



## PRODUCT SHEET

### DGA Resin (Normal and Branched)

#### Main Applications

- Separation of Americium
- Separation of Actinium

#### Packing

Order N°.	Form	Particle size
DB-B01-S	Bottle (Min. 10 g) DGA, branched (DB)	50-100 µm
DN-B01-S	Bottle (Min. 10 g) DGA, normal (DN)	50-100 µm
DN-B25-S, DN-B50-S	25g bottle DN, 50g bottle DN	50-100 µm
DB-R50-S	50 2ml cartridges DB	50-100 µm
DN-R50-S, DN-R200-S	50 2ml cartridges DN, 200 2ml cartridges DN	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 (MnO <sub>2</sub> & DGA Resin method)	water	Ra-226, Ra-228	cartridges

\*developed by Eichrom Technologies Inc.

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## LITERATURE STUDY

### 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.

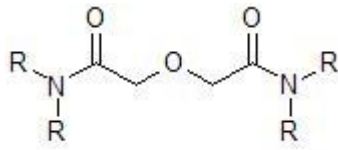


Figure 1 : DGA resin extractant, R = 8

Assumed extraction equilibrium:



With

M = Ln, Ac and E = DGA (extractant) in stationary phase and X = Cl<sup>-</sup> or NO<sub>3</sub><sup>-</sup>

Two forms of DGA resin exist, the non-branched or **Normal** (DGA resin, Normal or *N,N,N',N'*-tetra-n-octyldiglycolamide) and the **Branched** (DGA resin, Branched or *N,N,N',N'*-tetrakis-2-ethylhexyldiglycolamide). 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<sub>3</sub>. 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) with fear of breakthrough due to weak retention. Am(III) is strongly fixed to either DGA Resin in 5 M HNO<sub>3</sub> or HCl and can be eluted with 0.01 M HNO<sub>3</sub> or 0.5 M HCl (figure 2).

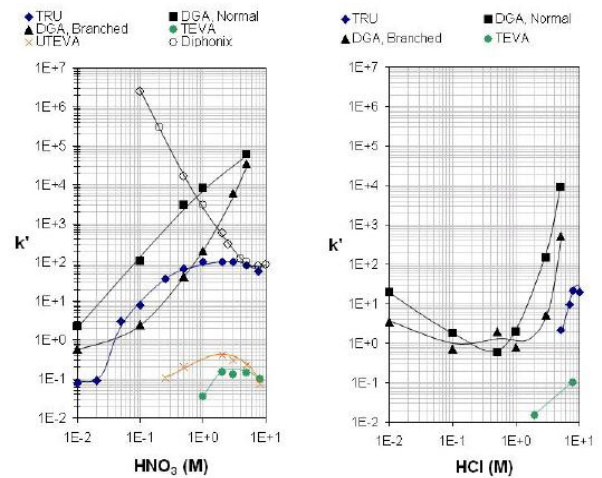


Figure 2: Am(III) retention profiles with different resins with variable concentrations of HNO<sub>3</sub> and HCl.

Retention profiles for 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 0.5 M HNO<sub>3</sub> followed by Am(III) with 0.5 M HCl.

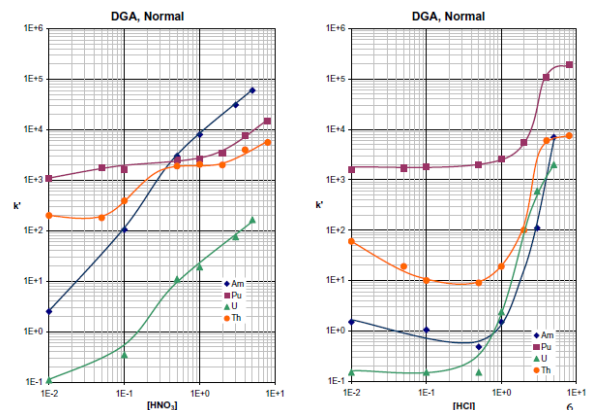
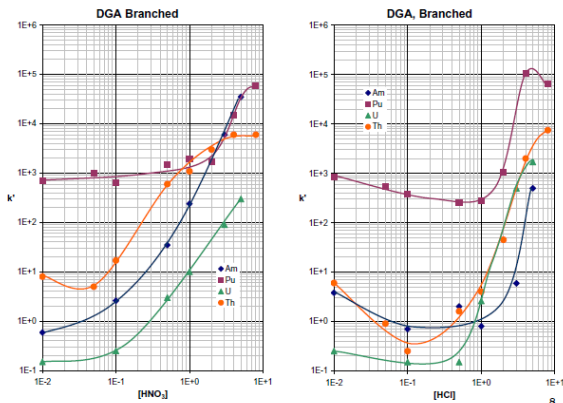


Figure 3a : Pu, Th, U et Am retention profiles with respect to HNO<sub>3</sub> and HCl concentrations on DGA, normal

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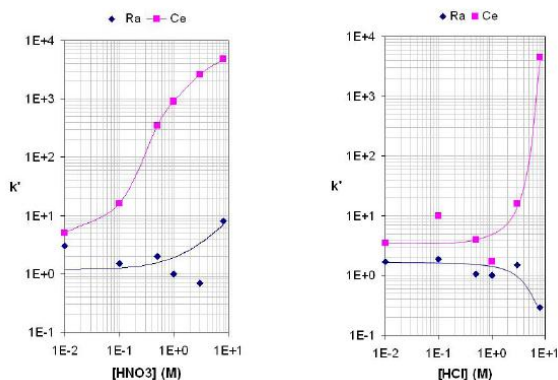
**Figure 3b :** Pu, Th, U et Am retention profiles with respect to HNO<sub>3</sub> and HCl concentrations on DGA, normal and DGA, branched resins

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<sub>4</sub>. Ra-228 is determined *via* its daughter Ac-228 either by gamma spectrometry or by gas flow proportional counting after micro-precipitation with CeF<sub>3</sub>.

