



# TK227 Resin: Uses for preconcentration and measurement of Sr-90 via Y-90

Aude Bombard ([abombard@triskem.fr](mailto:abombard@triskem.fr))

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Co-ordinating Group for Environmental Radioactivity





# Summary

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- Context of TK227 Resin development
- Characterisation of TK227 Resin
- Applications
- Extension to new supports
- Conclusions



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# Context of TK227 Resin development

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Measurement of Sr-90 via Y-90 in seawater samples by DGA,N Resin [1][2]

- Y-90 at equilibrium with Sr-90
- No need to wait 14 days for the (re-)measure @equilibrium after Y-90 ingrowth
  - Rapid methods developed to assay  $^{90}\text{Sr}$  at very low levels e.g. Method by Maxwell et al.[1] – 1-40L
  - Method by Kim et al.[2] - 1-50L/60kg

[1] Maxwell, S.L., Culligan, B.K., Hutchison, J.B. et al. Rapid determination of  $^{90}\text{Sr}$  in seawater samples. *J Radioanal Nucl Chem* **303**, 709–717 (2015).  
<https://doi.org/10.1007/s10967-014-3391-8>

[2] Hyuncheol Kim and Gahyun Kim: “A simple and straightforward technique for analyzing radionuclides in sea water” presented at the Raddec/Triskem Workshop (as part of the 2024 LSC conference) on April 18 in Portsmouth (UK). Available online: [https://www.triskem-international.com/scripts/files/662fa5023ef284.68970177/raddec\\_tki-ws-2024\\_6\\_kim.pdf](https://www.triskem-international.com/scripts/files/662fa5023ef284.68970177/raddec_tki-ws-2024_6_kim.pdf)



# Context of TK227 Resin development

## <sup>90</sup>Sr in seawater; procedure

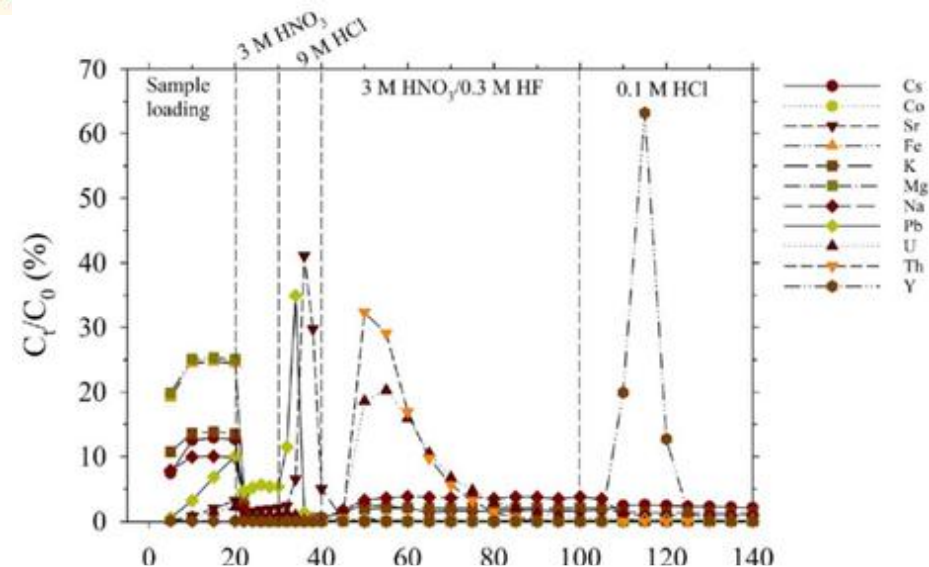
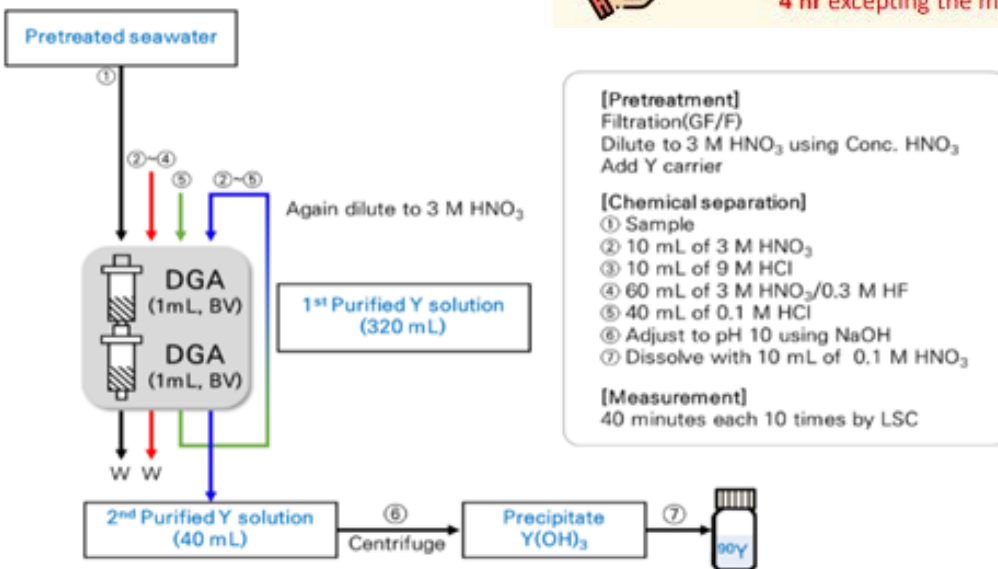


