PRODUCT SHEET

DGA Resin
(Normal and Branched)

Main Applications

- Separation of Americium
- Separation of Actinium

Packing

Order N°.	Form	Particle size
DN-B25-A, DN-B50-A, DN-B100-A, DN-B200-A	25g, 50g, 100g, 200g bottle DGA, normal (DN)	100-150 µm
DN-B10-S, DN-B25-S, DN-B50-S, DN-B100-S, DN-B200-S	10g, 25g, 50g, 100g, 200g bottle DGA, normal (DN)	50-100 µm
DN-R10-S	10 2ml cartridges DGA, normal (DN)	50-100 µm
DB-B10-S	10g bottle DGA, branched (DB)	50-100 µm
DB-R50-S	50 2ml cartridges DGA, branched (DB)	50-100 µm

Physical and chemical properties

Density : 0,38g/ml

Capacity : 12 mg Eu/ml resin DN (DGA, normal)
15 mg Eu/ml resin DB (DGA, branched)

Conversion factor D_W/k' : 1,75

Conditions of utilization

Recommended T of utilization : /

Flow rate: Utilization with vacuum or with pressure for s grade resin

Storage: Dry and dark, T<30°C

For additional information see enclosed literature study

Methods*

Reference	Description	Matrix	Analytes	Support
ACW16 VBS	Am_Np_Pu_Th_Cm_U in water (VBS)	water	Am, Np, Pu, Th, Cm, U	cartridges
ACW17-VBS	Am_Np_Pu_Th_Cm_U_Sr in water (VBS)	water	Am, Np, Pu, Th, Cm, U, Sr	cartridges
RAW04	Radium-226/228 in water (MnO2 & DGA Resin method)	water	Ra-226, Ra-228	cartridges

*developped by Eichrom Technologies Inc.

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DGA Resin

DGA resin, unlike the other resins used for the separation of actinides, shows a great affinity for americium, in both nitric and hydrochloric acid media. Besides its affinity for americium, DGA resin may also be used for the separation of radium/actinium and calcium/strontium/yttrium.

The results presented here were obtained with DGA resin with particle size of 50-100 µm.

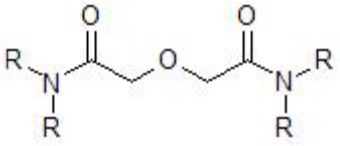

Figure 1: DGA resin extractant, R = 8

Assumed extraction equilibrium:

$$M^{3+} + 3X^- + 3\overline{DGA} \Leftrightarrow \overline{M(DGA)_3X_3}$$

$$M^{4+} + 4X^- + 2\overline{DGA} \Leftrightarrow \overline{M(DGA)_2X_4}$$

With

M = Ln, Ac and E = DGA (extractant) in stationary phase and X = Cl^- or NO_3^-

Two forms of DGA resin exist, the non-branched or **N**ormal (DGA resin, Normal or *N,N,N',N'*-tetra-n-octyldiglycolamide) and the **B**ranched (DGA resin, Branched or *N,N,N',N'*-tetrakis-2-ethylhexyl-diglycolamide). Both forms of DGA resin show more promising results in analytical applications for americium than our other resins. They both have very high affinity for americium under certain conditions and americium is readily eluted under other conditions (figure 2). Diphonix resin shows high affinity for Am(III), however, its elution is not as easy as with DGA resin. The TRU resin also show a good affinity for Am(III) with a retention factor of 100 for 0.5 to 5 M HNO_3. At those acidities, the retention factor k'Am(III) on DGA resin is 30 to 500 higher than on TRU.

The properties of the DGA Resins allow for the selective separation of Am(III) without fear of breakthrough due to weak retention. Am(III) is strongly fixed to either DGA Resin in 5 M HNO_3 or HCl and can be eluted with 0.01 M HNO_3 or 0.5 M HCl (figure 2).

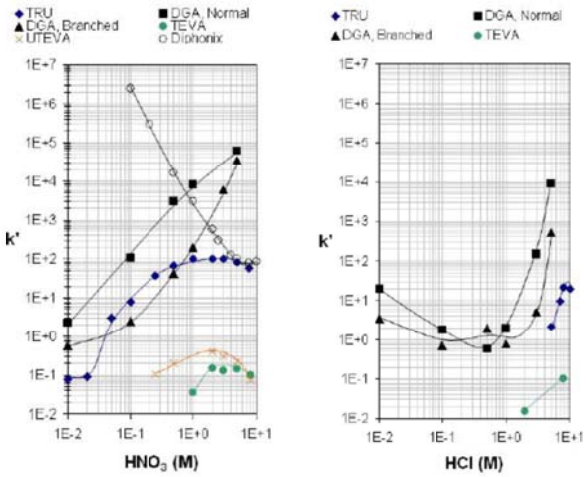

Figure 2: k' values of Am(III) on different resins in variable concentrations of HNO_3 and HCl.

