CHAPTER I
INTRODUCTION

Hydroxamic acids are the bidentate ligands with the functional grouping (I).

\[
\begin{array}{c}
- \text{N} - \text{OH} \\
\text{C} = \text{O}
\end{array}
\quad \begin{array}{c}
\text{O} - \text{N} - \text{OH} \\
\text{O} - \text{C} = \text{O}
\end{array}
\] (I) (II)

These acids are having the remarkable versatility for the organic and inorganic analysis (1-25). The parent compound, N-phenylbenzohydroxamic acid (II), was extensively used in spectrophotometry, amperometry, polarography, titrimetry, gravimetry, spot test analysis etc. (26-50).

Several N-aryl hydroxamic acids (III) have been synthesised by making substitution in N-atom (R) and in C-atom (R')

\[
\begin{array}{c}
\text{R} - \text{N} - \text{OH} \\
\text{R'} - \text{C} = \text{O}
\end{array}
\] (III)

Structurally, hydroxamic acids can be represented in the following two tautomeric forms (IV) and (V).

\[
\begin{array}{c}
\text{R} - \text{N} - \text{OH} \\
\text{R'} - \text{C} = \text{O}
\end{array}
\quad \begin{array}{c}
\text{N} - \text{OH} \\
\text{R'} - \text{C} - \text{OR}
\end{array}
\] (IV) (V)
These acids are capable of forming complexes with metal ions which are generally inner complex compounds. Complexes are usually found via the substitution of a hydrogen atom of hydroxylamine by a metal cation and ring closure via the carbonyl oxygen atom:

\[
\begin{align*}
\text{n} & \quad \left[ \begin{array}{c} R' - \text{N} - \text{OH} \\
R' - \text{C} = \text{O} \end{array} \right] \\
\text{H}^{n+} & \quad \iff \\
\text{H} & \quad \left[ \begin{array}{c} R' - \text{N} - \text{O} \\
R' - \text{C} = \text{O} \end{array} \right]_{\text{n}} \\
& \quad \text{nH}^+ \end{align*}
\]

Due to their non-ionic nature, these inner complexes can be extracted from aqueous solution or suspensions with water immiscible solvents viz. chloroform, carbon tetrachloride, toluene, o-dichlorobenzene, iso-amyl alcohol and higher alcohols and thus form the basis of separation processes employing solvent extraction. In case the extracts are coloured and sufficiently stable, they can be employed for developing spectrophotometric methods for the determination of metal ions.

**Substituted Arylhydroxamic Acids:**

It has been observed that with increase in length of conjugation by introduction of side chain double bond \((-\text{CH} = \text{CH} -)_n\) between \(R'\) group and carbon atom of carbonyl group (51-53), the sensitivity and selectivity of the reagent is increased and hence received considerable attention as analytical reagents (53-60).
Poly Hydroxamic Acids:

Polymers with carboxylic acids were further modified to give corresponding hydroxamic acid polymers (61-63). The pioneering work on poly hydroxamic acids was reported by Cornaz and Deuel (62,63), based on the conversion of carboxylic group in Amberlite IRC-50, acrylic acid, poly (methacrylic acid) etc. into hydroxamic acid. Kern and Schulz (64) have synthesised poly (methacrylohydroxamic acid) by reacting hydroxylamine hydrochloride with poly (methyl methacrylate) in presence of sodium methoxide. Grubhofer and Schleith (65) have prepared acid chloride by reacting highly cross linked methacrylic acid with thionyl chloride in presence of pyridine, however, the conversion was only 50% to acid chloride. Peden et al. have synthesised α,β unsaturated hydroxamic acids (66).

Veron et al. (67-73) have synthesised various chelating resins containing hydroxamic acid functional groups by reacting hydroxylamine with ester and phenyl-hydroxylamine with acid chloride, based on Scotten Bowman reaction of acid chloride (74). Cross linked copolymer of styrene ethylacrylate - acrylonitrile were synthesised from corresponding monomers by free radical polymerization prior to the reaction of hydroxylamine to yield macroporous microbead polyhydroxamic acid resins (68). Winston et al. have prepared hydroxamic acid polymers by condensing acryl/methacryl amide of amino acid with N-hydroxy succinamide, further the ester was polymerized and coupled with hydroxylamine in dimethyl formamide (75-81).
Marshall has synthesised chelating ion exchange polymer from polyacrylonitrile fibers by hydrolysis, acid chloride formation and finally reacting with hydroxylamine (62). Phillips and Fritz have prepared the hydroxamic acid derivatives from Amberlite XAD-4 converting the carboxylic acid group of resin to acid chloride and then coupling it with hydroxylamine (63-67). Recently a few synthesis of endocyclic poly hydroxamate macrocycles have been reported (65).