- Kim et al. [2][3][4]
- Gahyun et al. [5]



Elapsed time for analyzing the 60 kg of seawater?

4 hr excepting the measurement time



[2] Hyuncheol Kim and Gahyun Kim: "A simple and straightforward technique for analyzing radionuclides in sea water" presented at the Raddec/Triskem Workshop (as part of the 2024 LSC conference) on April 18 in Portsmouth (UK). Available online: [https://www.triskem-international.com/scripts/files/662fa5023ef284.68970177/raddec\\_tki-ws-2024\\_6\\_kim.pdf](https://www.triskem-international.com/scripts/files/662fa5023ef284.68970177/raddec_tki-ws-2024_6_kim.pdf)

[3] Video KAERI Method: "Simple and Straightforward technique for Sr-90 analysis in seawater". Available online: <https://www.youtube.com/watch?v=i2R2b98oTCU>

[4] Hyuncheol Kim, Yoo Gyum Kang, Yong-Jin Lee et al.: "Automated extraction chromatographic radionuclide separation system for analysis of <sup>90</sup>Sr in sea water", Talanta 217 (2020) 121055.

<https://doi.org/10.1016/j.talanta.2020.121055>

[5] Gahyun Kim, Sang-Do Choi, Jong-Myoung Lim, Hyuncheol Kim, Strontium-90 levels in seawater southeast of Jeju Island during 2021–2023, Marine Pollution Bulletin, Volume 193, 2023, 115258.

<https://doi.org/10.1016/j.marpolbul.2023.115258>



# Context of TK227 Resin development

**BUT acidification of 50L seawater @ 3M HNO<sub>3</sub> requires 9,5-10L of cc HNO<sub>3</sub>**

- Modification of DGA,N Resin to get Y-90 @ lower HNO<sub>3</sub> concentrations

Initial 3M HNO <sub>3</sub> – 50L	9,5L of cc HNO <sub>3</sub>
1M HNO <sub>3</sub>	3,2L
0,5M HNO <sub>3</sub>	1,6L
0,1M HNO <sub>3</sub>	320mL

- Ideally, 0,1M HNO<sub>3</sub> would be the best result.



# Context of TK227 Resin development

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How to increase retention of Y (trivalent elements)  
@lower  $\text{HNO}_3$  concentrations

➤ **use of ionic liquid**

✓ **All work presented about TK227 Resin was performed by I. Dovhyi**



# Summary

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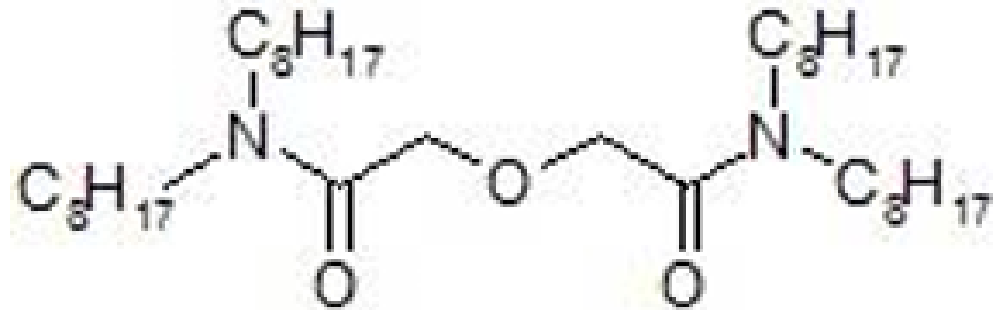
- *Context of TK227 Resin development*
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# Characterisation of TK227 Resin

