

Iron (III), Chromium (III) and Cupper (II) Complexes of L-Norvaline and Ferulic Acid

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Volume NaOH	pH				
	Nva	Nva + Fe ^{III}	FA	FA + Fe ^{III}	Nva + FA + Fe ^{III}
0	2.549	2.519	2.499	2.442	2.412
0.05	2.565	2.533	2.499	2.453	2.418
0.1	2.583	2.545	2.531	2.471	2.428
0.15	2.604	2.559	2.549	2.48	2.441
0.2	2.623	2.575	2.568	2.497	2.454
0.25	2.645	2.591	2.587	2.512	2.465
0.3	2.666	2.608	2.607	2.529	2.479
0.35	2.689	2.624	2.63	2.543	2.488
0.4	2.711	2.641	2.653	2.562	2.505
0.45	2.737	2.657	2.676	2.581	2.519
0.5	2.762	2.676	2.701	2.596	2.533
0.55	2.788	2.694	2.727	2.616	2.547
0.6	2.817	2.715	2.753	2.634	2.561
0.65	2.848	2.733	2.784	2.661	2.575
0.7	2.881	2.755	2.814	2.679	2.594
0.75	2.915	2.777	2.847	2.703	2.612
0.8	2.952	2.8	2.883	2.726	2.629
0.85	2.995	2.824	2.924	2.748	2.646
0.9	3.039	2.848	2.963	2.775	2.665
0.95	3.091	2.875	3.011	2.8	2.684
1	3.149	2.903	3.062	2.835	2.703
1.05	3.213	2.933	3.119	2.861	2.724
1.1	3.288	2.963	3.182	2.895	2.737
1.15	3.38	2.997	3.255	2.935	2.767
1.2	3.496	3.032	3.337	2.972	2.791
1.25	3.648	3.073	3.434	3.012	2.817
1.3	3.874	3.113	3.543	3.062	2.842
1.35	4.322	3.153	3.664	3.115	2.869
1.4	6.407	3.203	3.798	3.162	2.898
1.45	8.243	3.253	3.942	3.23	2.928
1.5	8.691	3.309	4.085	3.293	2.96
1.55	8.967	3.368	4.229	3.377	2.992
1.6	9.163	3.433	4.367	3.464	3.028
1.65	9.327	3.507	4.532	3.562	3.068
1.7	9.473	3.59	4.702	3.679	3.107
1.75	9.603	3.682	4.908	3.808	3.153

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1.8	9.728	3.798	5.184	3.949	3.202
1.85	9.84	3.96	5.657	4.095	3.252
1.9	9.947	4.261	7.179	4.246	3.315
1.95	10.049	5.118	7.972	4.4	3.383
2	10.147	6.931	8.32	4.557	3.458
2.05	10.232	8.244	8.553	4.755	3.546
2.1	10.315	8.701	8.748	4.971	3.639
2.15	10.388	8.97	8.921	5.257	3.757
2.2	10.453	9.171	9.087	5.693	3.888
2.25	10.516	9.33	9.246	6.275	4.042
2.3	10.571	9.478	9.421	6.733	4.217
2.35	10.623	9.61	9.592	7.07	4.412
2.4	10.666	9.73	9.777	7.425	4.624
2.45	10.708	9.844	9.939	7.857	4.877
2.5	10.745	9.949	10.09	8.249	5.163
2.55	10.779	10.039	10.215	8.516	5.469
2.6	10.814	10.133	10.313	8.728	5.774
2.65	10.842	10.211	10.401	8.918	6.012
2.7	10.87	10.301	10.477	9.091	6.183
2.75	10.897	10.372	10.538	9.271	6.324
2.8	10.918	10.434	10.597	9.441	6.446
2.85	10.944	10.495	10.645	9.62	6.565
2.9	10.968	10.55	10.693	9.788	6.686
2.95	10.991	10.601	10.734	9.949	6.791
3	11.011	10.642	10.771	10.068	6.903
3.05		10.683	10.802	10.194	7.029
3.1		10.72	10.835	10.303	7.177
3.15		10.754	10.864	10.387	7.384
3.2		10.787	10.892	10.454	7.635
3.25		10.818	10.919	10.523	7.914
3.3		10.847	10.941	10.582	8.169
3.35		10.87	10.965	10.631	8.39
3.4		10.899	10.987	10.675	8.582
3.45		10.922	11.007	10.717	8.733
3.5		10.946		10.754	8.875
3.55		10.966		10.787	8.997
3.6		10.983		10.818	9.101
3.65		11.004		10.849	9.205
3.7				10.875	9.305
3.75				10.899	9.391
3.8				10.926	9.482
3.85				10.948	9.559

