

Chromatography of some metal ions on paper impregnated with stannic phosphate

Papers impregnated with zirconium precipitates have been found useful for the separation of metal ions¹⁻³. Preliminary studies⁴ in these laboratories indicated that stannic phosphate (SP) papers would also offer similar possibilities. The present work was therefore undertaken to study the preparation and properties of SP papers for the separation of metal ions.

Experimental

15 × 3 cm strips were developed in 20 × 5 cm glass jars by the ascending technique and the solvent was allowed to migrate 11 cm from the point of application.

Test solutions

0.1 *M* solutions of metal ions were used. Bismuth and antimony chlorides were dissolved in 3 *N* and 2.7 *N* hydrochloric acid, respectively. Cerium, Ti, Pd and Y chlorides were dissolved in 1 *N* HCl. Gold chloride, platinum chloride, sodium tungstate and ammonium molybdate were dissolved in water. The selenium oxide was dissolved in water and made just alkaline with 1 *N* KOH. Tellurium metal was dissolved in conc. HNO₃ and the oxide thus obtained was dissolved in the least quantity of 1 *N* KOH. All other cations were taken as nitrates and dissolved in 0.1 *N* HNO₃. Usual methods for the detection of spots were used.

Preparation of ion-exchange papers

A 17.6% solution of stannic chloride pentahydrate and a 10% solution of phosphoric acid (89% w/w; sp. gr. 1.75) were prepared in water. Whatman No. 1 strips were dipped in the hot stannic chloride solution. The excess solution was removed by placing the strips on a filter sheet. The strips were then passed through hot phosphoric acid solution for a few seconds. The excess phosphoric acid was drained off. The strips were dried at room temperature and then washed with water till the wash water had a pH of 4. The strips were again dried and used as such.

The behaviour of group IB elements was studied on SP papers and on a SP column. The column was prepared in a 25 ml burette with an outer diameter of 1 cm. The burette was filled to a height of 2 cm with SP (50-100 mesh) prepared as described earlier⁵. It was found that Au(III) as AuCl₄' was not retained on the SP column. Tests with a solution of Au(III) and Cu(II) (as CuCl₂) showed that only Cu(II) was retained.

Ag(I) and Cu(II) as sulphates were retained on the column and could be readily separated by eluting first with 0.1 *N* HCl to remove the Cu(II) and then with NH₄OH-NH₄Cl (4 *N*) to remove the silver.

Au(III) had the same *R_F* value on SP paper as on ordinary Whatman No. 1 paper (*R_F* 0.47) with 0.1 *N* or 1 *N* HCl.

When a mixture of Ag(I) and Cu(II) sulphates was developed on SP paper with 0.1 *N* HCl, Ag(I) stayed at a point of application and Cu(II) had an *R_F* value of 0.61. Thus the SP papers and SP column showed analogous behaviour, differing only with respect to adsorption on cellulose in the case of the paper.

TABLE I

 R_F VALUES OF SOME METAL IONS ON PLAIN AND SP PAPERS

Metal ions	R_F values	
	Whatman No. 1 (0.1 N HCl)	Stannic phosphate paper (0.1 N HCl)
Pb(II)	0.83	0.09
Cu(II)	0.95	0.61
Fe(III)	0.96	0.05
Fe(II)	0.94	0.00
Ni(II)	0.94	0.73
Co(II)	0.95	0.50
UO ₂ (II)	0.95	0.06

To study the effect of impregnation a few metal ions were chromatographed on plain and SP papers. The results are summarized in Table I.

In order to investigate the utility of SP papers in qualitative analysis, numerous metal ions were chromatographed using HCl of different concentrations. The results are summarized in Table II. Hg(I), Al(III), Th(IV), Zr(IV) and Ti(IV) had an R_F of 0.00, in all the three HCl concentrations studied.

A few metal ions were also developed at higher acid concentrations. The results are summarized in Table III.

TABLE II

 R_F VALUES OF SOME METAL IONS IN A FEW HCl SYSTEMS

Metal ions	R_F values*		
	0.01 N HCl	0.1 N HCl	1 N HCl
Ag(I)	0.07	0.00	0.00
Tl(I)	0.16	0.24T	0.21T
Pb(II)	0.04	0.09	0.47T
Cu(II)	0.18	0.61	0.87
Cd(II)	0.09	0.71	0.87
Bi(III)	0.03	0.16T	0.87
Sb(III)	0.00	0.00	0.09
Fe(III)	0.03	0.05	0.06
Ni(II)	0.25T	0.73	0.92
Co(II)	0.07	0.50	0.89
UO ₂ (II)	0.05	0.06	0.35E
Pd(II)	0.87	0.90	0.94
Pt(IV)	0.90	0.94	0.94
Mo(VI)	0.04	0.03	0.07
W(VI)	0.00	0.00	0.13
Au(III)	0.50	0.47	0.47
Ce(III)	0.14T	0.15T	0.65T
La(III)	0.17T	0.32	0.65
Selenite	0.30T	0.30T	0.45E
Tellurite	0.00	0.03	0.12

* T = tails; E = elongated.

TABLE III
A FEW R_F VALUES IN SOME HCl AND HClO₄ SYSTEMS

Metal ions	R_F values*					
	HCl			HClO ₄		
	1 N	3 N	5 N	1 N	3 N	5 N
Sb(III)	0.09	0.82	0.87	0.04	0.17	0.20
Fe(III)	0.06	0.46E	0.71	0.04	0.13	0.15
Zr(IV)	0.00	0.00	0.00	—	—	—
Th(IV)	0.00	0.09	0.15	0.03	0.03	0.13
Ti(IV)	0.00	0.00	0.00	—	—	—
UO ₂ (II)	0.35 E	0.54 E	0.74 E	0.37 E	0.32 E	0.32 E

* E = elongated.

The R_F values of some metal ions, e.g. Pb(II), Cu(II), Cd(II), Bi(III), Ni(II), Co(II), Pd(II), U(VI), Ce(III), La(III) and Y(III) increase with increase in hydrochloric acid concentration (Table II). However, an increase in the perchloric acid concentration has no effect upon them (Table III). This shows that the change in R_F values is probably due to complex formation.

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The adsorption of metal ions on exchangers with phosphoric groups from perchloric acid solutions

The curious increase of adsorption of metal ions on Dowex-50 with an increase in the concentration of HClO₄ was first described by NELSON *et al.*¹, and we have since shown^{2,3} that it occurs also on cellulose sulphonic exchangers and from solutions of

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