CHAPTER V

TERNARY METAL, HISTIDINE OR IMDA OR NTA OR EDTA AND POLYPHENOLIC LIGAND SYSTEMS.

Histidine, IMDA, NTA and EDTA are known to form complexes with a large number of metal ions.[1-8] They are stable and do not dissociate at higher pH[9]. Histidine exhibits bi or tridentate character,[10] coordination taking place from COO^- and from nitrogen of the imidazole or two nitrogens from both imidazole and amino groups. IMDA behaves as a tridentate ligand,[11] coordination taking place from the nitrogen and two carboxylate oxygens.[12]

NTA behaves as a tri[13] or quadridentate[14] ligand, coordination taking place from nitrogen atom and two or three COO^- groups, respectively. EDTA mostly exhibits quadridentate character,[15] coordination taking place from two nitrogen atoms and two COO^-. The 1:1 complexes of these multidentate ligands are stable at higher pH, remaining coordination positions around the metal ions being occupied by water molecules. A secondary ligand can replace the water molecules to form mixed ligand complex MAL, where A = Histidine, IMDA, NTA or EDTA. The reaction can be represented as follows :

$$[MA] + L \rightleftharpoons [MAL]$$

$$K_{MAL} = \frac{[MAL]}{[MA][L]}$$

Mixed ligand complexes containing such charged primary ligand ions have been studied by earlier workers[5,16,17] as detailed in chapter I.

No work has been done on mixed ligand complexes of M-Histidine, M-IMDA, M-NTA and M-EDTA with polyphenols.

A study of such systems [MAL] has been carried out in the present investigation. In the [MAL] systems studied, M = Cu(II) or Ni(II) and A = Histidine, IMDA, NTA or EDTA and L = catechol, pyrogallol, 2,3-dihydroxynaphthalene, protocatechuic acid.

Essential conditions required for the formation of the above type of complexes is that [MA] should be formed at low pH and must be stable at higher pH where the combination of the secondary ligand takes place. The conditions are obeyed by the systems undertaken for the study.

Determination of mixed ligand constants :

The reagents and instruments used were same as detailed in previous chapters. For studying the ternary systems following solutions were prepared :

For Histidine :

1. 0.02M $HClO_4$, 0.002M Histidine, 0.178M $NaClO_4$.
2. 0.02M $HClO_4$, 0.002M $HClO_4$, 0.178M $NaClO_4$.
3. 0.02M $HClO_4$,,0.002M Histidine, 0.002M metal perchlorate, 0.176M $NaClO_4$.
4. 0.02M $HClO_4$, 0.002M $HClO_4$, 0.002M secondary ligand, 0.176M $NaClO_4$.
5. 0.02M $HClO_4$, 0.002M Histidine, 0.002M metal perchlorate, 0.002M secondary ligand, 0.174M $NaClO_4$.

For IMDA :

1. 0.02M $HClO_4$, 0.002M IMDA, 0.178M $NaClO_4$.
2. 0.02M $HClO_4$, 0.004M $HClO_4$, 0.176M $NaClO_4$,
3. 0.02M $HClO_4$, 0.002M IMDA, 0.002M metal perchlorate, 0.176M

$NaClO_4$.

4. 0.02M $HClO_4$, 0.004M $HClO_4$, 0.002M secondary ligand, 0.174M $NaClO_4$.
5. 0.02M $HClO_4$, 0.002M IMDA, 0.002M metal perchlorate, 0.002M secondary ligand, 0.174M $NaClO_4$.

For NTA :

1. 0.02M $HClO_4$, 0.002M NTA, 0.178M $NaClO_4$.
2. 0.02M $HClO_4$, 0.006M $HClO_4$, 0.174M $NaClO_4$.
3. 0.02M $HClO_4$, 0.002M NTA, 0.002M metal perchlorate, 0.176M $NaClO_4$.
4. 0.02M $HClO_4$, 0.006M $HClO_4$, 0.002M secondary ligand, 0.172M $NaClO_4$.
5. 0.02M $HClO_4$, 0.002M NTA, 0.002M metal perchlorate, 0.002M secondary ligand, 0.174M $NaClO_4$.

For EDTA :

1. 0.02M $HClO_4$, 0.002M EDTA, 0.178M $NaClO_4$.
2. 0.02M $HClO_4$, 0.004M $HClO_4$, 0.176M $NaClO_4$.
3. 0.02M $HClO_4$, 0.002M EDTA, 0.002M metal perchlorate, 0.176M $NaClO_4$.
4. 0.02M $HClO_4$, 0.004M $HClO_4$, 0.002M, secondary ligand, 0.174M $NaClO_4$.
5. 0.02M $HClO_4$, 0.002M EDTA, 0.002M metal perchlorate, 0.002M secondary ligand, 0.174M $NaClO_4$.

Total volume was made upto 50.0 ml. and ionic strength μ was maintained 0.2M. Each of the above samples was titrated against 0.2M NaOH. The plot of pH against volume of alkali have been presented in figs. V 1 to V 3, V 7 to V 14, V 23 to V 30, and V 39 to V 44.

The horizontal distance between the curves (1) and (3) in the above figures is maintained almost constant at high pH showing that [M - A] 1:1 complex does not dissociate at higher pH. [M^{2+} + A + L] curve (5) is not below the [M - A] curve (3) in the lower pH range. This is an evidence that in this range where M^{2+} and A^{-n} 1:1 complexation takes place, the polyphenols do not combine with metal ion. In case of protocatechuic acid (MAL) curve shows separation from (MA) curve at lower pH due to the self dissociation of carboxylic group, even though the ligand coordinates with the metal at higher pH. After pH $\sim$ 6.5 curve (5) goes below curve (4) (secondary ligand + extra acid corresponding to COOH group present in the primary ligand). This confirms that in this range polyphenols and phenolic acid coordinate with MA resulting in the liberation of extra H^+ ions.

In case of [M-IMDA] system coordination of secondary ligand starts slightly before the complexation of 1:1 M-IMDA complex. However, above pH $\sim$ 6.5 formation of 1:1 M-IMDA complex is complete and the horizontal distance between curve (4) and (5) is due to the liberation of extra hydrogen as a result of coordination of secondary ligand with M-IMDA .

The additional hydrogen ions liberated due to coordination of secondary ligand can be determined from the horizontal distance between curve (5) and the secondary ligand curve (4), because in the secondary ligand samples, equivalent amount of extra perchloric acid corresponding to the number of COOH groups in the primary ligand, have been added to compensate for the hydrogen ions liberated by the combination of M^{2+} with primary ligand in the [MAL] solution curve (5). The horizontal distance between curve (4) and (5) is used for calculation of $\bar{n}$, where $\bar{n}$ is the average number of secondary ligand molecules associated with one [MA]. The equation applicable for the calculation of $\bar{n}$ will be same as in binary system.

$$\bar{n} = \frac{(V''' - V'')\left[N + E^{\circ} + T_L^{\circ}(Y - \bar{n}_H)\right]}{(V^{\circ} + V'')\bar{n}_H\, T_M^{\circ}}$$

T_M° = concentration of [MA], which is equivalent to the concentration of metal salt used. In the above equation V'' and V''' are the volumes of alkali added to reach the same pH in the secondary ligand curve and in mixed ligand curve, respectively. pL values were calculated using equation given in chapter II. Formation constant values were obtained by plotting pL against log $(1-\bar{n})/\bar{n}$ using linear plot method. The values have been presented in tables V 5 to V 7, V 13 to V 20, V 26 to V 33, and V 39 to V 44.

In case of [Cu.Hist. L] and [Ni.Hist.Protocatechuic acid] and [Copper(II).EDTA Protocatechuic acid] systems the method could not be applied because the coordination of secondary ligand starts before the formation of [MA] 1:1 complex is complete. In the system [Ni.EDTA.Pyrogallol], calculations could not be possible because the separation between curve (4) and curve (5) is very small.

It is observed that in all the four cases (Histidine, IMDA, NTA, and EDTA) in the ternary systems studied, the order of formation constants corresponding to the association of polyphenols and phenolic acids with [MA] is same as in the binary metal and pyrogallol, catechol, 2,3-dihydroxynaphthalene or protocatechuic acid systems.[18-20] This can be explained as in the earlier chapter II. Observation of the values reported in the table V 45 and V 46, show that the K_{MAL} corresponding to the association of the secondary ligand with Ni.Histidine is less by 0.81 than the first formation constants K_{ML_1}, corresponding to the association of the polyhydroxy phenolic ligand with metal ion. In case of the complexes of Cu. or Ni. and IMDA with polyphenols the K_{MAL} values are less than K_{ML_1} by 2.0-4.0 log units. In case of Cu.NTA and Ni.NTA chelates the K_{MAL} values are less by 1.9 - 6.0 log units than the first formation constant K_{ML_1}. In Cu.EDTA and Ni.EDTA chelates, K_{MAL} values are also less than K_{ML_1} values by 3.0 - 7.0 log units. K_{MAL} values are even less than K_{ML_2}, the second formation constants. This may be explained to be due to the coulombic repulsion between the charged primary ligands, $[\text{Histidine}]^{-1}$, $[\text{IMDA}]^{-2}$, $[\text{NTA}]^{-3}$ or $[\text{EDTA}]^{-4}$ and the incoming secondary ligand L^{-2}. This repulsion is greater than the repulsion between the first polyphenolic ion and the second polyphenolic ion during the formation of ML_2 in the binary system. K_{MAL} is, therefore, even less than K_{ML_2}.

An observation of table V 45 shows that the order is

$Cu^{2+} > Ni^{2+}$. This is in agreement with the Irving-Williams order.[21] The order of the mixed ligand formation constant K_{MAL} is

$$K_{M.Hist.L} > K_{M.IMDA.L} > K_{M.NTA.L} > K_{M.EDTA.L}$$

This can be explained in terms of electrostatic repulsion and steric hinderence. As the charge on the primary ligand goes on increasing the repulsion on the incoming secondary ligand is much and hence the value of K^{MA}_{MAL} goes down.

It is, however, observed that though formation constants of copper complexes differ from the formation constants of nickel complexes by 5.1 log units in the above binary systems, but the difference $K_{Cu.A.L} - K_{Ni.A.L}$ is less where A = NTA or EDTA. This observation can be explained in terms of Jahn-Tellor distortion.[22] Cu(II) complexes (d^9 case) are more stable than Ni(II) chelates (d^8 case), because Jahn-Tellor distortion brings in additional stability in copper complexes. Ligands along Z axis are at a greater distance than those in the equitorial plane. It can naturally be expected that in this elongation distortion, the incoming ligand which has to occupy the position along Z axis, will be losely held by the metal ion. The formation constants corresponding to the association of that ligand will have a lower value.

NTA acts as a tri[13] or tetradentate[14], EDTA is tetradentate.[15] As such NTA must be occupying three positions and EDTA four positions around Cu(II) ion, three in xy plane. The secondary ligand has to occupy the remaining positions, one necessarily along Z axis. In the absence of Jahn-Tellor effect, in case of Ni(II) complexes, ligands along the Z axis are held at the same distance as those along the xy plane, whereas in distorted Cu(II) complex the secondary ligand has to span more. This is the reason why $K_{Cu.A.L}$ is less and the difference $K_{Cu.A.L} - K_{Ni.A.L}$ is less than in compounds of binary systems.

In case of ternary complexes where histidine or IMDA are the primary ligands, they occupy two positions in the equitorial plane. Thus two positions in the equitorial plane are available for the secondary ligand. It has not to occupy positions along the axial direction. Thus $K_{Cu.A.L}$ is not lowered down.

Table V 1

N = 0.2M V° = 50 ml. μ = 0.2M   t = 30°C.

E° = 0.02M   *E° = 0.022M T°_{Hist} = 0.002M T°_M = 0.002M

*Perchloric acid		Histidine		Ni.Histidine	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.50	0.00	1.55	0.00	1.55
1.00	1.55	1.00	1.75	1.00	1.60
1.50	1.60	1.50	1.80	1.50	1.70
2.00	1.65	2.00	1.90	2.00	1.80
2.50	1.70	2.50	1.95	2.50	1.90
3.00	1.80	3.00	2.10	3.00	2.10
3.50	1.90	3.50	2.30	3.50	2.35
4.00	2.10	4.00	2.70	4.00	2.65
4.50	2.50	4.50	5.00	4.50	3.55
5.00	2.60	4.55	5.25	4.80	3.70
5.20	2.90	4.59	5.50	5.00	4.00
5.30	3.15	4.63	5.75	5.09	4.25
5.40	3.50	4.67	6.00	5.16	4.50
5.45	3.75	4.71	6.25	5.24	4.75
5.50	4.20	4.75	6.50	5.30	5.00
5.52	8.75	4.80	6.75	5.36	5.25
5.54	8.95	4.85	7.00	5.40	5.50
5.58	9.25	4.89	7.25	5.44	5.75
5.62	9.50	4.94	7.50	5.47	6.00
5.68	9.75	4.98	7.75	5.50	6.25
5.74	10.00	5.03	8.00	5.54	7.70
5.80	10.25	5.08	8.25	5.58	8.20
5.90	10.50	5.13	8.50	5.63	8.50
		5.20	8.75	5.70	8.75
		5.26	9.00	5.75	9.00
		5.35	9.25	5.85	9.25
		5.50	9.50	5.90	9.50
		5.58	9.75	6.03	9.75
		5.67	10.00	6.14	10.00
		5.80	10.25	6.30	10.25
		5.90	10.50	6.50	10.50

Table V 2

$N = 0.2M$ $V^\circ = 50$ ml. $\mu = 0.2M$ $t = 30^\circ C.$

$E^\circ = 0.02M$ $^*E^\circ = 0.022M$ $T^\circ_{Hist} = 0.002M$ $T^\circ_M = 0.002M$

$T^\circ_L = 0.002M$

*Catechol		Ni.Hist.Catechol	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.50	0.00	1.55
1.00	1.55	1.00	1.60
1.50	1.60	1.50	1.70
2.00	1.65	2.00	1.80
2.50	1.70	2.50	1.90
3.00	1.80	3.00	2.10
3.50	1.90	4.00	2.65
4.00	2.10	4.50	3.55
4.50	2.50	4.80	3.70
5.00	2.60	5.00	4.00
5.20	2.90	5.09	4.25
5.30	3.15	5.16	4.50
5.40	3.50	5.24	4.75
5.42	3.60	5.30	5.00
5.45	3.75	5.36	5.25
5.50	4.20	5.40	5.50
5.52	8.40	5.44	5.75
5.54	8.55	5.47	6.00
5.58	8.75	5.50	6.25
5.63	9.00	5.51	7.00
5.66	9.10	5.54	7.45
5.69	9.25	5.28	7.75
5.75	9.50	5.63	8.00
5.85	9.75	5.85	8.50
5.94	10.00	6.00	8.75
6.02	10.25	6.14	9.00
6.08	10.35	6.25	9.25
6.15	10.50	6.33	9.50
6.20	10.60	6.40	9.75
6.30	10.75	6.49	10.00
6.45	11.00	6.70	10.50

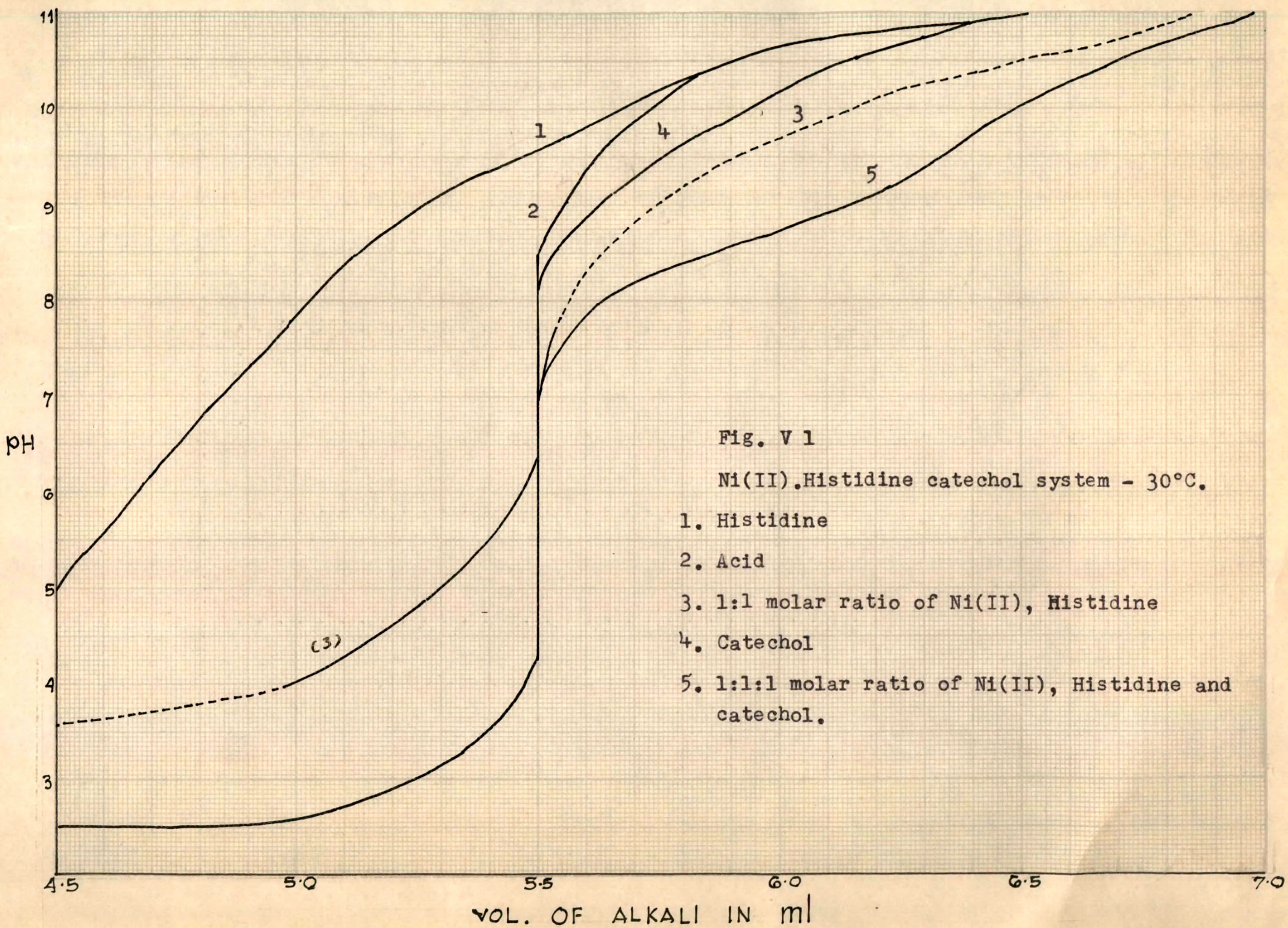


Fig. V 1

Ni(II).Histidine catechol system - 30°C.

1. Histidine
2. Acid
3. 1:1 molar ratio of Ni(II), Histidine
4. Catechol
5. 1:1:1 molar ratio of Ni(II), Histidine and catechol.

Table V 3

$N = 0.2M \quad V^\circ = 50$ ml. $\qquad \mu = 0.2M \quad t = 30°C.$

$E^\circ = 0.02M \quad {}^*E^\circ = 0.022M \qquad T^\circ_{Hist} = 0.002M, \; T^\circ_M = 0.002M$

$T^\circ_L = 0.002M$

*Pyrogallol		Ni.Hist.Pyrogallol	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.50	0.00	1.55
1.00	1.55	1.00	1.60
1.50	1.60	1.50	1.70
2.00	1.65	2.00	1.80
2.50	1.70	2.50	1.90
3.00	1.80	3.00	2.10
3.50	1.90	3.50	2.35
4.00	2.10	4.00	2.65
4.50	2.50	4.50	3.55
5.00	2.60	5.00	4.00
5.20	2.90	5.16	4.50
5.30	3.15	5.24	4.75
5.40	3.50	5.30	5.00
5.42	3.60	5.36	5.25
5.45	3.75	5.40	5.50
5.50	4.20	5.44	5.75
5.52	7.75	5.47	6.00
5.55	8.00	5.50	6.25
5.58	8.25	5.52	6.90
5.62	8.50	5.56	7.20
5.68	8.75	5.62	7.50
5.74	9.00	5.69	7.75
5.81	9.25	5.80	8.00
5.90	9.50	5.92	8.25
6.00	9.75	6.06	8.50
6.09	10.00	6.18	8.75
6.13	10.10	6.30	9.00
6.18	10.25	6.40	9.25
6.23	10.35	6.50	9.50
6.33	10.50	6.55	9.75
6.55	10.75	6.62	10.00
6.70	11.00	6.80	10.50

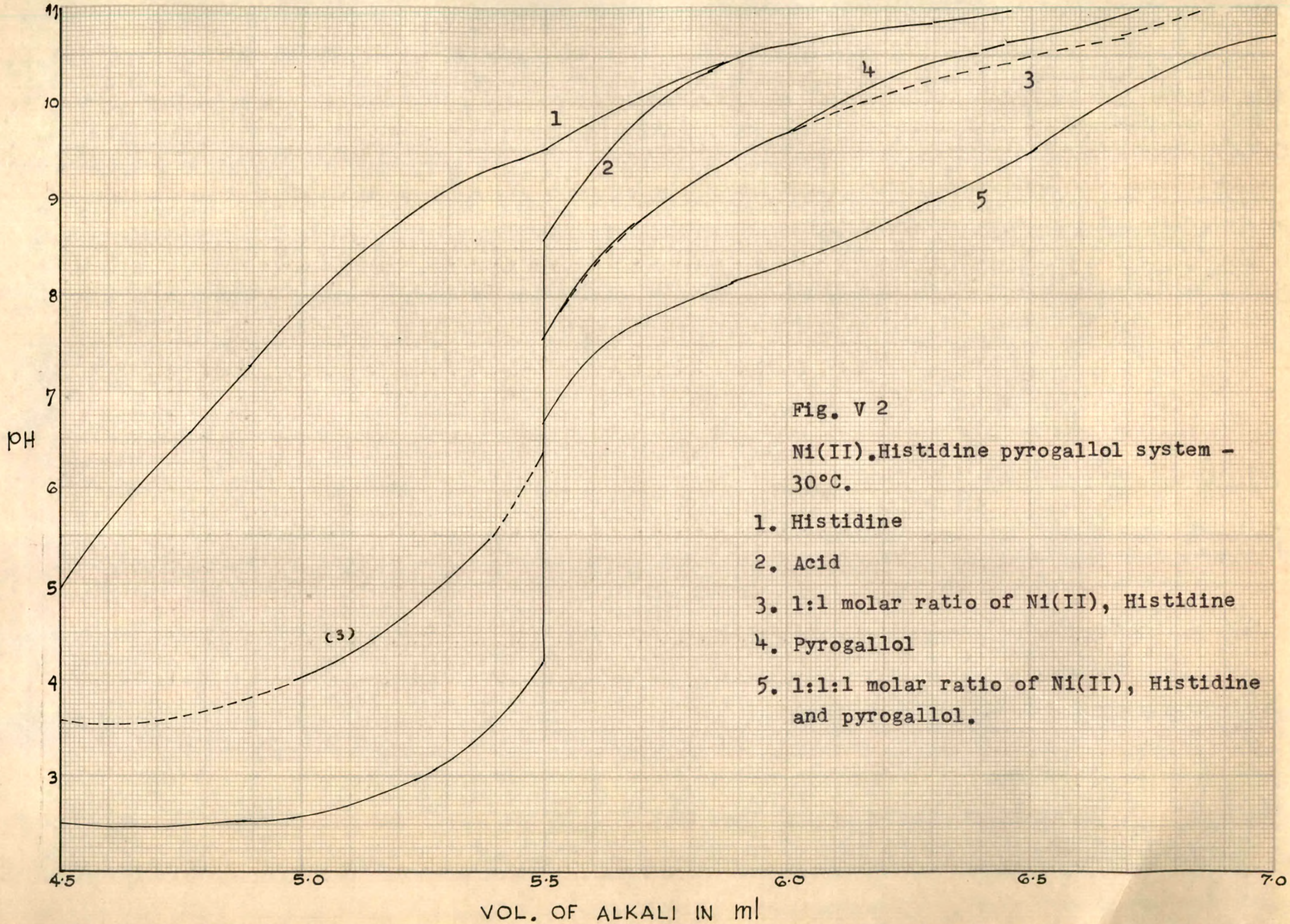


Fig. V 2

Ni(II).Histidine pyrogallol system – 30°C.

1. Histidine
2. Acid
3. 1:1 molar ratio of Ni(II), Histidine
4. Pyrogallol
5. 1:1:1 molar ratio of Ni(II), Histidine and pyrogallol.