TK227 resin is comprised of

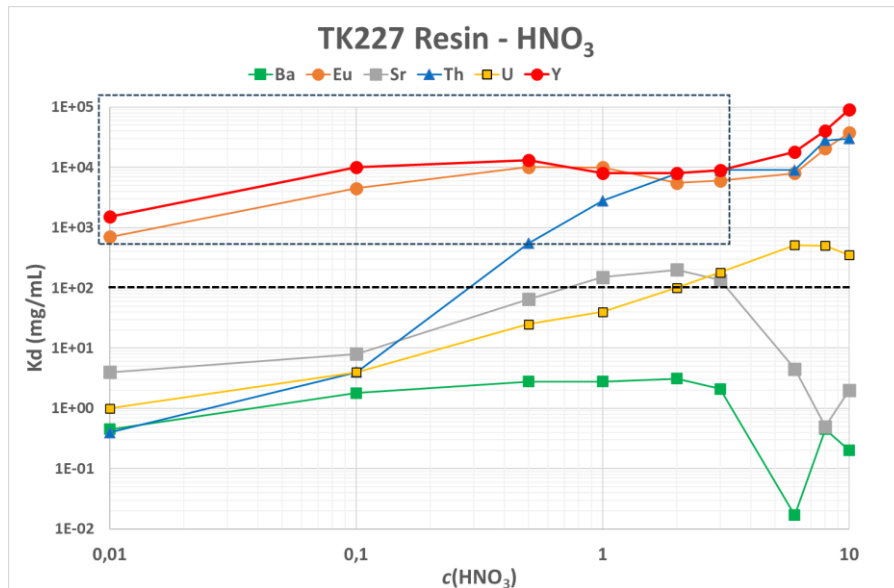
- Inert support
- TO-DGA extractant
- Ionic liquid
- Long chain alcohol





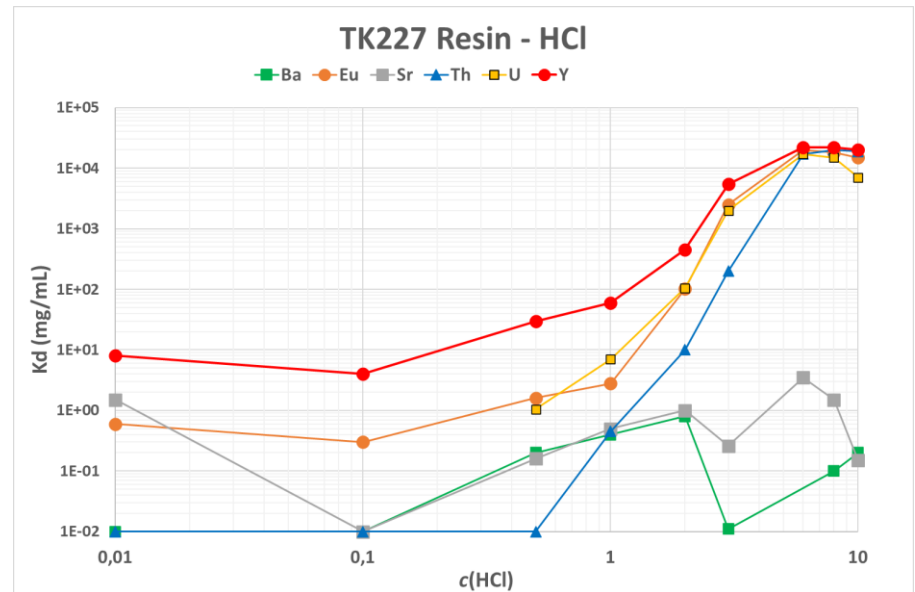
# Characterisation of TK227 Resin

K<sub>d</sub> values of elements of interest in HNO<sub>3</sub> medium on TK227 Resin



- Strong uptake of Y on the HNO<sub>3</sub> concentrations tested (same for Eu)
- Uptake of Sr between 1 and 3M HNO<sub>3</sub>
- Strong Th uptake above 0,5M HNO<sub>3</sub>
- Uptake of U above 2M HNO<sub>3</sub>