The k' values of U, Pu and Th are presented in figures 3. The diagrams show that higher Pu/Am separation factors are obtained for the normal version of DGA Resin. Pu(IV) shows strong affinity for the resin with a retention factor k'> 3000 over the entire acid range studied. U and Th affinities towards the DGA Resins depend upon the acid, its concentration and the type of DGA Resin. Given these data, the combination of TEVA and DGA Resin, normal would allow one to first separate tetravalent elements on TEVA, leaving U and Am which would be retained on DGA resin. U would be first eluted with 0.1 M HNO_3 followed by Am(III) with 0.25 M HCl.

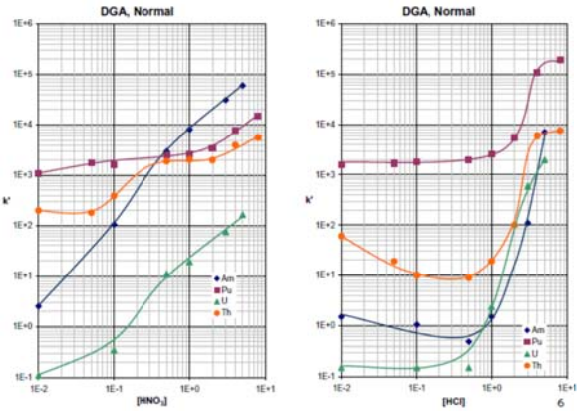

Figure 3a: k' values of Pu, Th, U and Am on DGA, normal in HNO_3 and HCl of varying concentration

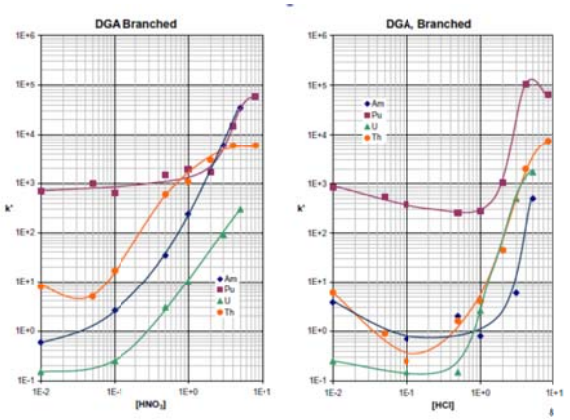

Figure 3b: k' values of Pu, Th, U and Am in HNO_3 and HCl of varying concentration on DGA, normal and DGA, branched resins

DGA resin can also be used for the separation of radium-actinium and yttrium-strontium.

Ra/Ac separation

For the determination of Ra-226 and Ra-228, Ba-133 is used as a tracer to evaluate Ra chemical yield. Ba-133 quantification is done by gamma spectrometry. Ra-226 is quantified by alpha spectrometry after micro-precipitation with $BaSO_4$. Ra-228 is determined through its daughter Ac-228 either by gamma spectrometry or by gas flow proportional counting after micro-precipitation with CeF_3.

Figure 4 shows k' values of Ra and Ce under varying acid concentrations.

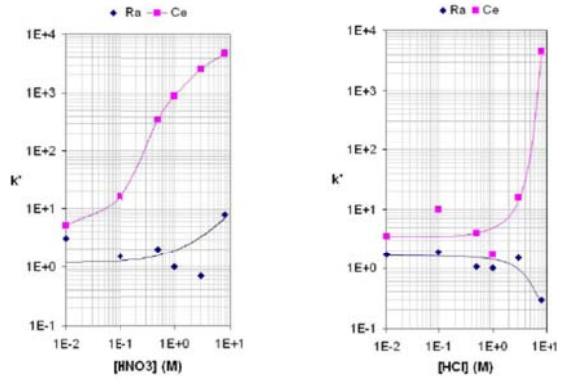

Figure 4 : Ra and Ce elution profiles with respect to acidic media and concentrations.