A detailed survey of literature on hydroxamic acids and ion-exchange resins is deliberately avoided because of their various aspects chemistry viz. method of preparation, properties, molecular arrangements, structure and applications in diverse field have been reviewed exhaustively and excellently covered by a number of specialised monographs, review articles and text-books (68-126).

A review of the literature available on the applications of poly hydroxamic acids (61-73, 75-87, 127-165) is summarised in Table I.
### TABLE - I

**Review of Literature on Polyhydroxamic Acids and Their Applications**

<table>
<thead>
<tr>
<th>Polymer</th>
<th>Metal ions studied</th>
<th>Separation of metal ions</th>
<th>Eluant</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. acyl-phenyl hydroxyamine resin from PMMP 226</td>
<td>Fe(III) &amp; (III)(3.0); V(IV)(5.0); Cu(II)(4.0); Co(II); Ni(III).</td>
<td>Hg-Pb (1.53);</td>
<td>28 H₂SO₄ (Cu, Co, Ni)</td>
<td>68</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>H₂COOH (Pb)</td>
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<td></td>
<td></td>
<td></td>
<td>NaNO₂-HNO₃ (Pb)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>68 H₂COOH (Pb)</td>
<td></td>
</tr>
<tr>
<td>2. H-benzy-anil-Phe Hydroxylamine polymer</td>
<td>Cu(II)(5.0); V(IV)(3.0); &amp; (3.0); Fe(III)(3.0); W(II)(12.0)(7.0)</td>
<td>Cu(II)-Co(II)</td>
<td>28 H₂SO₄, CuO, Fe, 100%</td>
<td>67</td>
</tr>
<tr>
<td>Poly(ethylenimine)</td>
<td></td>
<td></td>
<td>48 H₂SO₄ (V)</td>
<td></td>
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<tr>
<td>Toluene-cetylcobalamin</td>
<td></td>
<td></td>
<td>2.5% acid</td>
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<tr>
<td>polymer</td>
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<td></td>
<td>(3.0); V-Pe</td>
<td></td>
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<td>3. Cellulose Hytronamic acid polymer</td>
<td>Cu(II), Fe(III), Ca(II), Ca(II).</td>
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<td>137.138</td>
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<tr>
<td>Polymer</td>
<td>Metal ions studied</td>
<td>Separation of metal ions</td>
<td>Eluant</td>
<td>References</td>
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<tr>
<td>4. Cellulose hydroxamic acid polymer</td>
<td>Metal ions mixed:</td>
<td></td>
<td></td>
<td>359, 360</td>
</tr>
<tr>
<td></td>
<td>Cr(III)+Fe(III) 11.603³, 11.603³;</td>
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<tr>
<td></td>
<td>Cr(III)+Cu(II) 15.023³, 14.893³;</td>
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<tr>
<td></td>
<td>Cr(III)+Ag(II) 14.203³, 12.372³;</td>
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<td></td>
<td>Cr(III)+Hg(II) 14.893³, 12.327³;</td>
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<tr>
<td></td>
<td>Cu(II)+Cu(III) 13.903³, 12.437³;</td>
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<tr>
<td></td>
<td>Cu(II)+Zn(II) 14.413³, 12.372³;</td>
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<tr>
<td></td>
<td>Cu(II)+Cr(III) 12.763³, 12.273³;</td>
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<tr>
