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Prof. Anna Fedorovna KUZINA

100th Anniversary of birthday



K. E. G E R M A N

RUSSIAN ACADEMY OF SCIENCES

A.N. FRUMKIN INSTITUTE OF PHYSICAL CHEMISTRY AND
ELECTROCHEMISTRY

100th Anniversary of birthday
1918 - 2018



In IPC AN USSR, 1956 – 1992 (after coming back from Ozersk)

Some fundamental chemistry of Tc

Initial studies of technetium

irradiation of Mo in reactors for Tc (Krasnoyarsk)

synthesis of new Tc compounds

electrochemistry of technetium

analytical chemistry of technetium

Separation of Tc at PA Mayak

Conversion to Tc metal

Cluster compounds of technetium

First micro-grams of Tc-99

Mo-98 (n, γ)Mo99 \rightarrow (β -decay)Tc-99 in the nuclear reactor

Missions of Anna Kuzina to Krasnoyarsk

Work with Anatoly Tsarenko



Laboratory of radiochemistry. Sitting: Albina Oblova, Anna Kuzina, academician Viktor Spisyn, Lyubov Barsova, Vitaly Kabanov, L. Troitsky, standing 1st line : Sergey Kryutchkov, Konstantin German, Valeria Pershina, A. Kisileva, Nina Budantseva, < Tamara Yurik, 2d line Sergey Kabakchi, 3rd line V. Mironov , Alexander Maslennikov, Al Vikhalin A. Kudryavtsev, R. Alimov, 1982, Moscow IPCAN USSR (now IPCE RAS)

First motivation for exploring Tc chemistry for the Closed Fuel Cycle

Tc-99 is a key dose contributor at HLW repositories if TRU elements are greatly reduced by recycling

- long half-life of Tc ($t_{1/2} = 2.14 \times 10^5$ years),
- high mobility, and solubility under oxidizing conditions

Methods for managing the long-term threat of Tc to the environment

- Stable waste form/repository system providing with strict limits for Tc release over a long period of time (~1 million years?).
- Transmutation of radioactive Tc to stable Ru in nuclear reactors.

Main problems of Tc

Tc is important item in Nuclear Industry

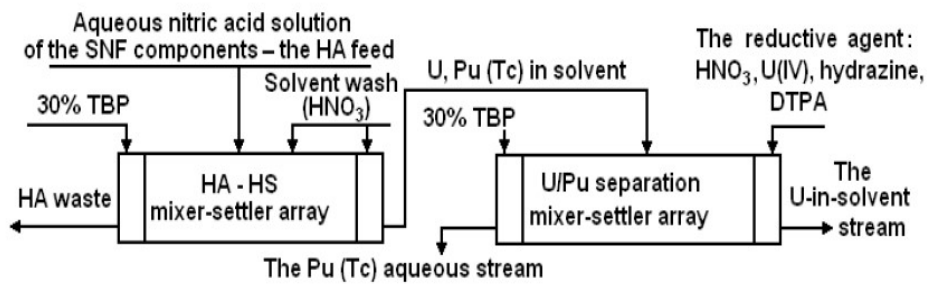
Tc redistribution in PUREX produces flows with long-lived high radioactive wastes

Tc interferes at U/Pu separation stage in PUREX process

Tc accumulation in High burn-up fuel together with Mo, Ru, Rh

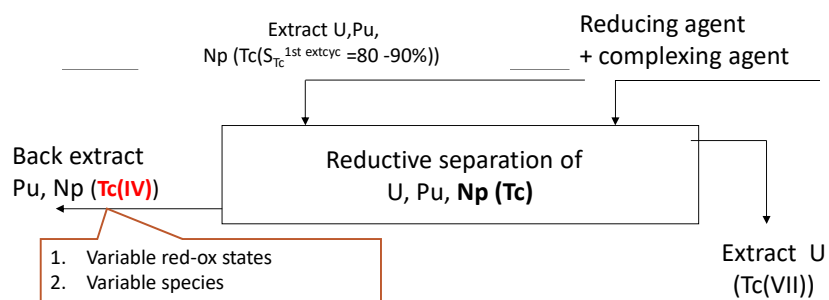
Tc in nuclear waste vitrification: Tc-Mo-Ru metal phases, Tc(VII) volatility

