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DISTRIBUTION STUDIES OF SOME METAL IONS IN CHLORIDE MEDIA

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Distribution coefficients have been measured for the partition of metal ions; Mg(II), Co(II), Ni(II), Cu(II), Zn(II) and Fe(III) between cation as well as anion exchangers and water – sodium chloride solutions. The values of partition coefficient K_D show the importance of chloride media as complexing agents giving anionic complexes.

INTRODUCTION

Cation – exchange separations of a number of metal ions in aqueous solution were found to be affected by using 0.5 *N* HCl as eluting agent [1,2]. The non – aqueous solvent i.e. water - acetone system for example, enhanced metal – halide complex formation for the separation of metal ions by cation – exchanger. The behaviour of several metal ions on Zeo – Karb 225 cation – exchanger has been studied using acetone – water – HCl system as eluent, for possible separation of copper (II) and nickel (II). On the other hand, such eluent was found to be less effective in certain separations; such as cobalt (II) – manganese (II) and iron (III) – copper (II) – zinc (II) [3].

The equilibrium distribution of only Zn or Ca ions during separation on KB – 4(9056 – 17 – 6) cation – exchanger in the Na – form, from $ZnCl_2$ or $CaCl_2$ solution in the presence of NaCl, are reported [4].

The addition of water – miscible organic solvent increases the absorption of metal ions on anion – exchanger at relatively low HCl concentration [5-9]. Ethanol – water – HCl eluting agent was employed to effect the anion – exchange separation of elements, which exhibit low absorption in aqueous – HCl solutions. The anion – exchange separation of manganese from nickel and calcium has been employed.

Sodium chloride was employed [10] to separate Mo (VI) using duolite anion – exchange resin at different pH values in aqueous media.

The aim of the present work is to determine and evaluate the values of the distribution coefficient for Mg (II), Co(II), Cu(II), Zn(II) and Fe(III) on Zeo – Karb 225 cation and varion AD anion – exchangers, in aqueous, aqueous – organic (methanol, ethanol, isopropanol and dioxane) – NaCl media at different ratios. Distribution data thus obtained are used for suggesting the possibilities of several separations.

EXPERIMENTAL

Materials and Methods: Zeo – Karb 225 cation – exchanger (Permutit Company Limited, London), sodium form, was used for cation – exchange distribution studies, and varion AD (chloride form) anion – exchanger type 2 (Trading Company for Chemicals, 11 – 1805, Budapest) was also used for anion – exchange distribution studies. Both exchangers are of analytical grade, 50 – 100 mesh.

Chlorides of the studied metal ions (E. Merck) were used for the preparation of 0.1 *N* solutions either in aqueous or aqueous – organic media. Each solution contained different concentrations of sodium chloride; and the used organic solvents; methanol, ethanol, isopropanol and dioxane were of B.D.H. grade.

The investigated metal ions were determined titrimetrically with EDTA using the suitable indicator [11]; muroxide for Ca(II), Ni(II) and Co(II), Eriochrome Black T. For Mg(II); xylenol orange for Fe(III); and methyl thymol blue for Cu(II). The distribution studies were carried out by equilibration in glass stoppered flask (100-ml) at $25^o + 0.1^oC$, each containing 1 g of the resin and 50 ml of the studied metal ion solution (0.1 *N*) in aqueous or aqueous – alcoholic – chloride media. After shaking in thermostat for 48 hr, each solution was analysed for the studied metal ion.

The weight distribution coefficients (K_D – values) were calculated from the following relation [12]:

$$K_D = \frac{\text{m.eq. metal/g of dry resin}}{\text{m.eq. metal/ml of solution}}$$

RESULTS AND DISCUSSIONS

Data given in Table 1 indicate that, the K_D – values decreases regularly with chloride concentration for Mg(II), Co(II), Ni(II), Cu(II), Zn(II) and Fe(III). The action of sodium chloride on the exchange equilibrium is probably similar to that of the chloride ion by lowering the effective concerntration of the cation in the solution through complex formation.