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3.9				10.969	9.642
3.95				10.991	9.722
4				11.013	9.801
4.05					9.872
4.1					9.948
4.15					10.022
4.2					10.091
4.25					10.163
4.3					10.231
4.35					10.292
4.4					10.35
4.45					10.407
4.5					10.461
4.55					10.508
4.6					10.555
4.65					10.6
4.7					10.641
4.75					10.677
4.8					10.714
4.85					10.746
4.9					10.778
4.95					10.805
5					10.834
5.05					10.859
5.1					10.885
5.15					10.909
5.2					10.932
5.25					10.951
5.3					10.972
5.35					10.99
5.4					11.009

Table 5. Potentiometric Titration Data for the Nva + FA + Cr^{III} System at 25°C and I=0.15 M NaNO₃

Volume NaOH	pH				
	Nva	Nva + Cr ^{III}	FA	FA + Cr ^{III}	Nva + FA + Cr ^{III}
0	2.549	2.549	2.499	2.517	2.531
0.05	2.565	2.561	2.499	2.529	2.543
0.1	2.583	2.575	2.531	2.544	2.561
0.15	2.604	2.598	2.549	2.564	2.578
0.2	2.623	2.618	2.568	2.58	2.597
0.25	2.645	2.632	2.587	2.599	2.617
0.3	2.666	2.657	2.607	2.617	2.637
0.35	2.689	2.678	2.63	2.635	2.656
0.4	2.711	2.702	2.653	2.66	2.68
0.45	2.737	2.724	2.676	2.681	2.7
0.5	2.762	2.741	2.701	2.704	2.726
0.55	2.788	2.774	2.727	2.726	2.75
0.6	2.817	2.802	2.753	2.75	2.774
0.65	2.848	2.828	2.784	2.782	2.802
0.7	2.881	2.86	2.814	2.808	2.827
0.75	2.915	2.88	2.847	2.839	2.858
0.8	2.952	2.924	2.883	2.866	2.891
0.85	2.995	2.964	2.924	2.907	2.924
0.9	3.039	3.002	2.963	2.944	2.96
0.95	3.091	3.047	3.011	2.984	2.998
1	3.149	3.095	3.062	3.029	3.04
1.05	3.213	3.148	3.119	3.078	3.08
1.1	3.288	3.205	3.182	3.131	3.132
1.15	3.38	3.271	3.255	3.186	3.183
1.2	3.496	3.347	3.337	3.252	3.237
1.25	3.648	3.434	3.434	3.324	3.297
1.3	3.874	3.531	3.543	3.403	3.36
1.35	4.322	3.649	3.664	3.489	3.426
1.4	6.407	3.797	3.798	3.585	3.497
1.45	8.243	3.975	3.942	3.688	3.574
1.5	8.691	4.195	4.085	3.791	3.65
1.55	8.967	4.479	4.229	3.899	3.727
1.6	9.163	4.907	4.367	4.01	3.806
1.65	9.327	5.424	4.532	4.122	3.888
1.7	9.473	5.8	4.702	4.232	3.972
1.75	9.603	6.016	4.908	4.343	4.059

