PRODUCT SHEET

TK400 Resin

Main Applications

- Separation of protactinium
- Separation of iron
- Separation of gallium
- Separation of niobium

Packing

Order N°.	Form	Particle size
TK400-B25-A, TK400-B50-A, TK400-B-100-A, TK400-B200-A	25g, 50g, 100g and 200g bottles TK400 Resin	100-150 µm
TK400-C20-A	20 and 50 2 mL TK400 Resin columns	100-150 µm
TK400-B10-S, TK400-B25-S, TK400-B50-S, TK400-B100-S, TK400-B200-S	25g, 50g, 100g and 200g bottles TK400 Resin	50-100 µm
TK400-R10-S	10 2mL TK400 Resin cartridges	50-100 µm

Physical and chemical properties

Density: 0.38 g/mL TK400 Resin
Capacity: 10mg Fe/ml minimum[1]

Conditions of utilization

Recommended T of utilization : 20-25°C
Flow rate: A grade: 0.6 – 0.8 mL/min, utilization with vacuum or with pressure for s grade resin
Storage: Dry and dark, T<30°C

For additional information see enclosed literature study

[1] Capacity determined with a load solution of 10ml of 10mg Fe^{3+}/ml in HCl 9M on a 2ml TK400 column.

TRISKEM INTERNATIONAL
ZAC de l'Eperon – 3, rue des Champs Géons – 35170 Bruz – FRANCE
Tel +33 (0)2.99.05.00.09 – Fax +33 (0)2.23.45.93.19 – www.triskem.com – email : contact@triskem.fr

TK400 RESIN

The TK400 Resin is an extraction chromatographic resin that is comprised of octanol impregnated onto an inert support. Knight et al.[1] showed that long-chained alcohols, especially octanol, show very interesting selectivity towards Pa at high HCl concentrations, allowing for facile Pa/Np separation using column chromatography. Jerome et al.[2] and Ivanov et al.[3] characterized the TK400 Resin with respect to its selectivity for a number of elements including Pa, Np, U and Th (Fig. 1).

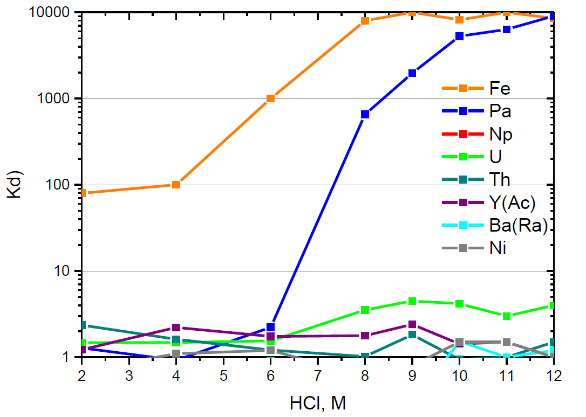

Figure 1 : Dw values of selected elements on TK400 Resin in HCl at varying concentration, data provided by Ivanov et al.[3]

They found that Pa retention sharply increases at high (≥ 7M) HCl concentrations whereas most other elements tested are not retained, an exception being Fe.

At HCl concentrations ≤ 6M HCl on the other hand D_W values of Pa were found to be low allowing for its elution in a small volume. Ostapenko et al.[4] found a similar trend for Pa retention with k' values being high for Pa at high HCl concentrations (9M). These results correspond overall well to the selectivity observed by Knight et al. when performing Np/Pa separation (Fig. 2).

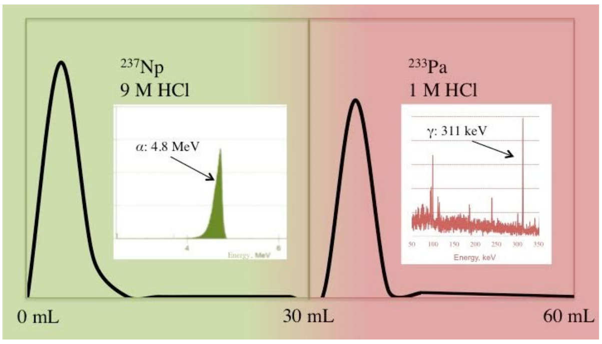

Figure 2: Elution study, Np/Pa separation on octanol resin (taken from Knight et al.[1])

The use of TK400 for Pa purification has been reported in a range of different fields[2-6], including applications such as nuclear medicine, geochemistry and nuclear forensics.