Table V 4

$N = 0.2M$ $V^\circ = 50$ ml. $\mu = 0.2M$ $t = 30°C.$

$E^\circ = 0.02M$ $^*E^\circ = 0.022M$ $T^\circ_{Hist} = 0.002M$ $T^\circ_M = 0.002M$

$T^\circ_L = 0.002M$

*2,3-Dihydroxy-naphthalene		Ni.Hist.2,3-Dihydroxy-naphthalene	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.50	0.00	1.55
1.00	1.55	1.00	1.60
1.50	1.60	1.50	1.70
2.00	1.65	2.00	1.80
2.50	1.70	2.50	1.90
3.00	1.80	3.00	2.10
3.50	1.90	4.00	2.65
4.00	2.10	4.50	3.55
4.50	2.50	5.00	4.00
5.00	2.60	5.09	4.25
5.20	2.90	5.16	4.50
5.30	3.15	5.24	4.75
5.35	3.25	5.30	5.00
5.40	3.50	5.36	5.25
5.45	3.75	5.40	5.50
5.50	4.20	5.44	5.75
5.55	7.75	5.47	6.00
5.60	8.00	5.50	6.25
5.64	8.25	5.55	6.90
5.70	8.50	5.60	7.00
5.75	8.75	5.68	7.25
5.80	9.00	5.80	7.50
5.88	9.25	6.00	7.75
5.98	9.50	6.16	8.00
6.07	9.75	6.26	8.25
6.10	9.85	6.34	8.50
6.16	10.00	6.40	8.75
6.20	10.15	6.44	9.00
6.25	10.25	6.48	9.25
6.28	10.35	6.52	9.50
6.35	10.50	6.58	9.75
6.50	10.75	6.65	10.00
6.70	11.00	6.82	10.50

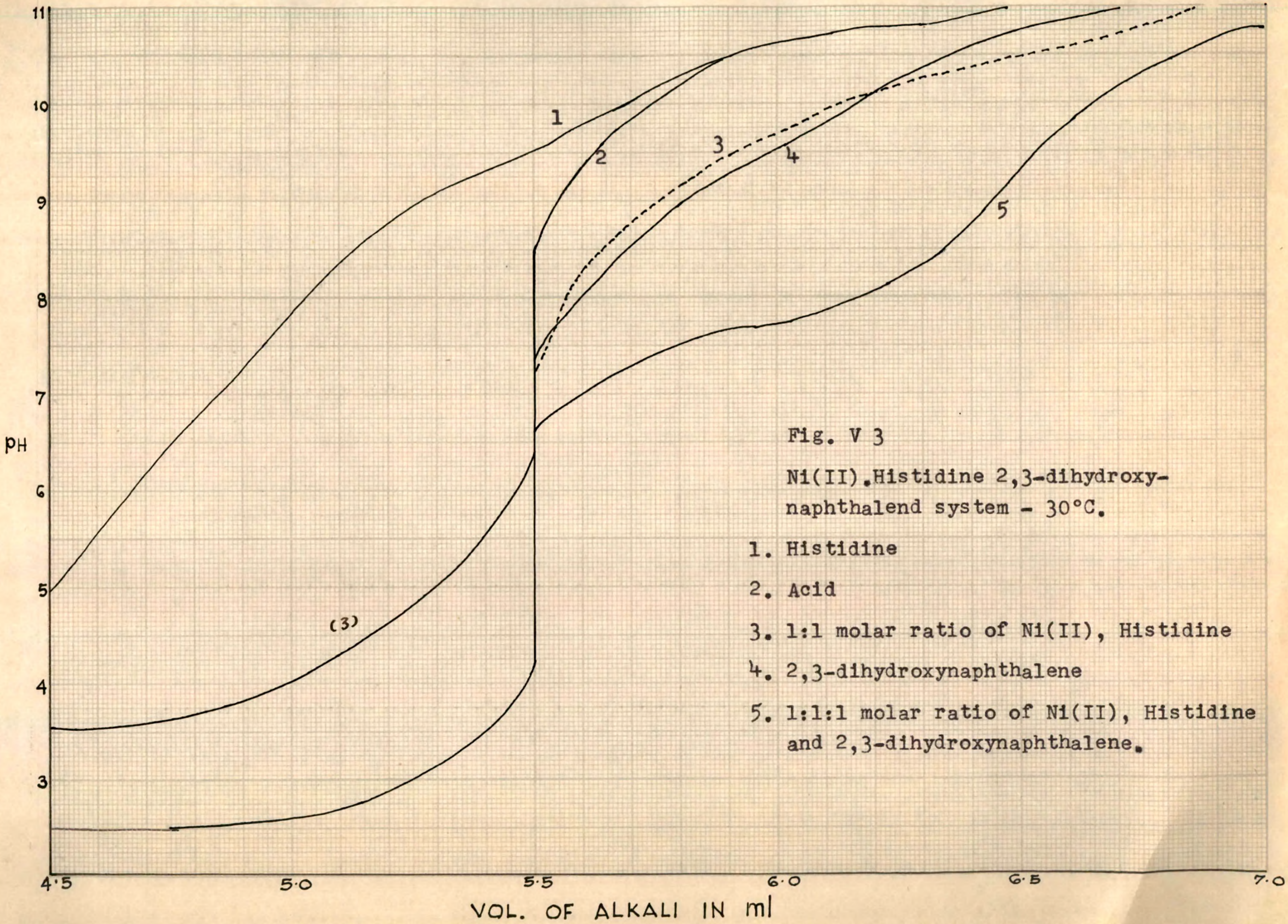


Fig. V 3

Ni(II).Histidine 2,3-dihydroxy-naphthalend system - 30°C.

1. Histidine
2. Acid
3. 1:1 molar ratio of Ni(II), Histidine
4. 2,3-dihydroxynaphthalene
5. 1:1:1 molar ratio of Ni(II), Histidine and 2,3-dihydroxynaphthalene.

Table V 5

B, $\bar{n}_H$, $\bar{n}$, $\log(1-\bar{n})/\bar{n}$, pL and pL$-\log(1-\bar{n})/\bar{n}$ data of Ni.Hist. catechol system - 30°C.

B	$\bar{n}_H$	V"	V"'	V"'-V"	$\bar{n}$	$\log(1-\bar{n})/\bar{n}$	pL	pL$-\log(1-\bar{n})/\bar{n}$
7.90	1.93_6	5.50	5.61	0.11	0.11_2	0.89_9	7.39_8	-
8.00	1.92_4	5.50	5.63	0.13	0.26_8	0.43_6	7.23_8	6.80_2
8.10	1.90_8	5.50	5.67	0.17	0.35_3	0.26_3	7.12_1	6.85_8
8.20	1.88_8	5.50	5.71	0.21	0.44_1	0.10_3	6.91_7	6.81_4
8.30	1.86_8	5.50	5.76	0.26	0.55_2	$\bar{1}.90_9$	6.73_7	6.82_8
8.40	1.84_8	5.52	6.82	0.30	0.63_7	$\bar{1}.75_5$	6.58_9	6.83_4
8.50	1.79_2	5.53	5.86	0.33	0.72_9	$\bar{1}.57_0$	6.40_5	6.83_5

$\log K_{MAL} = 6.82 \pm 0.03$

Table V 6

B, $\bar{n}_H$, $\bar{n}$, $\log(1-\bar{n})/\bar{n}$, pL and pL$-\log(1-\bar{n})/\bar{n}$ data of Ni.Hist. pyrogallol system - 30°C.

B	$\bar{n}_H$	V"	V"'	V"'-V"	$\bar{n}$	$\log(1-\bar{n})/\bar{n}$	pL	pL$-\log(1-\bar{n})/\bar{n}$
8.00	1.84_0	5.55	5.80	0.25	0.26_9	0.43_1	6.28_1	5.84_7
8.10	1.80_0	5.56	5.85	0.29	0.31_8	0.33_1	6.04_3	5.71_2
8.20	1.78_4	5.58	5.90	0.32	0.35_5	0.25_9	5.96_2	5.70_3
8.30	1.75_2	5.59	5.97	0.38	0.42_6	0.12_9	5.82_4	5.69_5
8.40	1.71_2	5.60	6.00	0.40	0.46_2	0.06_6	5.70_8	5.64_2
8.50	1.68_0	5.62	6.08	0.46	0.53_5	$\bar{1}.93_9$	5.52_6	5.58_7
8.60	1.61_6	5.65	6.12	0.47	0.57_1	$\bar{1}.87_5$	5.41_4	5.53_8

$\log K_{MAL} = 5.66 \pm 0.08$

Table V 7

B, $\bar{n}_H$, $\bar{n}$, $\log(1-\bar{n})/\bar{n}$, pL and pL-$\log(1-\bar{n})/\bar{n}$ data of Ni.Hist. 2,3-dihydroxynaphthalene system - 30°C.

B	$\bar{n}_H$	V"	V"'	V"'-V"	$\bar{n}$	$\log(1-\bar{n})/\bar{n}$	pL	pL-$\log(1-\bar{n})/\bar{n}$
7.30	1.93_2	5.50	5.70	0.20	0.20_5	0.58_8	9.25_4	8.66_6
7.40	1.91_2	5.50	5.75	0.25	0.25_9	0.45_6	9.08_9	8.63_3
7.50	1.89_3	5.51	5.80	0.29	0.30_3	0.36_1	8.92_9	8.56_8
7.60	1.87_2	5.52	5.85	0.33	0.34_9	0.27_0	8.76_7	8.49_7
7.70	1.85_2	5.54	5.96	0.42	0.44_9	0.08_9	8.66_2	8.57_3
7.80	1.82_4	5.56	6.04	0.48	0.52_1	$\bar{1}.96_3$	8.53_9	8.57_6
7.90	1.79_2	5.58	6.10	0.52	0.57_5	$\bar{1}.86_8$	8.40_7	8.53_9

$\log K_{MAL} = 8.57 \pm 0.09$

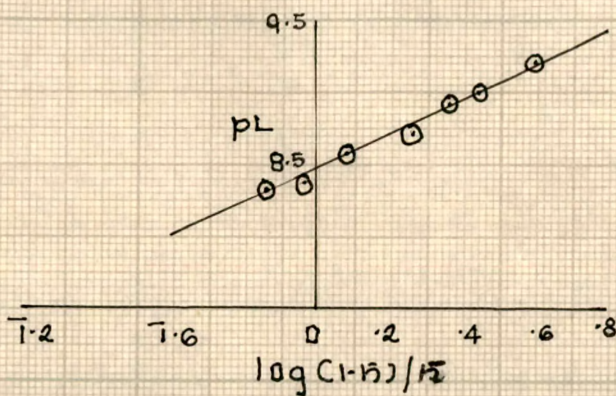


Fig. V 6

Ni(II).Histidine 2,3-dihy.naph.
system - 30°C.

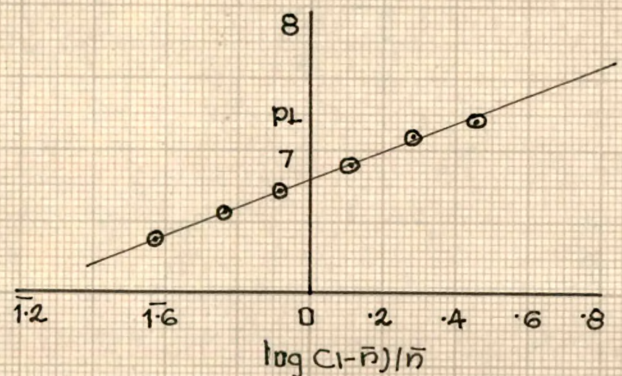


Fig. V 4

Ni(II).Histidine catechol system - 30°C.

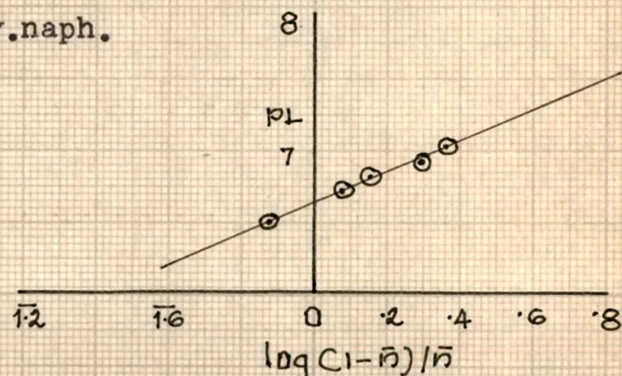


Fig. V 5

Ni(II).Histidine pyrogallol
system - 30°C.

Table V 8

N = 0.2M V° = 50 ml. μ = 0.2M t = 30°C.

E° = 0.02M *E° = 0.024M T°_{IMDA} = 0.002M T°_{M} = 0.002M

*Perchloric acid		IMDA		Cu.IMDA		Ni.IMDA	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.50	0.00	1.55	0.00	1.50	0.00	1.45
1.00	1.60	1.00	1.75	1.00	1.65	1.00	1.50
1.50	1.65	2.00	1.85	2.00	1.75	2.00	1.65
2.00	1.70	3.00	2.00	3.00	1.95	3.00	1.90
2.50	1.80	4.00	2.30	4.00	2.05	4.00	2.15
3.00	1.85	5.00	2.80	5.00	2.45	5.00	2.60
3.50	1.90	5.10	3.00	5.40	2.70	5.10	2.70
4.00	2.00	5.20	3.20	5.65	3.00	5.30	2.90
4.50	2.10	5.30	3.50	5.77	3.25	5.40	3.05
5.00	2.30	5.36	3.75	5.85	3.50	5.50	3.25
5.50	2.65	5.42	4.00	5.90	3.70	5.60	3.55
5.70	2.90	5.46	4.25	5.95	4.00	5.65	3.90
5.80	3.10	5.49	4.50	6.00	4.30	5.70	4.15
5.90	3.35	5.50	4.75	6.02	6.25	5.73	4.30
6.00	7.90	5.52	7.00	6.03	6.50	5.76	4.50
6.02	8.50	5.53	7.25	6.05	6.75	5.80	4.80
6.04	8.70	5.55	7.50	6.07	7.00	5.83	5.00
6.08	9.00	5.58	7.75	6.09	7.25	5.86	5.20
6.10	9.20	5.60	8.00	6.12	7.50	5.90	5.50
6.13	9.35	5.64	8.25	6.15	7.75	5.95	5.80
6.18	9.55	5.67	8.50	6.18	8.00	5.97	6.00
6.22	9.80	5.70	8.70	6.25	8.30	6.00	6.50
6.25	9.90	5.78	9.00	6.30	8.50	6.02	7.75
6.35	10.30	5.85	9.20	6.35	8.70	6.05	8.25
6.50	10.50	5.90	9.40	6.38	8.75	6.07	8.50
6.65	10.75	6.00	9.60	6.40	8.80	6.10	8.75
6.90	11.00	6.05	9.75		(ppt.)	6.15	9.00
		6.15	10.00			6.18	9.25
		6.25	10.25			6.23	9.50
		6.40	10.50			6.30	9.80
		6.65	10.75			6.35	10.00
		6.90	11.00			6.60	10.50
						6.72	10.75
						6.90	11.00

Table V 9

$N = 0.2M$ $V° = 50$ ml. $\mu = 0.2M$ $t = 30°C.$

$E° = 0.02M$ $^{*}E° = 0.024M$ $T°_{IMDA} = 0.002M$ $T°_{M} = 0.002M$

$T°_{L} = 0.002M$

*Catechol		Cu.IMDA.Catechol		Ni.IMDA.Catechol	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.50	0.00	1.50	0.00	1.45
1.00	1.60	1.00	1.65	1.00	1.50
1.50	1.65	2.00	1.75	2.00	1.65
2.00	1.70	3.00	1.95	3.00	1.90
2.50	1.80	4.00	2.05	4.00	2.15
3.00	1.85	5.00	2.45	5.00	2.60
3.50	1.90	5.40	2.70	5.10	2.70
4.00	2.00	5.65	3.00	5.30	2.90
4.50	2.10	5.77	3.25	5.40	3.05
5.00	2.30	5.85	3.50	5.50	3.25
5.50	2.65	5.90	3.70	5.60	3.55
5.70	2.90	5.95	4.00	5.65	3.90
5.80	3.10	6.00	4.30	5.70	4.15
5.90	3.35	6.03	5.75	5.73	4.30
6.00	5.00	6.06	6.00	5.76	4.50
6.03	7.50	6.10	6.25	5.80	4.80
6.06	7.75	6.17	6.50	5.83	5.00
6.08	8.00	6.28	6.75	5.86	5.20
6.12	8.25	6.48	7.00	5.90	5.50
6.15	8.50	6.65	7.25	5.95	5.80
6.20	8.70	6.80	7.50	6.00	6.20
6.27	9.00	6.90	7.75	6.03	6.50
6.35	9.25	6.95	8.00	6.05	6.70
6.45	9.50	7.00	8.25	6.08	7.00
6.60	9.80	7.03	8.50	6.10	7.30
6.70	10.00	7.05	8.75	6.12	7.50
6.78	10.25	7.08	9.00	6.15	7.75
7.00	10.50	7.10	9.25	6.18	8.00
		7.13	9.50	6.25	8.25
		7.17	9.75	6.33	8.50
		7.25	10.00	6.50	8.75
		7.35	10.25	6.65	9.00
		7.40	10.50	6.80	9.25
				6.87	9.50
				6.95	9.75
				7.05	10.00
				7.20	10.25
				7.35	10.50

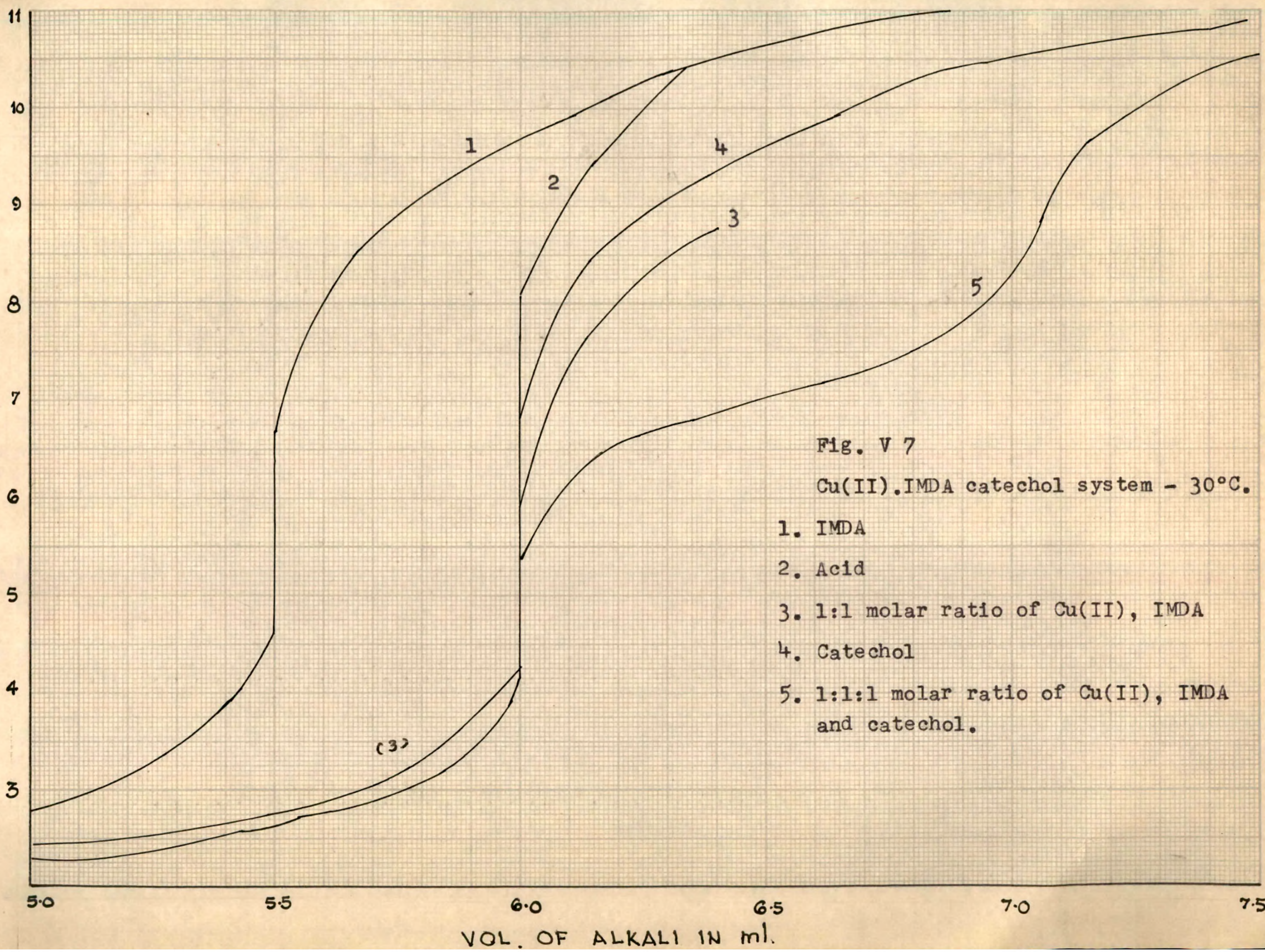


Fig. V 7

Cu(II).IMDA catechol system - 30°C.

1. IMDA
2. Acid
3. 1:1 molar ratio of Cu(II), IMDA
4. Catechol
5. 1:1:1 molar ratio of Cu(II), IMDA and catechol.

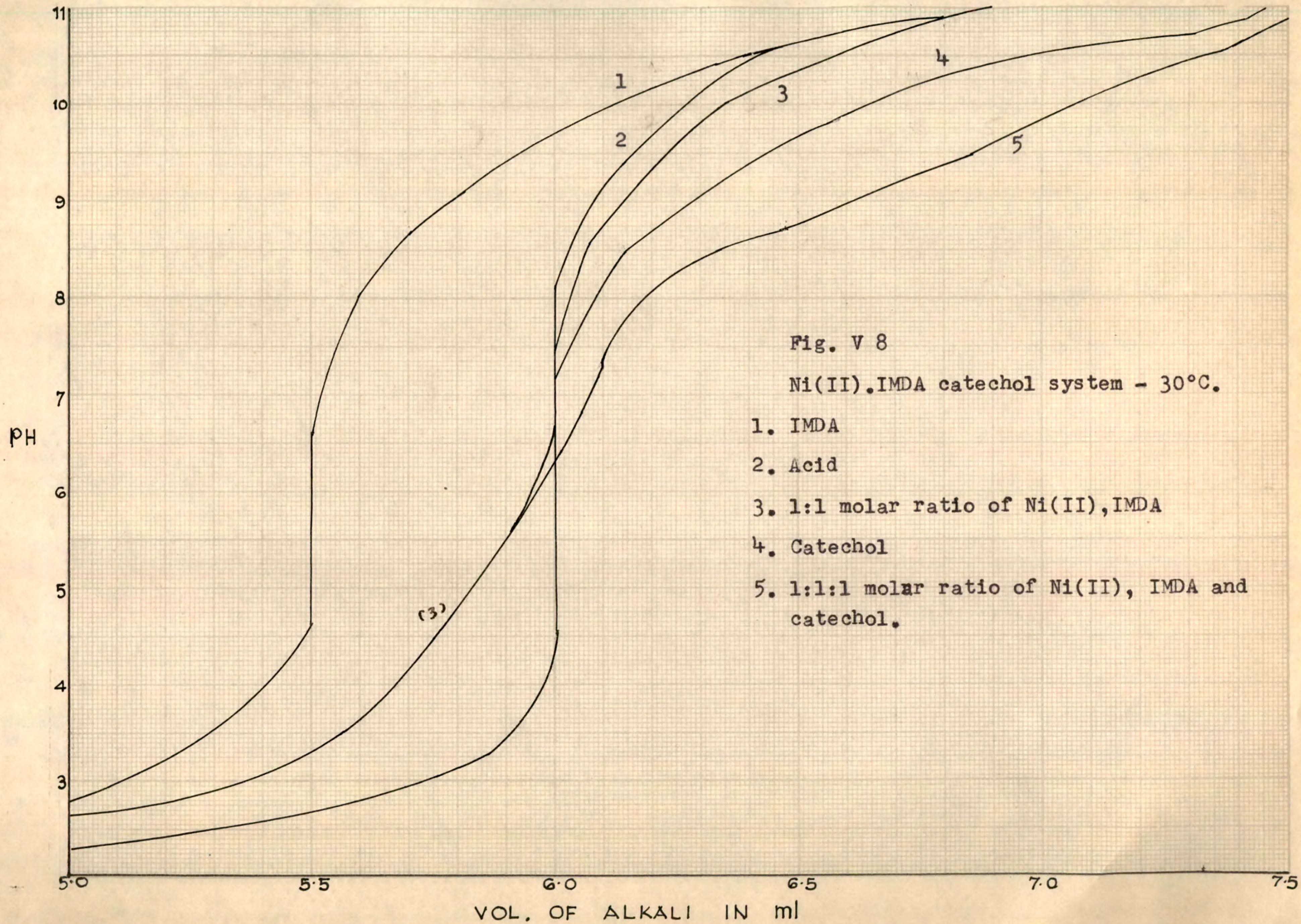


Fig. V 8

Ni(II).IMDA catechol system - 30°C.

1. IMDA
2. Acid
3. 1:1 molar ratio of Ni(II),IMDA
4. Catechol
5. 1:1:1 molar ratio of Ni(II), IMDA and catechol.

Table V 10

N = 0.2M V° = 50 ml. μ = 0.2M t = 30°C.

E° = 0.02M *E° = 0.024M T°_{IMDA} = 0.002M T°_{M} = 0.002M

T°_{L} = 0.002M

*Pyrogallol		Cu.IMDA.Pyrogallol		Ni.IMDA.Pyrogallol	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.50	0.00	1.50	0.00	1.45
1.00	1.60	1.00	1.65	1.00	1.50
1.50	1.65	2.00	1.75	2.00	1.65
2.00	1.70	3.00	1.95	3.00	1.90
2.50	1.80	4.00	2.05	4.00	2.15
3.00	1.85	5.00	2.45	5.00	2.60
3.50	1.90	5.40	2.70	5.10	2.70
4.00	2.00	5.65	3.00	5.30	2.90
4.50	2.10	5.77	3.25	5.40	3.05
5.00	2.30	5.85	3.50	5.50	3.25
5.50	2.65	5.90	3.70	5.60	3.55
5.70	2.90	5.95	4.00	5.65	3.90
5.80	3.10	6.00	5.20	5.70	4.15
6.00	5.30	6.05	6.00	5.73	4.30
6.02	7.00	6.15	6.25	5.75	4.50
6.05	7.25	6.28	6.50	5.80	4.80
6.08	7.50	6.50	6.75	5.83	5.00
6.11	7.75	6.60	7.00	5.86	5.20
6.15	8.00	6.68	7.25	6.00	6.30
6.20	8.25	6.75	7.50	6.02	6.50
6.25	8.50	6.83	7.75	6.05	6.76
6.30	8.75	6.89	8.00	6.08	7.00
6.35	9.00	6.95	8.25	6.11	7.25
6.45	9.25	7.02	8.50	6.14	7.50
6.52	9.50	7.10	8.75	6.20	7.75
6.60	9.75	7.16	9.00	6.26	8.00
6.70	10.00	7.25	9.25	6.36	8.25
6.78	10.25	7.30	9.50	6.50	8.50
6.90	10.50	7.37	9.75	6.73	8.75
		7.46	10.00	6.83	9.00
		7.50	10.25	6.92	9.25
		7.58	10.50	7.00	9.50
				7.06	9.75
				7.13	10.00
				7.23	10.25
				7.35	10.50

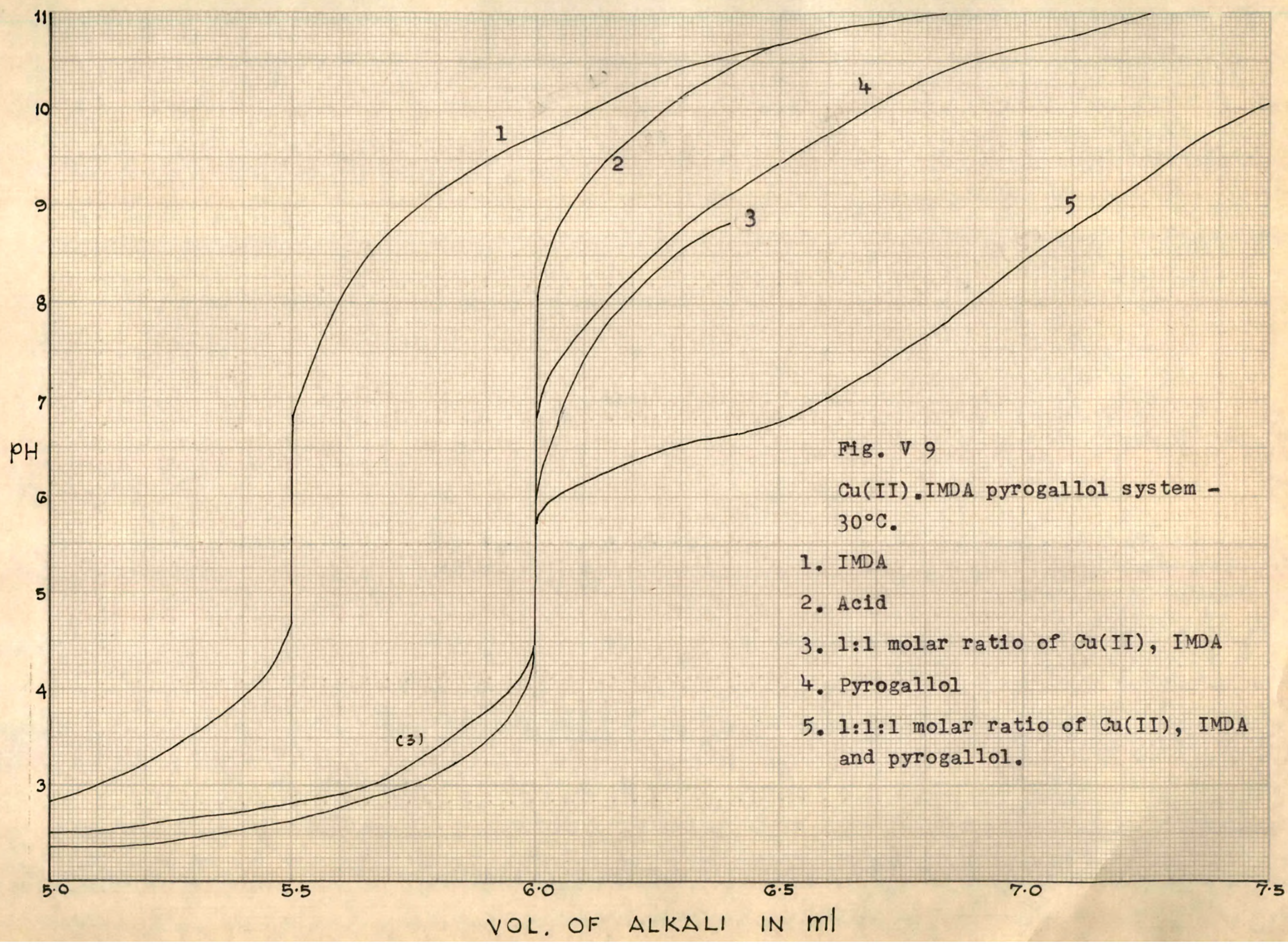


Fig. V 9

Cu(II).IMDA pyrogallol system - 30°C.

