NATIONAL BUREAU OF STANDARDS REPORT

INSTITUTE FOR BASIC STANDARDS

9432

ELECTROCHEMICAL DATA

Part IV

by

Harold J. DeWane and Walter J. Hamer

NBS Project Number: 2110432

NASA Contract Number: R-09-022-029

(Quarterly Report from NBS to NASA

for period July 1, 1966 to September 30, 1966)

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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Electrochemical Data

I. Introduction

The present report summarizes the work on the electrolytic conductance of hydrochloric acid. It is based on a study of the literature from 1925 to 1965. Rounded values of the equivalent conductance are given at temperatures from -20 to 65°C, and over the concentration ranges covered by the experimental data reported in the literature. They were obtained by the same methods described in Part III of this series, which covered the data at 25°C. AUTHOR

II. Results

Table 1 gives the equivalent conductance at rounded concentrations in absolute mhos. Values at -20, -10, 0, 10, 20, 30, 40 and 50°C are based on the data of Haase, R., Sauermann, P.-F. and Dücker, K.-H., Z. physik. Chem. Neue Folge 47, 224 (1965), except that at 50°C the values from 0.0001 to 0.01 N are derived from Cook, B. M. and Stokes, R. H., J. Phys. Chem. 67, 511 (1963). Values at 5, 15, 35, 45, 55, and 65°C are based on the data of Owen, B. B. and Stweeton, F. H., JACS, 63, 2811 (1941). The values at 25°C are based on the data of the authors cited in Part III.

Table 2 gives interpolation equations, constants and coefficients for hydrochloric acid at the various temperatures, and the concentration regions at which they are applicable. This table also gives the standard deviations of the various least square fits of the data.

III. Other Halogen Acids

Data on the equivalent conductance of the other halogen acids are being studied and will be reported on in future reports.