Figure 4 shows k' values of Ra and Ce with respect to varying acid concentrations.



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

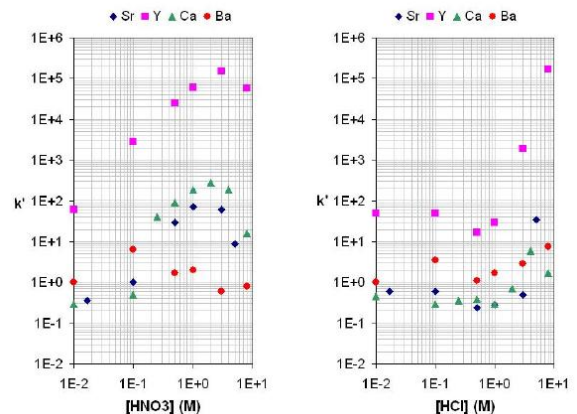
Ce is a chemical analogue of Ac and it can reasonably be assumed that Ac behaviour on this resin will be similar to Ce behaviour. In HNO<sub>3</sub> media, Ra shows no real affinity for the resin ( $1 < k'_{Ra} < 7$ ). However, Ce has  $k' > 1000$  for concentrations higher than 1M. So Ac should be

easily retained on the resin for concentrations in HNO<sub>3</sub> of 1–3M while Ra elutes. In HCl media, the separation is efficient at 8M (selectivity  $\alpha(\text{Ce}/\text{Ra}) > 10^5$ ). Cerium (and actinium) is easily stripped with low concentrations of HCl (e.g.,  $< 0.5\text{M}$  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 ( $k' > 10^5$  at 3M HNO<sub>3</sub>) and lower affinity for Sr, Ca and Ba. This allows first the elution of Sr, Ca and Ba then the selective stripping of Y.

Sr and Ca present similar elution profiles. Coupling Sr Resin and DGA resins allows the purification of Y-90 to a great extent.



**Figure 5 :** Sr, Y, Ca and Ba elution profiles on DGA Resin, Normal with respect to acidic media and concentration

### Interfering Elements

The study of the interfering elements like Bi, Pb, Fe and Cu gave the results shown Figure 6. DGA Resin can 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<sub>3</sub> concentrations. In addition, it is also important to note that k' value for Al(III) and Ti(IV) is less than 2 for all concentrations of either HNO<sub>3</sub> or HCl. 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

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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).

## 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., McAlister D.R., *27<sup>th</sup> Actinide separations Conferences*, (2003)
- (3) Horwitz, E.P.; et al, *Solv. Extr. Ion Exch.*, **26(1)**, in press (2008)
- (4) Maxwell III, S. L.; Culligan, B. K., *Journ. Radioanal. Nucl. Chem.*, **270 (3)**, 699 (2006)
- (5) Maxwell III, S. L.; *Journ. Radioanal. Nucl. Chem.*, **275 (2)**, 395 (2008)

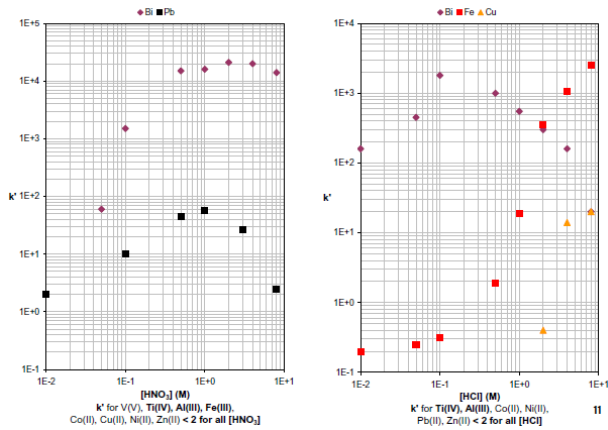


Figure 6 : Bi, Pb, Fe and Cu elution curves with respect to acidic media and concentrations.

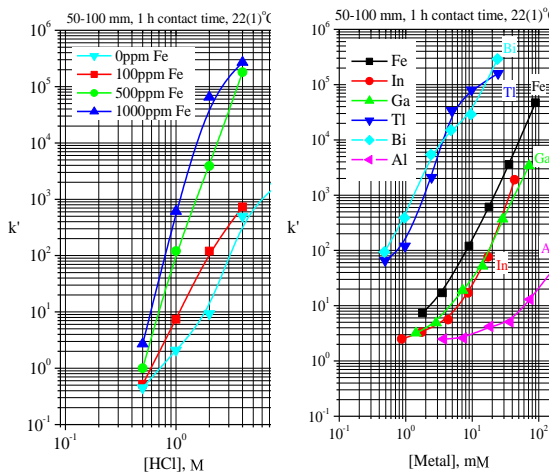


Figure 7 :  $k'$  values for varying metal and HCl concentrations on normal DGA