A KINETIC AND MECHANISTIC STUDY OF OXIDATION OF LEVODOPA
BY DIPERIODATONICKELATE(IV) IN AQUEOUS ALKALINE MEDIUM

The kinetic studies using nickel(IV) complex as an oxidant in the form of nickel(IV) oxime or nickel(IV) periodate are limited to a few cases due to its limited stability and solubility in aqueous medium. In kinetic studies, involving nickel(IV) as an oxidant, the intervention of nickel(III) as an intermediate may occur. Indeed stable nickel(III) complexes are also known. Moreover, when nickel(IV)periodate is the oxidant, since multiple equilibria between the different nickel(IV) species are involved, one needs to know which of the species is the active oxidant.

Levodopa is the levorotary isomer of 3-(3,4dihydroxyphenyl)-L-alanine. It is converted into dopamine by decarboxylation after penetrating the blood-brain barrier. Thus it acts by replacing depleted brain dopamine in patients of Parkinsonism. It is administered orally for the treatment of Parkinsonism. It also finds use to control neurologic symptoms of chronic manganese poisoning which resemble those of Parkinsonism.

In earlier reports on diperiodatonickelate(IV) oxidation, periodate had retarding effect in almost all the reactions and monoperiodatonickelate(IV) (MPN) is considered to be the active species. However, in the present study we have observed entirely different kinetic observations and diperiodatonickelate(IV) (DPN) was found to be the active form of the oxidant. The literature survey reveals that there are no reports on the kinetics and mechanism of oxidation of levodopa by diperiodatonickelate(IV).
and other oxidising agents. In view of the medical applicability of levodopa and in order to understand the active species of nickel(IV) in such a media, a detailed study is undertaken to arrive at a plausible mechanism.

EXPERIMENTAL

Materials

The chemicals used were of analytical reagent grade. The solution of levodopa (Merck) was prepared by dissolving appropriate amount of sample in warm very dilute alkaline solution. Double distilled water was used throughout the work. The solid diperiodatonickelate(IV) complex (DPN) was prepared by the known method as follows: A solution of 3.0 g (1.3×10⁻² mole) of potassium metaperiodate in about 0.40 dm³ of boiling water was added to a 0.10 dm³ of boiling solution containing 2.0 g (7.0×10⁻³ mole) of nickel sulphate with vigorous stirring. The resultant boiling solution was treated with 4.0 g of potassium peroxydisulphate (1.5 × 10⁻² mole) over a period of 25 to 30 minutes, added in 0.40g increments. Boiling was continued for 10 minutes after complete addition of potassium peroxydisulphate. The reaction takes place as indicated below.

\[
\text{NiSO}_4 + \text{KIO}_4 + \text{K}_2\text{S}_2\text{O}_8 + 2\ ½ \text{H}_2\text{O} \rightarrow \text{KNiO}_6. \ ½ \text{H}_2\text{O} + 2\text{KHSO}_4 + \text{H}_2\text{SO}_4
\]

The dark red coloured, almost black, crystals that formed (KNiO₆·1/2 H₂O) were allowed to settle and were then washed several times by decantation with 1% potassium peroxydisulphate solution. The product was transferred to a G₃ sintered glass crucible and repeatedly washed with boiling water to remove any adsorbed periodate. The moisture was removed by suction and final drying was made at room temperature over
anhydrous calcium chloride. The complex was characterised by its UV-VIS spectrum, which shows a broad absorbance band at 410 nm. A stock solution of diperiodatonickelate(IV) was prepared by dissolving the above prepared compound (KNI \( \text{Io}_6 \cdot 1/2 \text{H}_2\text{O} \)) in 1.0 mol dm\(^{-3}\) potassium hydroxide solution and 100 mg of KIO\(_4\) is added to it. The resulting solution was stirred vigorously for about 30 minutes at 50\(^\circ\)C and kept aside over 24 hours to get red coloured solution. The dissolved material was filtered through G\(_4\) sintered glass crucible and the filtrate, diperiodatonickelate(IV) solution, was found to be sufficiently stable. The resulting solution was standardised gravimetrically after reducing nickel(IV) to nickel(II) and precipitating the nickel(II) as dimethylglyoxime complex. Periodate (BDH) solution was prepared by weighing the requisite amount of a sample in hot water and it was kept for 24 hours. Its concentration was ascertained iodometrically at neutral pH maintained by a phosphate buffer. The nickel(II) solution was made by dissolving appropriate amount of nickel sulphate (BDH) in water. In the reaction mixture potassium hydroxide (BDH) and potassium nitrate (BDH) were used to provide the required alkalinity and ionic strength respectively.