TABLE 1 - Equivalent electrolytic conductance (Λ) of hydrochloric acid

c	-20°C	-10°C	0°C	5°C	10°C	15°C	20°C	25°C	30°C	35°C	40°C	45°C	50°C	55°C	65°C
0.0001	-----	-----	-----	296.4	-----	360.8	-----	424.5	-----	487.0	-----	547.9	577.7	606.6	662.9
.0005	-----	-----	-----	295.2	-----	359.2	-----	422.5	-----	484.7	-----	545.2	575.1	603.5	660.0
.001	-----	-----	-----	294.3	-----	358.0	-----	421.2	-----	483.1	-----	543.2	573.1	601.3	657.8
.005	-----	-----	-----	291.0	-----	353.5	-----	415.7	-----	476.7	-----	535.5	564.4	592.6	647.3
.01	-----	-----	-----	288.6	-----	350.3	-----	411.9	-----	472.2	-----	530.3	558.7	586.5	641.2
.05	-----	-----	-----	280.3	-----	339.9	-----	398.9	-----	456.7	-----	512.4	-----	565.6	616.9
.1	-----	-----	-----	275.0	-----	333.3	-----	391.1	-----	446.8	-----	501.1	-----	552.8	602.8
.5	-----	-----	228.7	254.8	283.0	308.1	336.4	360.7	386.8	411.9	436.9	461.1	482.4	508.0	552.3
1.0	-----	-----	211.7	235.2	261.6	283.9	312.2	332.2	359.0	379.4	402.9	424.8	445.3	468.1	509.3
1.5	-----	-----	196.2	216.9	241.5	261.5	287.5	305.8	331.1	349.4	371.6	391.5	410.8	431.7	469.9
2.0	-----	-----	182.0	199.9	222.7	240.7	262.9	281.4	303.3	321.6	342.4	360.6	378.2	398.0	433.6
2.5	-----	131.7	168.5	184.3	205.1	221.4	239.8	258.9	277.0	295.8	315.2	332.0	347.6	366.7	399.9
3.0	-----	120.8	154.6	169.5	188.5	203.4	219.3	237.6	253.3	271.5	289.3	304.8	319.0	336.9	368.0
3.5	85.5	111.3	139.6	155.6	172.2	186.5	201.6	218.3	232.9	248.6	263.9	279.4	292.1	308.6	337.2
4.0	79.3	102.7	129.2	143.4	158.1	171.5	185.6	200.0	214.2	228.4	242.2	256.6	268.2	283.6	310.1
4.5	73.7	94.9	119.5	132.0	145.4	157.4	170.6	183.1	196.6	209.5	222.5	235.2	246.7	260.2	284.7
5.0	68.5	87.8	110.3	121.3	133.5	144.4	156.6	167.4	180.2	191.9	204.1	215.4	226.5	238.4	261.0
5.5	63.6	81.1	101.7	111.4	122.5	132.3	143.6	152.9	165.0	175.6	187.1	197.1	207.7	218.3	239.1
6.0	58.9	74.9	93.7	102.2	112.3	121.2	131.5	139.7	151.0	160.6	171.3	180.2	190.3	199.7	218.9
6.5	54.4	69.1	86.2	93.8	103.0	111.0	120.4	127.7	138.2	146.8	156.9	164.8	174.3	182.7	200.4
7.0	50.2	63.7	79.3	86.0	94.4	101.7	110.2	116.9	126.4	134.3	143.6	150.8	159.7	167.2	183.5
7.5	46.3	58.6	73.0	78.9	86.5	93.3	100.9	107.0	115.7	122.9	131.6	138.1	146.2	153.1	168.1
8.0	42.7	54.0	67.1	72.4	79.4	85.6	92.4	98.2	106.1	112.6	120.6	126.7	134.0	140.4	154.1
8.5	39.4	49.8	61.7	66.5	72.9	78.7	84.7	90.3	97.3	103.2	110.7	116.4	123.0	128.8	141.5
9.0	36.4	45.9	56.8	61.2	67.1	72.5	77.8	83.1	89.4	94.8	101.7	107.1	112.9	118.3	130.1
9.5	33.6	42.3	52.3	56.4	61.8	66.8	71.5	76.6	82.3	87.3	93.6	98.7	103.9	108.8	119.7
10.0	31.2	39.1	48.2	52.0	57.0	61.6	65.8	70.7	75.9	80.5	86.3	91.1	95.7	-----	-----
10.5	28.9	36.1	44.5	48.0	52.7	56.9	60.7	65.3	70.1	74.3	79.6	84.1	88.4	-----	-----
11.0	26.8	33.4	41.1	44.4	48.8	52.6	56.1	60.2	64.9	68.7	73.6	77.7	81.7	-----	-----
11.5	24.9	31.0	38.0	41.1	45.3	48.5	51.9	55.3	60.1	63.6	68.0	71.7	75.6	-----	-----
12.0	23.1	28.7	35.3	38.0	42.0	-----	48.0	-----	55.6	-----	62.8	-----	70.0	-----	-----
12.5	21.4	26.7	32.7	-----	39.0	-----	44.4	-----	51.4	-----	57.9	-----	64.8	-----	-----
13.0	20.0	24.9	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

TABLE 2 - Interpolation equations, constants, and coefficients for hydrochloric acid

$$\Lambda = A + Bc + Cc^2 + Dc^3 + Ec^4 + Fc^5 + Gc^6$$

t°C	A	B	C	D	E x 10^{-1}	F x 10^{-2}	G x 10^{-4}	s	c
-20	188.486	-63.0162	16.8512	-2.88586	2.76616	-1.36131	2.68729	0.1	3.5-13.0
-10	225.132	-58.7706	12.3280	-1.88762	1.71785	-0.819972	1.58613	0.1	3.5-13.0