<td></td>
<td>Cu(III).</td>
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<tr>
<td>5. Chelex 100</td>
<td>Fe</td>
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<td>78</td>
</tr>
<tr>
<td>6. Cross linked hydroxamic acid polymer</td>
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<td>155</td>
</tr>
<tr>
<td>7. Cross linked hydroxamic acid resin (containing amidoxime or hydromalic acid functional groups)</td>
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<td>157</td>
</tr>
<tr>
<td>Polymer</td>
<td>Metal ions studied</td>
<td>Separation of metal ions</td>
<td>Eluent</td>
<td>References</td>
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<tr>
<td>3. Dowlite CS-46</td>
<td>Fe(II) (1.55); Co(II) (3.8); Co(II) (3.8); Ni(II) (3.5); UO$_2$(II) (2.4)</td>
<td>Fe - Cu (1.55); Fe, Cu - other metal ions (3.8)</td>
<td>2M H$_2$SO$_4$</td>
<td>71</td>
</tr>
<tr>
<td>3. Endocyclic hydroxamate macrocule</td>
<td>Ni(II) and Fe</td>
<td>--</td>
<td>--</td>
<td>35</td>
</tr>
<tr>
<td>10. Hydronamic acid polymer of Amberlite I.A.C. 50</td>
<td>Fe(II), Fe(III) &amp; (III), Mn(II), Mn(II)</td>
<td>--</td>
<td>--</td>
<td>61</td>
</tr>
<tr>
<td>11. N-Hydroxy-4-carbamoyl</td>
<td>Ni(II) (4.6); Tb(I) (2.5); Ni(II) (4.6); Tb(III) (2.5)</td>
<td>--</td>
<td>--</td>
<td>53, 127</td>
</tr>
<tr>
<td>Ni5-1</td>
<td>Ni (1.4)</td>
<td>Tb(IV) (12.5); U(IV)-(U(VI) (2.8)</td>
<td>2M HCl</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.5M HCl, 3M HF</td>
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<td></td>
<td>0.5M HCl; 0.5M HCl-0.1M</td>
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<td>Dantonic acid (TH)</td>
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<td></td>
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<td>HCl, HClO$_4$</td>
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<tr>
<td>Polymer</td>
<td>Metal ions studied</td>
<td>Separation of metal ions</td>
<td>Bluent</td>
<td>References</td>
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<tr>
<td>12. N-Methyl hydroxamic acid XAD-4 resin</td>
<td>Mg(II)(5.4); Ca(II)</td>
<td>--</td>
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<td>84</td>
</tr>
<tr>
<td></td>
<td>(5.6); Mn(II)(5.2);</td>
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<td></td>
<td>Co(II)(4.0);</td>
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<td></td>
<td>Ni(II)(3.6); Zn(II)</td>
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<td></td>
<td>Zn(II)(3.6); Cr(III)</td>
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<tr>
<td></td>
<td>(3.6); Cr(III)(3.6);</td>
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<td></td>
<td>La(III)(2.5); La(III)</td>
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<td></td>
<td>Eu(III)(2.8); Eu(III)</td>
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<td></td>
<td>Cu(II)(2.1); U(VI)</td>
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<td></td>
<td>Sc(III)(1.0); Th(IV)</td>
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<td></td>
<td>Ca(II)(1.5) Fe(III)(1.0)</td>
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</tbody>
</table>