1. IMDA
2. Acid
3. 1:1 molar ratio of Cu(II), IMDA
4. Pyrogallol
5. 1:1:1 molar ratio of Cu(II), IMDA and pyrogallol.

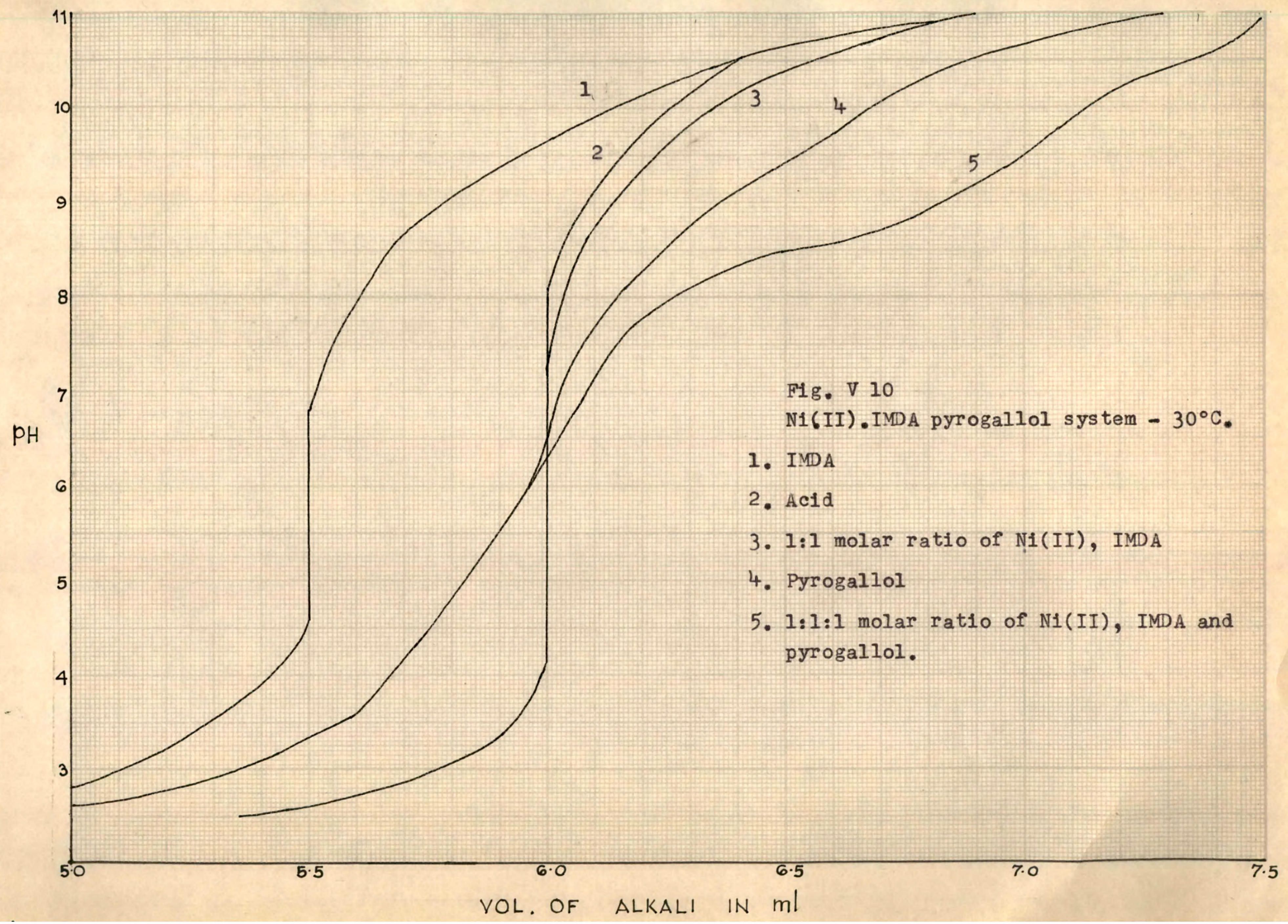


Fig. V 10
Ni(II).IMDA pyrogallol system - 30°C.
1. IMDA
2. Acid
3. 1:1 molar ratio of Ni(II), IMDA
4. Pyrogallol
5. 1:1:1 molar ratio of Ni(II), IMDA and pyrogallol.
pH
11
10
9
8
7
6
5
4
3
5·0
5·5
6·0
6·5
7·0
7·5
VOL. OF ALKALI IN ml
1
2
3
4
5

Table V 11

N = 0.2M V° = 50 ml. μ = 0.2M t = 30°C.

E° = 0.02M $^{*}E^{\circ}$ = 0.024M T°_{IMDA} = 0.002M T°_{M} = 0.002M

T°_{L} = 0.002M

*2,3-Dihydroxy-naphthalene		Cu.IMDA.2,3-Dihydroxy-naphthalene		Ni.IMDA.2,3-Dihydroxy-naphthalene	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.50	0.00	1.45	0.00	1.45
1.00	1.60	1.00	1.65	1.00	1.50
1.50	1.65	2.00	1.75	2.00	1.65
2.00	1.70	3.00	1.95	3.00	1.90
2.50	1.80	4.00	2.05	4.00	2.15
3.00	1.85	5.00	2.45	5.00	2.60
3.50	1.90	5.40	2.70	5.10	2.70
4.00	2.00	5.65	3.00	5.30	2.90
4.50	2.10	5.77	3.25	5.40	3.05
5.00	2.30	5.85	3.50	5.50	3.25
5.50	2.65	5.90	3.70	5.60	3.55
5.70	2.90	5.95	4.00	5.65	3.90
5.80	3.10	6.00	5.00	5.70	4.15
5.90	3.35	6.03	5.50	5.73	4.30
6.00	6.10	6.07	5.75	5.76	4.50
6.02	6.75	6.13	6.00	5.80	4.80
6.05	7.00	6.20	6.25	5.83	5.00
6.08	7.25	6.40	6.50	5.86	5.20
6.10	7.50	6.65	6.75	6.00	6.25
6.15	7.75	6.72	7.00	6.05	6.50
6.18	8.00	6.78	7.25	6.09	6.75
6.23	8.25	6.82	7.50	6.13	7.00
6.30	8.50	6.85	7.75	6.20	7.30
6.36	8.75	6.89	8.00	6.25	7.50
6.42	9.00	6.91	8.25	6.32	7.75
6.48	9.25	6.94	8.50	6.40	8.00
6.52	9.50	6.96	8.75	6.52	8.25
6.58	9.75	6.98	9.00	6.65	8.50
6.62	10.00	7.02	9.25	6.75	8.75
6.70	10.25	7.06	9.50	6.82	9.00
6.77	10.50	7.10	9.75	6.88	9.25
		7.16	10.00	6.93	9.50
		7.23	10.25	6.98	9.75
		7.30	10.50	7.03	10.00
				7.11	10.25
				7.17	10.50

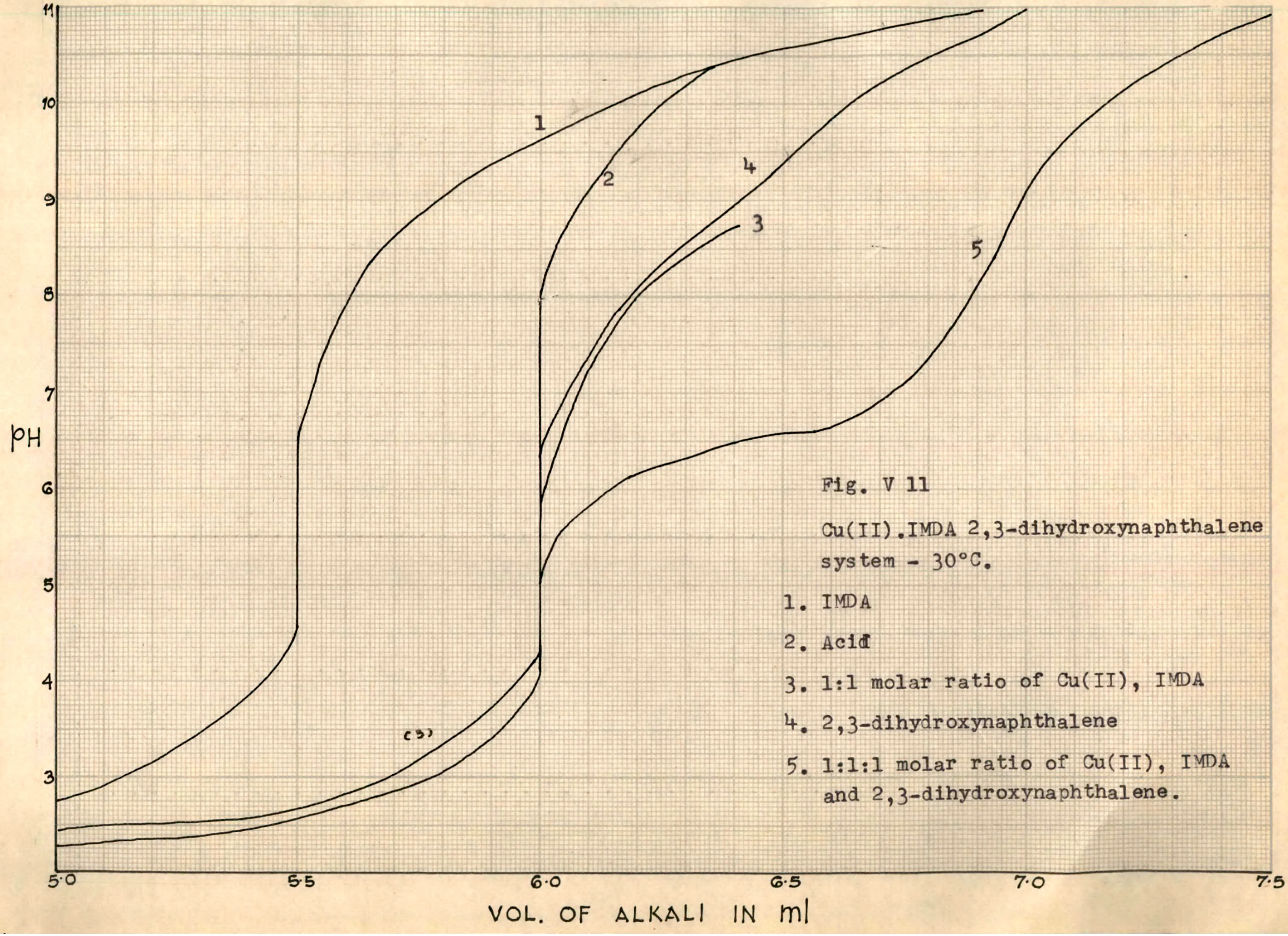


Fig. V 11

Cu(II).IMDA 2,3-dihydroxynaphthalene system - 30°C.

1. IMDA
2. Acid
3. 1:1 molar ratio of Cu(II), IMDA
4. 2,3-dihydroxynaphthalene
5. 1:1:1 molar ratio of Cu(II), IMDA and 2,3-dihydroxynaphthalene.

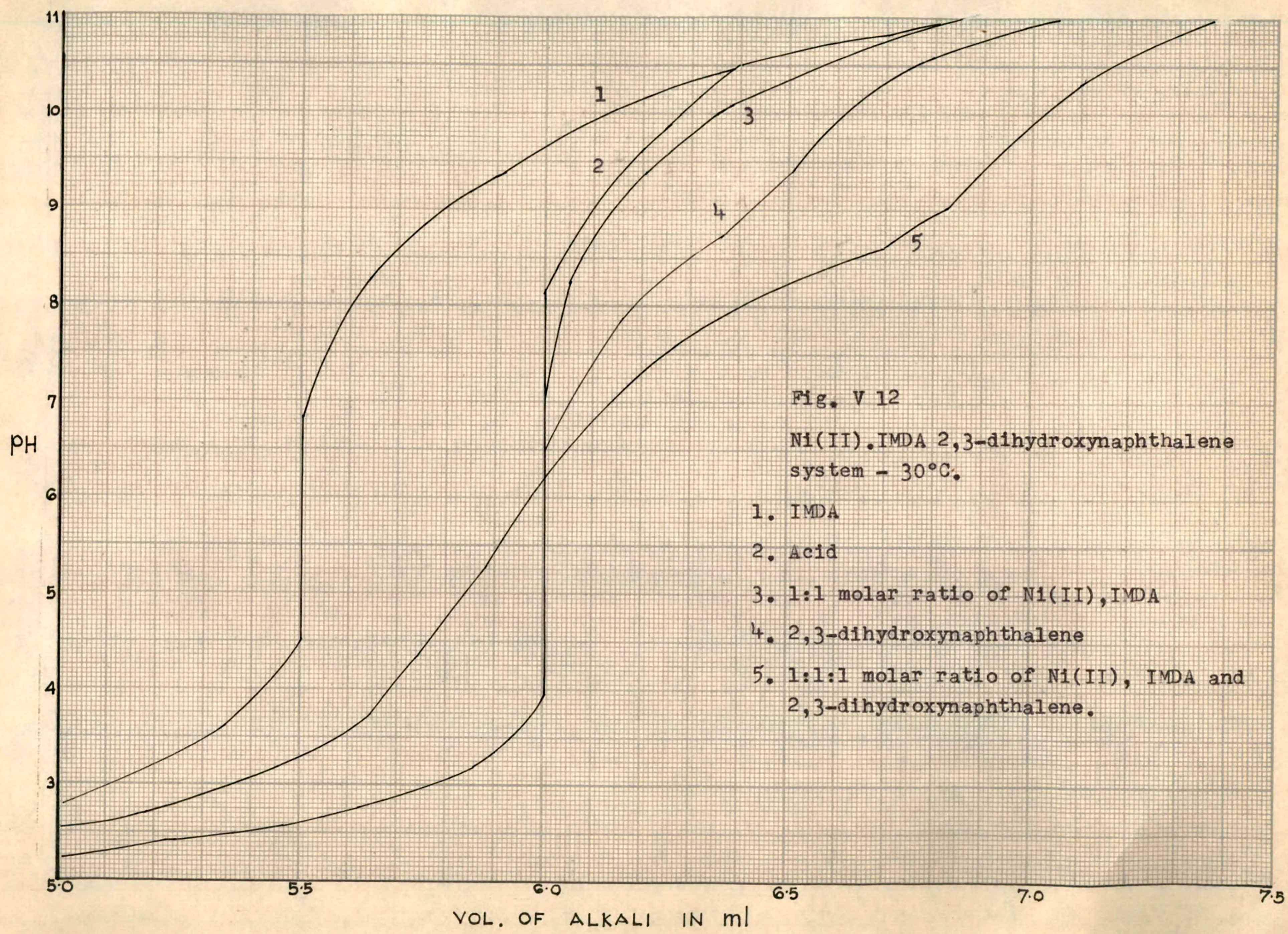


Fig. V 12

Ni(II).IMDA 2,3-dihydroxynaphthalene system - 30°C.

1. IMDA
2. Acid
3. 1:1 molar ratio of Ni(II),IMDA
4. 2,3-dihydroxynaphthalene
5. 1:1:1 molar ratio of Ni(II), IMDA and 2,3-dihydroxynaphthalene.

Table V 12

N = 0.2M V° = 50 ml. μ = 0.2M t = 30°C.

E° = 0.02M $^*E^\circ$ = 0.024M T°_{IMDA} = 0.002M T°_M = 0.002M

T°_L = 0.002M

*Protocatechuic acid		Cu.IMDA.Protocatechuic acid		Ni.IMDA.Protocatechuic acid	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.50	0.00	1.50	0.00	1.50
1.00	1.60	1.00	1.60	1.00	1.60
1.50	1.65	1.50	1.65	1.50	1.65
2.00	1.70	2.00	1.70	2.00	1.70
2.50	1.80	2.50	1.80	2.50	1.80
3.00	1.85	3.00	1.85	3.00	1.85
3.50	1.90	3.50	1.90	3.50	1.90
4.00	2.00	4.00	2.00	4.00	2.00
4.50	2.10	4.50	2.10	4.50	2.10
5.00	2.30	5.00	2.30	5.00	2.30
5.50	2.65	5.50	2.65	5.50	2.65
5.70	2.90	5.70	2.90	5.70	2.90
5.80	3.10	5.80	3.10	5.80	3.10
5.90	3.25	5.90	3.25	5.90	3.25
6.00	3.50	6.00	3.50	6.00	3.50
6.08	3.75	6.08	3.75	6.08	3.75
6.15	4.00	6.15	4.00	6.15	4.00
6.23	4.25	6.23	4.25	6.23	4.25
6.30	4.50	6.30	4.50	6.30	4.50
6.35	4.75	6.35	4.75	6.35	4.75
6.40	5.00	6.40	5.00	6.40	5.00
6.45	5.25	6.45	5.50	6.45	5.25
6.50	6.00	6.50	5.80	6.50	6.00
6.52	7.50	6.55	6.00	6.55	7.25
6.55	7.75	6.60	6.25	6.57	7.50
6.59	8.00	6.70	6.50	6.61	7.75
6.64	8.25	6.90	6.80	6.67	8.00
6.68	8.50	7.00	7.00	6.80	8.25
6.75	8.75	7.20	7.25	6.95	8.50
6.81	9.00	7.25	7.50	7.07	8.75
6.88	9.25	7.30	7.80	7.17	9.00
6.95	9.50	7.33	8.00	7.25	9.25
7.00	9.75	7.35	8.25	7.30	9.50
7.06	10.00	7.38	8.50	7.37	9.75
7.15	10.25	7.45	9.10	7.44	10.00
7.30	10.50	7.50	9.50	7.50	10.25
		7.60	10.00	7.55	10.50
		7.70	10.30		
		7.75	10.50		

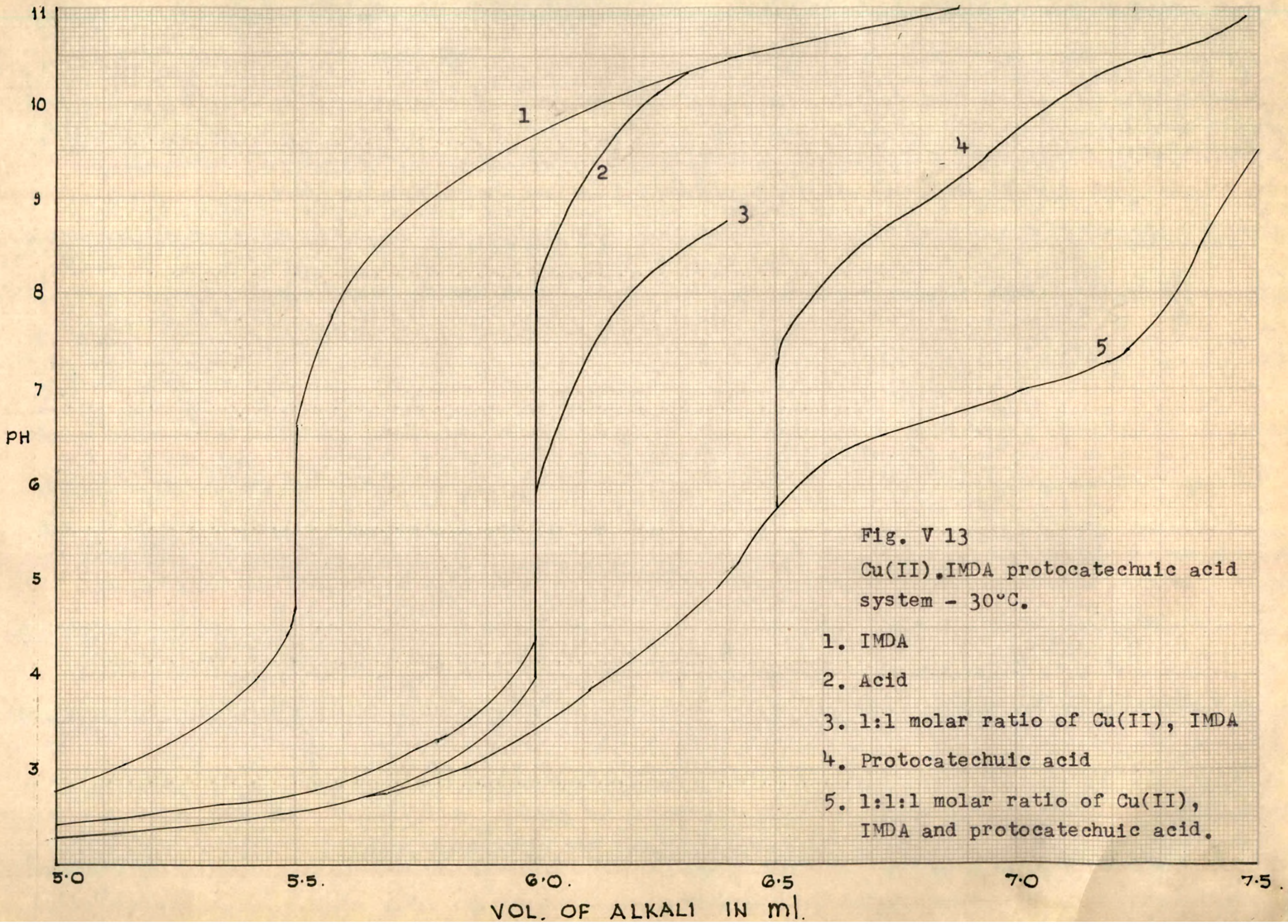


Fig. V 13
Cu(II).IMDA protocatechuic acid system - 30°C.

1. IMDA
2. Acid
3. 1:1 molar ratio of Cu(II), IMDA
4. Protocatechuic acid
5. 1:1:1 molar ratio of Cu(II), IMDA and protocatechuic acid.

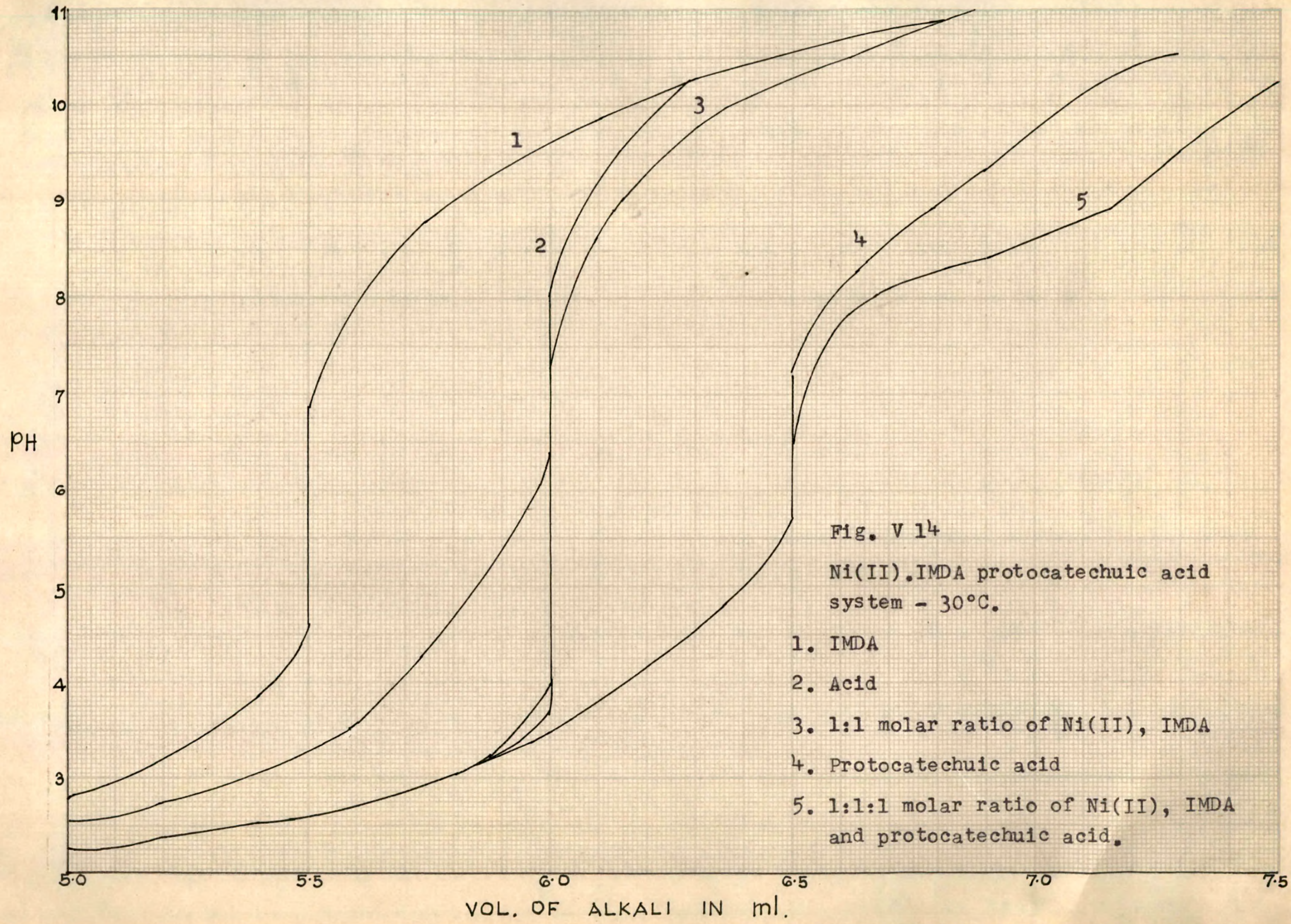


Fig. V 14

Ni(II).IMDA protocatechuic acid system - 30°C.

1. IMDA
2. Acid
3. 1:1 molar ratio of Ni(II), IMDA
4. Protocatechuic acid
5. 1:1:1 molar ratio of Ni(II), IMDA and protocatechuic acid.

Table V 13

B, $\bar{n}_H$, $\bar{n}$, $\log(1-\bar{n})/\bar{n}$, pL and pL-$\log(1-\bar{n})/\bar{n}$ data of Cu.IMDA. catechol system - 30°C.