Since, periodate was present in excess in diperiodatonickelate(IV) complex the possibility of levodopa oxidation by periodate in an aqueous alkaline medium has been checked. The progress of the reaction was followed iodometrically. The results indicated that the reaction between periodate and levodopa was negligibly slow in comparison with the reaction between diperiodatonickelate(IV) and levodopa under the experimental conditions.
Kinetics

Since the reaction was too fast to be monitored by the usual method, kinetic measurements were performed on a Hitachi 150-20 spectrophotometer (Tokyo, Japan) connected to a rapid kinetic accessory (HITECH SFA-12 unit). The oxidation of levodopa by diperiodatonickelate(IV) was followed under pseudo-first order conditions, where levodopa concentration was in excess over diperiodatonickelate(IV) concentration at 30 ± 0.1°C unless otherwise stated. The reaction was initiated by mixing previously thermostatted solutions of diperiodatonickelate(IV) and levodopa of required concentrations, which also contained the required quantities of potassium hydroxide, potassium nitrate and potassium meta-periodate. The total concentration of hydroxide was calculated by considering the potassium hydroxide present in diperiodatonickelate(IV) as well as the potassium hydroxide additionally added. Similarly, the total meta-periodate concentration was calculated by considering the meta-periodate present in diperiodatonickelate(IV) solution and that additionally added. The reaction was followed by measuring the absorbance of the unreacted diperiodatonickelate(IV) in the reaction mixture in a 1 cm quartz cell in the thermostatted compartment of Hitachi 150-20 spectrophotometer (Tokyo, Japan) spectrophotometer at 410 nm, where other constituents of the reaction do not absorb significantly. Diperiodatonickelate(IV) concentration from 1.0 × 10⁻⁵ to 1.4 × 10⁻⁴ mol dm⁻³ in 0.20 mol dm⁻³ alkali obeyed Beer’s law with molar absorbance index, ε = 7500 ± 375 dm³ mol⁻¹ cm⁻¹ at 410 nm (Fig.VII(i) (p.204)). The first order rate constants, k_{obs}, were determined from the plots of log[DPN] versus time. The plots were linear over 80% completion of the reaction and the rate constants were reproducible within ± 5%.
Fig. VII (i)

Verification of Beer’s law for diperiodatonickelate(IV) concentrations at 410 nm in 0.20 mol dm$^{-3}$ alkali at 25$^0$C
As in the previous Chapters the role of surface, effect of dissolved oxygen and added carbonate have been studied and it was found that there is no effect on the rate of reaction.

RESULTS

Stoichiometry and product analysis

Different reaction mixtures with different sets of concentrations of diperiodatonicelate(IV) and levodopa at constant ionic strength and alkali were kept for 2 hours at 25°C in a nitrogen atmosphere. When diperiodatonicelate(IV) concentration was greater than that of levodopa concentration, the unreacted diperiodatonicelate(IV) concentration was determined spectrophotometrically by measuring the absorbance at 410 nm. The product, nickel(II) was found gravimetrically as dimethylglyoxime complex. The carboxylic acid was separated by ether extraction and was identified as 3, 4 dihydroxy phenyl acetic acid. The phenolic and -COOH groups were confirmed by spot tests. The I.R. spectrum of 3, 4 dihydroxy phenyl acetic acid showed bands at 1657 cm\(^{-1}\), 2854 cm\(^{-1}\) and 3450 cm\(^{-1}\) due to a carbonyl (C=O) stretching, and phenolic OH stretching respectively. The results indicated that one mole of levodopa consumes two moles of diperiodatonicelate(IV) according to the equation (1) (Table VII(i)(p.206)).