Russian reprocessing plant RT-1 , PUREX part



The flowsheet of the HA cycle

Technetium interfering role in the PUREX Pu/U separation stage



Difficulties in stability of U/Pu separation at UK, Russian and French facilities

Catalytic Tc effects in many chem. reactions

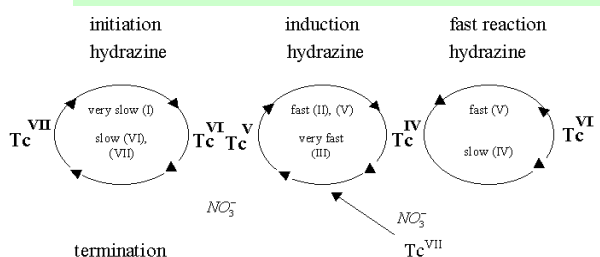
Variable Tc redox states

Tc - Waste problems

Tc-DTPA complex precipitation



Authors	Order in $[\text{N}_2\text{H}_5]_0$	Order in $[\text{H}^+]$	Order in $[\text{TcO}_4^-]$
Krinityn, Tsarenko, 1982	0	0	1
Kuzina et al., 1981	1	0	2
Koltunov et al.	0.85	1.4	1
Ramazanov et al.	1	2	1.2
Kemp et al.	-	-	кинет. циклы
Zilberman, Mashkin	HN_3 , catalytic cycles		



Конечные хим. формы в реакции $\text{Tc}(\text{VII})$ с N_2H_5^+ согласно разным авторам варьируют от $\text{Tc}(2+)$ до $\text{Tc}(\text{VII})$ = необходимы структ. и спектроскоп. данные

Best research
award
of 1980-1986
at PO MAYAK

Main approach

Ion-exchange separation

VP-1AP -- IEX

100 kg of KTcO_4 separated
during the 10 sessions

Purification : problems and
solutions($\text{Tc}/\Delta\text{Pu}$)

Ордена Трудового Красного Знамени
ИНСТИТУТ ФИЗИЧЕСКОЙ ХИМИИ АКАДЕМИИ НАУК СССР

Отчет о выполнении
задания № 1 от 10.10.81
Зам. нац. ка 1 апреля 1981
Зна. № 1

"УТВЕРЖДАЮ"

Зам. директора ИФХ АН СССР
доктор физ.-мат. наук
А.П.Захаров
"31" декабря 1982г.

О Т Ч Е Т

по теме: "Разработка и усовершенствование технологии
выделения технеция-99 из растворов
после переработки твделов", Я-11-06

Авторы

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Development of ion-exchange technology for Tc separation
in IPCE RAS (1971-1976)



Prof. A.F. Kuzina

(Tc Group leader till 1987)

presenting her Tc samples
prepared in the Institute from the
concentrate separated from
radioactive wastes generated at
Krasnoyarsk Reprocessing Plant
to Glean SEABORG (1978)

Separation of macro amounts of Tc-99g in USSR



Prof. Anna KUZINA and acad. Victor SPITSYN
analyzing the sample of Tc metal

- ✓ 1 kg of Tc was converted to metal in hot cell of IPCE RAS and distributed among different Russian institutes
- ✓ In 1971-1976 IPC RAS in collaboration with Krasnoyarsk Mining Enterprise has separated from HAW some kilograms of $K^{99}TcO_4$
- ✓ In 1983 -1986 collaboration of PO "Mayak", IPCE RAS and Radium Institute resulted in elaboration of anion-exchange technology for Tc separation and 40 kg of $K^{99}TcO_4$. This work was awarded with the special Diploma of the Russian authorities