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1.8	9.728	6.199	5.184	4.468	4.143
1.85	9.84	6.413	5.657	4.592	4.229
1.9	9.947	6.663	7.179	4.733	4.325
1.95	10.049	7.009	7.972	4.899	4.43
2	10.147	7.509	8.32	5.086	4.521
2.05	10.232	8.18	8.553	5.324	4.632
2.1	10.315	8.65	8.748	5.624	4.75
2.15	10.388	8.938	8.921	5.928	4.878
2.2	10.453	9.14	9.087	6.178	5.029
2.25	10.516	9.315	9.246	6.433	5.191
2.3	10.571	9.462	9.421	6.722	5.363
2.35	10.623	9.586	9.592	7.033	5.537
2.4	10.666	9.707	9.777	7.409	5.659
2.45	10.708	9.818	9.939	7.76	5.742
2.5	10.745	9.917	10.09	8.037	5.805
2.55	10.779	10.013	10.215	8.282	5.856
2.6	10.814	10.107	10.313	8.485	5.908
2.65	10.842	10.198	10.401	8.675	5.952
2.7	10.87	10.279	10.477	8.825	6.004
2.75	10.897	10.35	10.538	8.993	6.064
2.8	10.918	10.417	10.597	9.142	6.12
2.85	10.944	10.477	10.645	9.316	6.183
2.9	10.968	10.532	10.693	9.478	6.243
2.95	10.991	10.583	10.734	9.648	6.32
3	11.011	10.611	10.771	9.815	6.394
3.05		10.667	10.802	9.968	6.505
3.1		10.713	10.835	10.098	6.626
3.15		10.745	10.864	10.219	6.824
3.2		10.78	10.892	10.316	7.058
3.25		10.806	10.919	10.407	7.432
3.3		10.839	10.941	10.47	7.878
3.35		10.865	10.965	10.532	8.188
3.4		10.887	10.987	10.594	8.418
3.45		10.913	11.007	10.637	8.598
3.5		10.935		10.669	8.737
3.55		10.952		10.715	8.862
3.6		10.972		10.749	8.976
3.65		10.989		10.782	9.086
3.7		11.007		10.814	9.189
3.75				10.842	9.286
3.8				10.87	9.378
3.85				10.894	9.464

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3.9				10.918	9.551
3.95				10.939	9.639
4				10.961	9.721
4.05				10.981	9.811
4.1				11.005	9.892
4.15					9.975
4.2					10.052
4.25					10.132
4.3					10.209
4.35					10.275
4.4					10.341
4.45					10.398
4.5					10.457
4.55					10.507
4.6					10.557
4.65					10.601
4.7					10.64
4.75					10.679
4.8					10.715
4.85					10.747
4.9					10.773
4.95					10.805
5					10.833
5.05					10.858
5.1					10.884
5.15					10.905
5.2					10.926
5.25					10.947
5.3					10.968
5.35					10.988
5.4					11.005

Table 6. Potentiometric Titration Data for the Nva + FA + Cu^{II} System at 25°C and I=0.15 M NaNO₃