<p>| 11. N-Hydroxy-N-phenyl carbamoyl XAD-4 resin | VNI 0.2M H2SO4; Cu(II)(4.0); |                      |             | 83         |
|                                              | Al(III)(4.0); Fe(III)(4.0); La(III)(3.8); |                      |             |            |
|                                              | Th(IV) 0.1M HCl; Zr(IV) 2M HCl; |                      |             |            |
|                                              | Ti(IV)(2.0); U(VI)(4.0); Bo(VI); |                      |             |            |
|                                              | 2M HCl + 0.1M tartaric acid; |                      |             |            |
|                                              | V(VI) 2M HCl + 0.1M tartaric acid- |                      |             |            |
|                                              | Mg(II), Ca(II), Pb(II), Mn(II), |                      |             |            |
|                                              | As(III), Mo(VI), Se(VI), |                      |             |            |
|                                              | U(VI), and Se(VI); |                      |             |            |
|                                              | 0.5, 2.4, 10M HCl (V). |                      |             |            |
|                                              | 0.1M HCl (Cu), 0.1M citric acid, 0.1M oxalic acid |                      |             |            |
|                                              | 1.2M HCl or 5M H3PO4 |                      |             |            |
|                                              | 1M HCl, 0.1M oxalic acid |                      |             |            |
|                                              | 0.2M H2, 0.1M HCl |                      |             |            |
|                                              | 1M H3PO4 + 0.1M tartaric acid |                      |             |            |
|                                              | 1M NaHCO3 |                      |             |            |
|                                              | 2M HCl |                      |             |            |</p>
<table>
<thead>
<tr>
<th>Polymer</th>
<th>Metal ions studied</th>
<th>Separation of metal ions</th>
<th>Eluant</th>
<th>References</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>polyure of Amberlite</td>
<td>Back extracted Zn(II).</td>
<td>Ti(IV) and U(VI).</td>
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<td></td>
<td>MG-4 containing M-</td>
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<td></td>
<td>N-Methylphenyl hydromonic acid groups</td>
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<tr>
<td>15. Poly (acylhydromonic acid)</td>
<td>Na(Cd(II). Ag(III). Mg(II). Ca(II), Sr(II), Ba(II), Mn(II), Cd(II), Ag(I), Al(III), Fe(II).</td>
<td>Pb(II). Bi(III), Hg(II), Fe(II).</td>
<td>Fe(II), Co(II), Ni(II), Cu(II) and Se(IV) and U(VI).</td>
<td>--</td>
</tr>
<tr>
<td>16. Poly (acylhydromonic acid) resin</td>
<td>Fe(II), Fe(III). Cu(II), Mn(II), Ni(II).</td>
<td>HCl</td>
<td>HgSO₄, 5M HCl, 5M HNO₃</td>
<td>69.78</td>
</tr>
<tr>
<td></td>
<td>Cu(II), V(IV), Mg(II), Hg(II) and Pd(II).</td>
<td>20 wt</td>
<td>citric acid, 14 H₂O/H₂O</td>
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<tr>
<td></td>
<td></td>
<td>V-Fe (2.01).</td>
<td>4M HCl.</td>
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<td>U-Fe (8.21).</td>
<td>2M HCl.</td>
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<td></td>
<td>Cu-Co-Mg-Cu (3.51).</td>
<td>1M HCl. 2H HCl</td>
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<td></td>
<td></td>
<td>Cu-Mn (4.6).</td>
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<tr>
<td>Polymer</td>
<td>Metal ions studied</td>
<td>Separation of metal ions</td>
<td>Eluant</td>
<td>References</td>
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<tr>
<td>17. Poly (acrylohydroxamic acid)</td>
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<td>139,138.</td>
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<tr>
<td>18. Poly (acrylohydroxamic acid) (from Bezran and Aculliam)</td>