Figure 3 shows D_W values of an additional set of elements in HCl on the TK400 Resin determined by Dirks et al.[7].

The resin shows high selectivity for Nb at high HCl concentrations over other elements tested such as Ta, Zr, Hf and lanthanides which are not, or only very poorly as in the case of Ta, retained by the resin.

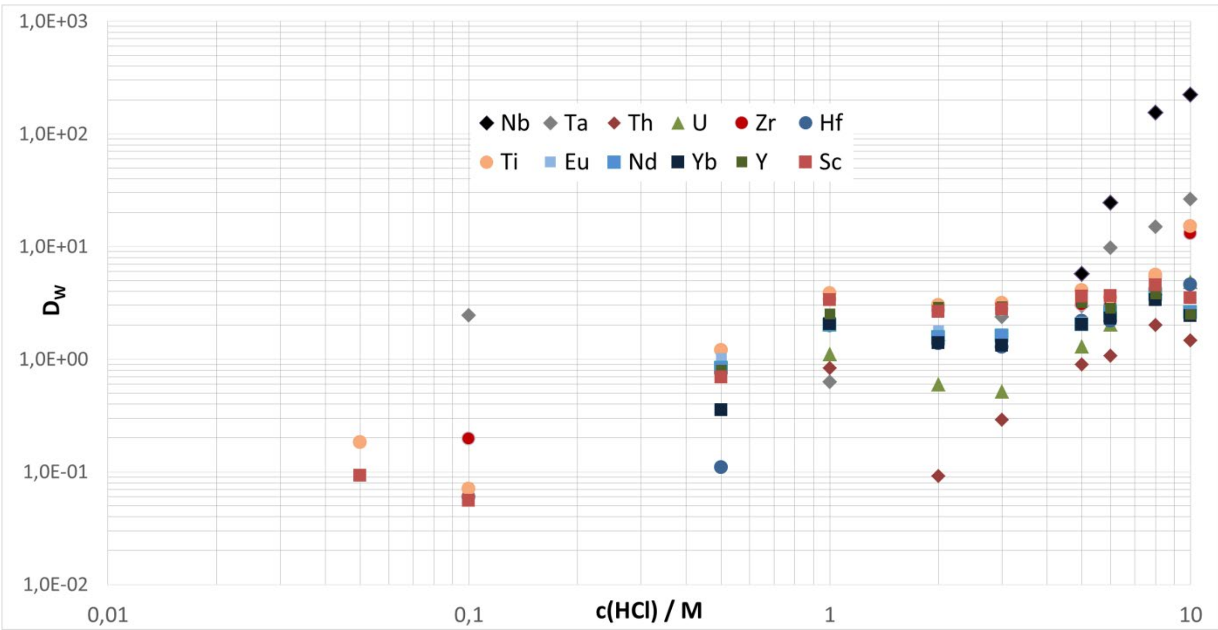

Figure 3: Dw values of selected elements on TK400 Resin in HCl at varying concentration taken from Dirks et al.[7]