Ce is a chemical analogue of Ac and it can reasonably be assumed that Ac behaviour on this resin will be similar to Ce behaviour. In HNO_3 media, Ra shows no real affinity for the resin (1< k'Ra<7). However, Ce has k'>1000 for concentrations higher than 1M. So Ac should be easily retained on the resin for concentrations in HNO_3 of 1–3M while Ra elutes. In HCl media, the separation is efficient at 8M (selectivity α(Ce/Ra) > 10^5.) Cerium (and actinium) is easily stripped with low concentrations of HCl (e.g., <0.5M HCl).

Y/Sr Separation

Experiments were also performed to determine the behaviour of Y, Sr and Ca on DGA Resin. The results obtained are presented in Figure 5. Contrary to Sr resin, DGA resin shows very strong affinity for Y (k' > 10^5) in 3M HNO_3 and lower affinity for Sr, Ca and Ba. This allows first the elution of Sr, Ca and Ba then the selective stripping of Y. Coupling Sr Resin and DGA resins allows obtaining purified Sr and Y fractions e.g. for Sr-89 and Sr-90 (via Y-90) determination through Cerenkov counting.

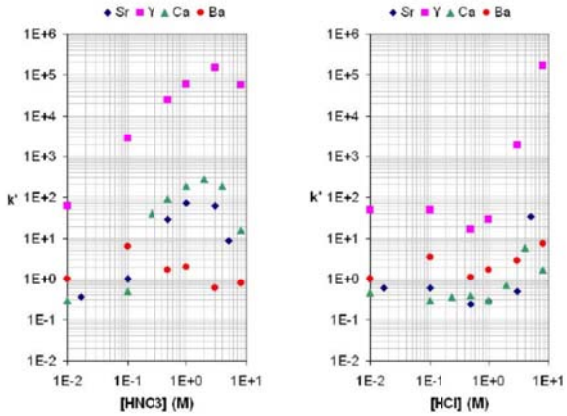

Figure 5: k' values of Sr, Y, Ca and Ba on DGA Resin, Normal in HNO_3 and HCl of varying concentration

Interfering Elements

The study of the interfering elements like Bi, Pb, Fe and Cu gave the results shown Figure 6. DGA Resin can potentially be used for Bi separation. The resin shows no affinity for iron and copper both at low HCl concentrations, and over a wide range of HNO_3 concentrations. In addition, it is also important to note that k' values for Al(III) and Ti(IV) are less than 2 for all HNO_3 or HCl concentrations. Horwitz et al. (3) could show that high concentrations of Fe(III), and other cations, can lead to a sharp increase of the Am k' values in hydrochloric media (Fig. 7), an effect that was used in order to rapidly preconcentrate Am (and Pu) from leached soil samples. The robustness of DGA against interferences from cations generally found in environmental samples makes its application e.g. in the analysis of Am in large soil samples very interesting (4, 5).

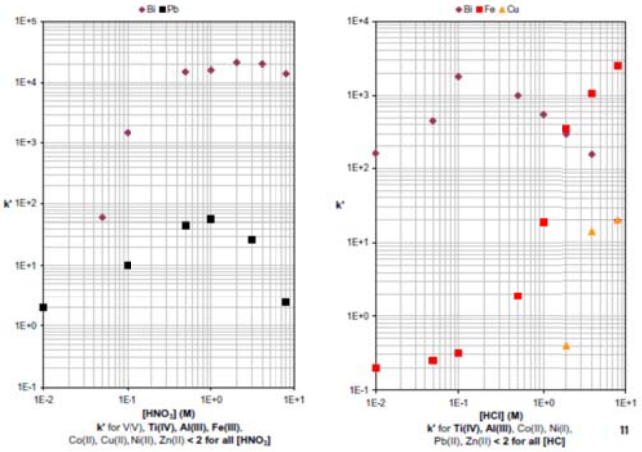

Figure 6 : k' values of Bi, Pb, Fe and Cu in HNO_3 and HCl of varying concentrations.

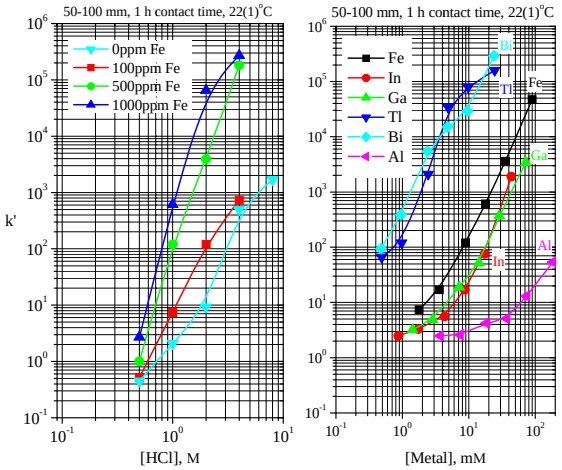

Figure 7 : k' values for Am in varying metal and HCl concentrations on normal DGA

Pourmand and Dauphas determined distribution coefficients kd of 60 elements on DGA, normal resin in batch experiments for various acids and acid concentrations (6), results are summarized in figures 8 – 10.