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<td>--</td>
<td>132,133.</td>
</tr>
<tr>
<td>19. Poly (acrylo-6-chloroacrylohydroxamic acid)</td>
<td>C8</td>
<td>--</td>
<td>HCl</td>
<td>135</td>
</tr>
<tr>
<td>20. Poly (vinylphenene) acrylohydroxamic acid copolymer</td>
<td>--</td>
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<td>140</td>
</tr>
<tr>
<td>21. Poly (acrylohydroxamic acid)</td>
<td>3d metals</td>
<td>--</td>
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<td>143</td>
</tr>
<tr>
<td>Polymer</td>
<td>Metal ions studied</td>
<td>Separation of metal ions</td>
<td>Eluant</td>
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<td>-------------------------------------------</td>
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</tr>
<tr>
<td>Poly (acrylohydroxytartic acid) resin</td>
<td>Cu(II), Zn(II), Ni(II)</td>
<td>1M HCl, HNO₂, H₂SO₄/Cu(II), Zn(II)</td>
<td>(54.151)</td>
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<tr>
<td></td>
<td>Pb(II), Cd(II)</td>
<td>1-5M HCl, HNO₂, H₂SO₄</td>
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<tr>
<td></td>
<td>Co(II), Cu(II)</td>
<td>CH₃COOH, MeOH (50%)</td>
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<tr>
<td></td>
<td>Ni(II)</td>
<td>5% H₂O₂, 0.25M tartaric acid</td>
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<td></td>
<td>Zn(II)</td>
<td>0.5M HCl</td>
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<tr>
<td></td>
<td>Cu-CO-Ni (Co(2.01), Cu-Ni)</td>
<td>0.15M tartaric acid (Co)</td>
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<tr>
<td>Poly(6-p-bromophenylpolyacrylohydroxamic acid) resin</td>
<td>Cu(III), Pb(III), Cd(III), Cr(VI)</td>
<td>1M HCl, HNO₂, H₂SO₄/Cu(III), Cr(VI)</td>
<td>(154)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V(II), Cr(VI), Zn(III), Co(III)</td>
<td>CH₃COOH, MeOH (50%)</td>
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<tr>
<td></td>
<td>Ni(III), Mn(III), Zn(II)</td>
<td>5% H₂O₂, 0.25-1M tartaric acid</td>
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<tr>
<td>Cu(II), Pb(II), Zn(II), Cd(II), Cr(VI)</td>
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<tr>
<td>Polymer</td>
<td>Metal ions studied</td>
<td>Separation of metal ions</td>
<td>Blunt</td>
<td>References</td>
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<tr>
<td>24. Poly (styrene DVB acryloyl/trimanic acid resin)</td>
<td>Ag(II), Cu(II), Al(III), Fe(III), Au(III)</td>
<td>In H₂SO₄, In Mg₂O₂</td>
<td>U-Hg.</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>U-Hg, Pb, Cu, Fe, Ti</td>
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<td></td>
<td></td>
<td></td>
<td>Re, V, Th, Bi, Sr.</td>
<td></td>
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<tr>
<td>25. Poly (N-Methyl-acrylamide hydroxamic acid)</td>
<td>Pe</td>
<td>--</td>
<td>--</td>
<td>75</td>
</tr>
<tr>
<td>26. Polycrylonitrile fibres</td>
<td>Cu(II), Fe(III)</td>
<td>--</td>
<td>--</td>
<td>82</td>
</tr>
<tr>
<td>27. Polyhydroxamic acid resin</td>
<td>Hg(II), Cu(II), Fe(III), Cr(III)</td>
<td>U</td>
<td>--</td>
<td>149</td>
</tr>
<tr>
<td>28. Polyhydroxamic acid</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>158</td>
</tr>
<tr>
<td>Polymer</td>
<td>Metal ions studied</td>
<td>Separation of metal ions</td>
<td>Eluant</td>
<td>References</td>
</tr>
<tr>
<td>----------------------</td>
<td>------------------------------------------------------------------------------------</td>
<td>--------------------------</td>
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<td>------------</td>
</tr>
<tr>
<td>29. Polyphosphonic acid resin</td>
<td>Cu(II)(4.4); Fe(III)(1.5); Mn(II)(5.0); Sn(II) (5.4); Zn(II)(6.0); Pb(II) (5.8);</td>
<td></td>
<td>HCl</td>
<td>161.162</td>
</tr>
<tr>
<td></td>
<td>Be(II)(2.0); Y(III)(3.8); U(III)(4.5).</td>
<td></td>
<td>Citrate buffer, pH 4.5</td>
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</tr>
<tr>
<td>30. Polyphosphonic acid resin</td>
<td>Cu(II)(4.4); Mn(II)(1.0); Ag(II)(1.4).</td>
<td></td>
<td>KNO₃ 0.5% pH 4; 0.5M HCl; 0.5M HNO₃</td>
<td></td>
</tr>
</tbody>
</table>