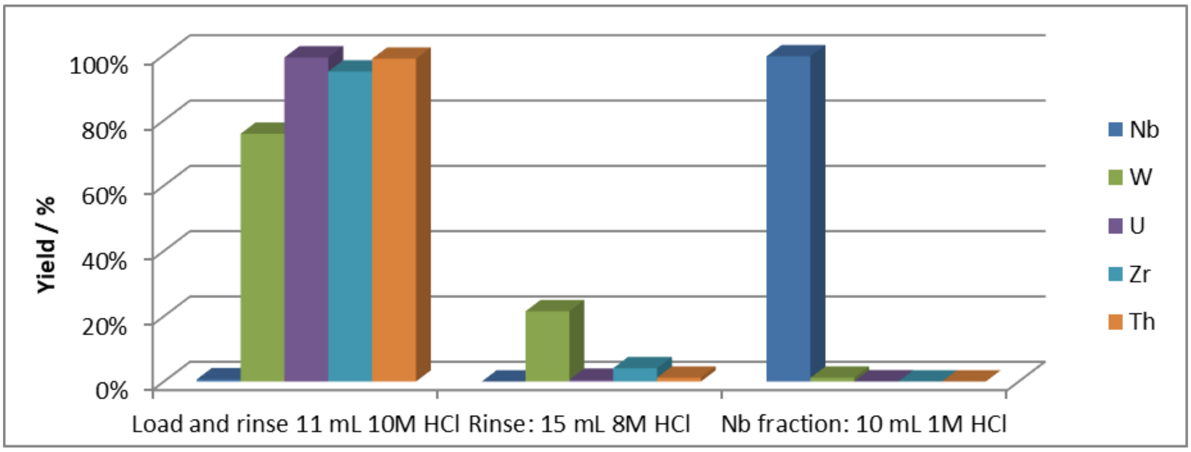

Figure 2: Elution study, Nb separation from selected cations, 2 mL TK400 column

With respect to its selectivity the TK400 Resin shows the potential to allow several interesting separations such as Nb/Zr and Pa/U/Th.
The results of an elution study on the separation of Nb from a number of elements, including Zr, and the separation method used to obtain these results are shown in Fig. 4 and Fig. 5, respectively.
Jerome et al.[2] employed the TK400 Resin for the separation of Pa from its descendants following the procedure shown in Fig. 6.
They found that U, Th, Ac, Ra and Pb were removed from the resin during load and rinse, allowing for obtaining a clean Pa fraction with high chemical yield (~83%).

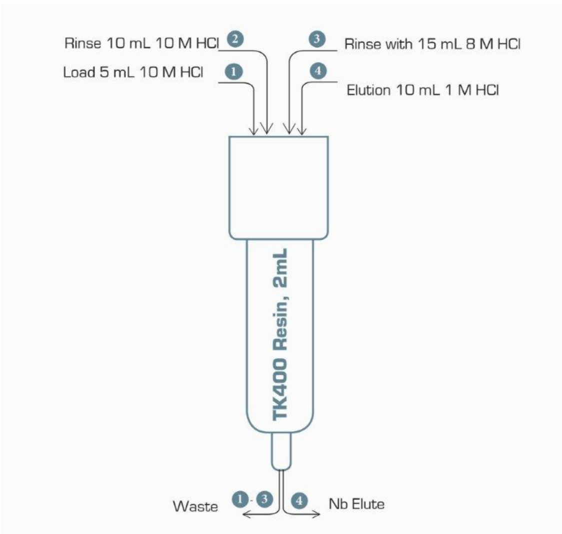

Figure 3: Nb separation on TK400 Resin

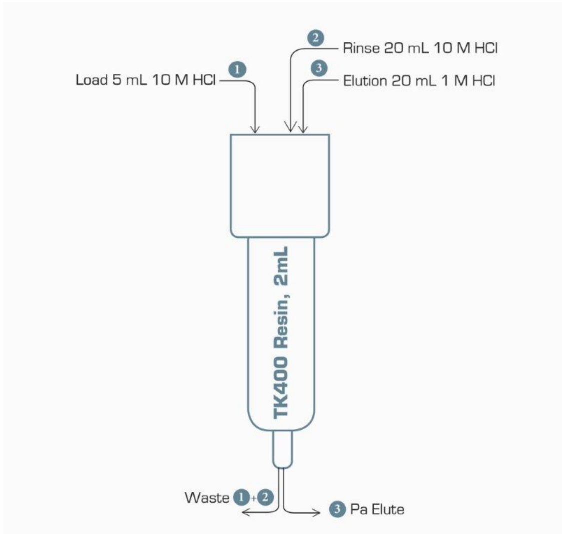

Figure 4: Pa separation from its descendants following Jerome et al.[2]

Another interesting application of the TK400 Resin was described by Tieu et al.[8]. They used the TK400 Resin for a single cartridge separation of Ga-68 from irradiated solid Zn targets, rather than the more frequently encountered ZR Resin/TK200 Resin combination. The authors achieved chemical yields of 82%. Ga was recovered in 3.5 mL 0.2M HCl of sufficient purity to allow for labeling [68Ga]Ga-DOTA-TATE with >70% RCY[b].

