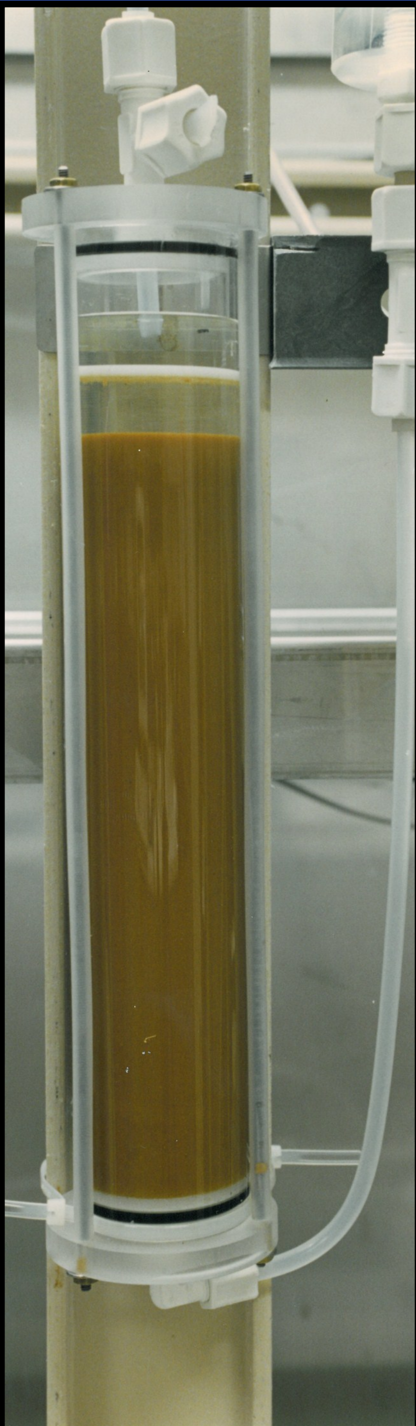
Experts in complex separations, from analytical to process scale.

DIPHONIX & MONOPHOS RESINS

eichrom NPO
expertise. collaboration. results.



Performance—Diphonix and Monophos Resins allow:

- Selective separation of multi-valent elements on both analytical and industrial scale.
- Effective partitioning of selected metals even in the presence of macroconcentrations of competing ions.
- Divalent metal purification to 99.999% by removal of iron.
- Processes to be installed and operated for over five years on a single charge of resin (depending on rigors of the application and regenerant used).
- Processes to be installed and operated with a single system containing >100 cubic feet of resin.
- Flux rates in the range of 1-20 gpm/ft^2 cross sectional bed area depending on concentration of treated solutions.

Large scale industrial applications:

- Selective Mn removal from spring (bottled) water regenerate with $MgCl_2$.
- Fe (III) removal from acidic Cu, Ni and Co electrowinning electrolytes.
  - Regeneration under reductive conditions **(Fig. 5)**.
  - Regeneratation using HEDPA (1-hydroxyethane-1, 1-diphosphonic acid) **(Fig. 6)**.
- U removal from caustic waste.

Sample preconcentration (matrix removal) in analytical applications:

- Actinides in large soil, food and fecal samples.

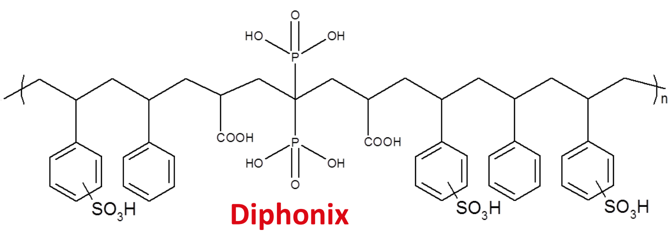
1955 University Lane in Lisle, IL 60532 · 630-963-0320 · Fax: 630-963-1928
www.eichrom.com · www.alarasolutions.com

