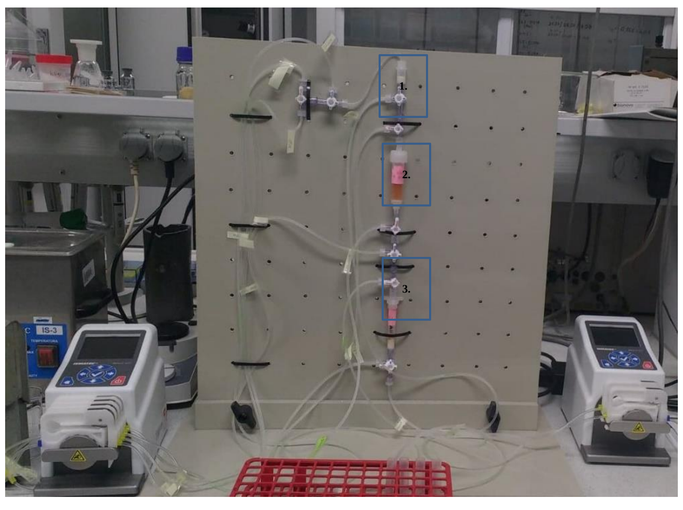
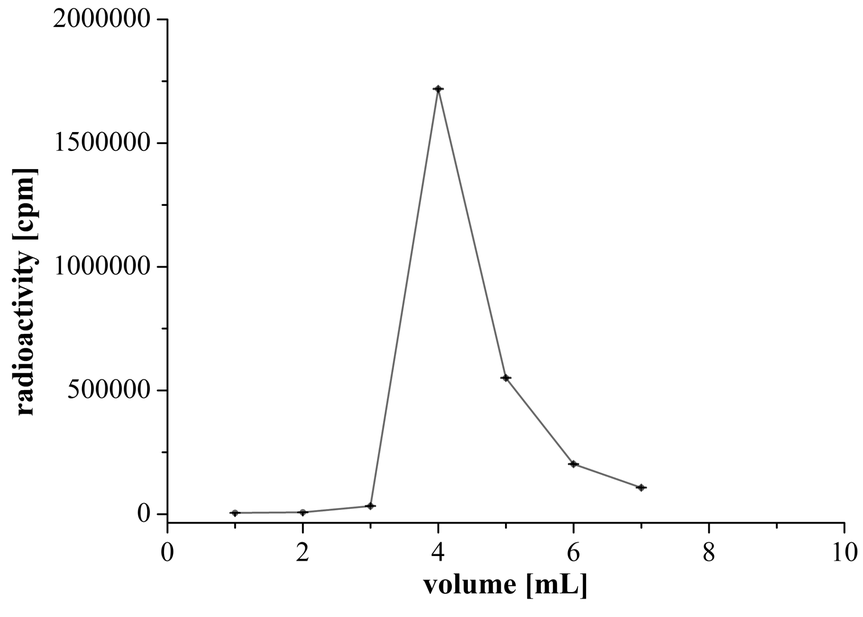
Separation and purification of ^{99m}Tc from simulated molybdenum target

Przemysław Koźmiński, Magdalena Gumiela, Aleksander Bilewicz

Centre of Radiochemistry and Nuclear Chemistry, Institute of Nuclear Chemistry and Technology, Dorodna 16, 03-195 Warsaw, Poland