The fact that the TK400 Resin shows higher Fe capacity than e.g. TRU Resin makes its use in the analysis of i.e. decommissioning samples interesting. A method combining the use of the TK400 Resin (separation of Fe, Nb and Mo from most matrix elements) and ZR Resin (subsequent separation of Fe from Nb and Mo) is currently being optimized. Figures 7 and 8 show typically obtained elution profiles.

[b] RCY : RadioChemical Yield

PRODUCT SHEET

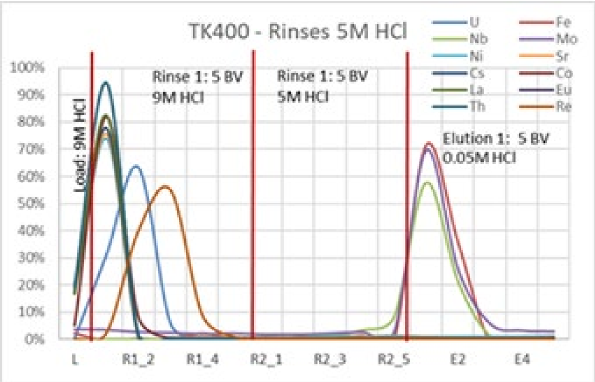

Figure 5: Fe/Nb/Mo separation from selected elements, TK400 Resin

As may be seen, while Fe, Nb and Mo are well retained a large number of other elements, such as e.g. Zr, U, Th, Cs, Co,… are removed during load and rinse.
These three elements may then be eluted in dilute HCl and directly loaded onto ZR Resin for further separation (Fig. 8).

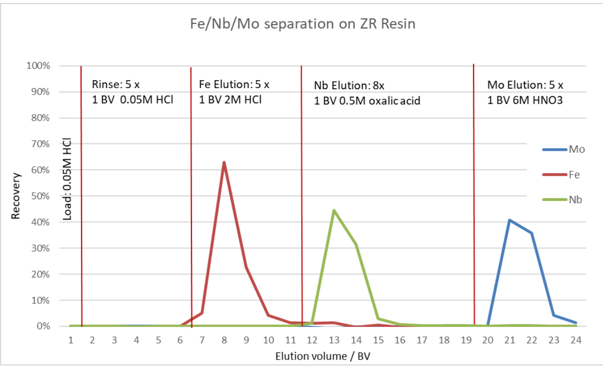

Figure 6: Fe, Nb and Mo separation on ZR Resin

The fact that the TK400 Resin shows high selectivity for Fe and Nb but not for Zr may also allow its use in the separation of Zr-89 from solid Y targets, with the aim to further lowering the amount of these impurities in the final product.

First tests showed that loading a simulated dissolved target solution containing Zr, Y, Nb and Fe through a TK400 Resin cartridge at 9M (or 10M) HCl, followed by a rinse under the same conditions will allow retaining Nb and Fe on the TK400 while Zr (and Y) will pass through. Combining the load and rinsing fractions containing Zr, adjusting them to 11M HCl and loading this solution through a TBP Resin cartridge (similar to the method described by Graves et al.[9]) will then allow a clean Zr separation with high chemical yield. It should be noted that alternatively 10M HCl may be used as loading condition on both cartridges. This could simplify the separation, as the intermediate HCl concentration adjustment is not necessary. It might further allow for the use of stacked cartridges in the initial loading step, this modification will require further testing though.
Zr is finally eluted from the TBP cartridge using dilute HCl.
If desired, Nb and Fe may be recovered from the TK400 cartridge using dilute HCl.
Fig. 9 and 10 show typically obtained elution studies under the described conditions.