\[
\text{R-CH}_2\text{-CH-COO}^- + 2 [\text{Ni(OH)}_2 (\text{H}_3\text{IO}_6)_2 (\text{H}_2\text{IO}_6)_2]^{3-} + 3 \text{OH}^- \longrightarrow \\
\text{R-CH}_2\text{-COOH} + 2 \text{Ni(OH)}_2 + 2\text{H}_3\text{IO}_6^{2-} + 2\text{H}_2\text{IO}_6^{3-} + \text{H}_2\text{O} + \text{CO}_2 + \text{NH}_3 \quad (1)
\]

where \( R = \quad \text{HO} \text{-} \text{OH} \text{-} \text{OH} \)
Table VII(i)

Stoichiometry of oxidation of levodopa by diperiodatonicelate(IV) in 0.20 mol dm$^{-3}$ alkali at 25$^0$C

<table>
<thead>
<tr>
<th>Taken [DPN] $\times 10^4$ (mol dm$^{-3}$)</th>
<th>[levodopa] $\times 10^4$ (mol dm$^{-3}$)</th>
<th>Found [DPN] $\times 10^4$ (mol dm$^{-3}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>0.5</td>
<td>0.48</td>
</tr>
<tr>
<td>2.0</td>
<td>1.0</td>
<td>0.02</td>
</tr>
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<td>2.5</td>
<td>0.5</td>
<td>1.51</td>
</tr>
<tr>
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<td>2.0</td>
<td>1.02</td>
</tr>
<tr>
<td>6.0</td>
<td>1.5</td>
<td>2.98</td>
</tr>
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</table>
**Reaction order**

The reaction orders were determined from the slopes of log\(k_{obs}\) versus log(concentration) plots by varying the concentrations of the reductant, periodate and alkali in turn while keeping all other concentrations and conditions constant.

**Effect of \[\text{diperiodatonickelate(IV)}\]**

The concentrations of diperiodatonickelate(IV) was varied in the range 1.0\(\times\)10^{-5}-1.0\(\times\)10^{-4} mol dm\(^{-3}\) at fixed concentrations of levodopa, alkali and ionic strength. The non-variation of the pseudo-first order rate constants at different concentrations of diperiodatonickelate(IV) indicates first order in diperiodatonickelate(IV) concentration (Table VII(ii)(p.209)).

**Effect of \[\text{levodopa}\]**

The substrate, levodopa, was varied in the concentration range from 1.0\(\times\)10^{-4} to 1.0\(\times\)10^{-3} mol dm\(^{-3}\), keeping all other reactant concentrations constant, at a fixed ionic strength (Table VII(ii) (p.209)). The order with respect to levodopa concentration was determined by the slope of the plot of log\(k_{obs}\) versus log[levodopa] and was found to be less than unity (Fig.VII(ii) (p.210)) \(r = 0.9986, S = 0.014\).

**Effect of \[\text{alkali}\]**

The effect of alkali concentration on the rate of reaction was studied, in the range 0.05 to 0.50 mol dm\(^{-3}\), at constant concentrations of reactants and at constant ionic strength (Table VII(ii) (p.209). The order with respect alkali concentration was obtained from the plot of log\(k_{obs}\) versus log[OH\(^-\)] and was found to be less than unity (Fig.VII(ii) (p.210)) \(r = 0.9998, S = 0.005\).
Effect of [periodate]

The effect of periodate concentration was studied by varying the concentration from $1.0 \times 10^{-3}$ to $1.0 \times 10^{-2}$ mol dm$^{-3}$, keeping all other reactant concentrations constant. It was found that the added periodate has no significant effect on the rate of reaction (Table VII(ii) (p.209)).