Volume NaOH	pH				
	Nva	Nva + Cu ^{II}	FA	FA + Cu ^{II}	Nva + FA + Cu ^{II}
0	2.549	2.562	2.499	2.496	2.536
0.05	2.565	2.57	2.499	2.509	2.546
0.1	2.583	2.595	2.531	2.513	2.563
0.15	2.604	2.608	2.549	2.541	2.579
0.2	2.623	2.633	2.568	2.558	2.6
0.25	2.645	2.646	2.587	2.579	2.614
0.3	2.666	2.675	2.607	2.596	2.634
0.35	2.689	2.699	2.63	2.618	2.656
0.4	2.711	2.72	2.653	2.644	2.68
0.45	2.737	2.745	2.676	2.666	2.699
0.5	2.762	2.77	2.701	2.684	2.721
0.55	2.788	2.797	2.727	2.716	2.75
0.6	2.817	2.826	2.753	2.743	2.777
0.65	2.848	2.858	2.784	2.765	2.804
0.7	2.881	2.885	2.814	2.799	2.832
0.75	2.915	2.92	2.847	2.825	2.862
0.8	2.952	2.953	2.883	2.867	2.893
0.85	2.995	2.995	2.924	2.906	2.93
0.9	3.039	3.038	2.963	2.947	2.966
0.95	3.091	3.085	3.011	2.991	3.006
1	3.149	3.14	3.062	3.04	3.038
1.05	3.213	3.195	3.119	3.095	3.097
1.1	3.288	3.262	3.182	3.157	3.146
1.15	3.38	3.34	3.255	3.224	3.203
1.2	3.496	3.432	3.337	3.302	3.26
1.25	3.648	3.544	3.434	3.391	3.33
1.3	3.874	3.676	3.543	3.496	3.401
1.35	4.322	3.848	3.664	3.613	3.477
1.4	6.407	4.064	3.798	3.74	3.563
1.45	8.243	4.303	3.942	3.878	3.652
1.5	8.691	4.565	4.085	4.017	3.741
1.55	8.967	4.853	4.229	4.162	3.831
1.6	9.163	5.154	4.367	4.31	3.925
1.65	9.327	5.475	4.532	4.454	4.016
1.7	9.473	5.803	4.702	4.618	4.103
1.75	9.603	6.162	4.908	4.803	4.196
1.8	9.728	6.559	5.184	5.033	4.29
1.85	9.84	7.08	5.657	5.355	4.37
1.9	9.947	8.05	7.179	5.855	4.471
1.95	10.049	9.122	7.972	6.289	4.568
2	10.147	9.556	8.32	6.528	4.665
2.05	10.232	9.818	8.553	6.687	4.773
2.1	10.315	10.003	8.748	6.846	4.89

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2.15	10.388	10.142	8.921	7.019	5.011
2.2	10.453	10.253	9.087	7.285	5.148
2.25	10.516	10.344	9.246	7.764	5.311
2.3	10.571	10.418	9.421	8.179	5.504
2.35	10.623	10.479	9.592	8.448	5.734
2.4	10.666	10.537	9.777	8.655	6.016
2.45	10.708	10.586	9.939	8.831	6.313
2.5	10.745	10.63	10.09	8.998	6.535
2.55	10.779	10.673	10.215	9.158	6.69
2.6	10.814	10.708	10.313	9.317	6.819
2.65	10.842	10.742	10.401	9.481	6.922
2.7	10.87	10.775	10.477	9.653	7.026
2.75	10.897	10.8	10.538	9.819	7.115
2.8	10.918	10.823	10.597	9.969	7.219
2.85	10.944	10.855	10.645	10.106	7.34
2.9	10.968	10.881	10.693	10.224	7.477
2.95	10.991	10.897	10.734	10.317	7.634
3	11.011	10.923	10.771	10.399	7.81
3.05		10.944	10.802	10.469	8.015
3.1		10.96	10.835	10.532	8.221
3.15		10.982	10.864	10.587	8.414
3.2		11	10.892	10.622	8.587
3.25		11.021	10.919	10.671	8.752
3.3			10.941	10.701	8.907
3.35			10.965	10.752	9.047
3.4			10.987	10.783	9.188
3.45			11.007	10.814	9.331
3.5				10.841	9.469
3.55				10.866	9.603
3.6				10.894	9.737
3.65				10.915	9.864
3.7				10.938	9.983
3.75				10.959	10.088
3.8				10.976	10.18
3.85				11	10.265
3.9				11.018	10.339
3.95					10.404
4					10.463
4.05					10.516
4.1					10.563
4.15					10.605
4.2					10.646
4.25					10.673
4.3					10.706
4.35					10.746
4.4					10.765
4.45					10.803
4.5					10.815
4.55					10.848

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4.6					10.873
4.65					10.892
4.7					10.916
4.75					10.937
4.8					10.952
4.85					10.973
4.9					10.993
4.95					11.006