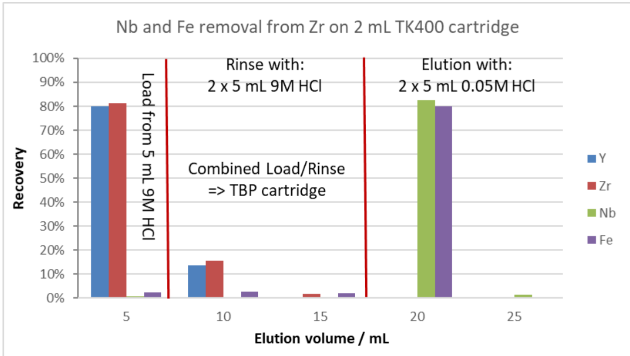

Figure 7: Nb and Fe removal from Zr (and Y) on a 2 mL TK400 Resin cartridge

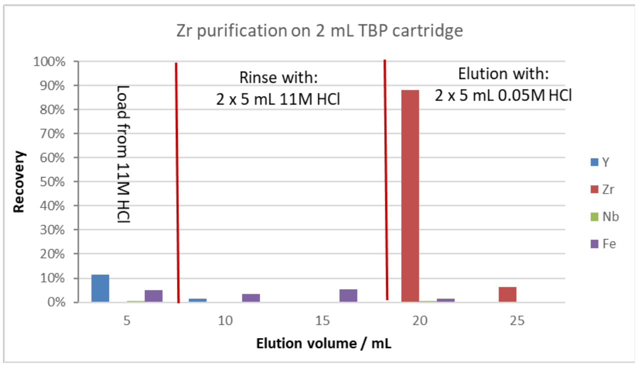

Figure 8: Zr purification on a 2 mL TBP Resin cartridge

Bibliography

(1) A.K. Knight et al.: "A chromatographic separation of neptunium and protactinium using 1-octanol impregnated onto a solid phase support", J Radioanal Nucl Chem (2016) 307:59–67

(2) Jerome SM, Collins SM, Happel S, Ivanov P, Russell BC. Isolation and purification of protactinium-231. Appl Radiat Isot. 2018 Apr;134:18-22.doi: 10.1016/j.apradiso.2017.07.051. Epub 2017 Jul 27. PMID: 28823475.

(3) P Ivanov: “Studies on the use of TK400 resin for the separation of 231Pa from actinide elements and decay products”, European Users Group Meeting in Cambridge (UK) - 21/09/2018

(4) V. Ostapenko et al.: “Sorption of protactinium(V) on extraction chromatographic resins from nitric and hydrochloric solutions”, J Radioanal Nucl Chem, (2016), DOI 10.1007/s10967-016-4996-x

(5) Süfke F, Lippold J, Happel S. Improved Separation of Pa from Th and U in Marine Sediments with TK400 Resin. Anal Chem. 2018 Jan 16;90(2):1395-1401. doi: 10.1021/acs.analchem.7b04723. Epub 2018 Jan 4. PMID: 29256247.

(6) C Gilligan, J Dunne: “Preparation of a 233Pa standard for uranium age dating measurements by MC-ICP-MS.”, European Users Group Meeting in Cambridge (UK) - 21/09/2018

(7) C. Dirks et al.: “New developments – TrisKem”, presented at the RANC 2016 conference, 10-16.04.16 - Budapest, Hungary

(8) Tieu W, Hollis CA, Kuan KKW, Takhar P, Stuckings M, Spooner N, Malinconico M. Rapid and automated production of [68Ga]gallium chloride and [68Ga]Ga-DOTA-TATE on a medical cyclotron. Nucl Med Biol. 2019 Jul-Aug;74-75:12-18. doi: 10.1016/j.nucmedbio.2019.07.005. Epub 2019 Jul 12. PMID: 31421441.

(9) S A. Graves et al., Evaluation of a chloride-based 89Zr isolation strategy using a tributyl phosphate (TBP)-functionalized extraction resin, Nuclear Medicine and Biology, Volumes 64–65, 2018, Pages 1-7, https://doi.org/10.1016/j.nucmedbio.2018.06.003