Effect of initially added products

Effect of initially added products such as Ni(II) in the form of NiSO$_4$ and 3,4 dihydroxy phenylacetic acid, was studied by keeping all other reactant concentrations constant. It was found that the added products have negligible effect on the rate of reaction.

Effect of dielectric constant and ionic strength

The effect of dielectric constant (D) was studied by varying the t-butyl alcohol-water (v/v) content in the reaction mixture with all other conditions being constant. It was found that the change in the dielectric constant does not have any significant effect on the rate of reaction. Similarly, by the variation of ionic strength between 0.1 to 1.0 mol dm$^{-3}$, using potassium nitrate, it was observed that the ionic strength had negligible effect on the reaction rate.

Test for free radicals:

To test the intervention of the free radicals, the reaction mixture was mixed with acrylonitrile and kept for 2 hours in nitrogen atmosphere. On dilution with methanol, white precipitate of polymer was formed, indicating the intervention of free radicals in the reaction. The blank experiment of either diperiodatonickelate(IV) or levodopa with
Table VII(ii)

Effect of diperiodatonickelate(IV), levodopa, alkali and periodate concentrations on the oxidation of levodopa by diperiodatonickelate(IV) in an alkaline medium, at $I = 0.30$ mol dm$^{-3}$ and at 25$^\circ$C.

<table>
<thead>
<tr>
<th>[DPN]$\times 10^5$ (mol dm$^{-3}$)</th>
<th>[levodopa]$\times 10^4$ (mol dm$^{-3}$)</th>
<th>[OH$^-$] (mol dm$^{-3}$)</th>
<th>[IO$_4^-$]$\times 10^3$ (mol dm$^{-3}$)</th>
<th>$k_{obs} \times 10^2$ (s$^{-1}$)</th>
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<td>6.09</td>
</tr>
<tr>
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<td>6.0</td>
<td>0.2</td>
<td>10.0</td>
<td>6.12</td>
</tr>
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</table>
Figure VII(ii)

Order with respect to levodopa and alkali concentrations on the oxidation of levodopa by diperiodatonicelate(IV) in aqueous alkaline medium at 25°C

(Conditions as in Table VII(ii)(p.209))
acrylonitrile alone did not induce polymerisation under the same conditions as those induced with the reaction mixture. Initially added acrylonitrile decreases the rate which also indicates the free radical intervention\textsuperscript{9}.

**Effect of Temperature**

The rate of reaction was measured at different temperatures under varying levodopa concentrations keeping other conditions constant. The rate constants, $k$ of the slow step of Scheme\textsuperscript{1} were obtained from the intercepts of the plots of $1/k_{obs}$ versus $1/[\text{levodopa}]$ at four different temperatures. The values are given in Table\textsuperscript{VII(iii)(p.212)}. The energy of activation was calculated from the plot of $\log k(Y^*_{cal})$ versus $1/T$ (Fig.VII(ii) (p.213) from which the activation parameters were evaluated and are given in Table VII(iii) (p.212).