At 0.05 aqueous sodium chloride solution, the relatively high values of K_D, and consequently the decrease in the stabilities of the probably formed choride complexes follow the following order of the studied metal ions, Ni(II) > Fe(III) > Mg(V) > Co(II) > Cu(II) > Zn(II) (Table 1). In methanol, the stabilities of the chloro – complexes increase with the concentration of sodium chloride. The large decrease in the K_D values at high sodum chloride concentrations is attributed to the formation of chloro – complexes which are held less strongly by the resin.

The lowering in the K_D – values for the metal ions is probably due to the relative ion – pairing of the chlorides of these metal ions [13], since ion – pairing will lower the effective concentration of the cation in the solution by the formation of MCl^+ acting in a way similar to complex formation. moreover, it has been found that, the variation of sodium chloride concentration leads to a change in the sequence of the stabilities of the complexes formed.

Studies carried out in aqueous – organic solution, with varying sodium chloride concentrations, gave useful indications, regarding exchange trends as compared with aqueous solutions. A general decrease in K_D values with the quantity of alcohol (Table 1–3) is observed for nearly all metal ions at NaCl concentration of 0.6 and 1.0 *N*. These results prove that the ions show enhanced complex formation in such solutions which prevents the up – take of complex ions on the resin. At NaCl concentrations of 0.25 – 0.45*N* in ethanol, methanol and at 0.35 – 0.45*N*. NaCl in isopropanol, this phenomenon is also observed for nearly all the metal ions studied except for Zn(II), which probably forms relative unstable complexes at such conditions. The observed rise in K_D – values with the quantity of organic solvent at low NaCl concentration (0.05 – 0.15 *N*) in methanol, ethanol and (0.05 – 0.25*N*) in isopropanol may be due to solvent partition phenomena [14], showing that complexation in presence of low chloride ion concentration is not important.

Studies on the distribution coefficient in aqueous – dioxane system gave similar results as in case of aqueous – isopropanolic system except for Mg(II) and Fe(III). With increasing chloride concentration, at constant organic solvent quantity, the K_D – values decrease for all the studied metal ions, Mg(II) shows increasing K_D – values with the quntity of dioxane at the same chloride concentration, as compared with aqueous solution. By increasing the proportions of dioxane, the K_D – values of Fe(III) increase at chloride concentrations of 0.05 – 0.15*N*, and then decrease at high chloride concentrations of 0.25 – 1.0 *N*.

From the obtained results; Zn(II) could be separated from Mg(II), Co(II), Ni(II), Cu(II) and Fe(III) in aqueous 0.05 and 0.15 *M* NaCl media.

In aqueous – alcoholic media, Zn(II) could be separated at NaCl concentrations of 0.35, 0.45 *N* in all proportions of methanol and ethanol; and at isopropanol ratios of 30 – 50% V/V.

In dioxane system, at all ratios of organic solvent, and NaCl concentrations of 0.05 – 0.6 *N*, Fe(III) could be separated from the other metal ions. The best conditions for the separation of Mg(II) are; 0.6 – 1.0 *N* NaCl concentrations in presence of 40 – 50% V/V dioxane. Ni(II) could also be separated in presence of 50% dioxane and 0.6 *N* chloride solution (Table 4).

Anion – exchange studies have also been carried out for the same metal ions in chloride media.

In aqueous – chloride system (Table 5), it is found that Co(II), Cu(II), Zn(II) and Fe(III) give increasing K_D – values with the concentration of NaCl probably due to the formation of chloro–complex which could be absorbed by the anion–exchange resin. The observed high K_D – values of zinc at the same conditions indicate the possibility of forming more stable complexes absorbed strongly by the resin. Zero K_D – values for Mg(II) and Ni(II) are probably due to the formed soluble chloro – complexes by these matal ions at the same conditions. The incease in K_D – values with chloride concentration probably indicates that the ions which give stable negatively charged chloro – complexes of the type MCl_3 – [15] in both aqueous and aqueous – organic systems, and absorbed more readily on the sub – groub of the resin, are of the anionic type.