SYSTEM CERTIFICATION ISO 9001:2008 SGS

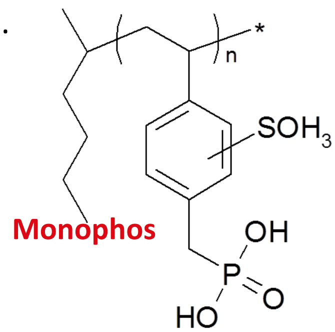
DIPHONIX & MONOPHOS RESINS

Diphonix Resin and Monophos Resin:

- Polymeric support: **styrene divinylbenzene.**
- Functional groups Diphonix: **geminally substituted diphosphonic acid, sulphonic and** carboxylic acid.
- Functional groups Monophos: **monophosphonic and sulphonic acid**.
- Functional groups **covalently bonded** to polymeric support.



(Fig. 1): Diphonix & Monophos



Functionalities:

Sulphonic acid groups:

- Increase hydrophilicity of resin.
- Increased metal accessibility and fast kinetics **(Fig. 2)**.

Gem-substituted diphosphonic or monophosphonic acid groups:

- Determine selectivity of the resin.
- Highly acidic groups:
  - Monophos: $pK_1 = 2.0$; $pK_2 = 7.0$
  - Diphonix: $pK_1 = 1.27$; $pK_2 = 2.41$; $pK_3 = 6.67$; $pK_4 = 10.04$
- High selectivity for Fe (III) over divalent cations in acid **(Fig. 3)**.
- High affinity for **actinides** & **polyvalent** cations over wide range of acid concentrations **(Figs. 4 & 5)**.

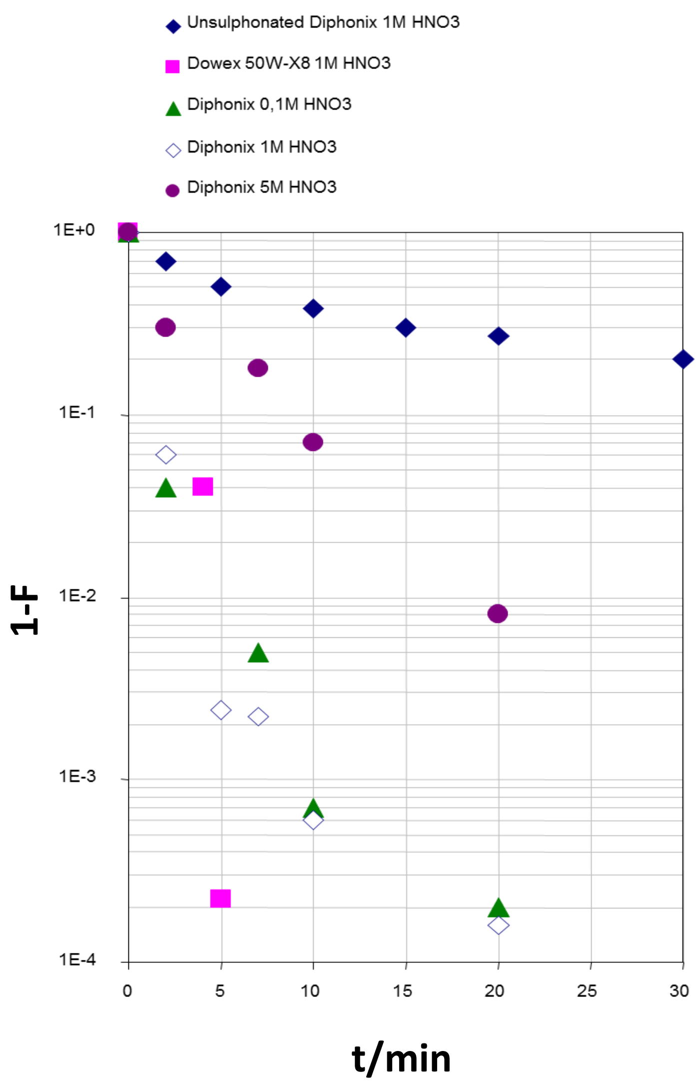
Characteristics of the Resins:

***Per Eichrom Fe Procedure (load 35g/L Cu, 180g/L H_2SO_4, 1g/L Fe (III).**

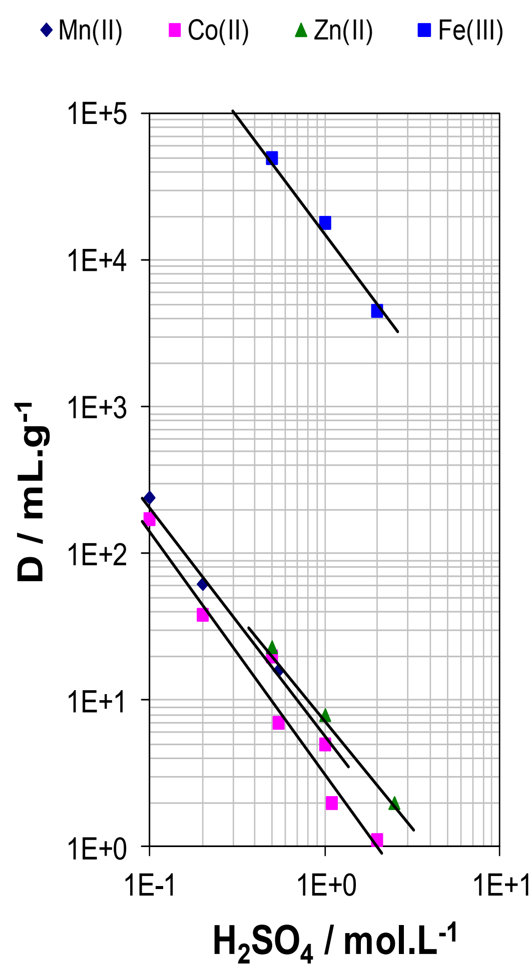
Characteristic	Diphonix Resin	Monophos Resin
Form	H+	H+
% Moisture Content	60-70%	55-70%
Phosphorous- Dry wt. Capacity (meq/g)	>1.1 meq/g	>3.3 meq/g
Total Dry wt. Acid Capacity (meq/g)	>5.3 meq/g.	>8 meq/g
Iron Capacity* (g Fe/L Hydrated Resin)	>10 g/L	>18 g/L
Particle Size (mesh)	16-50	16-50
% Whole Perfect Beads	>95%	>95%

DIPHONIX RESIN

expertise. collaboration. results.



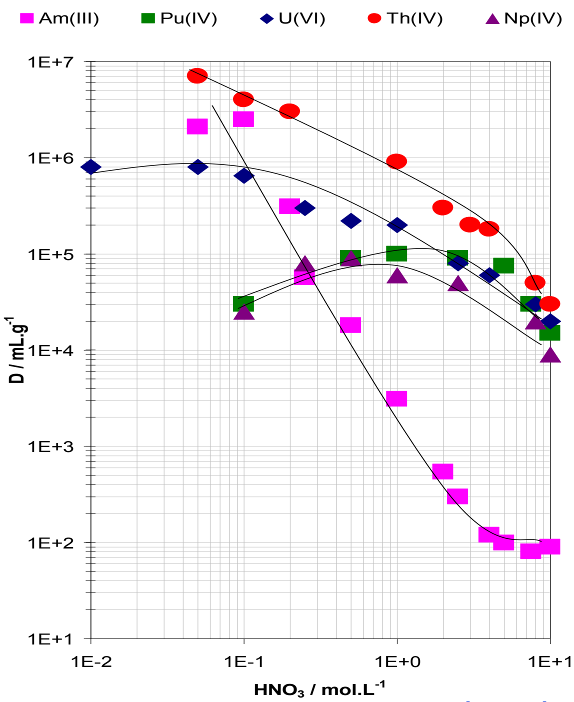
(Fig.2): Comparison uptake kinetics (1)