K<sub>d</sub> values of elements of interest in HCl medium on TK227 Resin

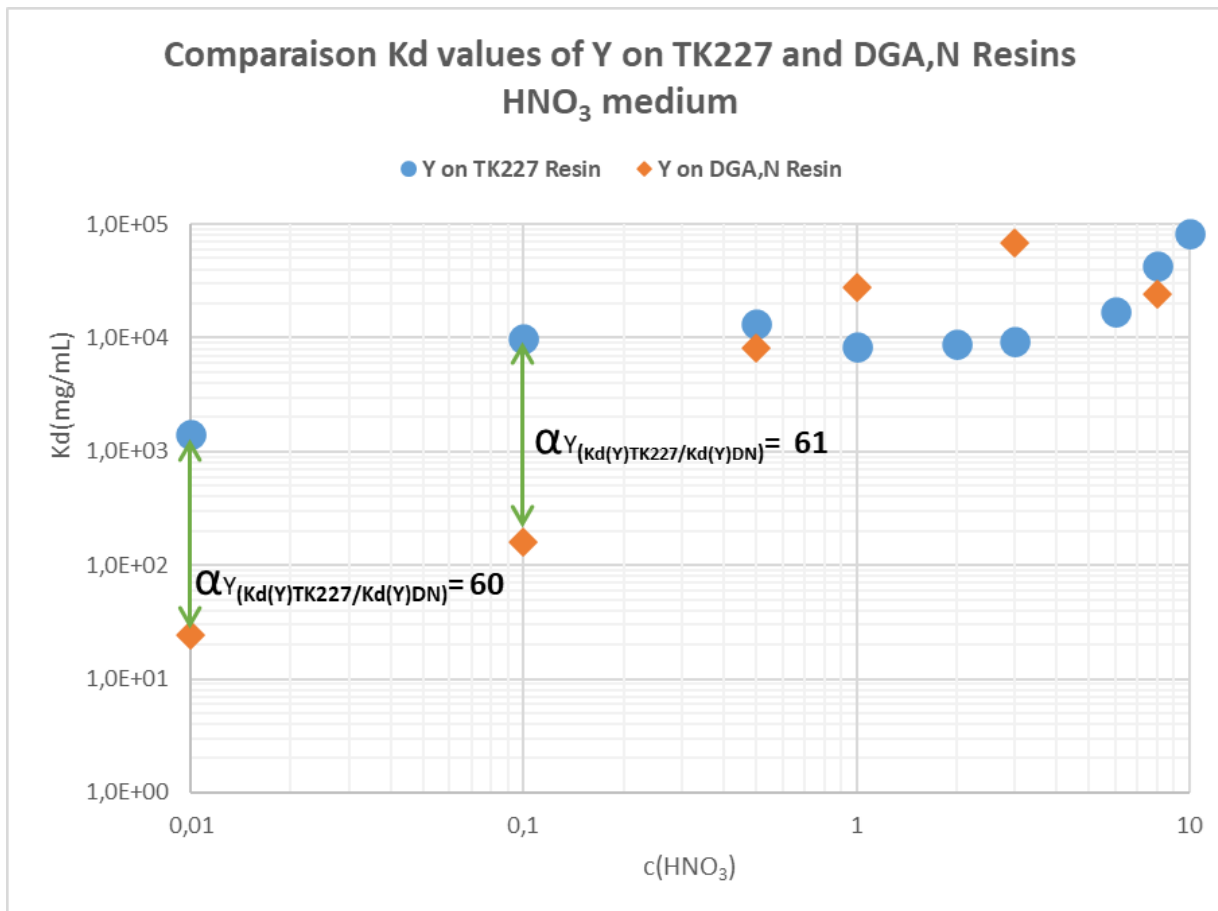


In HCl,

- No retention below 0,5M HCl
- Retention increase for Y, Eu, Th and U at high HCl concentration



# Characterisation of TK227 Resin



- ✓ Developed TK227 allows for higher retention of Y at low HNO<sub>3</sub> concentrations
- ✓ Y-carrier needed (minimum of 1mg).