B	$\bar{n}_H$	V"	V"'	V"'-V"	$\bar{n}$	$\log(1-\bar{n})/\bar{n}$	pL	pL-$\log(1-\bar{n})/\bar{n}$
6.40	2.00_0	6.00	6.13	0.13	0.12_1	0.86_1	10.30_4	9.44_3
6.50	2.00_0	6.00	6.17	0.17	0.15_8	0.72_6	10.22_0	9.49_4
6.60	2.00_0	6.00	6.20	0.20	0.18_6	0.64_1	10.03_5	9.39_4
6.70	2.00_0	6.00	6.25	0.25	0.23_2	0.51_9	9.96_3	9.44_4
6.80	1.98_4	6.00	6.30	0.30	0.28_0	0.41_0	9.79_3	9.38_3
6.90	1.98_4	6.00	6.40	0.40	0.40_3	0.17_0	9.57_3	9.40_3
7.00	1.98_2	6.00	6.50	0.50	0.50_4	$\bar{1}.99_3$	9.40_0	9.40_7

$\log K_{MAL}$ = 9.42 ± 0.07

Table V 14

B, $\bar{n}_H$, $\bar{n}$, $\log(1-\bar{n})/\bar{n}$, pL and pL-$\log(1-\bar{n})/\bar{n}$ data of Cu.IMDA. pyrogallol system - 30°C.

B	$\bar{n}_H$	V"	V"'	V"'-V"	$\bar{n}$	$\log(1-\bar{n})/\bar{n}$	pL	pL-$\log(1-\bar{n})/\bar{n}$
6.20	2.00_0	6.00	6.12	0.12	0.11_2	0.89_9	9.71_9	8.82_0
6.30	2.00_0	6.00	6.18	0.18	0.16_8	0.69_4	9.54_5	8.85_1
6.40	2.00_0	6.00	6.20	0.20	0.18_6	0.64_1	9.45_5	8.81_4
6.50	2.00_0	6.00	6.28	0.28	0.26_1	0.45_2	9.30_1	8.84_9
6.60	2.00_0	6.00	6.40	0.40	0.37_3	0.22_5	9.07_1	8.84_6
6.70	2.00_0	6.00	6.45	0.45	0.42_0	0.14_0	8.90_8	8.76_8
6.80	2.00_0	6.00	6.52	0.52	0.48_5	0.02_6	8.80_6	8.78_0
6.90	2.00_0	6.00	6.55	0.55	0.49_4	0.01_0	8.70_0	8.69_0

$\log K_{MAL}$ = 8.81 ± 0.09

Table V 15

B, $\bar{n}_H$, $\bar{n}$, $\log(1-\bar{n})/\bar{n}$, pL and pL-$\log(1-\bar{n})/\bar{n}$ data of Cu.IMDA. 2,3-dihydroxynaphthalene system - 30°C.

B	$\bar{n}_H$	V"	V"'	V"'-V"	$\bar{n}$	$\log(1-\bar{n})/\bar{n}$	pL	pL-$\log(1-\bar{n})/\bar{n}$
6.00	2.00_0	6.00	6.13	0.13	0.13_0	0.82_5	11.74_1	10.91_6
6.10	2.00_0	6.00	6.16	0.16	0.16_0	0.72_0	11.55_7	10.83_7
6.20	2.00_0	6.00	6.25	0.25	0.25_0	0.47_7	11.40_8	10.93_1
6.30	2.00_0	6.00	6.30	0.30	0.30_0	0.36_8	11.23_9	10.87_1
6.40	2.00_0	6.00	6.35	0.35	0.35_0	0.26_8	11.07_3	10.80_5
6.50	2.00_0	6.00	6.40	0.40	0.40_0	0.17_6	10.90_8	10.83_2
6.60	2.00_0	6.00	6.54	0.54	0.54_0	$\bar{1}.94_7$	10.81_0	10.86_3
6.70	2.00_0	6.02	6.58	0.56	0.56_0	$\bar{1}.89_5$	10.73_9	10.84_4

$\log K_{MAL} = 10.86 \pm 0.07$

Table V 16

B, $\bar{n}_H$, $\bar{n}$, $\log(1-\bar{n})/\bar{n}$, pL and pL-$\log(1-\bar{n})/\bar{n}$ data of Cu.IMDA. protocatechuic acid system - 30°C.

B	$\bar{n}_H$	V"	V"'	V"'-V"	$\bar{n}$	$\log(1-\bar{n})/\bar{n}$	pL	pL-$\log(1-\bar{n})/\bar{n}$
6.40	2.00_0	6.50	6.65	0.15	0.14_8	0.76_0	11.02_2	10.26_2
6.50	2.00_0	6.50	6.70	0.20	0.19_8	0.60_7	10.84_7	10.24_0
6.60	2.00_0	6.50	6.77	0.27	0.26_7	0.43_8	10.68_7	10.24_9
6.70	2.00_0	6.50	6.85	0.35	0.34_6	0.27_6	10.53_6	10.26_0
6.80	2.00_0	6.50	6.90	0.40	0.39_6	0.18_3	10.36_9	10.18_6
6.90	2.00_0	6.50	6.96	0.46	0.45_5	0.07_8	10.24_2	10.16_4
7.00	2.00_0	6.50	7.06	0.56	0.55_5	$\bar{1}.90_4$	10.10_1	10.19_7
7.10	2.00_0	6.50	7.14	0.64	0.63_4	$\bar{1}.76_1$	9.93_2	10.17_1

$\log K_{MAL} = 10.22 \pm 0.06$

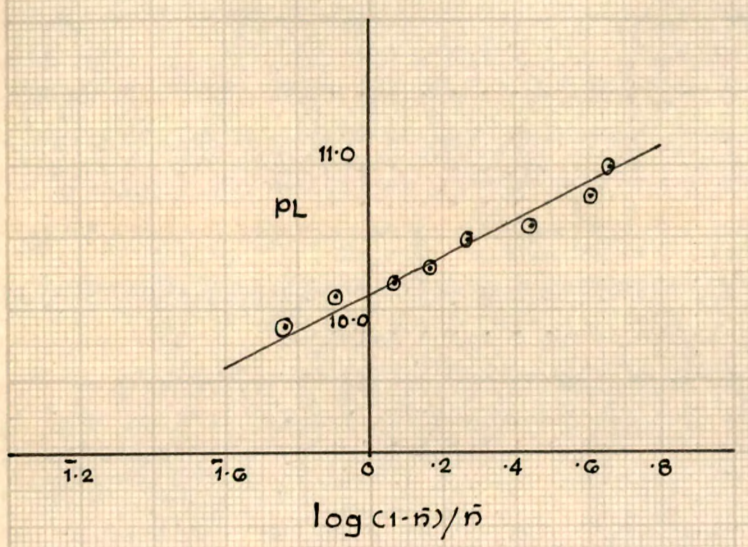


Fig. V 18

Cu(II).IMDA protocatechuic acid system - 30°C.

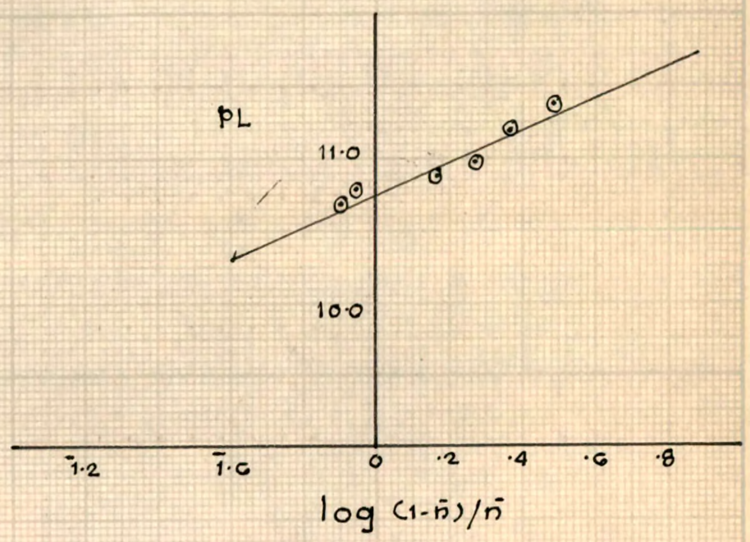


Fig. V 17

Cu(II).IMDA 2,3-dihy.naph. system - 30°C.

Fig. V 15

Cu(II).IMDA catechol system - 30°C.

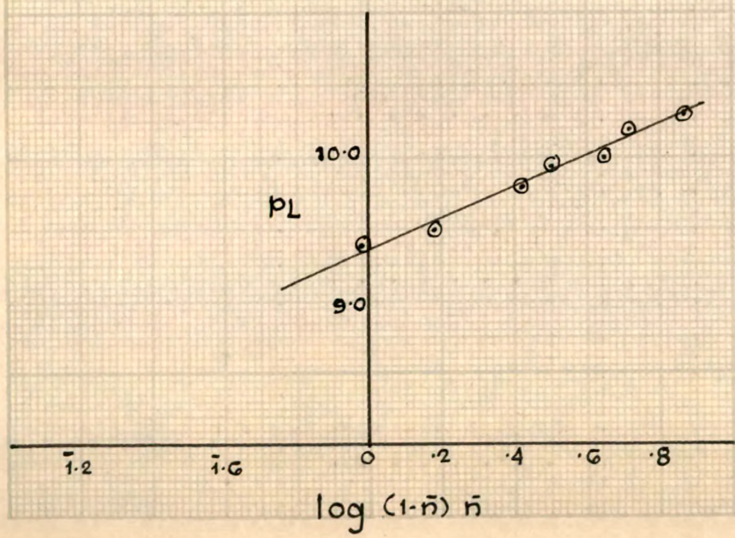


Fig. V 16

Cu(II).IMDA. pyrogallol system - 30°C.

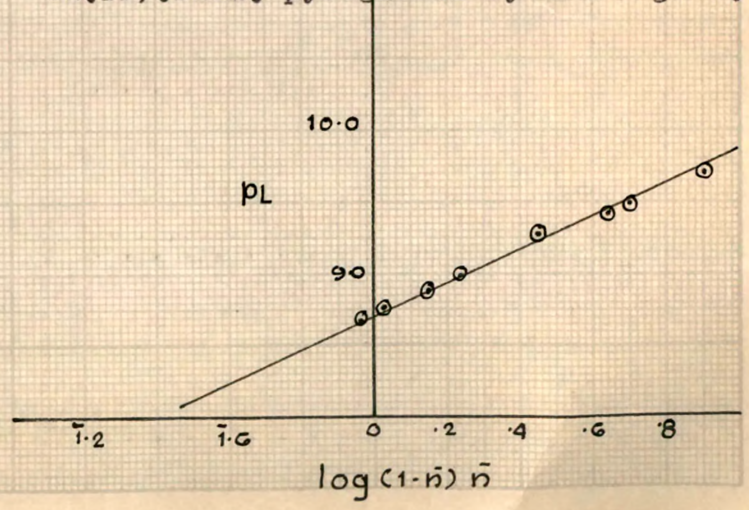


Table V 17

B, $\bar{n}_H$, $\bar{n}$, $\log(1-\bar{n})/\bar{n}$, pL and pL-$\log(1-\bar{n})/\bar{n}$ data of Ni.IMDA. catechol system - 30°C.

B	$\bar{n}_H$	V"	V"'	V"'-V"	$\bar{n}$	$\log(1-\bar{n})/\bar{n}$	pL	pL-$\log(1-\bar{n})/\bar{n}$
8.40	1.84_8	6.14	6.27	0.13	0.14_0	0.78_8	6.49_4	5.70_6
8.50	1.81_6	6.15	6.33	0.18	0.19_8	0.60_7	6.32_3	5.71_6
8.60	1.79_2	6.18	6.40	0.22	0.24_5	0.48_8	6.19_6	5.70_2
8.70	1.74_4	6.20	6.46	0.26	0.29_8	0.37_2	6.04_5	5.67_3
8.80	1.71_9	6.23	6.52	0.29	0.33_7	0.29_3	5.90_2	5.60_9
8.90	1.67_2	6.25	6.59	0.34	0.40_6	0.16_4	5.78_6	5.62_2
9.00	1.56_0	6.28	6.65	0.37	0.47_4	0.04_5	5.68_2	5.63_7

$\log K_{MAL}$ = 5.66 ± 0.06

Table V 18

B, $\bar{n}_H$, $\bar{n}$, $\log(1-\bar{n})/\bar{n}$, pL and pL-$\log(1-\bar{n})/\bar{n}$ data of Ni.IMDA. pyrogallol system - 30°C.

B	$\bar{n}_H$	V"	V"'	V"'-V"	$\bar{n}$	$\log(1-\bar{n})/\bar{n}$	pL	pL-$\log(1-\bar{n})/\bar{n}$
8.00	1.84_0	6.15	6.26	0.11	0.11_7	0.87_7	6.10_4	5.22_7
8.10	1.80_0	6.17	6.29	0.12	0.13_3	0.81_4	6.03_0	5.21_6
8.20	1.78_4	6.19	6.35	0.16	0.17_9	0.65_1	5.87_8	5.22_7
8.30	1.75_2	6.21	6.39	0.18	0.20_5	0.58_8	5.75_4	5.16_6
8.40	1.71_2	6.22	6.45	0.23	0.26_8	0.43_6	5.58_9	5.15_3
8.50	1.68_0	6.25	6.56	0.31	0.36_0	0.23_3	5.40_7	5.17_4
8.60	1.61_6	6.27	6.62	0.35	0.43_3	0.12_0	5.28_4	5.16_4

$\log K_{MAL}$ = 5.18 ± 0.04

Table V 19

B, $\bar{n}_H$, $\bar{n}$, $\log(1-\bar{n})/\bar{n}$, pL and pL-$\log(1-\bar{n})/\bar{n}$ data of Ni.IMDA. 2,3-dihydroxynaphthalene system - 30°C.

B	$\bar{n}_H$	V"	V"'	V"'-V"	$\bar{n}$	$\log(1-\bar{n})/\bar{n}$	pL	pL-$\log(1-\bar{n})/\bar{n}$
8.00	1.77_3	6.18	6.40	0.22	0.24_8	0.48_1	7.88_7	7.40_6
8.10	1.71_3	6.20	6.45	0.25	0.29_1	0.38_6	7.77_4	7.38_8
8.20	1.67_3	6.22	6.50	0.28	0.33_4	0.29_9	7.70_7	7.49_8
8.30	1.63_3	6.25	6.55	0.30	0.36_7	0.23_6	7.61_7	7.38_1
8.40	1.55_3	6.28	6.60	0.32	0.41_2	0.15_4	7.47_8	7.32_4
8.50	1.51_4	6.30	6.65	0.35	0.46_2	0.06_6	7.44_3	7.37_7
8.60	1.43_4	6.33	6.70	0.37	0.51_6	$\bar{1}.97_2$	7.31_5	7.34_3
8.70	1.39_4	6.35	6.74	0.39	0.55_9	$\bar{1}.89_7$	7.24_5	7.34_8

$\log K_{MAL} = 7.38 \pm 0.09$

Table V 20

B, $\bar{n}_H$, $\bar{n}$, $\log(1-\bar{n})/\bar{n}$, pL and pL-$\log(1-\bar{n})/\bar{n}$ data of Ni.IMDA. protocatechuic acid system - 30°C.

B	$\bar{n}_H$	V"	V"'	V"'-V"	$\bar{n}$	$\log(1-\bar{n})/\bar{n}$	pL	pL-$\log(1-\bar{n})/\bar{n}$
8.10	1.84_0	6.60	6.70	0.10	0.10_7	0.92_1	7.67_1	6.75_0
8.20	1.80_0	6.63	6.77	0.14	0.15_3	0.74_3	7.51_6	6.77_3
8.30	1.76_0	6.65	6.82	0.17	0.19_1	0.62_6	7.35_6	6.73_0
8.40	1.72_0	6.67	6.90	0.23	0.26_4	0.44_5	7.22_0	6.77_5
8.50	1.68_0	6.68	6.95	0.27	0.31_8	0.33_1	7.08_0	6.74_9
8.60	1.60_0	6.70	7.00	0.30	0.37_0	0.23_1	6.95_3	6.72_2
8.70	1.56_0	6.73	7.06	0.33	0.41_7	0.14_5	6.82_2	6.67_7
8.80	1.52_0	6.75	7.13	0.38	0.49_4	0.01_0	6.73_2	6.72_2

$\log K_{MAL} = 6.74 \pm 0.07$

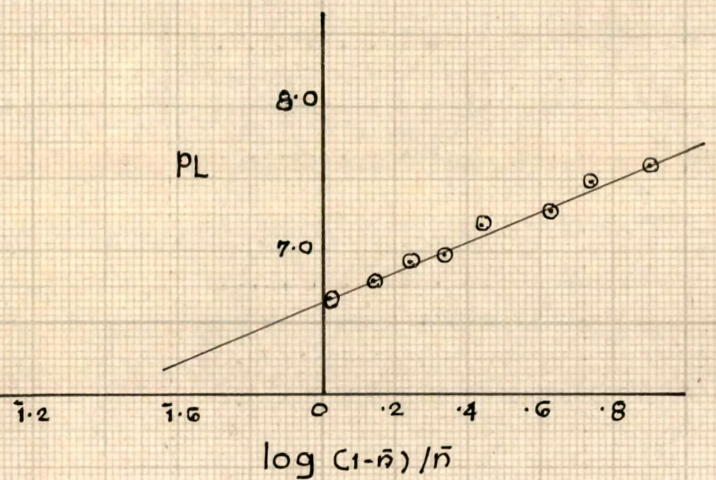
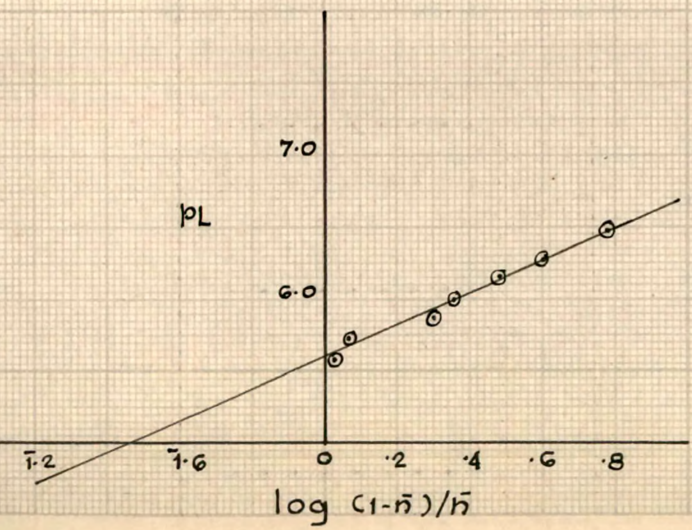


Fig. V 22

Ni(II).IMDA protocatechuic acid system - 30°C.

Fig. V 19

Ni(II).IMDA catechol system - 30°C.



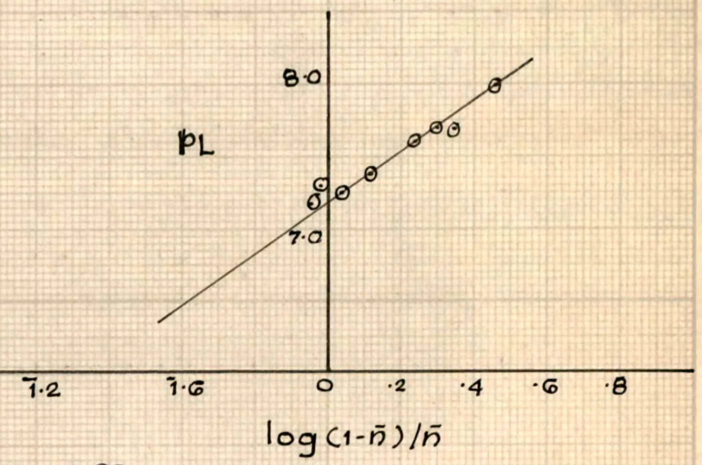


Fig. V 21

Ni(II).IMDA 2,3-dihy.naph.system - 30°C.

Fig. V 20

Ni(II).IMDA pyrogallol system - 30°C.

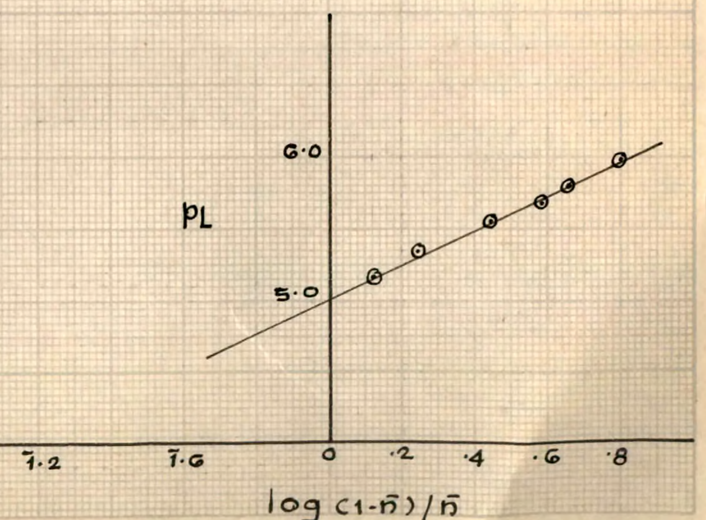


Table V 21

N = 0.2M V° = 50 ml. μ = 0.2M t = 30°C.

E° = 0.02M *E° = 0.026M T°_{NTA} = 0.002M T°_{M} = 0.002M

*Perchloric acid		NTA		Cu.NTA		Ni.NTA	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.45	0.00	1.50	0.00	1.40	0.00	1.50
1.00	1.50	1.00	1.60	1.00	1.50	1.00	1.60
2.00	1.60	2.00	1.65	2.00	1.60	2.00	1.65
3.00	1.70	3.00	1.75	3.00	1.70	3.00	1.80
4.00	1.90	4.00	2.00	4.00	1.90	4.00	1.90
5.00	2.10	5.00	2.30	5.00	2.10	5.00	2.00
5.50	2.15	5.50	2.80	5.50	2.15	5.50	2.15
6.00	2.40	5.60	2.90	6.00	2.55	6.00	2.40
6.10	2.50	5.70	3.15	6.05	2.60	6.05	2.55
6.20	2.75	5.80	3.40	6.10	2.75	6.10	2.65
6.30	3.00	5.90	3.70	6.20	2.95	6.15	2.80
6.35	3.20	5.95	3.95	6.30	3.20	6.20	3.00
6.40	3.40	6.00	4.35	6.40	3.60	6.25	3.20
6.45	3.70	6.05	7.85	6.50	4.60	6.30	3.45
6.50	4.20	6.08	8.05	6.54	8.30	6.35	3.70
6.54	9.00	6.12	8.30	6.58	8.70	6.40	3.94
6.60	9.60	6.16	8.50	6.60	8.75	6.45	4.30
6.65	9.95	6.20	8.70	6.64	9.00	6.50	4.60
6.70	10.15	6.25	8.90	6.68	9.20	6.54	8.60
6.75	10.30	6.30	9.10	6.70	9.30	6.58	9.00
6.80	10.40	6.35	9.20	6.75	9.45	6.60	9.10
6.85	10.45	6.40	9.40	6.80	9.60	6.65	9.50
6.90	10.55	6.45	9.55	6.85	9.70	6.70	9.70
6.95	10.65	6.50	9.70	6.90	9.85	6.75	10.00
7.00	10.70	6.60	9.95	7.00	10.10	6.80	10.20
7.05	10.80	6.70	10.15	7.05	10.30	6.85	10.40
7.10	10.90	6.80	10.40	7.10	10.40	6.90	10.55
7.16	11.00	6.85	10.50	7.20	10.55	6.95	10.65
		6.90	10.55	7.30	10.70	7.00	10.70
		7.00	10.70	7.40	10.85	7.05	10.80
		7.10	10.90	7.50	10.95	7.10	10.90
		7.16	11.00	7.16	11.00	7.55	11.00

Table V 22

N = 0.2M $V° = 50$ ml. $\mu = 0.2M$ t = 30°C.

E° = 0.02M *E° = 0.026M $T^{o}_{NTA} = 0.002M$ $T^{o}_{M} = 0.002M$

$T^{o}_{L} = 0.002M$

*Catechol		Cu.NTA.Catechol		Ni.NTA.Catechol	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.45	0.00	1.45	0.00	1.45
1.00	1.50	1.00	1.50	1.00	1.50
2.00	1.60	2.00	1.60	2.00	1.60
3.00	1.70	3.00	1.70	3.00	1.70
4.00	1.90	4.00	1.90	4.00	1.90
5.00	2.10	5.00	2.10	5.00	2.10
5.50	2.15	5.50	2.15	5.50	2.15
6.00	2.40	6.00	2.60	6.00	2.40
6.10	2.50	6.10	2.75	6.10	2.50
6.20	2.75	6.20	2.95	6.20	2.75
6.30	3.00	6.30	3.20	6.30	3.00
6.35	3.20	6.35	3.40	6.35	3.20
6.40	3.40	6.40	3.60	6.40	3.40
6.45	3.70	6.50	4.60	6.45	3.70
6.50	4.20	6.54	7.05	6.50	4.20
6.54	8.00	6.58	7.20	6.54	7.55
6.58	8.25	6.60	7.25	6.58	7.80
6.60	8.40	6.65	7.35	6.60	8.00
6.65	8.60	6.70	7.45	6.65	8.20
6.70	8.80	6.80	7.60	6.70	8.50
6.75	9.00	6.90	7.75	6.75	8.60
6.80	9.20	7.00	7.85	6.80	8.80
6.85	9.30	7.10	8.00	6.85	8.90
6.90	9.50	7.20	8.35	6.90	9.05
6.95	9.60	7.30	8.70	6.95	9.15
7.00	9.70	7.40	9.00	7.05	9.35
7.05	9.80	7.50	9.50	7.15	9.55
7.10	9.90	7.60	9.90	7.30	9.75
7.20	10.05	7.70	10.20	7.45	9.95
7.30	10.30	7.80	10.50	7.60	10.20
7.45	10.60	7.90	10.65	7.80	10.50
7.55	10.80	8.00	10.75	8.00	10.75

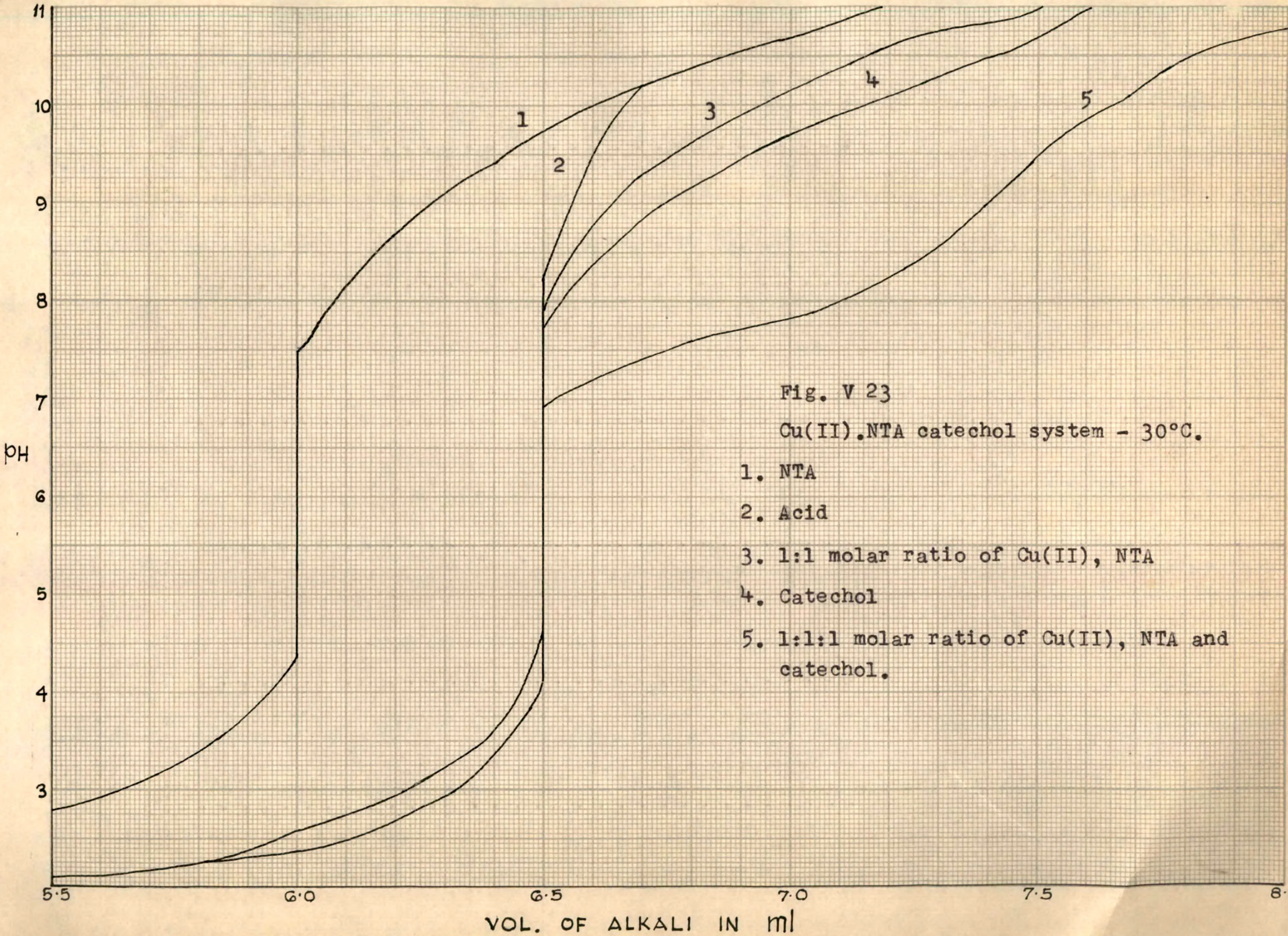


Fig. V 23

Cu(II).NTA catechol system - 30°C.

