IPT — a New Extracting Agent for Metal Ions

DAVID DYRSSEN

Department of Inorganic Chemistry, Royal Institute of Technology, Stockholm 70, Sweden

An extensive investigation of the β-isopropyl derivative of tropolone (IPT) as a reagent for the extraction of metal ions has been carried out at our institute in cooperation with the Research Institute of National Defence and with the support of the Swedish Council for Atomic Research.

The distribution of 27 metal ions between chloroform and 0.1 M perchlorate solutions has been studied at 25°C as a function of the concentration of IPT in the chloroform phase and the hydrogen ion concentration in the aqueous phase. With an IPT concentration of 0.1 M the following metals are extracted below pH 1: Sc(III), Fe(III), Cu(II), In(III), Th(IV), U(VI) and probably Al(III) and Ga(III). Between pH 2 and 6 the following ions are extracted: Co(II), Ni(II), Zn(II), Cd(II), Y(III), the lanthanide ions and Am(III). Above pH 7 it is possible to extract Ca, Sr, Ba and some Ag. For these elements as probably also for Ni, Zn, Cd, U(VI) and large trivalent ions the extraction might be improved by the addition of TBP, quinoline or some more basic compound (*e.g.* laurylamine) to the chloroform.

IPT has a considerably larger distribution constant ($K_d = 2\,340$ for chloroform/water) than TTA ($K_d = 37$ for benzene/water). IPT does not seem to undergo any such tautomeric or hydration equilibria as TTA. Furthermore, TTA decomposes rapidly in alkaline solutions while IPT does not. In addition the value of $pK_a + \log K_d$ for the IPT-chloroform system (10.41) is considerably larger than for the TTA-benzene system (7.80). An IPT-chloroform solution can therefore be used over a wider pH-range, *e.g.* for the extraction of alkaline earth metals. With some exceptions (*e.g.* Cu(II), Cd(II), U(VI), Fe(III) and In(III)) the pH values for 50 % extraction (equal phase volumes) are quite comparable for IPT and TTA as may be seen from Table 1.

The solubilities of the extactable metal chelates are often low (10^{-3} to 10^{-4} M) and this restricts the use of IPT for the extraction of large quantities of metals. In some cases (*e.g.* Cu(II), Fe(III) and U(VI)) the extinction coefficient of the extractable IPT complex is very high at 400—450 mμ where IPT itself does not absorb light.

IPT will probably always be a high-priced chemical. However, cedar wood or thuja may contain as much as 4 % and it is not very difficult to isolate the compound from the powdered heartwood or roots. It is possible that some other derivative of tropolone (*e.g.* nootkatin) will have still more favorable properties as an extracting agent for metal ions.

Table 1. Values of $\log\,[HA]_{org}\,[H^+]^{-1}$ for 50 % extraction.

Element	HA = IPT, org = $CHCl_3$, $[HA]_{org}$ = 0.1 M	HA = TTA[a], org = C_6H_6, $[HA]_{org}$ = 0.2 M
Ag(I)	8.71	—
Ca(II)	7.19	6.0
Sr(II)	7.58	7.1
Ba(II)	8.47	7.3
Co(II)	3.84	3.4
Ni(II)	3.86	>4.3
Cu(II)	—0.80	0.68
Zn(II)	3.13	—
Cd(II)	4.05	>7.3
U(VI)	—1.11	1.27
Sc(III)	—0.35	0.29
Fe(III)	—3.33	—0.94
Y(III)	2.46	2.50
In(III)	—1.34	1.48
La(III)	3.44	3.54
Pr(III)	2.83	2.98
Sm(III)	2.52	2.59
Eu(III)	2.41	2.59
Tb(III)	2.28	2.54
Ho(III)	2.08	2.45
Tm(III)	2.04	2.35
Yb(III)	1.96	2.27
Lu(III)	1.76	2.29
Am(III)	2.41	2.52
Th(IV)	—0.84	—0.2

[a] Values taken from a summary by Poskanzer, A. M. and Foreman, B. M., Jr. in *J. Inorg. & Nuclear Chem.* **16** (1961) 323.

The full report of our work, which includes experimental details, distribution data, extraction curves, equilibrium constants and composition of the extractable complexes, will be published in the *Transactions of the Royal Institute of Technology*.

Received September 25, 1961.