# Summary

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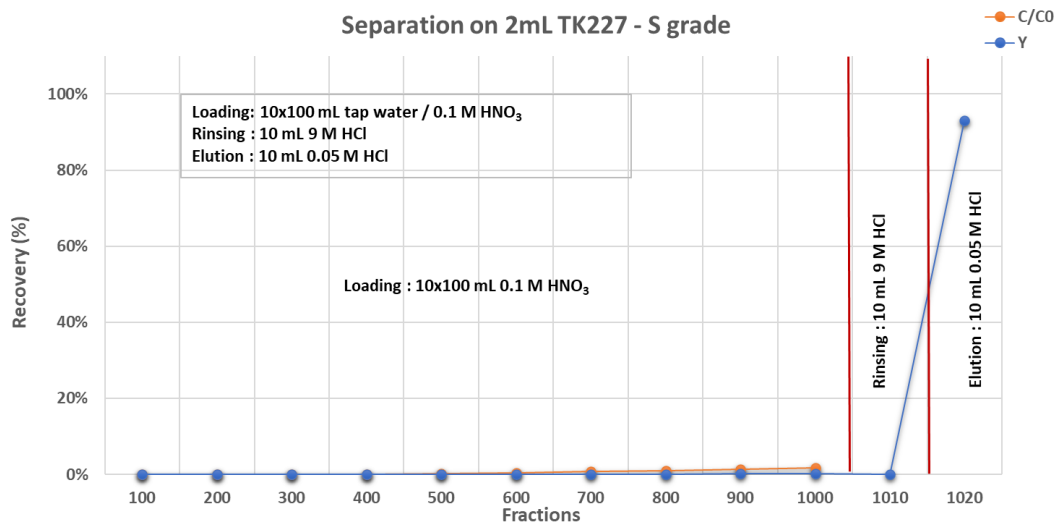
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# Applications:

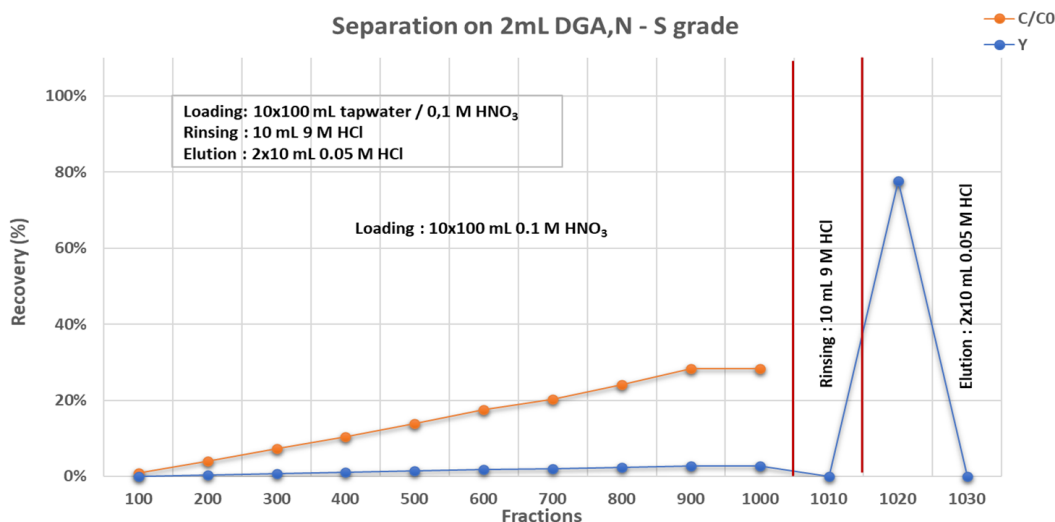
## Y breakthrough studies - tapwater

1L samples acidified @ pH 1, Test of Y breakthrough on 2mL cartridges of both TK227 and DGA,N Resins (Fractions measured by ICP-MS)



### TK227 Resin:

- Slight Y breakthrough observable starting at 700mL but remain quite low.
- Elution of Y in 10-20mL



### DGA,N Resin:

- Y breakthrough starting immediately with loading at 0,1M HNO<sub>3</sub>
- Elution of remaining Y in 10-20mL