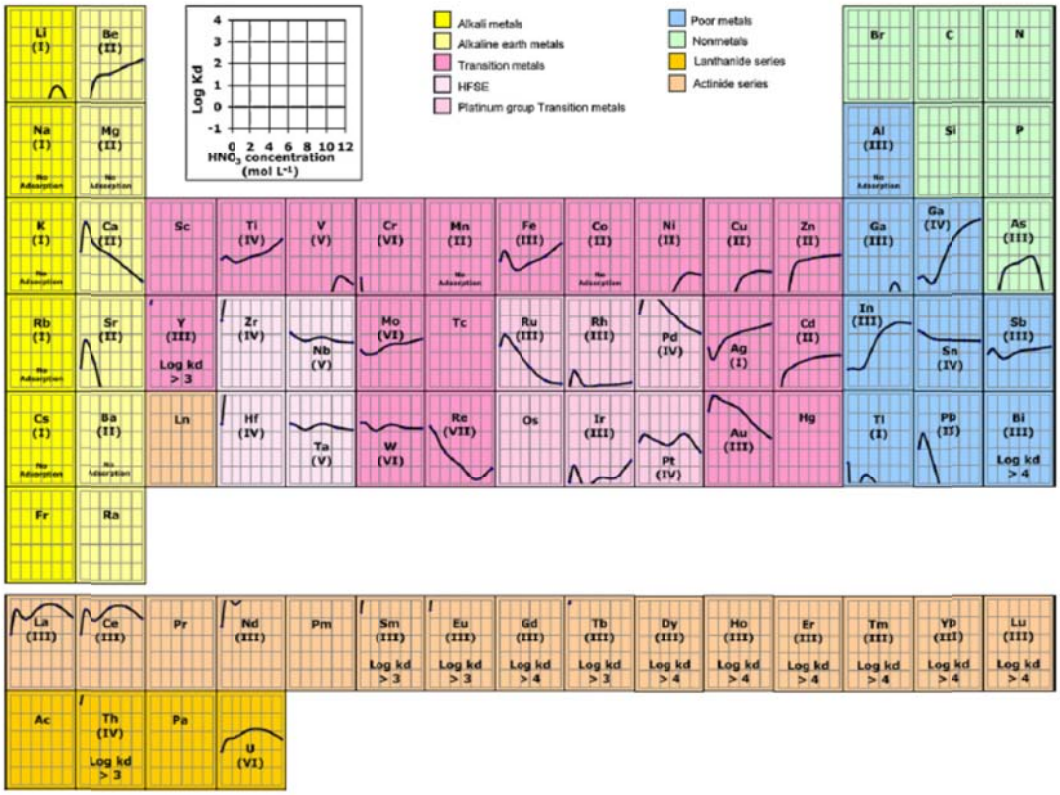

Fig.8: k_d values of 60 elements on normal DGA in HNO_3, y-axis: k_d in logarithmic scale, x-axis: HNO_3 concentration in mol.L^{-1} (measurements at 0.1, 1, 3, 6, 9 und 12 mol.L^{-1}) (6)