The obtained K_D values in alcoholic – media (Tables 5-7) could be obtained in the presence of anion-exchange separation of different metal ions. Thus, it is possible to give a chance to a certain metal ion to form chloro-complexs at suitable chloride concentration and then passing it through the anion – exchange resin. By this procedure; and although K_D – values decrease relatively after NaCl concentration of 0.45 *N*, it is possible to separate Zn(11) from the other metal ions at all the studied concentrations. Co(II) could also be separated from Cu(II), Ni(II) and Mg(II) at 0.45 *N* NaCl concentration and the studied ratios of alcohol. Whereas, Fe(III) gives precipitate in alcoholic

Table 1. K_D–values in aqueous–methanol–Chloride media, on cation exchanger.

Metal ions	Chloride concentration (*N*)						
	0.05	0.15	0.25	0.35	0.45	0.6	1
			0% v/v methanol				
Mg (II)	15.262	12.620	11.000	9.047	7.943	5.111	4.620
Co (II)	16.880	15.310	13.450	12.150	11.760	8.000	4.945
Ni (II)	–13.529	11.820	10.382	8.782	7.894	4.687	2.632
Cu (II)	16.870	14.760	11.760	9.820	7.303	7.894	3.750
Zn (II)	–19.366	17.600	–14.500	–11.780	–9.320	7.352	3.488
Fe (III)	14.280	13.125	12.125	–10.967	9.030	7.980	4.740
			10% v/v methanol				
Mg (II)	19.500	15.560	12.580	8.820	7.340	5.880	3.260
Co (II)	19.256	16.500	13.250	12.000	8.823	5.490	2.000
Ni (II)	16.450	13.850	10.730	8.730	6.380	4.270	1.929
Cu (II)	19.000	15.360	11.530	8.350	6.320	5.300	1.930
Zn (II)	19.285	17.990	14.388	11.988	11.800	–5.460	2.023
Fe (III)	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.
			20% v/v Methanol				
Mg (II)	19.650	14.740	12.580	7.500	6.425	4.020	2.940
Co (II)	19.500	16.000	13.010	9.180	8.460	4.802	1.650
Ni (II)	16.620	13.950	10.980	6.980	5.570	3.630	1,024
Cu (II)	19.320	15.500	11.650	8.140	5.560	4.530	1.500
Zn (II)	–19.285	–18.200	14.550	12.120	11.320	4.500	1.750
Fe (III)	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.
			30% v/v methanol				
Mg (II)	19.850	13.270	9.375	6.350	5.780	4.913	2.222
Co (II)	20.200	15.460	12.670	8.210	8.210	4.500	1.222
Ni (II)	16.870	14.840	8.122	5.430	4.080	2.015	1.015
Cu (II)	16.800	15.200	11.500	7.900	5.130	4.120	1.025
Zn (II)	18.220	18.990	15.150	12.670	11.500	4.120	1.500
Fe (III)	ppt.	ppt.	ppt. ppt.		ppt.	ppt.	ppt.
			40% v/v methanol				
Mg (II)	20.170	12.000	9.111	6.000	5.220	4.000	2.000
Co (II)	21.500	15.730	12.120	7.500	6.320	2.980	0.999
Ni (II)	17.562	15.735	8.632	5.110	3.520	1.850	0.890
Cu (II)	18.150	16.980	12.500	8.500	6.100	4.410	1.980
Zn (II)	18.000	19.320	16.500	13.160	11.500	3.980	1.320
Fe (III)	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.