- Stirling

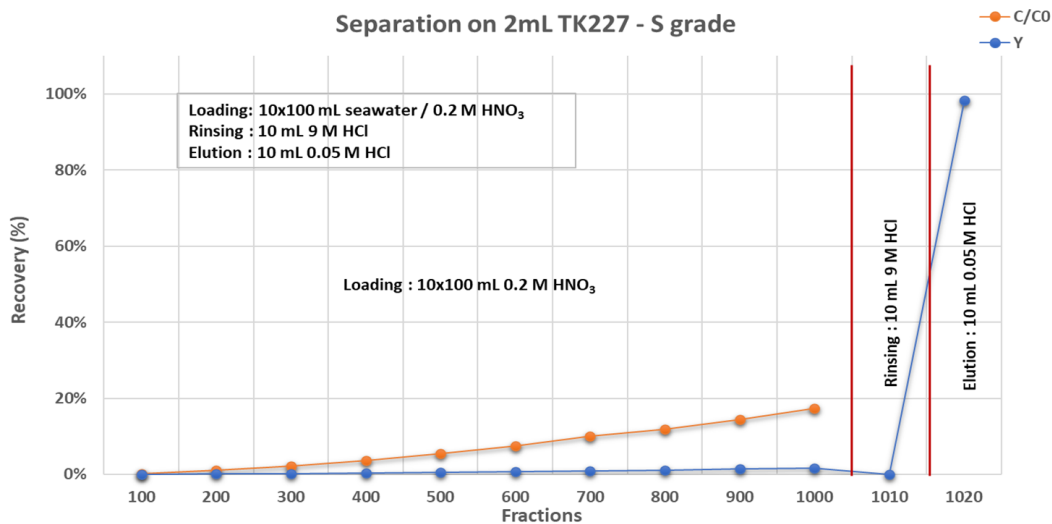


# Applications:

## Y breakthrough studies – seawater

1L samples acidified @ 0,2M HNO<sub>3</sub>, Test of Y breakthrough on 2mL cartridge of both TK227 and DGA,N Resins (Fractions measured by ICP-MS)

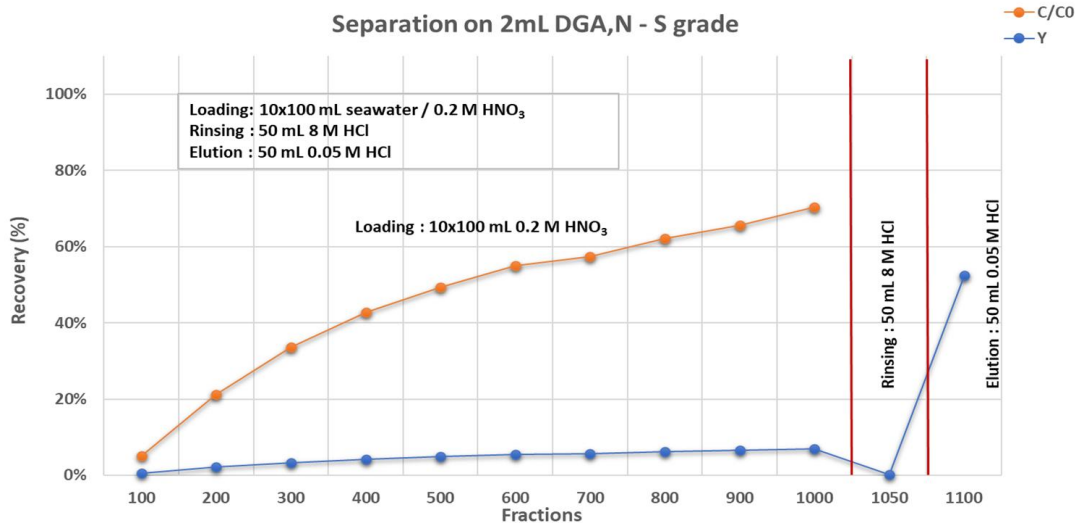
Separation on 2mL TK227 - S grade



### TK227 Resin:

- Y breakthrough observable starting at 300mL. Remain <20%.
- Elution of remaining Y in 10-20mL
- Better Y retention using higher HNO<sub>3</sub> conc. (e.g. 0,5M HNO<sub>3</sub>)