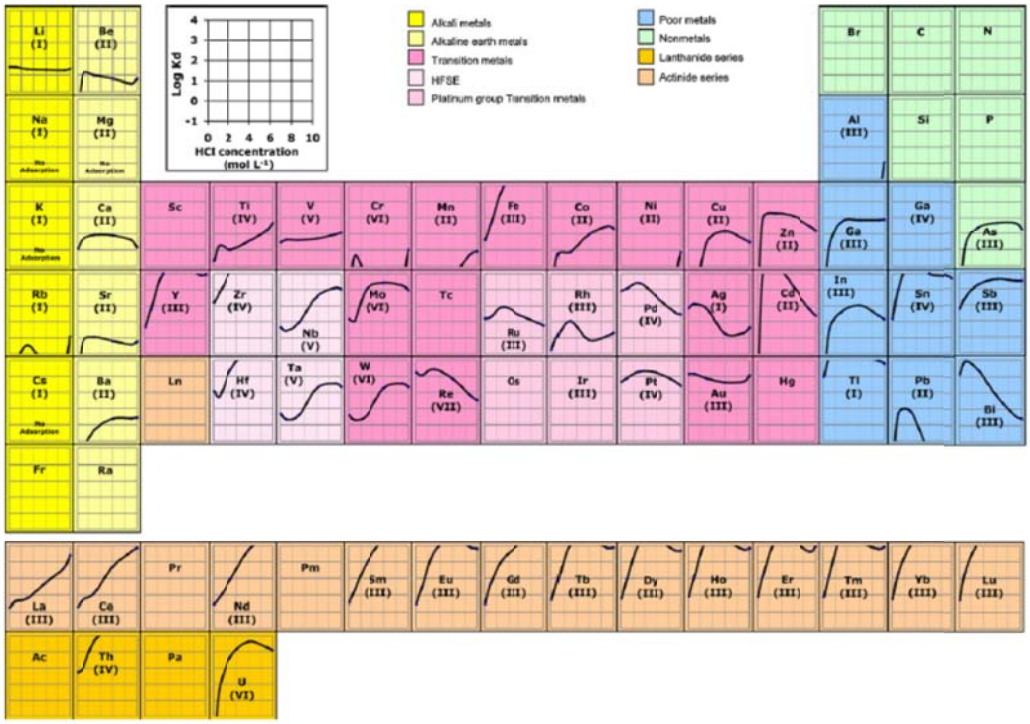

Fig.9: k_d values of 60 elements on normal DGA in HCl, y-axis: k_d in logarithmic scale, x-axis: HCl concentration in mol.L^{-1} (measurements at 0.1, 1, 3, 6, 9 und 10 mol.L^{-1}) (6)

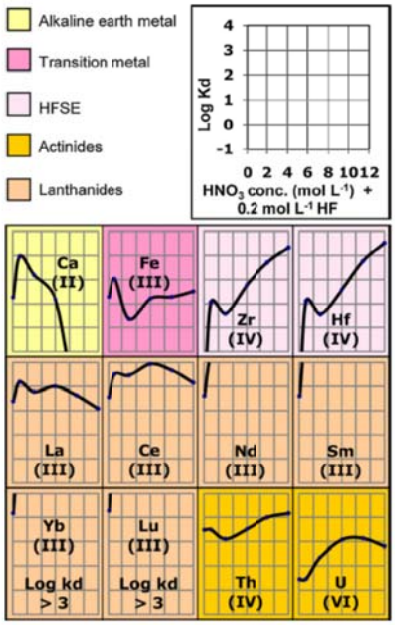

Fig.10: k_d values of 12 elements on normal DGA, 0.2M HF / xM HNO_3 (x = 0.1, 1, 3, 6, 9, 12), y-axis: k_d in logarithmic scale, x-axis: HNO_3 concentration in mol.L^{-1} (6)

The authors further performed an elution study using a multi-element solution containing 33 elements on a 2 mL DGA, normal cartridge using a vacuum box system. The sample was loaded from 3M HNO_3 / 0.2M boric acid, results and separation conditions are summarized in fig. 11.

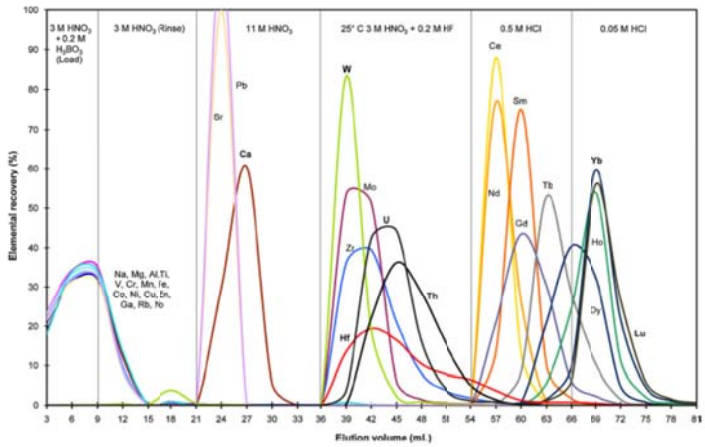

Fig.11: Elution study, 33 elements, 2 mL DGA, normal cartridge (6)

Bibliography

(1) *Horwitz E.P., McAlister D.R., Bond A.H., Barans R.E., Solvent Extrac. Ion Exch.,**23**, 219 (2005).*

(2) *Horwitz E.P., Bond A.H., Barans R.E., McAlisterD.R., 27th Actinide separations Conferences, (2003)*

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(5) Maxwell III, S. L.; Journ. Radioanal. Nucl. Chem., **275 (2)**, 395 (2008)

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