1. NTA
2. Acid
3. 1:1 molar ratio of Cu(II), NTA
4. Catechol
5. 1:1:1 molar ratio of Cu(II), NTA and catechol.

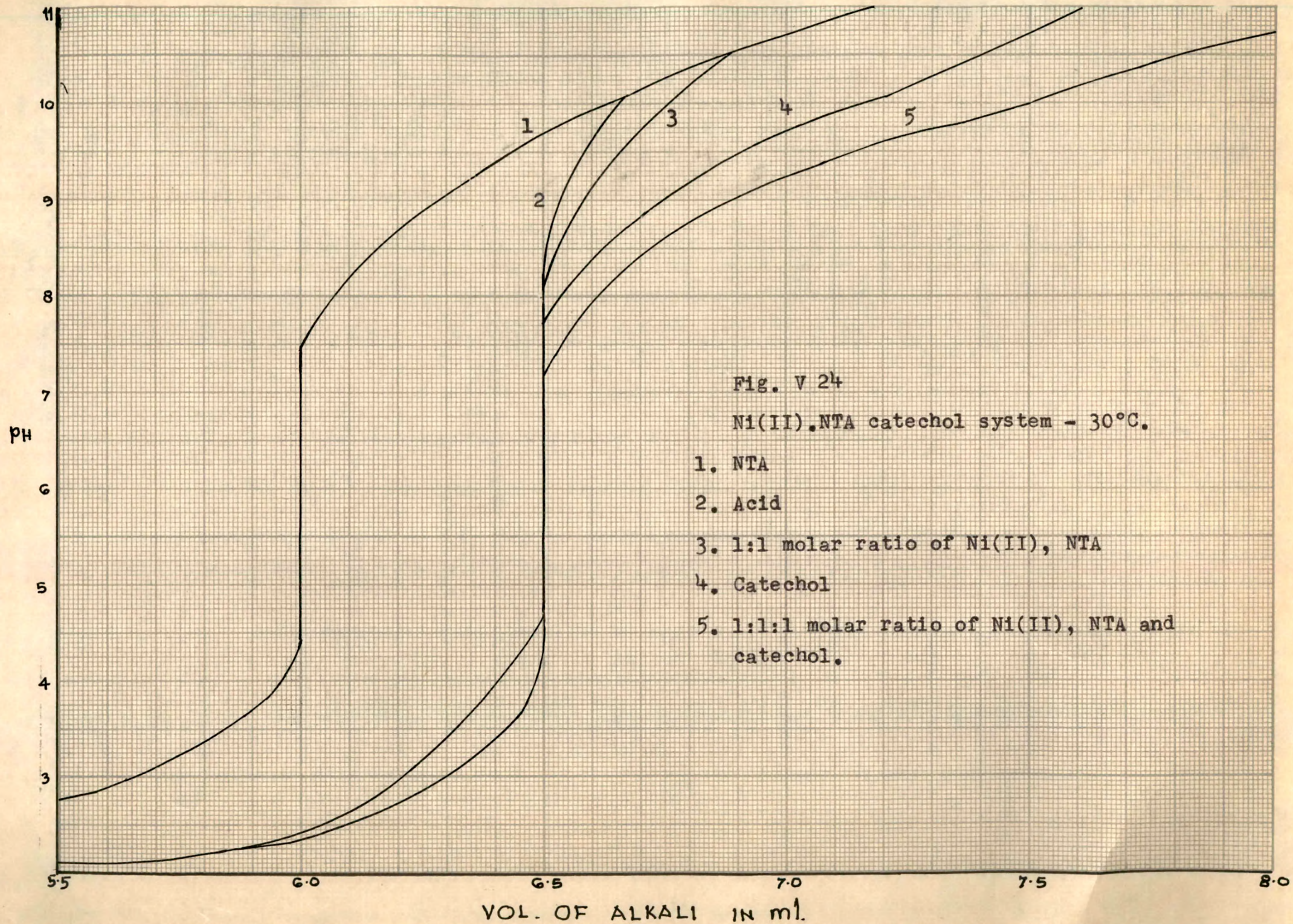


Fig. V 24

Ni(II).NTA catechol system - 30°C.

1. NTA
2. Acid
3. 1:1 molar ratio of Ni(II), NTA
4. Catechol
5. 1:1:1 molar ratio of Ni(II), NTA and catechol.

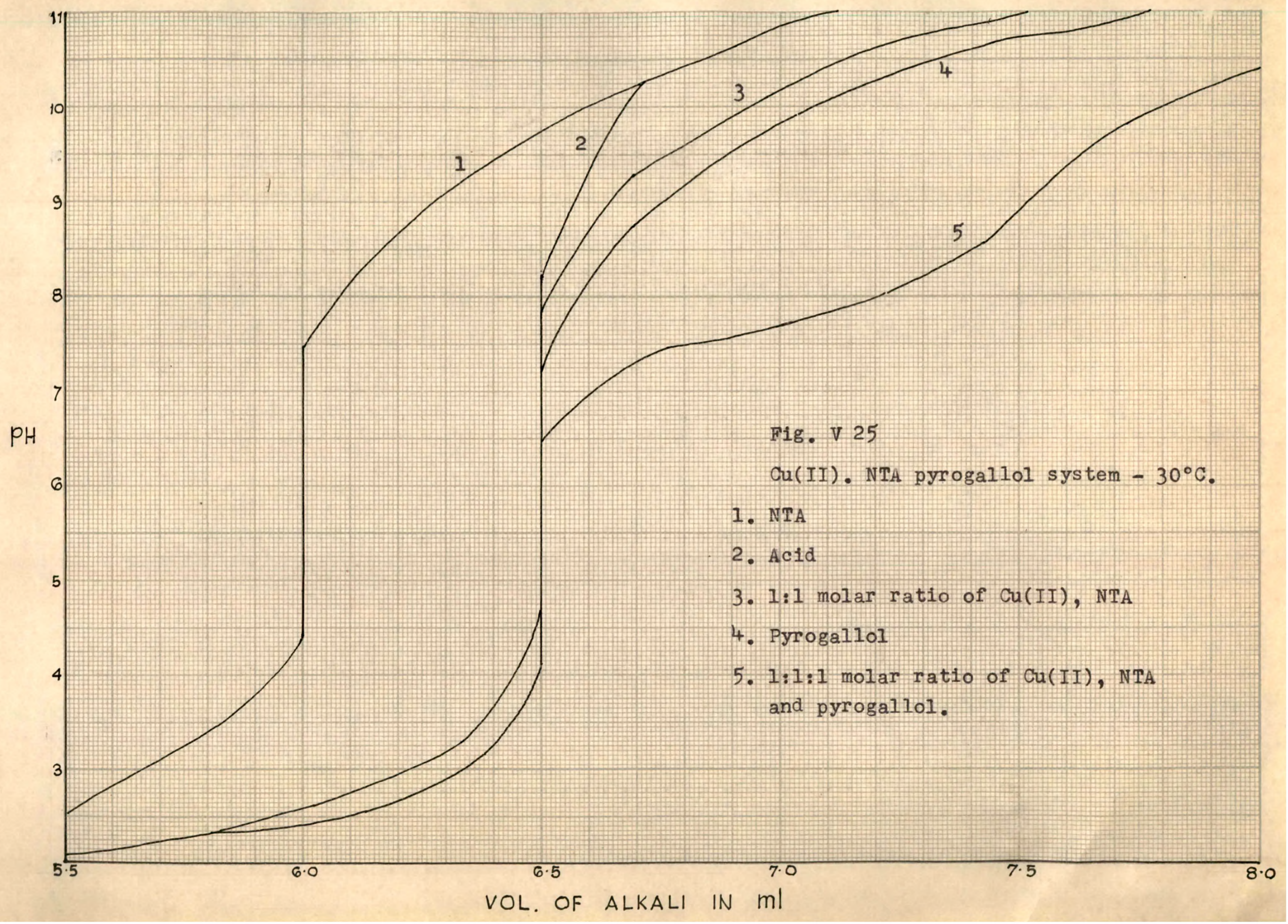
Table V 23

N = 0.2M V° = 50 ml. μ = 0.2M t = 30°C.

E° = 0.02M *E° = 0.026M T°_{NTA} = 0.002M T°_{M} = 0.002M

T°_{L} = 0.002M

*Pyrogallol		Cu.NTA.Pyrogallol		Ni.NTA.Pyrogallol	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.45	0.00	1.45	0.00	1.45
1.00	1.50	1.00	1.50	1.00	1.50
2.00	1.60	2.00	1.60	2.00	1.60
3.00	1.70	3.00	1.70	3.00	1.70
4.00	1.90	4.00	1.90	4.00	1.90
5.00	2.10	5.00	2.10	5.00	2.10
5.50	2.15	5.50	2.15	6.00	2.40
6.00	2.40	6.00	2.60	6.20	2.75
6.20	2.75	6.10	2.75	6.30	3.00
6.30	3.00	6.20	2.95	6.35	3.20
6.35	3.20	6.30	3.20	6.40	3.40
6.40	3.40	6.35	3.40	6.45	3.70
6.45	3.70	6.40	3.60	6.50	4.20
6.50	4.20	6.50	4.60	6.54	7.20
6.54	7.75	6.55	6.75	6.58	7.45
6.58	8.05	6.60	7.00	6.60	7.60
6.60	8.20	6.70	7.30	6.65	7.90
6.64	8.35	6.83	7.50	6.70	8.15
6.68	8.65	7.05	7.75	6.75	8.35
6.75	8.95	7.20	8.00	6.80	8.55
6.80	9.20	7.30	8.25	6.85	8.80
6.85	9.35	7.40	8.50	6.90	8.95
6.90	9.50	7.46	8.75	6.95	9.20
7.00	9.80	7.51	9.00	7.00	9.35
7.05	10.00	7.57	9.25	7.10	9.55
7.15	10.20	7.63	9.50	7.20	9.75
7.30	10.45	7.70	9.75	7.30	9.95
7.50	10.70	7.80	10.00	7.40	10.10
7.60	10.80	7.90	10.20	7.70	10.45
7.70	10.90	8.00	10.40	7.80	10.60
7.75	11.00	8.10	10.50	7.90	10.70


pH
11
10
9
8
7
6
5
4
3
5·5
6·0
6·5
7·0
7·5
8·0
VOL. OF ALKALI IN ml
1
2
3
4
5
Fig. V 25
Cu(II). NTA pyrogallol system - 30°C.
1. NTA
2. Acid
3. 1:1 molar ratio of Cu(II), NTA
4. Pyrogallol
5. 1:1:1 molar ratio of Cu(II), NTA and pyrogallol.

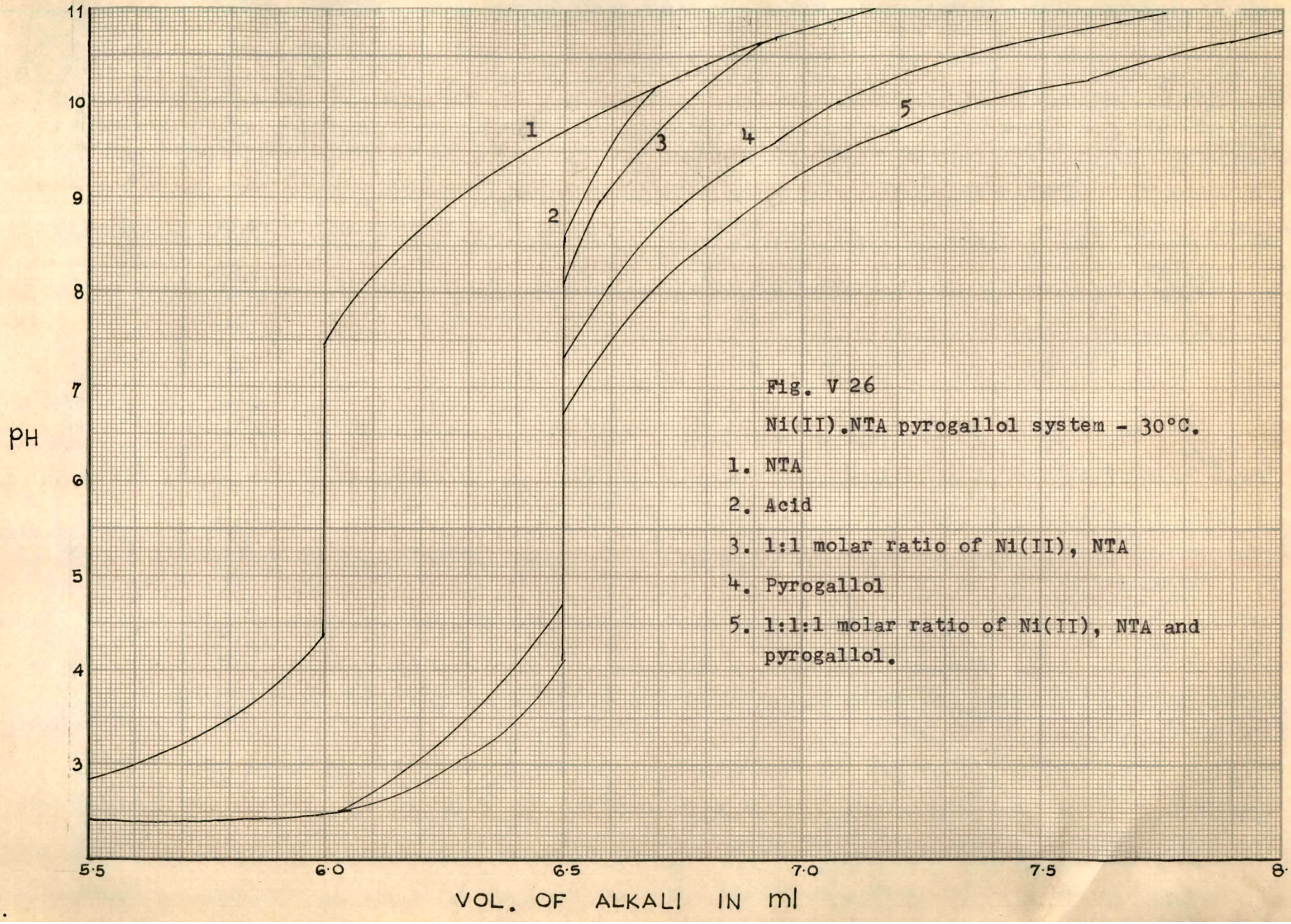


Fig. V 26

Ni(II).NTA pyrogallol system - 30°C.

1. NTA
2. Acid
3. 1:1 molar ratio of Ni(II), NTA
4. Pyrogallol
5. 1:1:1 molar ratio of Ni(II), NTA and pyrogallol.

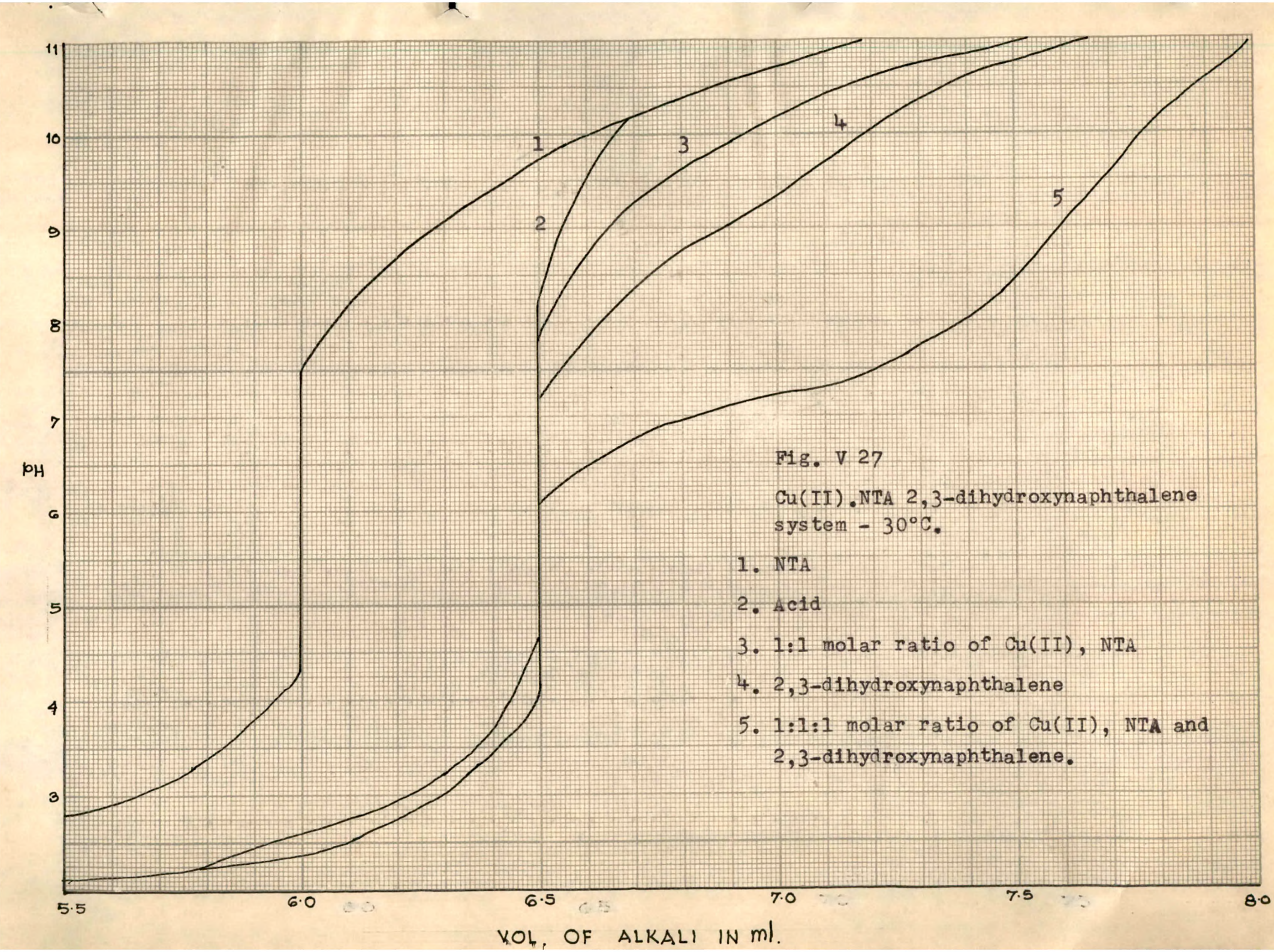
Table V 24

N = 0.2M   V° = 50 ml. μ = 0.2M   t = 30°C.

E° = 0.02M   *E° = 0.026M T°_{NTA} = 0.002M T°_{M} = 0.002M

T°_{L} = 0.002M

*2,3-Dihydroxy-naphthalene		Cu.NTA.2,3-Dihydroxy-naphthalene		Ni.NTA.2,3-Dihydroxy-naphthalene	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.45	0.00	1.45	0.00	1.50
1.00	1.50	1.00	1.50	1.00	1.60
2.00	1.60	2.00	1.60	2.00	1.65
3.00	1.70	3.00	1.70	3.00	1.80
4.00	1.90	4.00	1.90	4.00	1.90
5.00	2.10	5.00	2.10	5.00	2.00
5.50	2.15	5.50	2.15	5.50	2.15
6.00	2.40	6.00	2.60	6.00	2.40
6.10	2.50	6.10	2.75	6.05	2.55
6.20	2.75	6.20	2.95	6.10	2.65
6.30	3.00	6.30	3.20	6.20	3.00
6.35	3.20	6.35	3.40	6.25	3.20
6.40	3.40	6.40	3.60	6.30	3.45
6.45	3.70	6.50	4.60	6.40	3.95
6.50	4.20	6.55	6.30	6.45	4.30
6.54	7.50	6.60	6.50	6.50	4.60
6.58	7.75	6.70	6.80	6.54	7.10
6.60	7.90	6.80	7.00	6.58	7.35
6.65	8.15	7.00	7.25	6.60	7.45
6.70	8.40	7.20	7.50	6.65	7.70
6.75	8.60	7.30	7.75	6.70	7.90
6.80	8.70	7.39	8.00	6.75	8.10
6.85	8.85	7.50	8.50	6.80	8.30
6.90	9.00	7.60	9.00	6.85	8.40
6.95	9.15	7.64	9.25	6.90	8.50
7.00	9.35	7.66	9.50	7.10	8.70
7.05	9.50	7.73	9.75	7.30	9.00
7.10	9.75	7.77	10.00	7.50	9.50
7.20	10.10	7.82	10.25	7.60	9.70
7.30	10.35	7.88	10.50	7.70	10.00
7.40	10.65	7.95	10.75	7.80	10.40
7.60	10.90	8.00	10.95	8.00	10.65


11
10
9
8
7
6
5
4
3
pH
5.5
6.0
6.5
7.0
7.5
8.0
VOL. OF ALKALI IN ml.
1
2
3
4
5
Fig. V 27
Cu(II).NTA 2,3-dihydroxynaphthalene system - 30°C.
1. NTA
2. Acid
3. 1:1 molar ratio of Cu(II), NTA
4. 2,3-dihydroxynaphthalene
5. 1:1:1 molar ratio of Cu(II), NTA and 2,3-dihydroxynaphthalene.

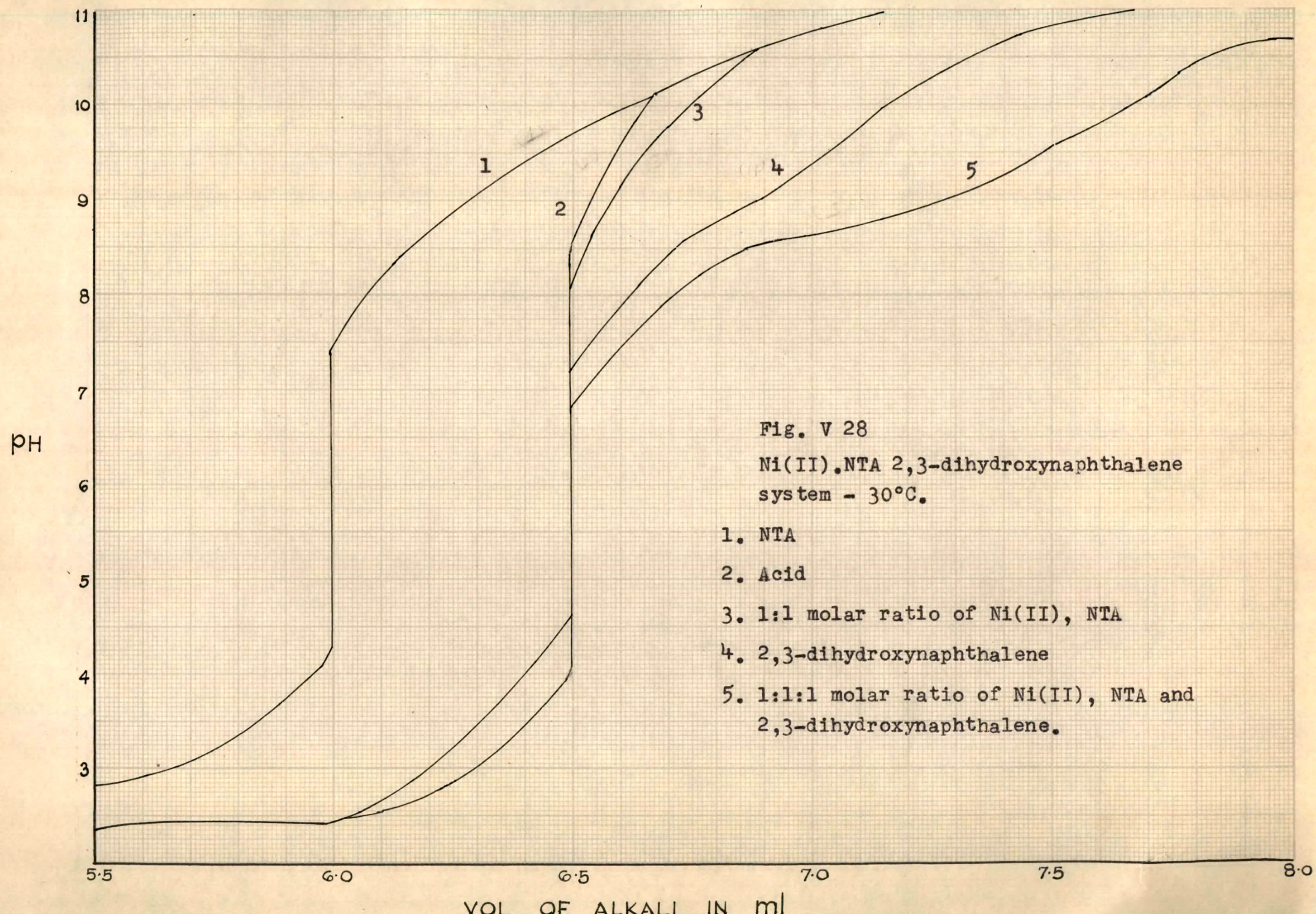


Fig. V 28

Ni(II).NTA 2,3-dihydroxynaphthalene system - 30°C.

