KINETIC INVESTIGATIONS ON THE REACTION OF PERTECHNETATE WITH DIMERCAPTOPUSCINIC ACID

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The kinetics of the reaction of pertechnetate with racemic and meso-dimercaptosuccinic acid in acidic solution have been studied. The reaction is first order in each reactant and is dependent on the acidity of the solution.

Technetium forms compounds with dimercaptosuccinic acid (DMSA) in the oxidation state +V and +IV of technetium, which are of importance in radiopharmacology /1, 2/. Generally, for their synthesis pertechnetate is reduced in the presence of DMSA, either with stannous chloride or, more directly, with DMSA itself.

We have investigated the reaction of $^{99m}$Tc/$^{99}$Tc pertechnetate with rac-DMSA as well as meso-DMSA /3/ in acidic solution. meso-DMSA is sparingly soluble in water and therefore the investigations with this substance were limited.

It was found that pertechnetate in acidic solution is converted to an oxobis(dimercaptosuccinato) technetium(V) complex, its detailed structure being unknown so far. By analogy to the reaction of pertechnetate with cysteine /4/, we assume that two molecules of the sulfur compound are necessary to reduce Tc(VII) to Tc(V) according to the stoichiometric equation

$$\text{TcO}_4^- + 4 \text{DMSA} \xrightarrow{H^+} \text{TcO(DMSA)}_2 + 2 \text{ox-DMSA}$$
Table 1

Kinetic data for the reaction of pertechnetate with rac-DMSA at 25 °C

<table>
<thead>
<tr>
<th>[HCl] (mol 1⁻¹)</th>
<th>[DMSA] x10² (mol 1⁻¹)</th>
<th>k x10³ (s⁻¹)</th>
<th>k₁ x10² (1 mol⁻¹ s⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.6</td>
<td>3.9</td>
<td>2.3</td>
<td>5.9</td>
</tr>
<tr>
<td></td>
<td>2.9</td>
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<td>4.7</td>
</tr>
<tr>
<td>0.8</td>
<td>3.7</td>
<td>3.1</td>
<td>8.4</td>
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<tr>
<td></td>
<td>3.0</td>
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<tr>
<td></td>
<td>1.85</td>
<td>1.5</td>
<td>8.1</td>
</tr>
<tr>
<td></td>
<td>0.93</td>
<td>0.7</td>
<td>7.5</td>
</tr>
</tbody>
</table>

The time dependence of pertechnetate concentration has been determined radiochromatographically (/4/, water as eluant). This reaction has also been characterized spectrophotometrically. At a large excess of DMSA (5x10⁻³ to 2x10⁻¹ mol 1⁻¹) over pertechnetate, (1x10⁻⁴ mol 1⁻¹) the reaction is pseudo-first order

\[-d[TcO^2^-]_4\over dt = k[TcO^2^-]_4\]

Representative second order rate constants

\[k_1 = k / [DMSA]\]

are given in Table 1. The rate constants can be measured with an error of >15%. No significant differences are observed in the reaction rate between the two isomeric forms.