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	50% v/v methanol						
Mg (II)	20.150	11.500	10.500	6.700	5.000	3.500	1.140
Co (II)	21.950	15.830	11.500	6.820	5.450	1.500	0.727
Ni (II)	18.352	16.935	9.650	5120	3.958	1.000	0.525
Cu (II)	21.750	18.210	13.650	9.120	7.800	4.750	1.676
Zn (II)	17.350	20.500	17.650	14.510	11.370	3.550	1.250
Fe (III)	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.

Table 2. K_D–values in aqueous–ethanol–chloride media on cation exchange.

Metal ions	Chloride concentration						
	0.05	0.15	0.25	0.35	0.45	0.6	1
	10% (v/v) Ethanol						
Mg (II)	18.320	15.230	12.210	–8.100	6.530	4.930	2.530
Co (II)	20.400	15.460	12.500	8.340	7.910	5.000	1.930
Ni (II)	17.250	14.320	11.520	7.500	7.200	4.120	1.730
Cu (II)	19.500	14.600	11.890	7.800	7.510	4.520	1.850
Zn (II)	19.000	18.500	11.800	11.230	11.800	6.000	2.000
Fe (III)	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.
	20% (v/v) Ethanol						
Mg (II)	19.860	14.200	10.200	5.830	4.520	3.100	2.240
Co (II)	20.640	15.000	12.000	8.110	7.510	4.880	1.430
Ni (II)	17.630	14.990	10.510	7.120	6.500	3.500	0.990
Cu (II)	19.880	15.000	10.950	7.500	7.210	3.890	1.400
Zn (II)	18.250	19.250	–12.320	11.230	10.320	5.460	1.635
Fe (III)	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.
	30% (v/v) Ethanol						
Mg (II)	20.150	12.500	8.880	4.250	3.670	2.700	1.990
Co (II)	20.900	15.200	11.230	7.500	7.130	4.000	1.110
Ni (II)	17.880	15.200	10.320	5.880	5.450	3.120	0.880
Cu (II)	18.200	15.000	10.650	7.200	6.020	3.500	1.000
Zn (II)	18.000	19.250	–14.500	12.510	11.230	5.250	1.500
Fe (III)	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.
	40% (v/v) Ethanol						
Mg (II)	20.760	13.510	9.150	4.100	3.600	2.500	1.750
Co (II)	21.500	15.400	11.000	7.000	6.190	3.330	0.975
Ni (II)	18.565	16.290	11.110	4.456	3.230	1.500	0.554
Cu (II)	19.350	15.780	11.110	7.970	7.120	3.650	1.100
Zn (II)	17.500	19.500	–16.350	13.760	12.510	5.000	1.300
Fe (III)	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.

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	50% (v/v) Ethanol						
Mg (II)	21.500	14.620	10.130	4.210	3.700	2.500	1.500
Co (II)	22.100	15.820	11.320	6.520	5.350	2.950	0.555
Ni (II)	19.998	17.780	12.570	4.012	2.050	1.990	o.452
Cu (II)	20.123	16.320	11.560	8.120	7.770	1.980	1.350
Zn (II)	17.150	20.600	–17.520	14.860	13.120	4.880	1.150
Fe (III)	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.

Table 3. K_D –values in aqueous–isopropanol–chloride, on cation exchanger.