1. NTA
2. Acid
3. 1:1 molar ratio of Ni(II), NTA
4. 2,3-dihydroxynaphthalene
5. 1:1:1 molar ratio of Ni(II), NTA and 2,3-dihydroxynaphthalene.

Table V 25

$N = 0.2M$ $V^\circ = 50$ ml. $\mu = 0.2M$ $t = 30°C.$

$E^\circ = 0.02M$ $^*E^\circ = 0.026M$ $T^\circ_{NTA} = 0.002M$ $T^\circ_M = 0.002M$

$T^\circ_L = 0.002M$

*Protocatechuic-acid		Cu.NTA.Proto-catechuic acid		Ni.NTA.Proto-catechuic acid	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.45	0.00	1.45	0.00	1.45
1.00	1.50	1.00	1.50	1.00	1.50
2.00	1.60	2.00	1.60	2.00	1.60
3.00	1.70	3.00	1.70	3.00	1.70
4.00	1.90	4.00	1.90	4.00	1.90
5.00	2.10	5.50	2.15	5.00	2.10
5.50	2.15	6.00	2.40	5.50	2.15
6.00	2.40	6.20	2.70	6.00	2.40
6.10	2.50	6.30	3.00	6.10	2.50
6.20	2.70	6.50	3.45	6.20	2.70
6.30	3.00	6.60	3.75	6.30	3.00
6.40	3.25	6.68	4.00	6.40	3.25
6.50	3.45	6.78	4.50	6.50	3.45
6.60	3.70	6.83	4.75	6.60	3.70
6.70	4.10	6.86	5.00	6.70	4.10
6.80	4.70	6.88	5.25	6.80	4.70
6.85	6.00	6.90	5.50	6.85	5.00
6.88	6.95	6.92	5.75	6.90	5.40
6.90	7.40	6.93	6.00	6.95	6.20
6.95	7.75	7.00	6.50	7.00	7.30
7.00	8.10	7.05	6.75	7.05	7.60
7.05	8.30	7.10	7.00	7.10	7.85
7.10	8.50	7.26	7.25	7.15	8.00
7.15	8.75	7.43	7.50	7.20	8.30
7.20	8.90	7.53	7.75	7.25	8.40
7.30	9.30	7.63	8.00	7.30	8.55
7.40	9.70	7.74	8.25	7.40	8.70
7.45	9.85	7.82	8.50	7.50	8.85
7.50	10.05	7.89	8.75	7.60	9.10
7.55	10.20	7.95	9.00	7.70	9.50
7.60	10.35	8.13	9.25	7.80	9.80
7.65	10.50	8.20	9.50	7.90	10.05
7.75	10.65	8.30	9.75	8.00	10.30
7.85	10.80	8.40	10.00	8.10	10.40
7.90	10.95	8.50	10.25	8.15	10.55

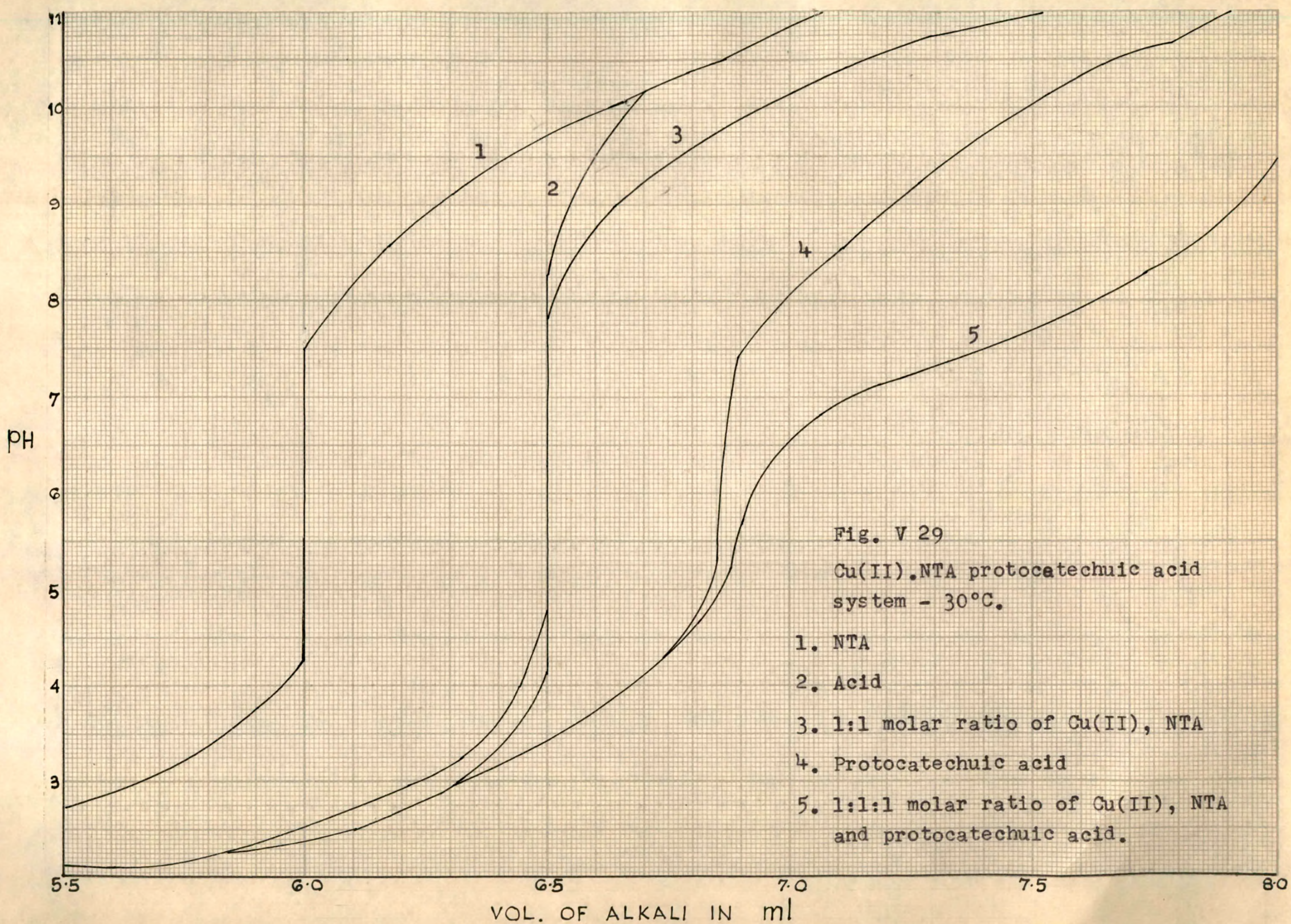


Fig. V 29

Cu(II).NTA protocatechuic acid system - 30°C.

1. NTA
2. Acid
3. 1:1 molar ratio of Cu(II), NTA
4. Protocatechuic acid
5. 1:1:1 molar ratio of Cu(II), NTA and protocatechuic acid.

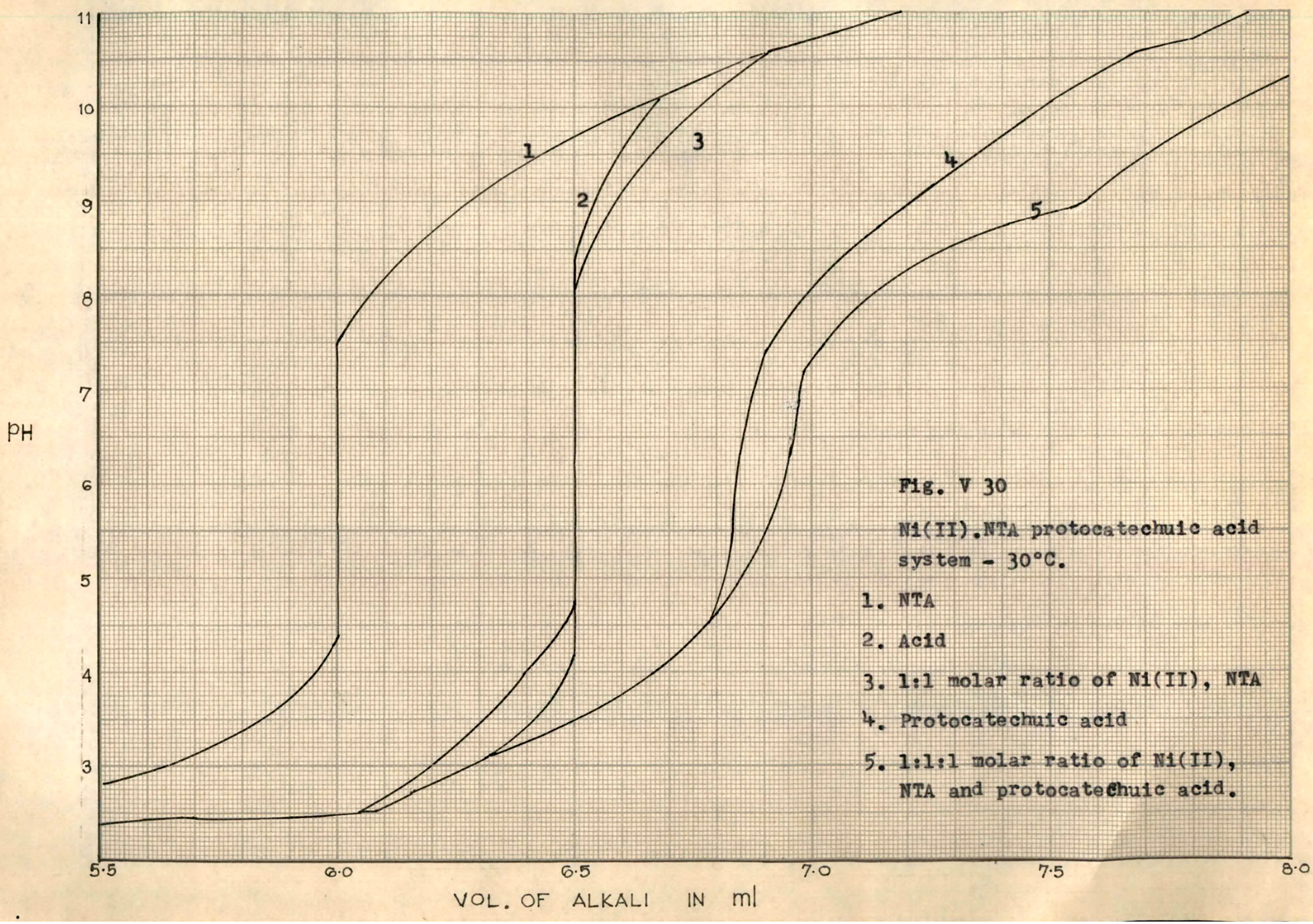


Fig. V 30

Ni(II).NTA protocatechuic acid system - 30°C.

1. NTA
2. Acid
3. 1:1 molar ratio of Ni(II), NTA
4. Protocatechuic acid
5. 1:1:1 molar ratio of Ni(II), NTA and protocatechuic acid.

Table V 26

B, $\bar{n}_H$, $\bar{n}$, $\log(1-\bar{n})/\bar{n}$, pL and pL-$\log(1-\bar{n})/\bar{n}$ data of Cu.NTA. catechol system - 30°C.

B	$\bar{n}_H$	V"	V"'	V"'-V"	$\bar{n}$	$\log(1-\bar{n})/\bar{n}$	pL	pL-$\log(1-\bar{n})/\bar{n}$
7.40	1.96_2	6.50	6.71	0.21	0.20_8	0.58_0	8.30_5	7.72_5
7.50	1.96_0	6.50	6.76	0.26	0.25_8	0.45_8	8.22_3	7.76_5
7.60	1.95_2	6.50	6.80	0.30	0.29_9	0.37_0	8.13_5	7.76_5
7.70	1.94_8	6.50	6.88	0.38	0.38_0	0.21_2	7.86_3	7.65_1
7.80	1.94_4	6.51	6.96	0.45	0.45_0	0.08_7	7.69_7	7.61_0
7.90	1.93_6	6.52	7.04	0.52	0.52_2	$\bar{1}.96_1$	7.61_3	7.65_2
8.00	1.92_4	6.54	7.10	0.56	0.56_6	$\bar{1}.88_4$	7.54_2	7.65_8

$\log K_{MAL}$ = 7.71 ± 0.06

Table V 27

B, $\bar{n}_H$, $\bar{n}$, $\log(1-\bar{n})/\bar{n}$, pL and pL-$\log(1-\bar{n})/\bar{n}$ data of Cu.NTA. pyrogallol system - 30°C.

B	$\bar{n}_H$	V"	V"'	V"'-V"	$\bar{n}$	$\log(1-\bar{n})/\bar{n}$	pL	pL-$\log(1-\bar{n})/\bar{n}$
7.30	1.95_2	6.50	6.70	0.20	0.19_9	0.60_4	7.53_6	6.93_2
7.40	1.94_4	6.51	6.76	0.25	0.25_0	0.47_7	7.45_4	6.97_7
7.50	1.92_8	6.52	6.84	0.32	0.32_2	0.32_3	7.17_9	6.85_6
7.60	1.92_0	6.53	6.92	0.39	0.39_8	0.17_9	7.04_1	6.86_2
7.70	1.90_4	6.54	7.00	0.46	0.47_0	0.05_2	6.94_0	6.88_8
7.80	1.88_0	6.55	7.08	0.53	0.54_8	$\bar{1}.91_6$	6.77_8	6.86_2
7.90	1.86_2	6.56	7.15	0.59	0.61_6	$\bar{1}.79_4$	6.75_4	6.96_0

$\log K_{MAL}$ = 6.91 ± 0.06

Table V 28

B, $\bar{n}_H$, $\bar{n}$, $\log(1-\bar{n})/\bar{n}$, pL and pL-$\log(1-\bar{n})/\bar{n}$ data of Cu.NTA. 2,3-dihydroxynaphthalene system - 30°C.

B	$\bar{n}_H$	V"	V"'	V"'-V"	$\bar{n}$	$\log(1-\bar{n})/\bar{n}$	pL	pL-$\log(1-\bar{n})/\bar{n}$
6.70	1.97_8	6.50	6.66	0.16	0.15_7	0.72_0	10.37_3	9.54_4
6.80	1.97_2	6.50	6.71	0.21	0.20_7	0.58_3	10.18_9	9.60_6
6.90	1.96_8	6.50	6.76	0.26	0.25_7	0.46_1	10.10_4	9.64_3
7.00	1.96_4	6.50	6.83	0.33	0.32_7	0.31_3	9.92_6	9.61_3
7.10	1.94_8	6.50	6.90	0.40	0.39_9	0.17_7	9.74_9	9.57_2
7.20	1.93_6	6.50	6.96	0.46	0.46_2	0.06_6	9.64_9	9.58_3
7.30	1.93_2	6.51	7.08	0.57	0.57_4	$\bar{1}.87_0$	9.43_1	9.56_1

$\log K_{MAL}$ = 9.60 ± 0.08

Table V 29

B, $\bar{n}_H$, $\bar{n}$, $\log(1-\bar{n})/\bar{n}$, pL and pL-$\log(1-\bar{n})/\bar{n}$ data of Cu.NTA. protocatechuic acid system - 30°C.

B	$\bar{n}_H$	V"	V"'	V"'-V"	$\bar{n}$	$\log(1-\bar{n})/\bar{n}$	pL	pL-$\log(1-\bar{n})/\bar{n}$
7.10	2.00_0	6.88	7.14	0.26	0.25_1	0.47_4	9.52_3	9.04_9
7.20	2.00_0	6.89	7.23	0.34	0.32_8	0.31_1	9.34_4	9.03_3
7.30	2.00_0	6.90	7.31	0.41	0.39_6	0.18_3	9.26_6	9.08_3
7.40	2.00_0	6.90	7.37	0.47	0.45_4	0.08_0	9.08_6	9.00_6
7.50	2.00_0	6.91	7.43	0.52	0.50_2	$\bar{1}.99_6$	9.00_4	9.00_8
7.60	1.94_9	6.92	7.47	0.55	0.53_1	$\bar{1}.94_6$	8.91_1	8.96_5
7.70	1.93_5	6.94	7.52	0.58	0.55_9	$\bar{1}.89_7$	-	-

$\log K_{MAL}$ = 9.01 ± 0.07

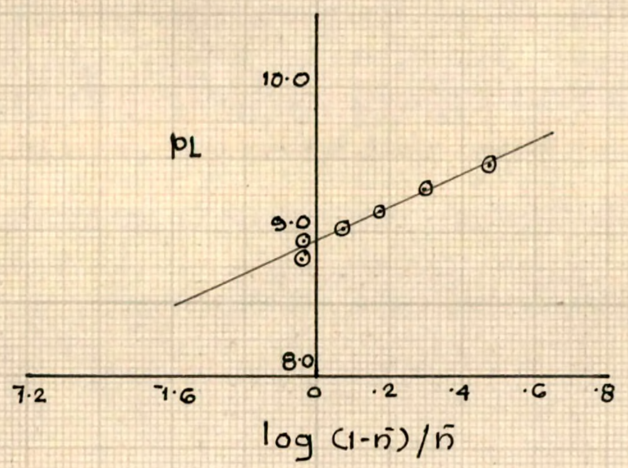


Fig. V 34

Cu(II).NTA protocatechuic acid system - 30°C.

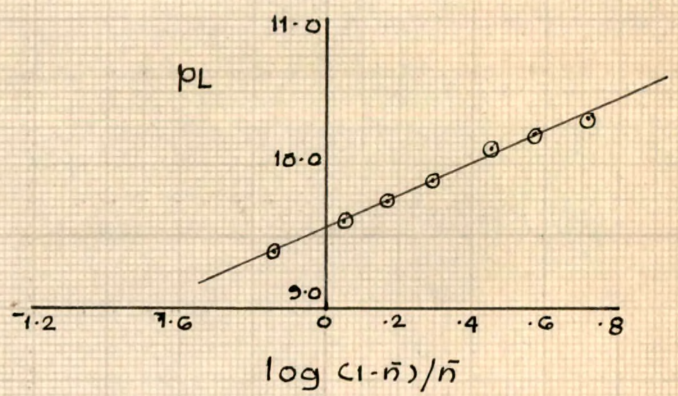


Fig. V 33

Cu(II).NTA 2,3-dihy.naph. system - 30°C.

Fig. V 31

Cu(II).NTA catechol system - 30°C.

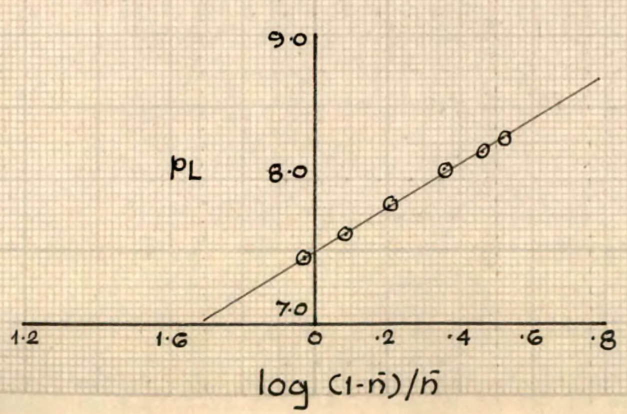


Fig. V 32

Cu(II).NTA pyrogallol system - 30°C.

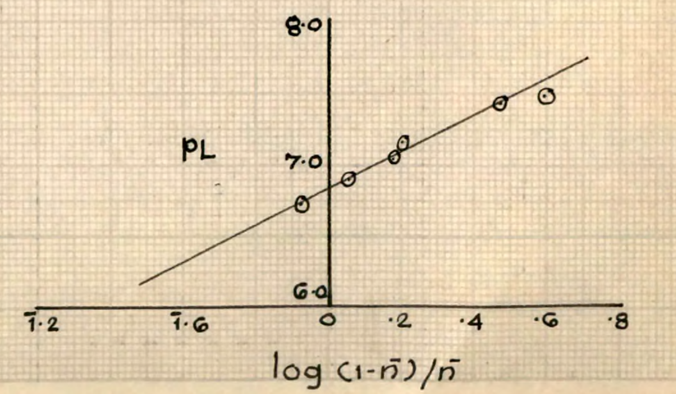


Table V 30

B, $\bar{n}_H$, $\bar{n}$, $\log(1-\bar{n})/\bar{n}$, pL and pL-$\log(1-\bar{n})/\bar{n}$ data of Ni.NTA. catechol system - 30°C.

B	$\bar{n}_H$	V"	V"'	V"'-V"	$\bar{n}$	$\log(1-\bar{n})/\bar{n}$	pL	pL-$\log(1-\bar{n})/\bar{n}$
9.20	1.48_0	6.81	6.93	0.12	0.15_6	0.73_3	5.27_7	4.54_4
9.30	1.44_0	6.84	7.03	0.19	0.24_8	0.48_1	5.02_4	4.54_3
9.40	1.37_7	6.88	7.09	0.21	0.29_4	0.38_0	4.90_0	4.52_0
9.50	1.29_7	6.90	7.13	0.23	0.34_2	0.28_4	4.78_3	4.49_9
9.60	1.26_6	6.95	7.20	0.25	0.38_1	0.21_0	4.76_8	4.55_8
9.70	1.22_6	7.00	7.28	0.28	0.44_0	0.10_4	4.56_4	4.46_0
9.80	1.15_4	7.04	7.35	0.31	0.51_7	$\bar{1}.97_0$	4.46_5	4.49_5

$\log K_{MAL} = 4.51 \pm 0.05$

Table V 31

B, $\bar{n}_H$, $\bar{n}$, $\log(1-\bar{n})/\bar{n}$, pL and pL-$\log(1-\bar{n})/\bar{n}$ data of Ni.NTA. pyrogallol system - 30°C.

B	$\bar{n}_H$	V"	V"'	V"'-V"	$\bar{n}$	$\log(1-\bar{n})/\bar{n}$	pL	pL-$\log(1-\bar{n})/\bar{n}$
9.40	1.22_0	6.86	7.01	0.15	0.23_7	0.50_7	4.10_7	3.60_0
9.50	1.16_0	6.90	7.07	0.17	0.28_3	0.40_3	4.02_7	3.62_4
9.60	1.10_0	6.94	7.13	0.19	0.33_3	0.30_1	3.75_9	3.45_8
9.70	1.09_3	6.97	7.17	0.20	0.35_3	0.26_3	3.65_0	3.38_7
9.80	1.03_3	6.99	7.22	0.23	0.42_9	0.12_4	3.55_8	3.43_4
9.90	0.99_3	7.02	7.27	0.25	0.48_5	0.02_6	3.40_7	3.38_1
10.00	0.96_2	7.05	7.32	0.27	0.54_1	$\bar{1}.92_8$	3.22_9	3.30_1

$\log K_{MAL} = 3.45 \pm 0.09$

Table V 32

B, $\bar{n}_H$, $\bar{n}$, $\log(1-\bar{n})/\bar{n}$, pL and pL$-\log(1-\bar{n})/\bar{n}$ data of Ni.NTA. 2,3-dihydroxynaphthalene system - 30°C.

B	$\bar{n}_H$	V"	V"'	V"'-V"	$\bar{n}$	$\log(1-\bar{n})/\bar{n}$	pL	pL$-\log(1-\bar{n})/\bar{n}$
8.40	1.55_3	6.70	6.84	0.14	0.17_4	0.67_6	7.73_3	7.05_7
8.50	1.51_4	6.73	6.92	0.19	0.24_3	0.49_3	7.45_2	6.95_9
8.60	1.43_4	6.75	7.01	0.26	0.35_1	0.26_6	7.21_3	6.94_7
8.70	1.39_4	6.80	7.11	0.31	0.43_0	0.12_2	7.03_3	6.91_1
8.80	1.35_6	6.83	7.19	0.36	0.51_3	$\bar{1}.97_7$	6.88_9	6.91_2
8.90	1.31_7	6.85	7.26	0.41	0.60_2	$\bar{1}.82_0$	6.78_9	6.96_9
9.00	1.27_6	6.90	7.32	0.42	0.63_6	$\bar{1}.75_7$	-	-

$\log K_{MAL} = 6.95 \pm 0.04$

Table V 33

B. $\bar{n}_H$, $\bar{n}$, $\log(1-\bar{n})/\bar{n}$, pL and pL$-\log(1-\bar{n})/\bar{n}$ data of Ni.NTA. protocatechuic acid system - 30°C.

B	$\bar{n}_H$	V"	V"'	V"'-V"	$\bar{n}$	$\log(1-\bar{n})/\bar{n}$	pL	pL$-\log(1-\bar{n})/\bar{n}$
8.50	1.68_0	7.10	7.28	0.18	0.20_6	0.58_5	6.96_7	6.38_2
8.60	1.60_0	7.12	7.33	0.21	0.25_2	0.47_2	6.75_4	6.28_2
8.70	1.56_0	7.14	7.38	0.24	0.29_6	0.37_6	6.70_4	6.32_8
8.80	1.52_0	7.16	7.46	0.30	0.37_9	0.21_4	6.47_9	6.26_5
8.90	1.48_0	7.20	7.54	0.34	0.44_1	0.10_3	6.40_8	6.30_5
9.00	1.40_0	7.22	7.57	0.35	0.48_0	0.34_8	-	-
9.10	1.36_8	7.24	7.60	0.36	0.50_5	$\bar{1}.99_1$	6.33_0	6.33_9

$\log K_{MAL} = 6.34 \pm 0.08$

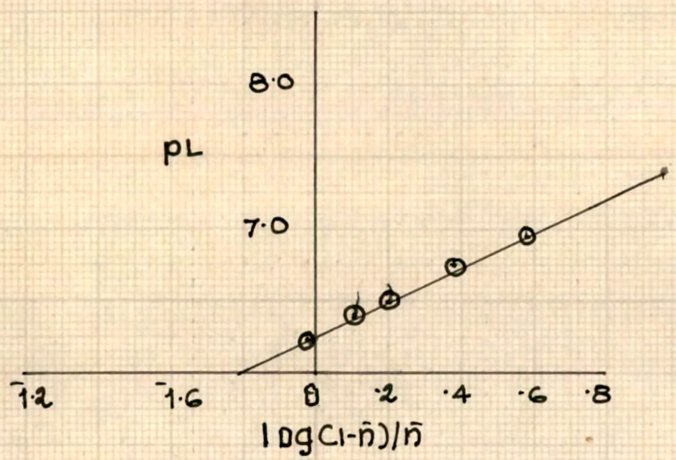


Fig. V 38

Ni(II).NTA protocatechuic acid system - 30°C.

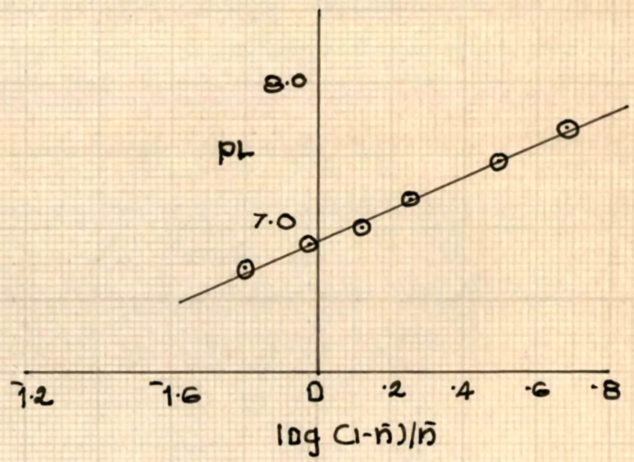


Fig. V 37

Ni(II).NTA 2,3-dihy.naph. system - 30°C.

