out wave, corresponding to the reduction of the hydroxylamino group to the amino group, and finally a wave at the potential where 6-aminoquinazoline shows a second wave.

Whereas the polarographic behaviour of 6-nitroquinazoline in neutral and alkaline solution can be explained on the basis of an unhydrated nucleus the lack of a wave in mineral acid solution corresponding to the reduction of 6-aminoquinazoline can only be explained by either a hydration of 6-nitroquinazoline in acid solution, which by reduction should yield the non-reducible, hydrated 6-aminoquinazoline, or by the formation of a non-reducible intermediate which could either form the hydrated 6-aminoquinazoline cation before or after having diffused away from the electrode.

The formation of a non-reducible intermediate can not be excluded. The fact that 6-nitroquinazoline does not form such an intermediate in the polarographic reduction makes it less likely.

The rate of hydration of 6-aminoquinazoline is either slower than that of quinazoline or a correspondingly smaller equilibrium concentration of the non-hydrated cation is present.

The polarographic evidence thus favours the hypothesis that 6-nitroquinazoline is hydrated in acid solution, although the evidence is not conclusive.

The wave-height of quinazoline in alkaline solution suggests a two-electron reduction, but a preparative reaction showed an electron consumption depending on the initial concentration in accordance with the scheme given above. The isolated dimeric compound (III) is believed to be dimerized at C-4 on the following grounds: (1) According to polarographic data 3,4-dihydroquinazoline is the reduction product obtained at low concentrations of quinazoline, (2) the presence of a hydrogen atom bonded to nitrogen (I. R.-spectrum) excludes a dimerization at one of the nitrogens or one of the carbon atoms in the benzene ring, (3) a dimerization at C-2 would yield a compound containing a carbon-nitrogen double bond which would be easier reducible than that of 3,4-dihydroquinazoline as such a compound could be regarded as a derivative of benzaldehyde imine.

Formation of a dimeric compound has also been found in the preparative reduction of quinoxaline and phthalazine in alkaline solution, although the polarographic wave-height suggests a two-electron reduction in this medium. Other compounds as N,N-diethyl benzoylbenzoic amide in acid solution,¹²

isonicotinic hydrazide,¹³ and hydrazine¹⁴ on oxidation in alkaline solution behave similarly. A theoretical treatment of such cases has been given by Meites.¹⁵

The dimer (III) can be oxidized to quinazoline with potassium hexacyanoferrate(III) in alkaline solution. The cleavage of a carbon-carbon bond with potassium hexacyanoferrate(III) is unusual. The dimers from the preparative reduction of phthalazine and quinoxaline can also be oxidized to phthalazine and quinoxaline, respectively, by alkaline potassium hexacyanoferrate(III). In the case of quinoxaline it is less surprising as the dimer in acid solution spontaneously cleaves into two stable, protonated radicals. The dimer (III) does not split into radicals in acid solution.

The reduction of 4-chloroquinazoline in a neutral phosphate buffer gives nearly quantitative yield of quinazoline, and the electrolytic reduction thus competes successfully with *e.g.* the catalytic reduction, where generally some 3,4-dihydroquinazoline is formed and some loss of 4-chloroquinazoline due to a hydrochloric acid catalyzed self-quaternization occurs.

EXPERIMENTAL

The polarograph was a recording polarograph Radiometer PO 4d. The potentiostat was a Wadsworth Controlled Potential Electro-Depositor. The capillary delivered 2.5 mg of mercury per second at a corrected mercury column height of 48.5 cm. The drop time was 3.7 sec.

Reduction of quinazoline. 1.00 g of quinazoline was reduced in 0.2 M potassium hydroxide at -1.5 V vs S.C.E. $n = 1.23$. A precipitate, 675 mg was filtered off and extracted in a Soxhlet apparatus with alcohol. A small amount of a grey, mercury-like substance remained in the Soxhlet-filter. The extracted compound (III) was filtered off, m.p. 274°. A recrystallization took place above 265° forming needlelike crystals. (Found: C 72.80; H 5.37; N 21.25. Calc. for $C_{10}H_{14}N_4$: C 73.26; H 5.38; N 21.36). UV-spectrum: pH 1, $\lambda_{\max} = 282$ m μ , $\log \epsilon = 3.9$. pH 12, $\lambda_{\max} = 292$ m μ , $\log \epsilon = 4.0$. The IR-spectrum (potassium bromide disc) contained a.o. bands at 3250 cm^{-1} (m) and 2950 – 2800 cm^{-1} (ms). The compound is soluble in acid, but only slightly soluble in water and most organic solvents. It forms, however, rather stable supersaturated solutions.

Reduction of 3,4-dihydroquinazoline. 0.5 g of 3,4-dihydroquinazoline, prepared by catalytic reduction of quinazoline, was reduced in a borate buffer pH 8.5 at -1.50 V vs S.C.E. $n = 2.2$. The reduced solution was made strongly alkaline and extracted with ether. After drying, the ether was removed leaving a residue which readily crystallized on contact with water. It was identified as 1,2,3,4-tetrahydroquinazoline hydrate from its m.p. 48–50° (49–50°)¹⁶ and the m.p. of the hydrochloride 193° (193°)¹⁶. The compound deteriorates on standing.

Reduction of 4-chloroquinazoline. 0.50 g of 4-chloroquinazoline was reduced in a phosphate buffer pH 6.5 containing 30 % alcohol. The potential was kept at -0.85 V vs S.C.E. and the temperature between 0° and 5°; $n = 2.0$. The concentration of quinazoline formed in the reduction was determined by polarography. Yield of quinazoline 95–100 %.

Oxidation of dimer III. 50 mg of III are added to a boiling solution of 0.5 g potassium hexacyanoferrate(III) in 30 ml 0.5 M potassium hydroxide. The compound goes rapidly into solution and after 2 min the solution is cooled. Excess of sodium sulfite is added, the volume made to 50.0 ml and the concentration of the quinazoline formed determined by polarography. Yield of quinazoline 85 %.

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