$$\Lambda = \Lambda_o - Sc^{1/2} + Ec \log c + Ac + Bc^{3/2} + Cc^2 + Dc^{5/2}$$

t°C	Λ_o	S	E	A	B	C	D	s	c
0	265.03	88.42	-------	137.963	-177.413	92.7510	-18.2200	0.07	0.5-3.5
0	265.03	88.42	-------	57.5126	-43.3796	12.0843	-1.10359	0.10	3.5-12.5
5	297.42	101.45	136.88	588.329	-1860.66	--------	--------	0.10	0 - 0.01
5	297.42	101.45	-------	103.189	414.041	-2474.81	3477.47	0.01	0.01-0.1
5	297.42	101.45	-------	143.672	-169.686	78.5958	-13.3975	0.09	0.1-3.3
5	297.42	101.45	-------	76.6573	-60.7656	17.6613	-1.69413	0.08	3.3-12.0
10	329.78	115.00	-------	167.354	-194.674	89.2927	-15.1538	0.14	0.5-3.6
10	329.78	115.00	-------	87.9928	-69.0294	19.9793	-1.91012	0.12	3.6-12.5
15	362.05	129.03	170.55	637.038	-1763.68	-------	--------	0.12	0 - 0.01
15	362.05	129.03	-------	30.2129	1403.63	-5817.09	7203.38	0.06	0.01-0.1
15	362.05	129.03	-------	178.321	-204.494	92.4328	-15.3605	0.08	0.1-3.4
15	362.05	129.03	-------	104.249	-83.4819	24.7903	-2.44755	0.06	3.4-11.5
20	394.16	143.59	-------	175.522	-150.370	36.5182	--------	0.01	0.5-3.2
20	394.16	143.59	-------	107.020	-81.4337	23.2970	-2.21043	0.14	3.2-12.5
25	426.06	158.63	206.31	816.291	-2357.11	-------	--------	0.05	0 - 0.01
25	426.06	158.63	-------	173.105	43.5147	-345.464	--------	0.14	0.01-0.1
25	426.06	158.63	-------	221.501	-252.771	115.606	-19.5824	0.10	0.1-3.0
25	426.06	158.63	-------	143.554	-116.628	35.2535	-3.56231	0.15	3.0-11.6
30	457.65	174.13	-------	202.319	-166.121	39.2792	--------	0.01	0.5-3.2
30	457.65	174.13	-------	139.378	-105.934	30.5564	-2.94264	0.15	3.2-12.5
35	488.91	190.06	244.09	1033.57	-3144.50	-------	--------	0.07	0 - 0.01
35	488.91	190.06	-------	62.4686	2225.76	-10030.0	13176.0	0.06	0.01-0.1
35	488.91	190.06	-------	264.592	-295.287	133.716	-22.5186	0.10	0.1-3.3
35	488.91	190.06	-------	157.608	-119.583	34.5545	-3.34375	0.14	3.3-11.5
40	519.75	206.42	-------	284.745	-310.940	139.117	-23.3201	0.01	0.5-3.6
40	519.75	206.42	-------	165.451	-122.051	34.7804	-3.33198	0.13	3.6-12.5
45	550.12	223.24	284.16	1051.38	-2307.60	--------	--------	0.10	0 - 0.01
45	550.12	223.24	-------	143.352	1716.09	-8031.14	10523.2	0.10	0.01-0.1
45	550.12	223.24	-------	311.829	-343.170	155.721	-26.4600	0.11	0.1-3.3
45	550.12	223.24	-------	196.780	-148.978	43.3720	-4.25969	0.12	3.3-11.5
50	579.94	240.42	305.04	3653.32	-95025.8	1143193.	-4694909.	0.15	0 - 0.01
50	579.94	240.42	-------	301.922	-296.692	117.737	-17.2082	0.08	0.5-3.7
50	579.94	240.42	-------	188.591	-133.516	37.1664	-3.49219	0.09	3.7-12.5
55	609.17	258.02	326.60	1361.45	-3968.29	--------	--------	0.10	0 - 0.01
55	609.17	258.02	-------	255.518	877.709	-4758.72	6156.27	0.06	0.01-0.1
55	609.17	258.02	-------	361.044	-390.808	176.840	-30.1100	0.10	0.1-3.3
55	609.17	258.02	-------	229.922	-170.083	49.1104	-4.82221	0.01	3.3-9.5

TABLE 2 (continued)

t°C	Λ_o	S	E	A	B	C	D	s	c
65	665.55	294.26	371.29	6109.75	-158229.0	1754166.	-6580456.	0.09	0 - 0.01
65	665.55	294.26	------	565.968	-1787.61	4760.06	-5501.35	0.13	0.01-0.1
65	665.55	294.26	------	413.887	-439.598	196.840	-33.1617	0.24	0.1-3.4
65	665.55	294.26	------	267.714	-193.878	55.3978	-5.41006	0.01	3.4-9.5