Fig. V 35

Ni(II).NTA catechol system - 30°C.

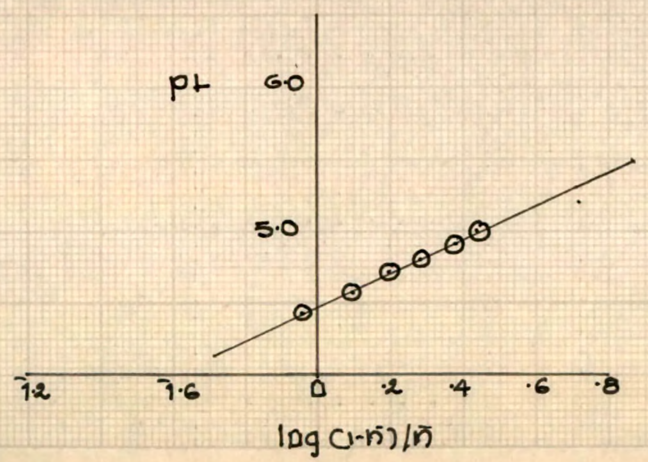


Fig. V 36

Ni(II).NTA pyrogallol system - 30°C.

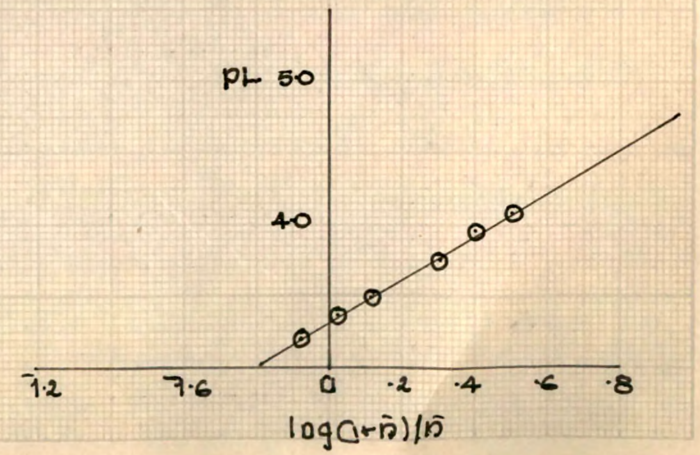


Table V 34

N = 0.2M V° = 50 ml. μ = 0.2M t = 30°C.

E° = 0.02M *E° = 0.024M T°_{EDTA} = 0.002M T°_{M} = 0.002M

*Perchloric acid		EDTA		Cu.EDTA		Ni.EDTA	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.45	0.00	1.45	0.00	1.45	0.00	1.45
1.00	1.50	1.00	1.60	1.00	1.60	1.00	1.50
1.50	1.55	1.50	1.65	1.50	1.65	1.50	1.55
2.00	1.60	2.00	1.70	2.00	1.75	2.00	1.65
2.50	1.65	2.50	1.80	2.50	1.90	2.50	1.70
3.00	1.70	3.00	1.90	3.00	2.00	3.00	1.85
3.50	1.80	3.50	2.05	3.50	2.20	3.50	1.95
4.00	1.90	4.00	2.30	4.00	2.25	4.00	2.05
4.50	1.95	4.50	3.60	5.00	2.40	4.50	2.10
5.00	2.00	5.00	4.00	5.20	2.55	5.00	2.15
5.50	2.30	5.08	4.30	5.40	2.75	5.30	2.35
5.70	2.60	5.12	4.50	5.60	3.00	5.60	2.80
5.80	2.90	5.17	4.75	5.70	3.20	5.70	3.05
5.90	3.20	5.20	4.95	5.80	3.50	5.80	3.35
6.00	3.80	5.25	5.20	5.90	3.90	5.90	3.80
6.02	9.00	5.30	5.50	5.95	4.20	5.95	4.15
6.04	9.20	5.35	5.85	6.00	4.70	6.00	4.50
6.08	9.55	5.40	6.20	6.04	8.25	6.04	7.50
6.10	9.60	5.43	6.50	6.07	8.50	6.08	8.00
6.13	9.75	5.48	7.00	6.10	8.70	6.11	8.30
6.18	10.00	5.52	7.40	6.14	9.00	6.13	8.50
6.22	10.10	5.55	7.70	6.20	9.40	6.17	8.85
6.25	10.30	5.60	8.05	6.28	9.80	6.20	9.10
6.30	10.45	5.65	8.40	6.32	10.00	6.24	9.40
6.35	10.60	5.70	8.70	6.37	10.20	6.28	9.65
6.40	10.75	5.75	8.95	6.45	10.45	6.32	9.90
6.48	11.00	5.80	9.15	6.50	10.55	6.35	10.05
		5.85	9.35	6.60	10.70	6.40	10.20
		5.90	9.50	6.70	10.80	6.50	10.45
		6.00	9.80	6.80	10.90	6.65	10.70
		6.10	10.10	6.84	11.00	6.75	10.90
		6.30	10.60			6.84	11.00
		6.48	11.00				

Table V 35

N = 0.2M   V° = 50 ml. μ = 0.2M   t = 30°C.

E° = 0.02M   *E° = 0.024M T^{o}_{EDTA} = 0.002M T^{o}_{M} = 0.002M

T^{o}_{L} = 0.002M

*Catechol		Cu.EDTA.Catechol		Ni.EDTA.Catechol	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.40	0.00	1.50	0.00	1.40
1.00	1.50	1.00	1.60	1.00	1.50
1.50	1.55	1.50	1.65	1.50	1.55
2.00	1.60	2.00	1.75	2.00	1.65
2.50	1.65	2.50	1.90	2.50	1.70
3.00	1.70	3.00	2.00	3.00	1.85
3.50	1.80	3.50	2.20	3.50	1.95
4.00	1.90	4.00	2.25	4.00	2.05
4.50	1.95	4.50	2.30	4.50	2.10
5.00	2.00	5.00	2.40	5.00	2.35
5.50	2.30	5.20	2.55	5.20	2.40
5.70	2.60	5.40	2.60	5.60	2.85
5.80	2.90	5.50	2.80	5.80	3.30
5.90	3.20	6.00	4.70	5.90	3.85
6.00	3.80	6.03	6.50	5.95	4.15
6.04	7.45	6.08	6.90	6.00	4.50
6.07	7.75	6.12	7.30	6.04	7.05
6.11	8.10	6.15	7.50	6.10	7.40
6.15	8.40	6.20	7.75	6.15	7.70
6.20	8.75	6.30	8.00	6.20	8.00
6.25	8.95	6.40	8.10	6.25	8.20
6.30	9.15	6.50	8.20	6.30	8.45
6.35	9.30	6.60	8.50	6.35	8.65
6.40	9.50	6.70	8.80	6.40	8.80
6.50	9.80	6.80	9.10	6.45	9.00
6.60	10.05	6.90	9.50	6.50	9.15
6.70	10.30	6.70	10.15	6.60	9.45
6.80	10.45	7.10	10.55	6.80	10.00
6.90	10.65	7.15	10.80	7.00	10.45
7.00	10.80	7.20	11.00	7.20	10.80

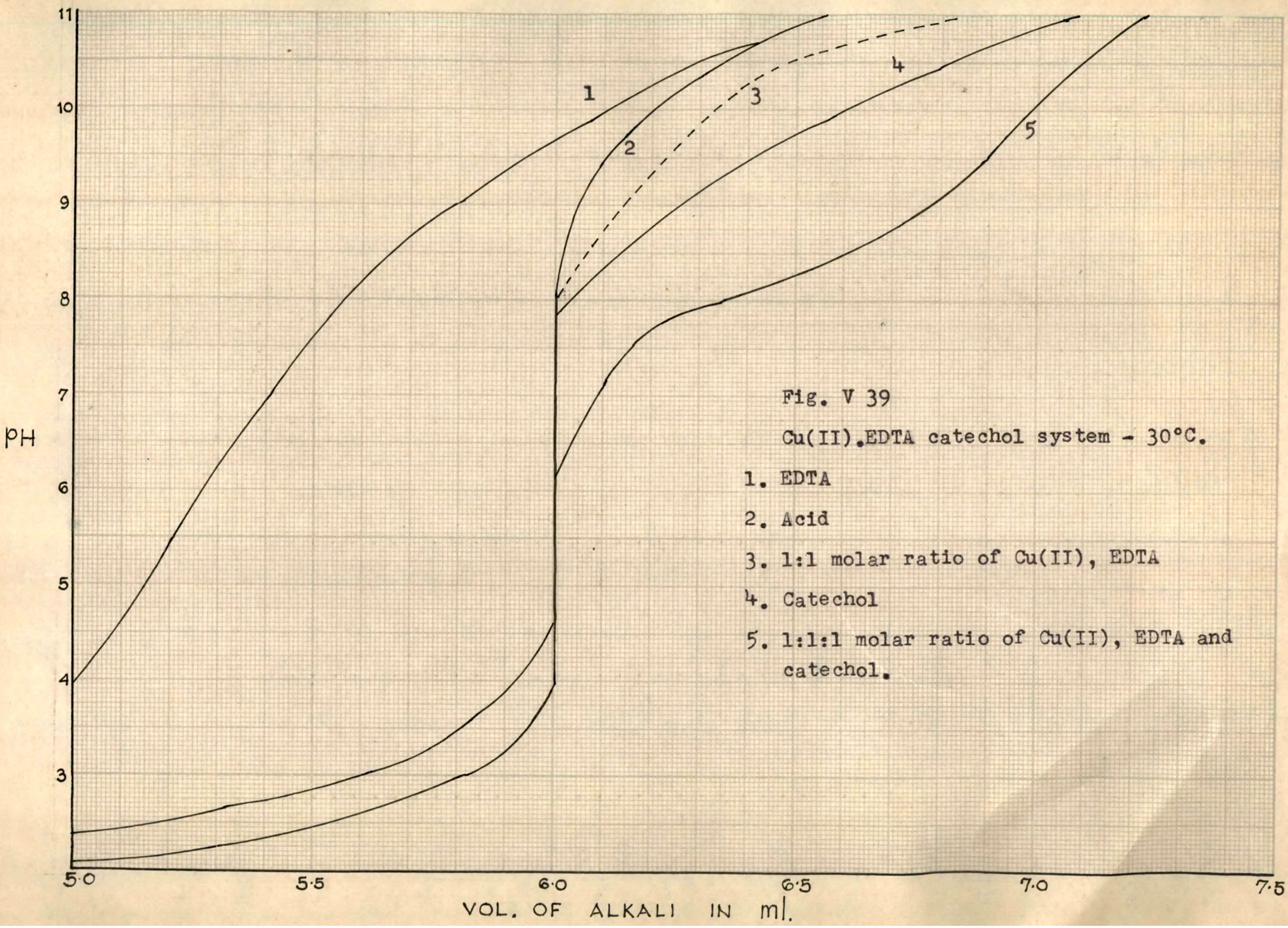


Fig. V 39

Cu(II).EDTA catechol system - 30°C.

1. EDTA
2. Acid
3. 1:1 molar ratio of Cu(II), EDTA
4. Catechol
5. 1:1:1 molar ratio of Cu(II), EDTA and catechol.

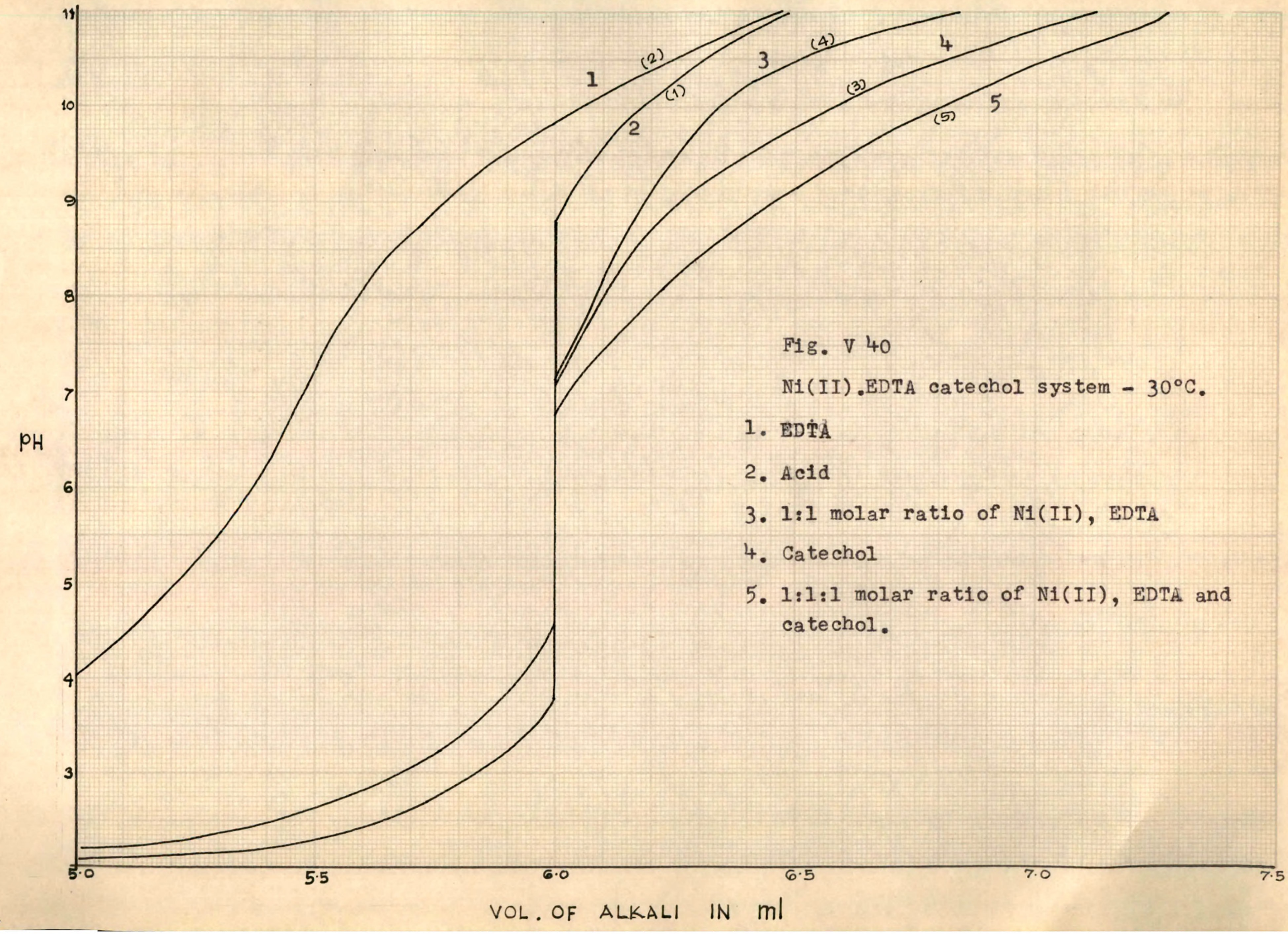


Fig. V 40

Ni(II).EDTA catechol system - 30°C.

1. EDTA
2. Acid
3. 1:1 molar ratio of Ni(II), EDTA
4. Catechol
5. 1:1:1 molar ratio of Ni(II), EDTA and catechol.

Table V 36

$N = 0.2M$ $V^{\circ} = 50$ ml. $\mu = 0.2M$ $t = 30°C.$

$E^{\circ} = 0.02M$ $^{*}E^{\circ} = 0.024M$ $T^{\circ}_{EDTA} = 0.002M$ $T^{\circ}_{M} = 0.002M$

$T^{\circ}_{L} = 0.002M$

*Pyrogallol		Cu.EDTA.Pyrogallol	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.45	0.00	1.50
1.00	1.50	1.00	1.60
1.50	1.55	1.50	1.65
2.00	1.60	2.00	1.70
2.50	1.65	2.50	2.00
3.00	1.70	3.50	2.20
3.50	1.80	4.00	2.25
4.00	1.90	5.00	2.40
4.50	1.95	5.40	2.75
5.00	2.00	5.60	3.00
5.50	2.30	5.70	3.20
5.70	2.60	5.80	3.50
5.80	2.90	5.90	3.90
5.90	3.20	5.95	4.20
6.00	3.80	6.00	4.70
6.04	7.50	6.02	5.55
6.10	8.00	6.06	6.05
6.16	8.30	6.10	6.45
6.20	8.55	6.15	6.95
6.30	8.95	6.20	7.25
6.40	9.30	6.28	7.65
6.45	9.45	6.42	8.00
6.50	9.60	6.50	8.25
6.60	9.90	6.57	8.50
6.70	10.15	6.68	9.00
6.80	10.40	6.82	9.50
6.90	10.60	6.90	9.75
7.00	10.70	6.98	10.00
7.20	10.90	7.08	10.25
7.30	11.00	7.17	10.50

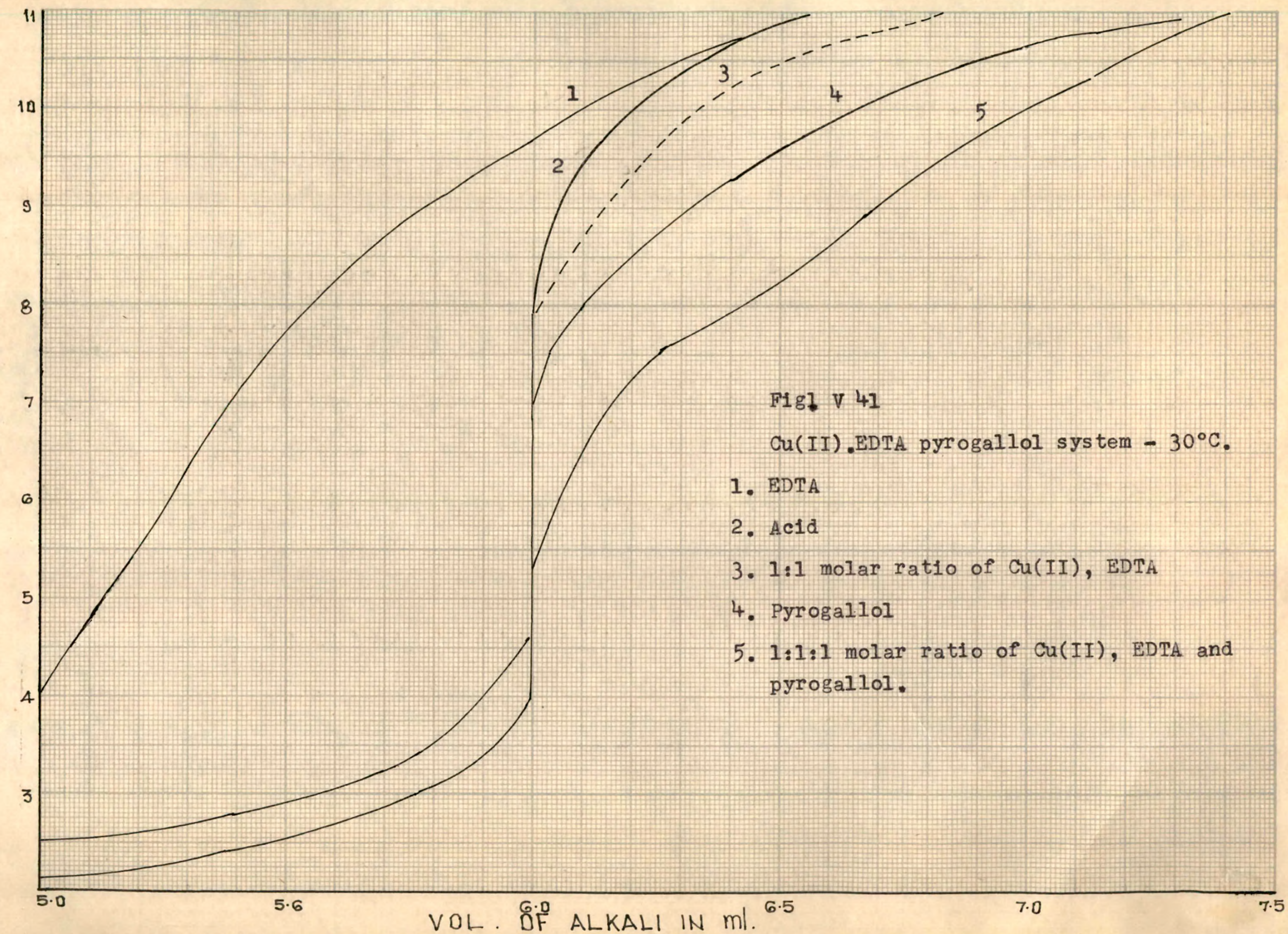


Fig. V 41

Cu(II).EDTA pyrogallol system - 30°C.

1. EDTA
2. Acid
3. 1:1 molar ratio of Cu(II), EDTA
4. Pyrogallol
5. 1:1:1 molar ratio of Cu(II), EDTA and pyrogallol.

Table V 37

$N = 0.2M$ $V° = 50$ ml. $\mu = 0.2M$ $t = 30°C.$

$E° = 0.02M$ $^*E° = 0.024M$ $T^o_{EDTA} = 0.002M$ $T^o_M = 0.002M$

$T^o_L = 0.002M$

*2,3-Dihydroxy-naphthalene		Cu.EDTA.2,3-Dihydroxy-naphthalene		Ni.EDTA.2,3-Dihydroxy naphthalene	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.45	0.00	1.50	0.00	1.40
1.00	1.50	1.00	1.60	1.00	1.50
1.50	1.55	1.50	1.65	1.50	1.55
2.00	1.60	2.00	1.75	2.00	1.65
2.50	1.65	2.50	1.90	2.50	1.70
3.00	1.70	3.00	2.00	3.00	1.85
3.50	1.80	3.50	2.20	3.50	1.95
4.00	1.90	4.00	2.25	4.00	2.05
4.50	1.95	4.50	2.30	4.50	2.10
5.00	2.00	5.00	2.40	5.00	2.15
5.50	2.30	5.20	2.55	5.30	2.35
5.70	2.60	5.40	2.75	5.60	2.80
5.80	2.90	5.60	3.00	5.70	3.05
5.90	3.20	5.70	3.20	5.80	3.35
6.00	3.80	5.80	3.50	5.90	3.80
6.02	7.40	5.90	3.90	5.95	4.15
6.04	7.60	5.95	4.20	6.00	4.50
6.08	7.80	6.00	4.70	6.04	6.70
6.12	8.00	6.04	6.70	6.08	7.00
6.16	8.20	6.08	7.00	6.12	7.30
6.20	8.30	6.12	7.25	6.16	7.55
6.24	8.45	6.16	7.45	6.20	7.80
6.28	8.60	6.20	7.60	6.25	8.00
6.30	8.65	6.30	7.85	6.30	8.20
6.35	8.80	6.40	8.00	6.40	8.55
6.40	8.90	6.54	8.20	6.45	8.70
6.50	9.20	6.68	8.50	6.50	8.85
6.55	9.40	6.80	8.80	6.60	9.10
6.65	9.75	6.95	9.20	6.70	9.40
6.70	9.90	7.00	9.35	6.80	9.65
6.80	10.20	7.10	9.80	6.90	9.90
6.90	10.45	7.20	10.20	7.00	10.20
7.00	10.70	7.30	10.60	7.05	10.45
7.10	10.95	7.40	10.90	7.10	10.60

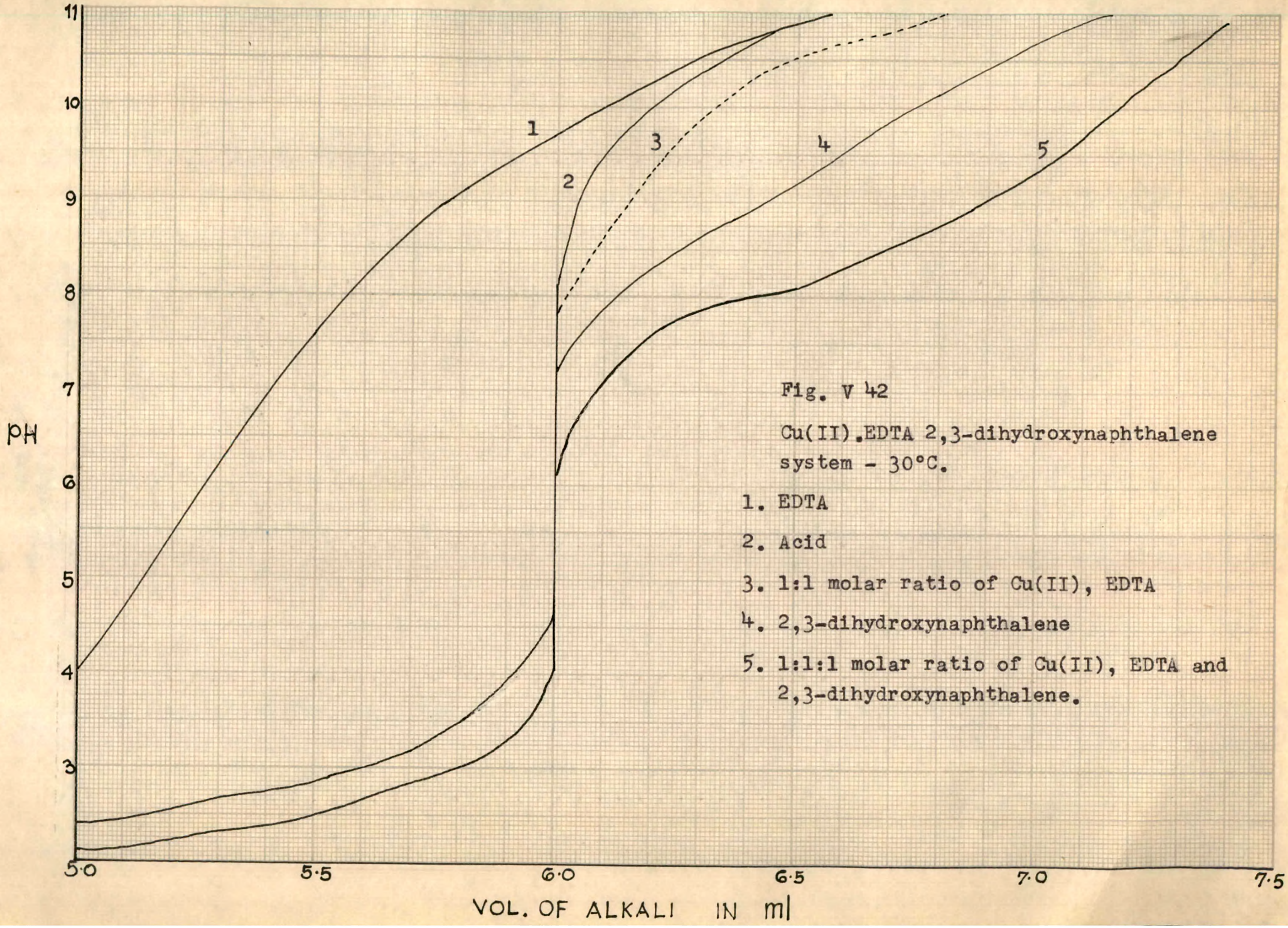


Fig. V 42

Cu(II).EDTA 2,3-dihydroxynaphthalene system - 30°C.