Au-hg 0.5M HCl
Ag(I),
Au

0.5, 0.05M HNO₃, 0.5M KNO₃
40% HCl, 14.45% HCl
HCl - EOH, 0.5M KNO₃

Au-Pb-Cu/Au 0.5M HCl;
Cu,
Au
Fe(II)
Ag

0.5M HCl
0.5M KNO₃
2M HCl
0.5M HNO₃
<table>
<thead>
<tr>
<th>No.</th>
<th>Polymer</th>
<th>Metal ions studied</th>
<th>Separation of metal ions</th>
<th>Eluant</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>31.</td>
<td>Polymers and copolymers of acrylo-hydroxamic acid, methacrylo-hydroxamic acid, croton hydroxamic acid, cinnamoylhydroxamic acid.</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>46</td>
</tr>
<tr>
<td>32.</td>
<td>Poly [acrylo-1-methylacrylo-1-methyl methacrylo-1-hydroxamic acid] with salino acid as spacer, Poly [acrylo-1-methacrylo-1-dihydroxamic acid].</td>
<td>Fe</td>
<td>--</td>
<td>--</td>
<td>76, 77, 79, 68, 61</td>
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<tr>
<td>33.</td>
<td>Poly (methacrylo-hydroxamic acid) resin</td>
<td>Cu(II), Cu(I), Zn(II).</td>
<td>--</td>
<td>--</td>
<td>62</td>
</tr>
<tr>
<td>34.</td>
<td>Poly [sulphohydroxamic acid].</td>
<td>Cu and Ni (I-6)</td>
<td>--</td>
<td>--</td>
<td>143</td>
</tr>
<tr>
<td>Polymer</td>
<td>Metal ions studied</td>
<td>Separation of metal ions</td>
<td>Eluant</td>
<td>References</td>
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</tr>
<tr>
<td>Styrene-DVB-Acryl hydroxamic acid copolymer</td>
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<td>--</td>
<td>--</td>
<td>68</td>
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<tr>
<td>Styreneacrylo-hydroxamic acid resin</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>139</td>
<td></td>
</tr>
<tr>
<td>Styrene Methylacryl- hydroxamic acid resin</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>139</td>
<td></td>
</tr>
<tr>
<td>Styrene Maleic anhydride hydroxamic acid copolymer</td>
<td>Cu, Fe, Co, Cl and U</td>
<td>--</td>
<td>HCl</td>
<td>114</td>
<td></td>
</tr>
</tbody>
</table>

Note:  
M = Molarity of the acid/base  
[ ] = pH of the metal solution  
[ ]^a = pH before addition of the sample  
[ ]^b = pH after addition of sample  
** = pH for 50% extraction.
AIMS AND SCOPE:

The polymers with chelating groups are selective for certain metal ions compared to acidic or basic groups. The analytical potentialities of hydroxamic acids are well known and are extensively used as complexing reagents for the separation and identification of several cations. Polyhydroxamic acids are amongst the chelating group polymers which are recently explored as ion-exchange materials. The review of the literature work reveals that very less work has been reported for the synthesis and analytical applications of polyhydroxamic acids. With this view it is desirable to synthesise the polyhydroxamic acids by introducing various substituents (in R and R') and to explore their potentiality for chromatographic separation of various cations. The knowledge of their proton-ligand and metal-ligand stability constants will lead to certain their complexation capacity to enable to develop the suitable procedure for the separation of various metals.

THE PRESENT INVESTIGATION:

The present thesis describes the synthesis and properties of polyacrylo- and polymethacrylo- hydroxamic acids. The preparations are made by reacting N-arylhydroxylamine with poly acid chloride at room temperature in diethyl ether solution containing aqueous suspension of sodium bicarbonate. These acids are characterised by HFLC, thermal analysis and infrared
spectra. Their $pK_a$'s are determined in 70% dioxan-water media at $35^\circ \pm 0.1^\circ$C.

The physical properties, volume and density, void-volume, swelling etc. of the synthesised N-phenyl-substituted polyacrylohydroxamic acids have been determined. These polymers are used as resins and their various parameters viz. sodium ion uptake, total cation exchange capacity, rate of sorption, effect of pH and distribution coefficient have been studied. The separation of copper, zinc, nickel, cobalt and lead using polyacrylohydroxamic acids is discussed. The optimum conditions for the separation of divalent ions from the mixture are established. The metal ligand stability constants ($\log \beta_2$) of divalent metal ions with N-phenyl-substituted polyacrylohydroxamic acids are determined in 70% dioxan-water media at $30^\circ \pm 0.1^\circ$C. The method is used for the chromatographic separation and determination of these metals in standard samples.

A new series of polymethacrylohydroxamic acids have been synthesised and complexes of divalent metal ions and their plausible separations are studied. The metal ligand stability constants ($\log \beta_2$) of these metal ions are determined in 70% dioxan-water media at $35\pm 0.1^\circ$C. The order of stability constants and physio-chemical properties have been discussed. These acids are found useful as ion exchange resins and parameters like rate of sorption, effect of pH on distribution coefficient, breakthrough
capacities, total ion exchange capacities etc. are determined. The chromatographic separation systems upto quinary metal ion (Cu, Zn, Ni, Co, Fe and Pb) have been carried out. The method is used for the determination of metal ions in synthetic samples.
REFERENCES

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24


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