Separation on 2mL DGA,N - S grade



### DGA,N Resin:

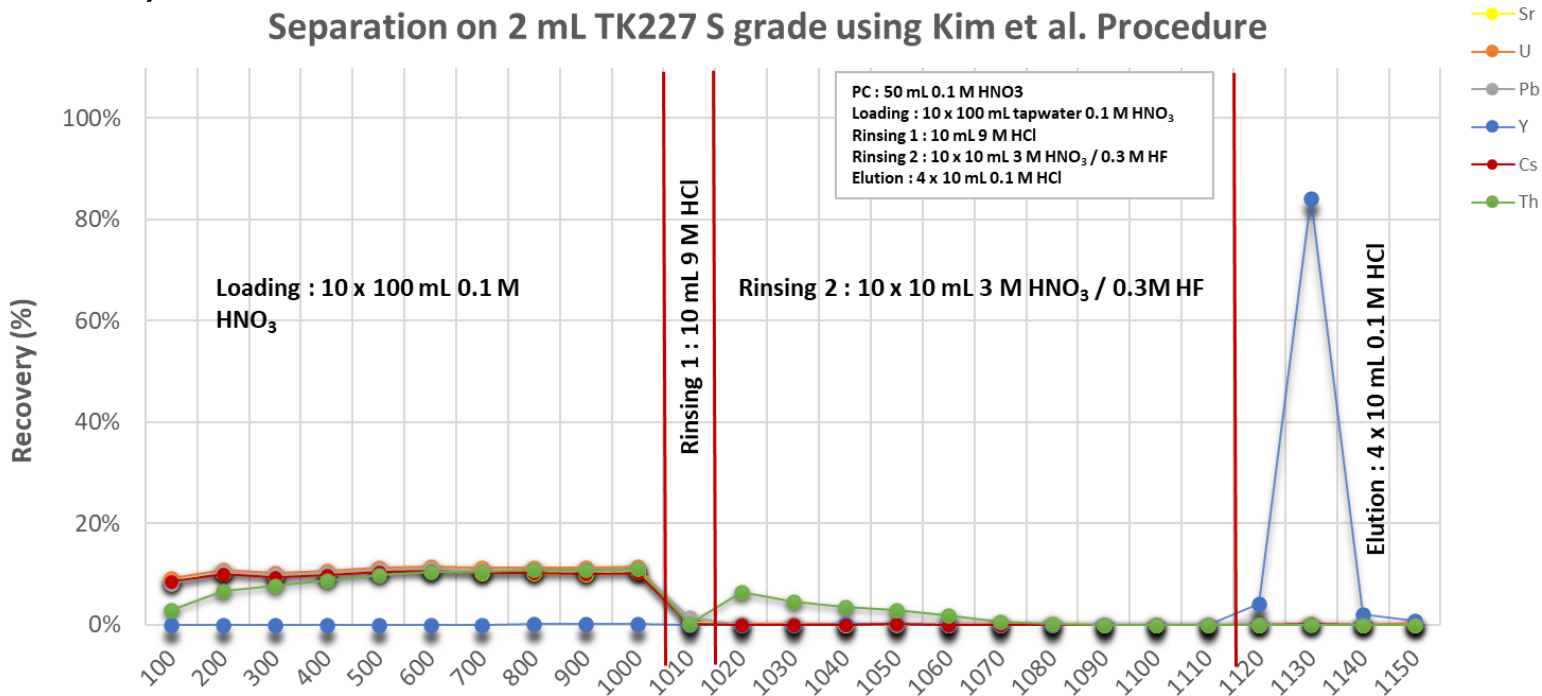
- Y breakthrough starting immediately with loading at 0,2M HNO<sub>3</sub>
- Elution of remaining Y in 50mL



# Applications:

## Elution studies on tapwater sample

1L Tapwater sample acidified @ pH 1, Elution study on 1x2mL cartridge TK227 using Kim et al. Conditions [1] (Fractions measured by ICP-MS)