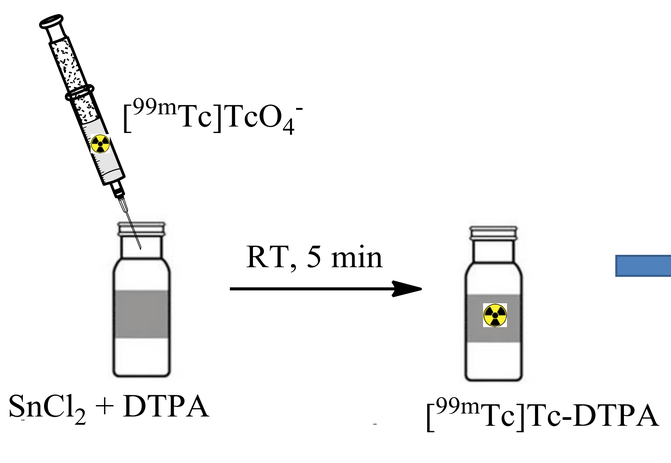
Radionuclide ^{99m}Tc is an ideal gamma emitter, because of its favorable half-life, photon energy, and versatile chemistry. It is annually used in about 30 million medical diagnostic procedures throughout the world. Till now the ^{99}Mo/^{99m}Tc generator remains as the main source of ^{99m}Tc production for nuclear medicine. A variety of alternative options including both reactor and accelerator paths are evolving for sustainable production of ^{99}Mo or ^{99m}Tc directly for clinical use. The aim of our study was to set-up the semi-automated purification module to cyclic [^{99m}Tc]TcO_4^- isolation for the gamma irradiated ^{100}Mo target. The separation process was carried out by using a 3-column purification system and the final product, [^{99m}Tc]TcO_4^-, was obtained in a total volume of 7 mL. To confirm proper separation achieved for ^{99m}Tc, a radio-labeling procedure using DTPA chelator was performed. The radiochemical purity was higher than 95%, which meets the strict radiopharmaceutical requirements. The yielded ^{99m}Tc can be separated with high efficiency from Mo in a quick and repeated way. Loss of ^{99m}Tc radioactivity during such a three-column separation process was not larger than 10%. It was also worth to investigate the dose having impact on separation process and the recovery yield of ^{99m}Tc, where water radiolysis could influence on chemical structure of the used resin.

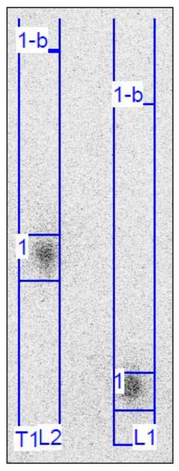




Elution profile of ^{99m}Tc from alumina column

Diagram of ^{99m}Tc separation using three-column purification system of semi-automated module.





ITLC analysis of [^{99m}Tc]Tc-DTPA:
acetone (right – L1); 0.9 % NaCl (left – L2)

Distribution of ^{99m}Tc activity during the separation process

Separation step	Activity of ^{99m}Tc [%]	Activity loss [%]
Initial solution	100	-
Waste from AnaLig® Tc-02	98.9	1.1
Waste from Dowex-50 WX2 and Al_2O_3	98.9	0.01
Eluate from Al_2O_3 column	90.5 ± 7.8	8.39

The ^{99m}Tc recovery yield from AnaLig®Tc-02 resin irradiated in cobalt-60 source.

	0.296 MGy The ^{99m}Tc recovery yield [%]	1.2 MGy The ^{99m}Tc recovery yield [%]
Control sample, resin in 2M NaOH	90	100
Resin in 2M NaOH	85.5 ± 19.1	100
Control sample, resin in 1M $(NH_4)_2CO_3$	---	70 ± 3.5
Resin in 1M $(NH_4)_2CO_3$	---	60 ± 2.1

RESULTS AND CONCLUSIONS

A semi-automated module prototype set up for the separation and use of ^{99m}Tc radionuclide yielded by decay of parent ^{99}Mo, obtained from ^{100}Mo targets irradiated by high-energy gamma beams is here described, along with subsequent extraction of [^{99m}Tc]TcO_4^- from Mo using AnaLig® Tc-02 extraction resin. The three-column module allows for the purification and preparation of ^{99m}Tc in a 7mL final volume. The procedure is fast and can be repeated every 24 h (the time needed to achieve the maximum activity for ^{99m}Tc). The suitability of the separation process based on AnaLig® Tc-02 resin has been confirmed by >95% yield of [^{99m}Tc]Tc-DTPA synthesis.

This research was funded by International Atomic Energy Agency (IAEA), Research Contract No 22521- GamaTech "Cyclic ^{99m}Tc Isolation from the Gamma Irradiated ^{100}Mo Target", and the Ministry of Science and Higher Education, grant number 3882/IAEA/2018/0.