Metal ions	Chloride concentration						
	0.05	0.15	0.25	0.35	0.45	0.6	1
	10% (v/v) Isopropanol						
Mg (II)	19.510	16.200	9.320	5.990	5.830	3.570	2.100
Co (II)	20.990	17.32	13.500	8.500	6.540	3.970	0.887
Ni (II)	17.630	15.350	12.630	7.500	6.920	4.110	1.340
Cu (II)	20.120	16.880	13.500	8.010	7.100	3.950	1.500
Zn (II)	18.110	17.880	13.950	9.780	7.505	4.215	1.210
Fe (III)	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.
	20% (v/v) Isopropanol						
Mg (II)	19.700	15.900	7.450	4.730	4.100	3.120	1.900
Co (II)	20.990	17.320	13.500	8.500	6.540	3.970	0.887
Ni (II)	17.830	15.500	12.600	7.400	6.000	3.210	0.560
Cu (II)	20.500	16.980	13.650	8.110	6.930	3.540	1.430
Zn (II)	17.670	18.500	15.500	9.700	6.500	4.500	1.150
Fe (III)	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.
	30% (v/v) Isopropanol						
Mg (II)	20.400	17.500	6.790	4.000	3.180	2.400	1.500
Co (II)	21.500	16.520	12.500	8.320	5.680	3.500	0.555
Ni (II)	17.970	15.600	12.420	7.100	5.000	2.820	0.320
Cu (II)	19.150	16.150	12.500	7.500	5.210	3.100	0.975
Zn (II)	16.320	20.150	17.520	14.350	10.500	3.900	1.100
Fe (III)	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.
	40% (v/v) Isopropanol						
Mg (II)	20.880	14.150	6.970	4.520	3.200	2.250	1.310
Co (II)	22.500	17.500	12.500	8.000	5.210	3.000	0.425
Ni (II)	18.340	16.500	12.000	6.530	4.110	2.000	0.250
Cu (II)	20.210	17.970	13.150	8.120	6.500	3.430	1.120
Zn (II)	16.320	20.150	17.520	14.350	10.500	3.500	0.997
Fe (III)	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.

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	50% (v/v) Isopropanol						
Mg (II)	21.170	14.650	7.200	4.600	3.400	2.100	1.250
Co (II)	23.430	18.000	12.760	7.500	4.880	2.500	0.325
Ni (II)	20.320	17.670	12.000	5.350	3.560	1.110	0.150
Cu (II)	22.150	18.880	14.180	8.670	6.970	3.970	1.550
Zn (II)	16.000	20.500	18.150	15.500	10.500	3.120	0.673
Fe (III)	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.

Table 4. K_D–values in aqueous–dioxane–chloride media, on cation exchange.

Metal Ions	Chloride concentration (*N*)						
	0.05	0.15	0.25	0.35	0.45	0.6	1
	10% (v/v) Dioxane						
Mg (II)	16.400	13.600	8.962	10.500	9.520	7.954	4.545
Co (II)	21.500	17.500	15.320	9.580	7.570	5.120	2.380
Ni (II)	18.350	15.640	13.500	7.000	5.210	4.000	2.000
Cu (II)	21.000	16.700	14.250	8.900	6.500	4.780	3.330
Zn (II)	19.440	14.500	11.530	9.120	7.690	5.430	2.445
Fe (III)	29.590	27.940	26.980	22.550	17.430	11.010	5.675
	20% (v/v) Dioxane						
Mg (II)	16.910	13.600	8.962	10.500	9.520	7.954	4.545
Co (II)	21.880	16.970	14.980	8.780	6.500	4.350	2.300
Ni (II)	18.500	15.700	13.050	7.100	4.950	3.000	1.430
Cu (II)	21.600	16.000	14.000	8.120	6.000	4.050	2.110
Zn (II)	17.500	15.100	13.210	10.110	7.500	5.000	2.000
Fe (III)	31.250	26.950	25.500	20.220	16.640	10.150	4.250
	30% (v/v) Dioxane						
Mg (II)	17.105	15.200	11.270	10.300	10.700	9.300	6.660
Co (II)	22.750	16.470	14.680	8.200	6.210	3.500	2.000
Ni (II)	19.100	15.930	12.000	6.500	4.650	2.210	1.110
Cu (II)	19.980	15.950	13.760	7.900	5.780	3.230	1.750
Zn (II)	17.000	16.750	14.500	11.760	7.400	4.670	2.000
Fe (III)	32.170	27.900	24.970	19.670	15.580	9.200	3.990
	40% (v/v) Dioxane						
Mg (II)	18.350	16.520	11.770	11.700	11.500	10.130	7.120
Co (II)	23.500	17.500	15.170	8.200	6.000	3.210	1.810
Ni (II)	20.650	18.357	13.500	6.136	4.000	1.500	0.880
Cu (II)	21.220	17.540	14.670	8.150	6.150	3.500	2.110
Zn (II)	16.320	18.560	16.710	12.890	7.010	4.210	1.500
Fe (III)	34.830	28.800	24.980	18.750	14.620	8.500	3.500