Searching technetium applications

Anti-corrosion protection

Anti-fouling protection

Light-matter defectoscopy

Catalysts

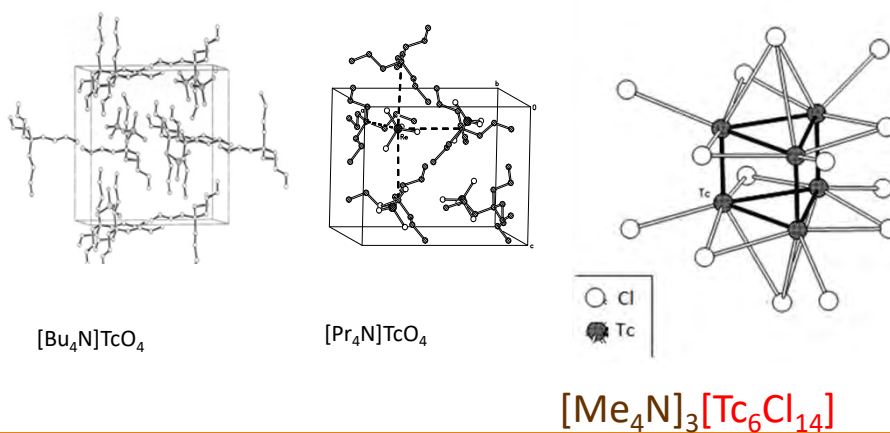
Ophtamo

Reference electro-current sources

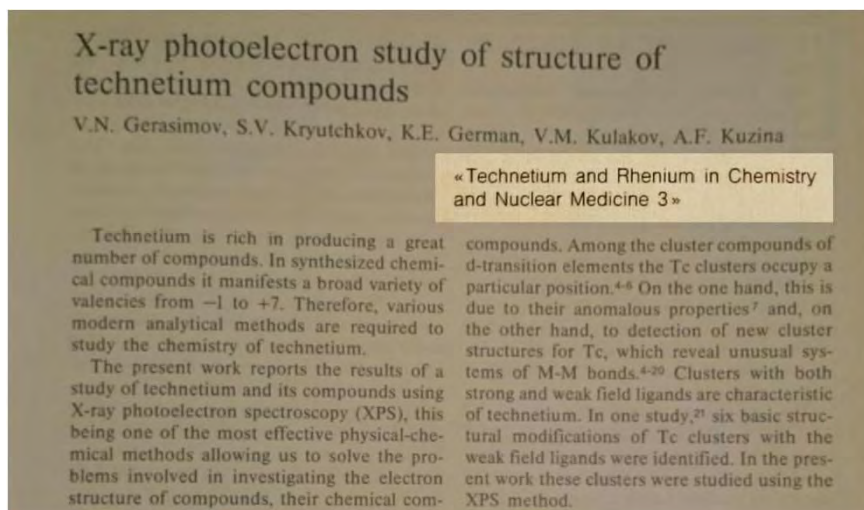
Batteries

...

A few examples of new Tc compound structures made in IPCE RAS (A. Kuzina, K.German, M.Grigoriev)



The last work, ESCA, 1990, Italy, Tc&Re symp.
(one of the most cited world publications on Tc)



100th Anniversary of birthday 1918 - 2018



- Anna Kuzina greatly supported international collaboration of IPC AN
- With Czechoslovakia, France, Poland, USA etc.
- A message from Roald Hoffman, 2018 :

Message to International Symposium on Technetium and Rhenium - Science and Utilization, 2018

The chemistry of rhenium and technetium is remarkably diverse and wide-ranging, given that one of the elements is among the rarest in the crust of the earth, and the other is almost entirely synthetic, the result of nuclear fission (I hope you like as much as I do, the image of nuclear physicists as synthetic chemists!) When these elements were first described nearly a hundred years ago, at much the same time, one could not have imagined that they would be used as superalloys and catalysts, tracers in medicine, or – in the Tc halide clusters – as examples of most unusual chemical bonding.

But they are so used, of value to our economy and well-being, a stimulus to our thinking. I wish the explorers of the Tc and Re worlds good science and great fun!

Roald Hoffmann, chemist and writer, who has worked, even if not much, with both Tc and Re chemistry, 08.08.2018

Walter Noddack, 125th Anniversary of birthday, 1893-2018



Discovery of
RHENIUM
+ Walter Noddack
+ Ida Tacke
+ Otto Berg



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