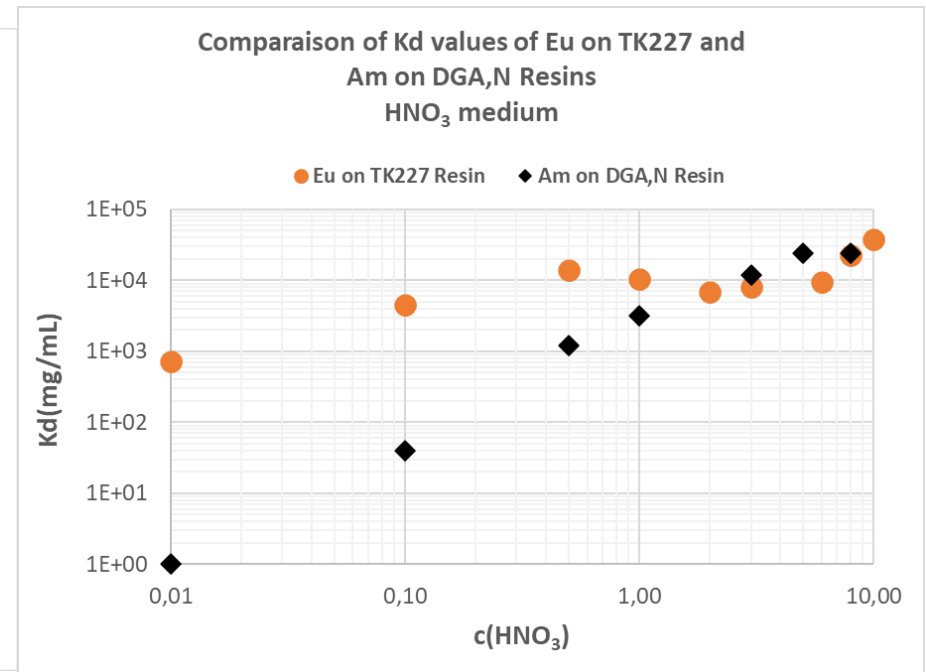
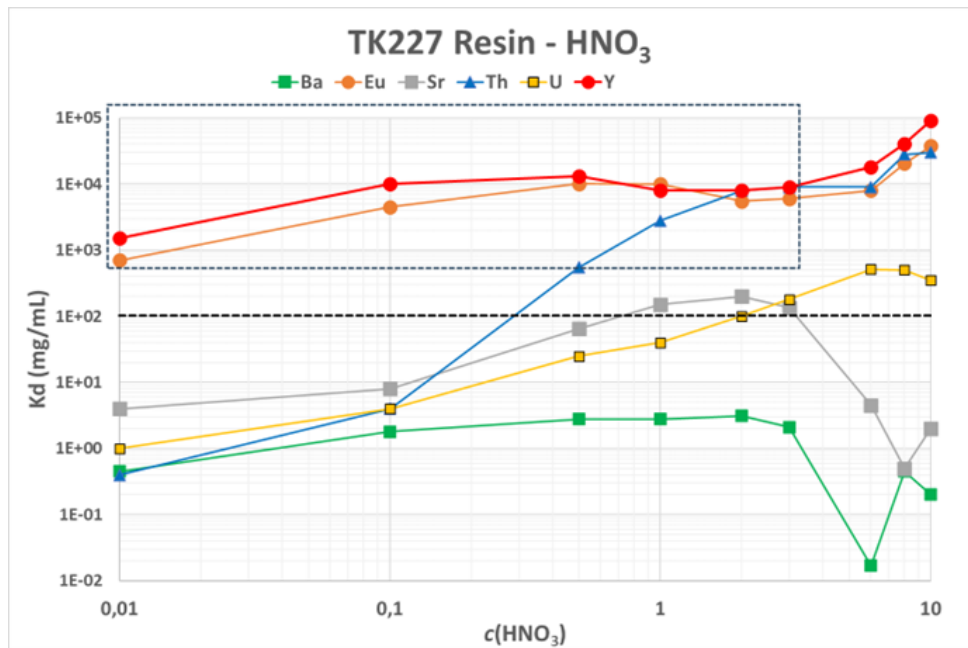


- Th, U, Sr, Pb, Cs elute during Loading and Rinsing 2
- Quantitative recovery of Y in 40mL 0,1M HCl
  - Only one preconcentration/purification step



# Applications: Use for Am separation @ low pH

- Eu (proxi for Am) with high uptake between 0,01 and 0,1M HNO<sub>3</sub>



Method development to be tested to preconcentrate/purify Am from low HNO<sub>3</sub> concentration

Load @ 0,1M HNO<sub>3</sub>; Rinse with 0,1M HNO<sub>3</sub>; Hypothesis on rinses: *Rinses with 8-9M HCl then 3M HNO<sub>3</sub>/0,3M HF*; Elution Am with 0,25M HCl

To be used in combination with TK200 Resin for (U,Th, Pu) separation as TK200/TK227.



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# Extension to New Supports: impregnated filtering membranes

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Use of filtering membranes as inert support instead of resin beads

Impregnation of the membrane with scaled extractant mix used for the TK227 Resin

Sample to be filtered through the membrane, then rinsed for direct measurement of membrane

- by LSC or GPC of Sr-90 via Y-90
- of e.g. Americium by alpha-spec



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# Conclusions

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The development of TK227 Resin has shown

- ✓ Y loading at 0,1-0,2M HNO<sub>3</sub> is possible
- ✓ Y is well separated from other elements
- ✓ Y needs to be carried
- It needs further testing (e.g. @ 0,5M-1M HNO<sub>3</sub>) to avoid Y breakthrough in 1L up to 50L
- On-going method development for preconcentration/purification both on resin and filtering membrane for:
  - ✓ **Sr-90 via Y-90 by LSC or GPC**
  - ✓ **Americium**

# Thank you for your attention!

[support@triskem.fr](mailto:support@triskem.fr)