**DISCUSSION**

The water soluble\textsuperscript{2,4} nickel(IV) periodate complex, $[\text{Ni(HIO}_6)_2\text{(OH)}_2]^6^+$, is reported\textsuperscript{3,10}. However, in an aqueous alkaline medium and at a higher pH range as employed in the study, periodate is unlikely to exist as $\text{HIO}_6^{4^-}$ (as present in the complex) is evident from its involvement in multiple equilibria\textsuperscript{11}, (2)-(4), depending on the pH of the solution.

\begin{align*}
\text{H}_3\text{IO}_6^- & \iff \text{H}_4\text{IO}_6^- + \text{H}^+ \quad K_1 = 5.1 \times 10^{-4} \quad (2) \\
\text{H}_4\text{IO}_6^- & \iff \text{H}_3\text{IO}_6^{2^-} + \text{H}^+ \quad K_2 = 4.9 \times 10^{-9} \quad (3) \\
\text{H}_3\text{IO}_6^{2^-} & \iff \text{H}_2\text{IO}_6^{3^-} + \text{H}^+ \quad K_3 = 2.5 \times 10^{-12} \quad (4)
\end{align*}

Periodic acid exists as $\text{H}_3\text{IO}_6$ in acid medium and as $\text{H}_4\text{IO}_6^-$ at around pH of 7. Under the conditions employed in the alkaline medium the main species are expected to be $\text{H}_3\text{IO}_6^{2^-}$ and $\text{H}_2\text{IO}_6^{3^-}$. At higher concentrations, periodate also tends to dimerise.
Table VII(iii)

(a) Effect of variation of temperature on the oxidation of levodopa by diperiodatonickelate(IV) in an aqueous alkaline medium

\[
\begin{align*}
[\text{DPN}] &= 6.0 \times 10^{-5} ; \\
[\text{OH}^-] &= 0.20 ; \\
I &= 0.30 / \text{mol dm}^{-3}.
\end{align*}
\]

<table>
<thead>
<tr>
<th>Temperature (K)</th>
<th>( k \times 10 )</th>
<th>log ( k )</th>
<th>( 1/T \times 10^3 )</th>
<th>( Y^*_{\text{calc}} )</th>
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<td>3.36</td>
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<tr>
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<td>-0.7595</td>
<td>3.25</td>
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</tr>
<tr>
<td>313</td>
<td>2.09</td>
<td>-0.6799</td>
<td>3.20</td>
<td>-0.6797</td>
</tr>
</tbody>
</table>

*Calculated

(b) Activation parameters with respect to slow step of Scheme 1.

\[
\begin{align*}
\text{Ea (kJ mol}^{-1}\text{)} & \quad 42.1 \pm 1.4 \\
\Delta S^\# (\text{JK}^{-1} \text{mol}^{-1}) & \quad -132 \pm 11 \\
\Delta H^\# (\text{kJ mol}^{-1}) & \quad 39.6 \pm 1 \\
\Delta G^\# (\text{kJ mol}^{-1}) & \quad 79.9 \pm 4 \\
\log A & \quad 6.4 \pm 0.2
\end{align*}
\]
Fig. VII(iii)

Effect of variation of temperature on the oxidation of levodopa by diperiodatonicelate(IV) in an aqueous alkaline medium

(Conditions as in Table VII(iii)(p.212))
Hence, at the pH employed in the study, the Ni(IV) periodate complex exists as diperiodatonickelate(IV), \([\text{Ni(H}_3\text{IO}_6)_2(\text{OH})_2]^{2-}\), a conclusion also supported by earlier study\(^3\).