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	50% (v/v) Dioxane						
Mg (II)	19.180	16.910	12.150	11.850	11.650	11.000	7.420
Co (II)	24.990	18.720	15.660	8.120	5.880	3.110	1.520
Ni (II)	21.760	18.880	12.150	5.120	3.012	0.980	0.210
Cu (II)	22.890	19.200	16.880	9.180	7.120	4.161	2.750
Zn (II)	15.820	19.930	17.200	13.500	6.500	4.000	1.350
Fe (III)	35.500	29.210	24.300	18.000	13.970	7.970	2.898

Table 5. K_D–values in aqueous–methanol–chloride media on anion exchanger.

Metal ions	Chloride concentration (*N*) 0.05	0.15	0.25	0.35	0.45	0.6	1.
	0% (v/v) Methanol						
Mg (II)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Co (II)	0.234	0.333	0.515	0.633	0.746	1.243	1.851
Ni (II)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cu (II)	0.000	0.212	0.485	0.523	0.701	0.741	1.163
Zn (II)	6.363	9.363	11.480	17.980	22.630	22.180	15.110
Fe (III)	0.574	0.635	0.789	0.801	0.837	3.630	0.588
	10% (v/v) Methanol						
Mg (II)	0.000	0.000	0.000	0.325	0.530	0.637	0.832
Co (II)	0.351	0.356	0.615	0.737	0.832	1.530	2.120
Ni (II)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cu (II)	0.000	0.256	0.543	0.632	0.788	1.001	1.345
Zn (II)	19.520	23.750	26.000	29.150	33.450	31.120	21.57
Fe (III)	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.
	20% (v/v) Methanol						
Mg (II)	0.000	0.121	0.280	0.450	0.638	0.752	1.000
Co (II)	0.371	0.436	0.651	0.838	0.950	1.635	2.530
Ni (II)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cu (II)	0.000	0.273	0.621	0.655	0.823	1.012	1.793
Zn (II)	20.000	24.250	29.250	32.140	35.550	32.000	24.25
Fe (III)	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.
	30% (v/v) Methanol						
Mg (II)	0.000	0.222	0.312	0.510	0.712	0.835	1.300
Co (II)	0.380	0.502	0.757	0.942	0.998	1.758	2.635
Ni (II)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cu (II)	0.000	0.312	0.825	0.932	1.332	1.727	2.247
Zn (II)	20.760	27.990	31.550	34.880	38.460	34.880	26.000
Fe (III)	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.

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Table 6. K_D–values in aqueous–ethanol–chloride media on anion exchanger.

Metal ions	Chloride concentration (*N*) 0.05	0.15	0.25	0.35	0.45	0.6	1
				10% (v/v) Ethanol			
Mg (II)	0.000	0.000	0.151	0.374	0.655	0.821	0.932
Co (II)	0.362	0.432	0.712	0.815	0.856	1.656	2.220
Ni (II)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cu (II)	0.000	0.335	0.675	0.752	0.888	1.123	1.536
Zn (II)	20.760	24.150	27.500	30.190	36.600	32.500	21.920
Fe (III)	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.
				20% (v/v) Ethanol			
Mg (II)	0.000	0.173	0.295	0.532	0.712	0.881	0.982
Co (II)	0.382	0.517	0.815	0.932	1.021	1.888	2.530
Ni (II)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cu (II)	0.000	0.532	0.835	0.935	1.021	1.562	2.354
Zn (II)	22.330	30.150	32.780	34.880	39.950	35.170	27.500
Fe (III)	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.
				30% (v/v) Ethanol			
Mg (II)	0.000	0.315	0.412	0.636	0.750	1.005	1.520
Co (II)	0.394	0.616	0.852	0.953	1.235	2.050	2.990
Ni (II)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cu (II)	0.000	0.532	0.835	0.935	1.021	1.562	2.354
Zn (II)	22.330	30.150	32.780	34.880	39.950	35.170	27.500
Fe (III)	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.