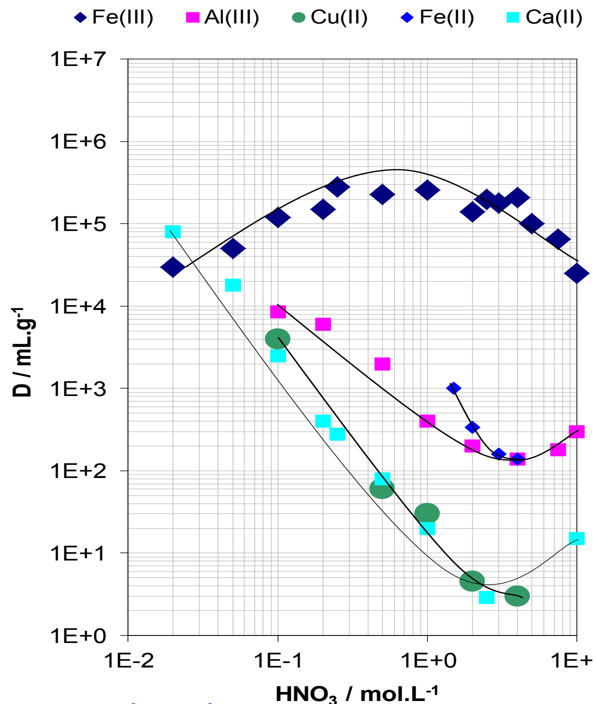
(Fig. 3): Uptake of selected cations on Diphonix in sulfuric acid (1)

DIPHONIX RESIN

eichrom NPO
expertise. collaboration. results.

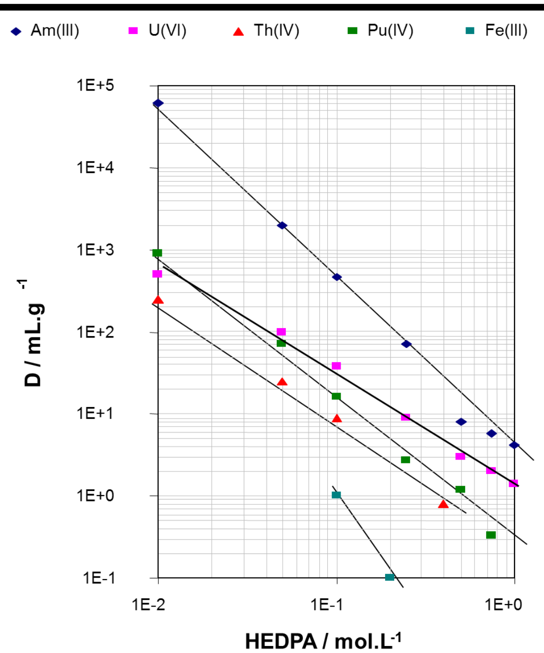


(Fig. 4)



(Fig. 5)

Actinides and polyvalent cations uptake with respect to the acid concentration (1).



(Fig. 6): D values for selected cations on Diphonix Resin, varying HEDPA concentrations (1)

Bibliography

(1) Chiarizia, R.; et al **Diphonix Resin: A Review of Its Properties and Applications**, Separation Science & Technology, Vol. 32, pp. 1-35 (1997).

(2) S.S. Xue, et al **Control of iron in copper electrolyte streams with a new monophos-phonic/sulfonic acid resin**, Min & Metallurgical Proc., 18 (3) 122-137 (2001).

(3) D.R. Shaw, D.B. Dreisinger, et al, **The Commercialization of the FENIX Iron Control System for Purifying Copper Electrowinning Electrolytes**, JOM, July 2004, 38-42.