The reaction between diperiodatonickelate(IV) and levodopa has 2:1 stoichiometry of oxidant to reductant with first order dependence in diperiodatonickelate(IV), less than unit order each in levodopa and alkali concentrations. In most of the reports\(^3,4\) on the diperiodatonickelate(IV) oxidation, periodate had a retarding effect and monoperiodatonickelate(III) (MPN) is considered to be the active species. However, in the present kinetic study, different kinetic observations have been observed. Periodate has totally no effect on the rate of the reaction. Accordingly, the diperiodatonickelate(IV) is considered to be the active species of the oxidant. The fractional order in the substrate, levodopa, presumably results a complex formation between the oxidant and substrate, which then decomposes in a slow a step to give the free radical derived from the levodopa and intermediate nickel(III) species. The free radical further reacts with nickel(III) species in a fast step to give intermediate, aldehyde of levodopa with nickel(II) product. Further, this intermediate aldehyde reacts with another mole of diperiodatonickelate(IV) species in a fast step to give the product. The evidence for the formation of nickel(III) intermediate species is supported by the literature\(^12\). Indeed it is to be noted that Michaelis-Menten plot, \(1/k_{\text{obs}}\) versus \(1/\text{[levodopa]}\) (Fig.VII(iv) (p.218)) \((r = 0.9932. \: S = 0.017)\) shows a non zero intercept which indicates the complex formation. Such complex formation between substrate and oxidant have been reported in the literature\(^13\). The experimental results support the following mechanism.
\[
\begin{align*}
[Ni(OH)_2(H_3IO_6)_2]^{2-} + OH^- &\rightleftharpoons K_4 [Ni(OH)(H_3IO_6)(H_2IO_6)]^{3-} + H_2O \\
[Ni(OH)_2(H_3IO_6)(H_2IO_6)]^{3-} + RCH_2CH-COO^- &\rightleftharpoons K_5 \text{Complex}(C) + H_2O
\end{align*}
\]

\[
\begin{align*}
\text{Complex}(C) \xrightarrow{\text{slow}} &\quad RCH_2CH + Ni(OH)_2^+ + H_3IO_6^{2-} + H_2IO_6^{3-} + H_2CO_3 \\
\text{fast} &\quad RCH_2CHO + Ni(OH)_2 + NH_3
\end{align*}
\]

\[
\begin{align*}
RCH_2CHO + [Ni(OH)_2(H_3IO_6)(H_2IO_6)]^{3-} + H_2O &\rightarrow RCH_2COOH + Ni(OH)_2 + H_3IO_6^{2-} + H_2IO_6^{3-} + 2H^+
\end{align*}
\]

Scheme 1

where R = \[
\begin{array}{c}
\text{levodopa} = \text{LDP} = Ni^{2+}
\end{array}
\]

levodopa = LDP = HO-CH=CH-COOH
The probable structure of the complex is

\[
\begin{align*}
\text{[Ni(OH)}_2 \text{(H}_3 \text{IO}_6)_2]\text{]}^{2-} & = \text{[Ni(OH)}_2 \text{(H}_3 \text{IO}_6)_2]\text{]}^{2-} \text{ [OH}^\text{-}]_f \text{ [LDP]}_f \\
+ K_4 K_5 \text{[Ni(OH)}_2 \text{(H}_3 \text{IO}_6)_2]\text{]}^{2-} & = \text{[Ni(OH)}_2 \text{(H}_3 \text{IO}_6)_2]\text{]}^{2-} \text{ [OH}^\text{-}]_f \\
+ K_4 K_5 \text{[Ni(OH)}_2 \text{(H}_3 \text{IO}_6)_2]\text{]}^{2-} & = \text{[Ni(OH)}_2 \text{(H}_3 \text{IO}_6)_2]\text{]}^{2-} \text{ [OH}^\text{-}]_f \text{ [LDP]}_f
\end{align*}
\]

where the subscripts ‘t’ and ‘f’ stands for total and free respectively.

\[
[Ni(OH)_2 (H_3IO_6)_2]_f^{2-} = \frac{[Ni(OH)_2 (H_3IO_6)_2]^{2-}}{(1 + K_4 [OH^-]_f + K_4 K_5 [OH^-]_f [LDP]_f)}
\]

From Scheme 1, rate law (12) may be derived as follows:

\[
\text{Rate} = k [C]
\]  

From the first and second steps of Scheme 1 we have,

\[
[C] = k K_5 [Ni(OH)_2 (H_3IO_6) (H_2IO_6)]^{2-} [LDP]
\]  

Substituting equations (6) and in (5) we get,

\[
\text{Rate} = k K_4 K_5 [Ni(OH)_2 (H_3IO_6)_2]_f^{2-} [OH^-]_f [LDP]_f
\]  