1. EDTA
2. Acid
3. 1:1 molar ratio of Cu(II), EDTA
4. 2,3-dihydroxynaphthalene
5. 1:1:1 molar ratio of Cu(II), EDTA and 2,3-dihydroxynaphthalene.

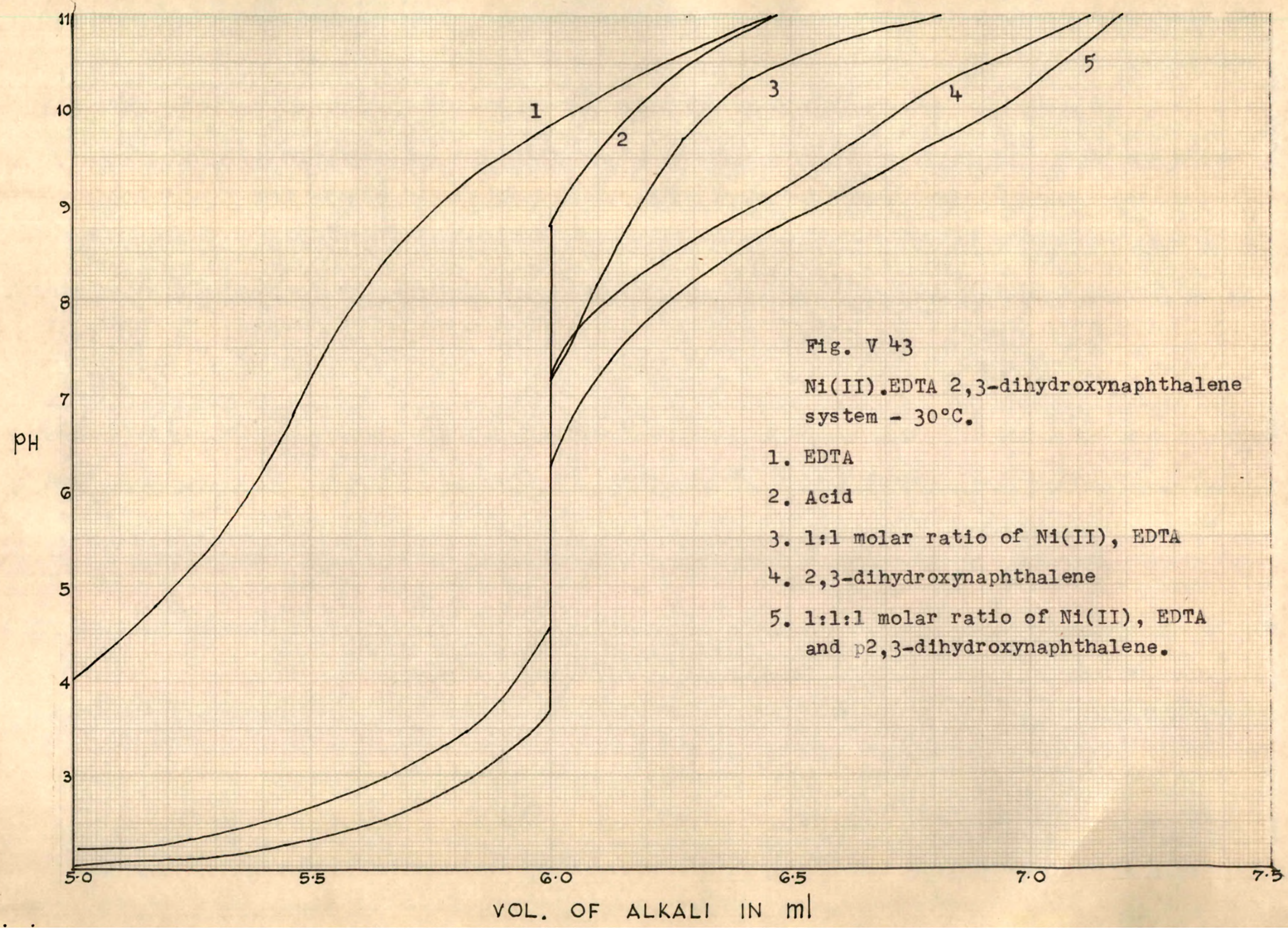


Fig. V 43

Ni(II).EDTA 2,3-dihydroxynaphthalene system - 30°C.

1. EDTA
2. Acid
3. 1:1 molar ratio of Ni(II), EDTA
4. 2,3-dihydroxynaphthalene
5. 1:1:1 molar ratio of Ni(II), EDTA and p2,3-dihydroxynaphthalene.

Table V 38

N = 0.2M V° = 50 ml. μ = 0.2M t = 30°C.

E° = 0.02M *E° = 0.024M T°_{EDTA} = 0.002M T°_{M} = 0.002M

T°_{L} = 0.002M

*Protocatechuic acid		Ni.EDTA.Protocatechuic acid	
Vol.of alkali (in ml.)	B	Vol.of alkali (in ml.)	B
0.00	1.45	0.00	1.45
1.00	1.50	1.00	1.50
2.00	1.70	2.00	1.70
3.00	1.75	3.00	1.75
4.00	1.85	4.00	1.85
5.00	2.00	5.00	2.00
5.50	2.30	5.50	2.30
5.70	2.60	5.70	2.60
5.80	2.90	5.80	2.90
5.90	3.20	5.90	3.20
6.00	3.80	6.00	3.70
6.10	4.15	6.05	3.80
6.15	4.35	6.15	4.10
6.20	4.60	6.25	4.45
6.25	5.05	6.30	4.65
6.28	5.60	6.35	4.95
6.32	6.20	6.40	5.35
6.35	6.50	6.45	5.80
6.38	6.80	6.48	6.10
6.40	7.00	6.52	6.45
6.45	7.30	6.54	6.70
6.50	7.70	6.60	7.15
6.54	7.90	6.65	7.50
6.60	8.25	6.70	7.90
6.65	8.45	6.75	8.15
6.70	8.70	6.80	8.40
6.75	8.95	6.85	8.65
6.80	9.20	6.90	8.80
6.90	9.60	7.00	9.10
6.95	9.80	7.05	9.30
7.00	9.95	7.10	9.45
7.05	10.10	7.20	9.70
7.10	10.20	7.30	10.00
7.20	10.45	7.40	10.30
7.40	10.80	7.50	10.50

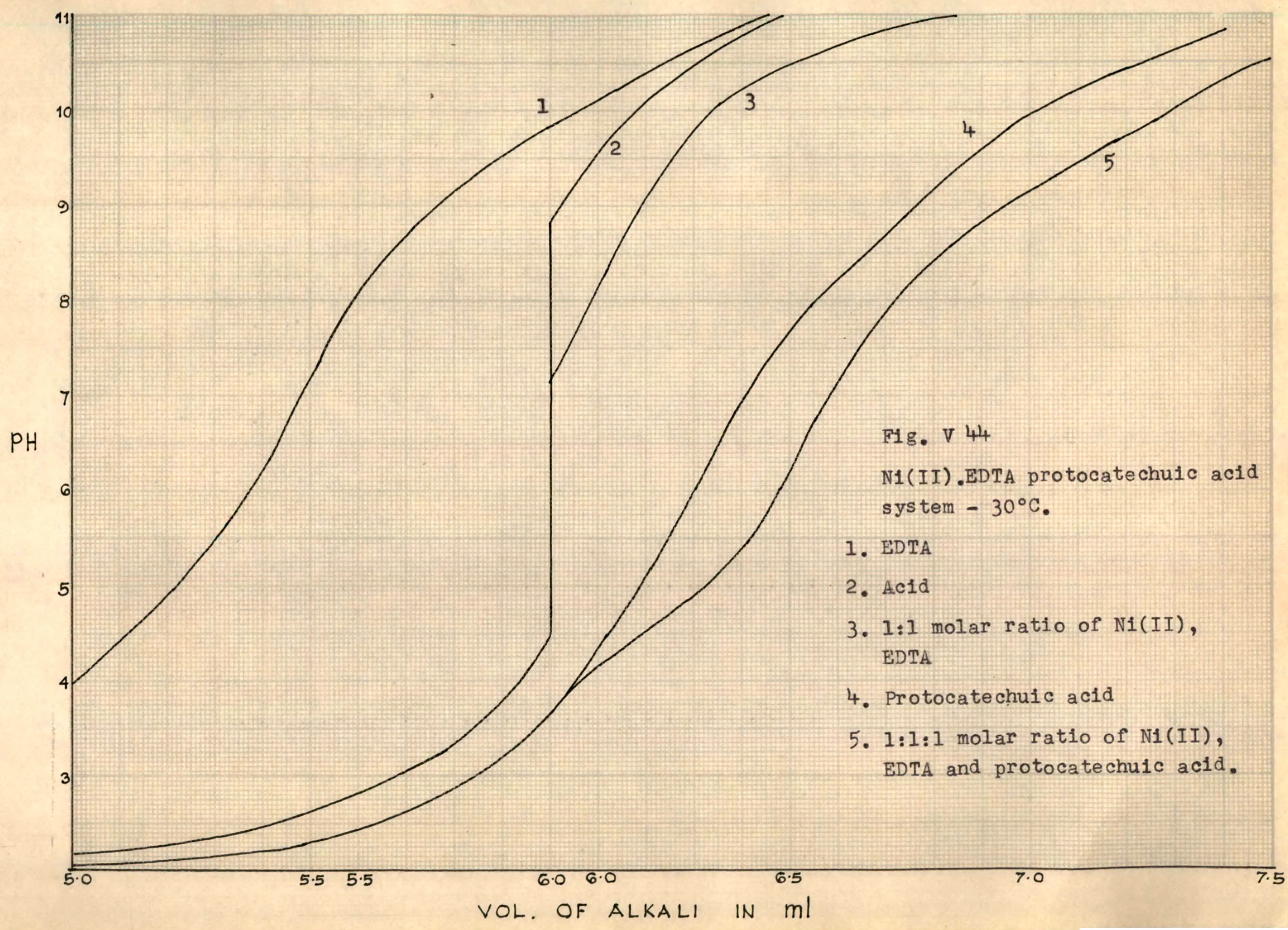


Fig. V 44

Ni(II).EDTA protocatechuic acid system - 30°C.

1. EDTA
2. Acid
3. 1:1 molar ratio of Ni(II), EDTA
4. Protocatechuic acid
5. 1:1:1 molar ratio of Ni(II), EDTA and protocatechuic acid.

Table V 39

B, $\bar{n}_H$, $\bar{n}$, $\log(1-\bar{n})/\bar{n}$, pL and pL-$\log(1-\bar{n})/\bar{n}$ data of Cu.EDTA. catechol system - 30°C.

B	$\bar{n}_H$	V"	V"'	V"'-V"	$\bar{n}$	$\log(1-\bar{n})/\bar{n}$	pL	pL-$\log(1-\bar{n})/\bar{n}$
7.70	1.94_8	6.00	6.19	0.19	0.19_1	0.62_6	7.70_9	7.08_3
7.80	1.94_4	6.00	6.21	0.21	0.21_2	0.57_0	7.61_9	7.04_9
7.90	1.93_6	6.01	6.27	0.26	0.26_3	0.44_7	7.45_3	7.00_6
8.00	1.92_4	6.02	6.32	0.30	0.30_6	0.35_5	7.35_4	6.99_9
8.10	1.90_8	6.04	6.42	0.38	0.39_1	0.19_2	7.14_4	6.95_2
8.20	1.88_8	6.06	6.48	0.40	0.41_1	0.15_6	7.03_2	6.87_6
8.30	1.86_8	6.08	6.53	0.45	0.47_3	0.05_5	6.89_1	6.83_6

$\log K_{MAL} = 7.02 \pm 0.06$

Table V 40

B, $\bar{n}_H$, $\bar{n}$, $\log(1-\bar{n})/\bar{n}$, pL and pL-$\log(1-\bar{n})/\bar{n}$ data of Cu.EDTA. pyrogallol system - 30°C.

B	$\bar{n}_H$	V"	V"'	V"'-V"	$\bar{n}$	$\log(1-\bar{n})/\bar{n}$	pL	pL-$\log(1-\bar{n})/\bar{n}$
7.70	1.90_4	6.06	6.26	0.20	0.20_6	0.58_5	6.70_8	6.12_3
7.80	1.88_0	6.08	6.35	0.27	0.28_1	0.40_8	6.59_1	6.08_3
7.90	1.85_6	6.09	6.38	0.29	0.30_6	0.35_5	6.51_0	6.15_5
8.00	1.84_0	6.10	6.41	0.31	0.33_0	0.30_7	6.43_4	6.12_7
8.10	1.80_0	6.12	6.45	0.33	0.35_9	0.25_1	6.31_2	6.06_1
8.20	1.78_4	6.14	6.49	0.35	0.38_5	0.20_3	-	-
8.30	1.75_2	6.16	6.52	0.36	0.40_3	0.17_0	-	-

$\log K_{MAL} = 6.13 \pm 0.07$

Table V 41

B, $\bar{n}_H$, $\bar{n}$, log(1-$\bar{n}$)/$\bar{n}$, pL and pL-log(1-$\bar{n}$)/$\bar{n}$ data of Cu.EDTA.
2,3-dihydroxynaphthalene system - 30°C.

B	$\bar{n}_H$	V"	V"'	V"'-V"	$\bar{n}$	log(1-$\bar{n}$)/$\bar{n}$	pL	pL-log(1-$\bar{n}$)/$\bar{n}$
7.70	1.85_2	6.06	6.22	0.16	0.16_9	0.69_1	8.47_9	7.78_8
7.80	1.82_4	6.08	6.28	0.20	0.21_5	0.56_2	8.32_4	7.76_2
7.90	1.79_2	6.10	6.32	0.22	0.24_0	0.50_0	8.19_9	7.69_9
8.00	1.77_3	6.12	6.42	0.30	0.33_1	0.30_5	8.04_2	7.73_7
8.10	1.71_3	6.14	6.49	0.35	0.40_0	0.17_6	7.92_0	7.74_4
8.20	1.67_3	6.16	6.54	0.38	0.44_4	0.09_7	7.82_5	7.72_8
8.30	1.63_3	6.20	6.58	0.38	0.45_7	0.07_4	7.63_2	-

$\log K_{MAL} = 7.73 \pm 0.05$

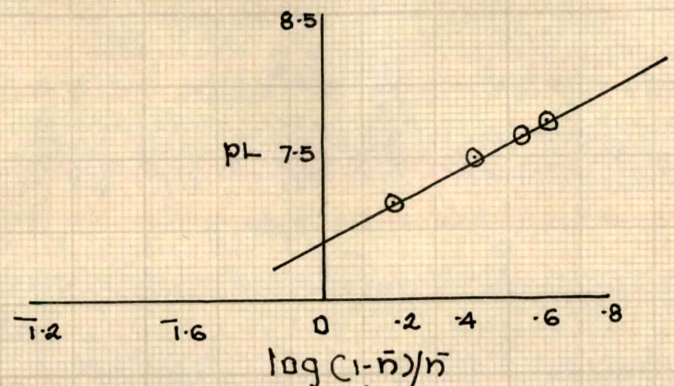


Fig. V 45

Cu(II).EDTA catechol system - 30°C.

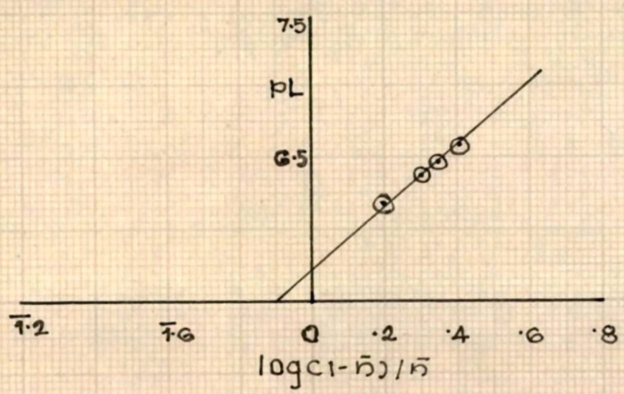


Fig. V 46

Cu(II).EDTA pyrogallol system - 30°C.

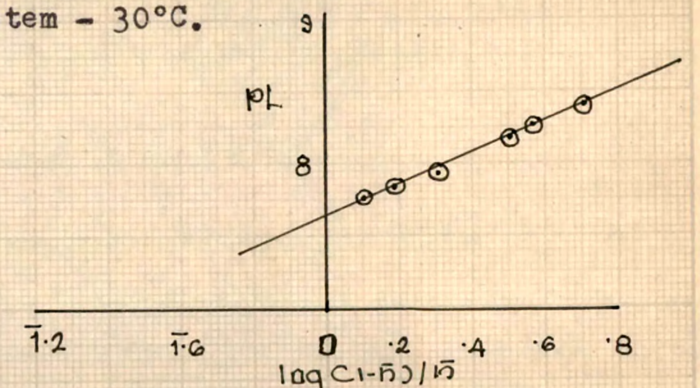


Fig. V 47

Cu(II).EDTA 2,3-dihy.naph. system - 30°C.

Table V 42

B, $\bar{n}_H$, $\bar{n}$, $\log(1-\bar{n})/\bar{n}$, pL and pL-$\log(1-\bar{n})/\bar{n}$ data of Ni.EDTA. catechol system - 30°C.

B	$\bar{n}_H$	V"	V"'	V"'-V"	$\bar{n}$	$\log(1-\bar{n})/\bar{n}$	pL	pL-$\log(1-\bar{n})/\bar{n}$
9.30	1.44_9	6.35	6.55	0.20	0.26_9	0.43_4	4.92_5	4.49_1
9.40	1.37_7	6.38	6.58	0.20	0.28_3	0.40_2	4.89_5	4.49_3
9.50	1.29_7	6.40	6.60	0.20	0.30_0	0.36_8	4.78_7	4.41_9
9.60	1.26_6	6.44	6.65	0.21	0.32_3	0.32_1	4.74_1	4.42_0
9.70	1.22_6	6.47	6.69	0.22	0.34_9	0.27_0	4.68_7	4.41_7
9.80	1.15_4	6.50	6.72	0.22	0.37_1	0.22_9	4.54_9	4.32_0
9.90	1.08_3	6.54	6.77	0.23	0.41_3	0.15_2	4.44_7	4.29_5

$\log K_{MAL}$ = 4.44 ± 0.05

Table V 43

B, $\bar{n}_H$, $\bar{n}$, $\log(1-\bar{n})/\bar{n}$, pL and pL-$\log(1-\bar{n})/\bar{n}$ data of Ni.EDTA. 2,3-dihydroxynaphthalene system - 30°C.

B	$\bar{n}_H$	V"	V"'	V"'-V"	$\bar{n}$	$\log(1-\bar{n})/\bar{n}$	pL	pL-$\log(1-\bar{n})/\bar{n}$
9.50	1.08_4	6.58	6.73	0.15	0.26_8	0.43_6	5.89_6	5.46_0
9.60	1.06_5	6.62	6.78	0.16	0.29_2	0.38_4	5.79_7	5.41_3
9.70	1.06_4	6.65	6.82	0.17	0.30_9	0.34_9	5.73_7	5.38_8
9.80	1.04_5	6.67	6.85	0.18	0.33_4	0.29_9	5.66_1	5.36_2
9.90	1.04_5	6.70	6.89	0.19	0.35_2	0.26_5	5.60_2	5.33_7
10.00	1.02_5	6.73	6.94	0.21	0.39_7	0.28_1	5.52_2	5.24_1
10.10	1.00_1	6.75	6.99	0.24	0.46_5	0.05_2	5.47_3	5.42_1

$\log K_{MAL}$ = 5.38 ± 0.08

Table V 44

B, $\bar{n}_H$, $\bar{n}$, $\log(1-\bar{n})/\bar{n}$, pL and pL-$\log(1-\bar{n})/\bar{n}$ data of Ni.EDTA. protocatechuic acid system - 30°C.

B	$\bar{n}_H$	V"	V"'	V"'-V"	$\bar{n}$	$\log(1-\bar{n})/\bar{n}$	pL	pL-$\log(1-\bar{n})/\bar{n}$
9.30	1.31_3	6.83	7.05	0.22	0.32_4	0.31_9	5.72_1	5.40_2
9.40	1.29_7	6.86	7.08	0.22	0.32_8	0.31_1	5.69_7	5.38_6
9.50	1.26_6	6.88	7.11	0.23	0.36_6	0.23_8	5.58_9	5.35_1
9.60	1.23_4	6.91	7.17	0.26	0.40_7	0.16_3	5.48_3	5.32_0
9.70	1.20_2	6.93	7.19	0.26	0.41_7	0.14_5	5.45_2	5.30_7
9.80	1.18_3	6.95	7.23	0.28	0.46_1	0.06_8	-	-
9.90	1.11_4	6.98	7.26	0.28	0.48_9	0.01_9	-	-

$\log K_{MAL} = 5.35 \pm 0.05$

Fig. V 45

Cu(II).EDTA catechol system - 30°C.

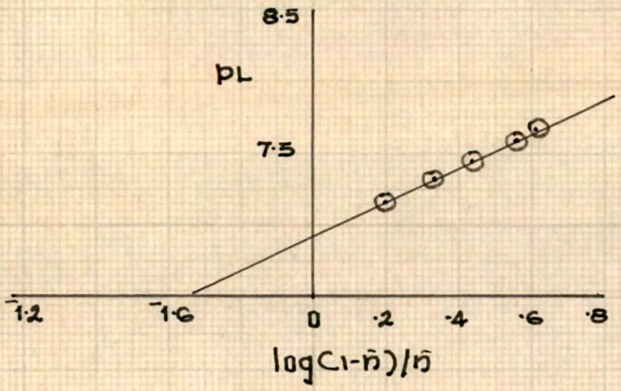


Fig. V 50

Ni(II).EDTA protocatechuic acid system - 30°C.

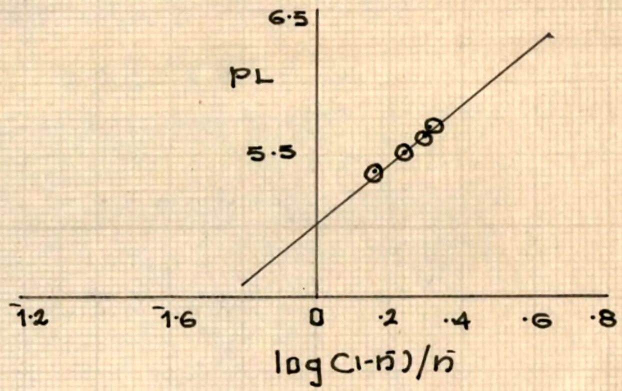


Fig. V 48

Ni(II).EDTA catechol system - 30°C.

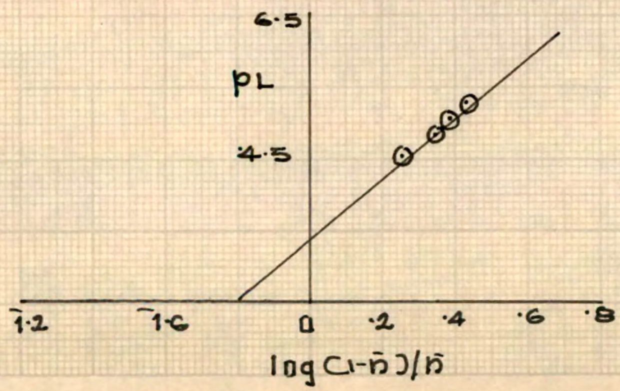


Fig. V 49

Ni(II).EDTA 2,3-dihy.naph. system - 30°C.

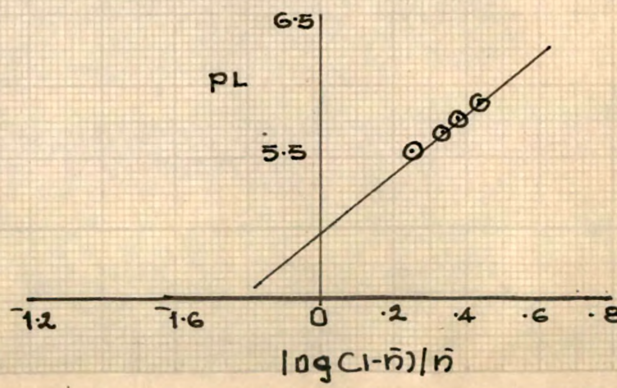


Table V 45

Logarithms of stability constants of ternary Histidine-M^{2+}-ligand complexes, IMDA-M^{2+}-ligand complexes, NTA-M^{2+}-ligand complexes and EDTA-M^{2+}-ligand complexes. - 30°C.

	Ligand (L)			
	Catechol	Pyrogallol	2,3-Dihydroxy-naphthalene	Protocatechuic acid
$\log K^{Ni.Hist.}_{Ni.Hist.L.}$	6.82 $\pm$ 0.03	5.66 $\pm$ 0.08	8.57 $\pm$ 0.09	-
$\log K^{Cu.IMDA.}_{Cu.IMDA.L}$	9.42 $\pm$ 0.07	8.81 $\pm$ 0.09	10.86 $\pm$ 0.07	10.22 $\pm$ 0.06
$\log K^{Ni.IMDA.}_{Ni.IMDA.L}$	5.66 $\pm$ 0.06	5.18 $\pm$ 0.04	7.38 $\pm$ 0.09	6.74 $\pm$ 0.07
$\log K^{Cu.NTA.}_{Cu.NTA.L}$	7.71 $\pm$ 0.06	6.91 $\pm$ 0.06	9.60 $\pm$ 0.06	9.01 $\pm$ 0.07
$\log K^{Ni.NTA.}_{Ni.NTA.L}$	4.51 $\pm$ 0.05	3.45 $\pm$ 0.09	6.95 $\pm$ 0.04	6.34 $\pm$ 0.08
$\log K^{Cu.EDTA.}_{Cu.EDTA.L}$	7.02 $\pm$ 0.06	6.13 $\pm$ 0.07	7.73 $\pm$ 0.05	-
$\log K^{Ni.EDTA.}_{Ni.EDTA.L}$	4.44 $\pm$ 0.05	-	5.38 $\pm$ 0.08	5.35 $\pm$ 0.05

Table V 46

	Ligand (L)			
	Catechol	Pyrogallol	2,3-Dihydroxy-naphthalene	Protocatechuic acid
$\log K^{Ni.}_{Ni.L} - \log K^{Ni.Hist.}_{Ni.Hist.L}$	0.98	1.41	1.15	-
$\log K^{Cu.}_{Cu.L} - \log K^{Cu.IMDA.}_{Cu.IMDA.L}$	3.55	4.07	4.56	3.95
$\log K^{Ni.}_{Ni.L} - \log K^{Ni.IMDA.}_{Ni.IMDA.L}$	2.14	1.89	2.34	2.03
$\log K^{Cu.}_{Cu.L} - \log K^{Cu.NTA.}_{Cu.NTA.L.}$	5.26	5.97	4.82	5.16
$\log K^{Ni.}_{Ni.L} - \log K^{Ni.NTA.}_{Ni.NTA.L}$	3.29	3.62	2.77	2.43
$\log K^{Cu.}_{Cu.L} - \log K^{Cu.EDTA.}_{Cu.EDTA.L}$	5.95	6.75	6.69	-
$\log K^{Ni.}_{Ni.L} - \log K^{Ni.EDTA.}_{Ni.EDTA.L}$	3.36	-	4.34	3.42

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