Table 7. K_D–values in aqueous–isopropanol–chloride media on anion exchanger.

Metal ions	Chloride concentration (*N*) 0.05	0.15	0.25	0.35	0.45	0.6	1
				10% (v/v) Isopropanol			
Mg (II)	0.000	0.255	0.353	0.553	0.760	0.855	1.012
Co (II)	0.375	0.453	0.732	0.856	0.915	1.835	2.560
Ni (II)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cu (II)	0.123	0.415	0.932	0.935	1.220	1.332	1.732
Zn (II)	30.130	25.150	28.200	31.500	37.560	34.500	22.500
Fe (III)	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.

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	20% (v/v) Isopropanol						
Mg (II)	0.022	0.351	0.423	0.651	0.835	0.880	1.225
Co (II)	0.387	0.555	0.851	0.952	1.256	1.998	2.730
Ni (II)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cu (II)	0.221	0.522	1.230	1.330	1.510	1.750	2.035
Zn (II)	22.150	26.330	32.500	35.600	38.460	36.700	23.100
Fe (III)	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.
	30% (v/v) Isopropanol						
Mg (II)	0.193	0.421	0.556	0.732	0.856	0.935	1.543
Co (II)	0.397	0.623	0.915	1.120	1.552	2.210	2.830
Ni (II)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cu (II)	0.315	0.615	1.350	1.456	1.830	1.992	2.537
Zn (II)	23.530	27.250	33.500	36.620	40.150	37.000	23.990
Fe (III)	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.	ppt.

Table 8. K_D–values in aqueous–dioxane–chloride media on anion exchanger.

Metal ions	Chloride concentration (*N*)						
	0.05	0.15	0.25	0.35	0.45	0.6	1
	10% (v/v) Dioxane						
Mg (II)	0.000	0.000	0.000	0.212	0.350	0.632	0.980
Co (II)	0.370	0.450	0.755	0.956	1.027	2.010	2.530
Ni (II)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cu (II)	0.153	0.512	0.957	0.992	1.050	1.453	1.560
Zn (II)	10.500	13.500	17.000	20.500	25.700	22.500	20.000
Fe (III)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	20% (v/v) Dioxane						
Mg (II)	0.000	0.000	0.000	0.212	0.350	0.632	0.980
Co (II)	0.382	0.502	0.756	0.966	1.672	2.120	2.630
Ni (II)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cu (II)	0.225	0.635	1.029	1.132	1.222	1.530	1.835
Zn (II)	10.990	14.500	17.120	21.220	26.500	23.130	20.120
Fe (III)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	30% (v/v) Dioxane						
Mg (II)	0.000	0.000	0.273	0.450	0.562	0.999	1.250
Co (II)	0.389	0.557	0.876	1.057	1.990	2.310	2.750
Ni (II)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cu (II)	0.325	0.727	1.111	1.235	1.550	1.670	2.670
Zn (II)	11.350	13.570	17.280	21.750	27.220	24.320	21.500
Fe (III)	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Continued. . . . .

systems, it is found that the addition of dioxane results in a soluble product giving zero K_D – values for Zn(II) are lower in dioxane system as compared with alcoholic systems (Table 8). For the remaining metal ions there is no marked difference in the K_D – values, in presence of both dioxane and alcohol.

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