But,

\[
[Ni(OH)_2 (H_3IO_6)_2]_t^{2-} = [Ni(OH)_2 (H_3IO_6)_2]_f^{2-} + [Ni(OH)_2 (H_3IO_6)(H_2IO_6)]_f^{3-}
\]
Similarly, 

\[ [\text{LDP}]_t = [\text{LDP}]_f + [\text{C}] \]

\[ [\text{LDP}]_t = [\text{LDP}]_f + K_4 K_5 [\text{Ni(OH)₂(H₃IO₆)}_2]_f^{2-} [\text{OH}^-]_f [\text{LDP}]_f \]

\[ [\text{LDP}]_t = [\text{LDP}]_f / (1 + K_4 K_5 [\text{Ni(OH)₂(H₃IO₆)}_2]_f^{2-} [\text{OH}^-]_f) \]

In view of low nickel(IV) concentrations used, the term \( K_4 K_5 [\text{Ni(OH)₂(H₃IO₆)}_2]_f^{2-} [\text{OH}^-]_f \) can be neglected in comparison with unity.

\[ \therefore [\text{LDP}]_t = [\text{LDP}]_f \tag{9} \]

Similarly,

\[ [\text{OH}^-]_t = [\text{OH}^-]_f + [\text{Ni(OH)₂(H₃IO₆)}]^{3-} \]

\[ [\text{OH}^-]_f = [\text{OH}^-]_f / (1 + K_4 [\text{Ni(OH)₂(H₃IO₆)}]^{2-}) \]

Since, \( K_4 [\text{Ni(OH)₂(H₃IO₆)}]^{2-} \) is too small in comparison with unity, it may also be neglected.

Hence, \( [\text{OH}^-]_t = [\text{OH}^-]_f \tag{10} \)

Substituting equations (8), (9) and (10) into equation (7), omitting the subscripts, we get,

\[ \text{Rate} = \frac{k K_4 K_5 [\text{Ni(IV)}] [\text{OH}^-] [\text{LDP}]}{1 + K_4 [\text{OH}^-] + K_4 K_5 [\text{OH}^-] [\text{LDP}]} \tag{11} \]

The rate law (11) can be rearranged to equation (12), which is suitable for verification.

\[ \frac{1}{k_{\text{obs}}} = \frac{1}{k K_4 K_5 [\text{LDP}] [\text{OH}^-]} + \frac{1}{k K_5 [\text{LDP}]} + \frac{1}{k} \tag{12} \]

According to equation (12), other conditions being constant, the plots of \( 1/k_{\text{obs}} \) versus \( 1/[\text{LDP}] \) \(( r = 0.9932. \ S = 0.017)\) and \( 1/k_{\text{obs}} \) versus \( 1/[\text{OH}^-] \) \(( r = 0.9858. \ S = 0.022)\) should be linear and are found to be so (Fig. (iv) (p.218)). From the intercepts of such plots, the value of \( k \) is obtained as \( 9.69 \times ± 0.1 \times 10^{-2} \text{ sec}^{-1} \).
Fig. VII(iv)

Verification of rate law (11) in the form of (12) for the oxidation of levodopa by diperiodatonicelate(IV) in an aqueous alkaline medium at 25°C

(Conditions as in Table VII(ii)(p.209))
The mechanism is supported by moderate values of thermodynamic activation parameters. High negative value of $\Delta S^\#$ suggests that the complex is more ordered than the reactants.

**Importance of Chapter VII**

Among various species of DPN in alkaline medium, deprotonated DPN is considered as the active species for the title reaction. It becomes apparent that in carrying out this reaction, the role of pH in the reaction medium is crucial. The rate constant of the slow step and other equilibrium constants involved in the mechanism were evaluated and activation parameters with respect to the slow step of the reaction were computed. The overall mechanistic sequence described here is consistent with product and kinetic studies.
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