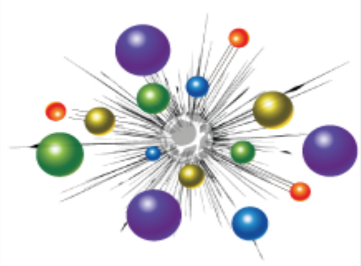


^{99m}Tc Master Milker (TcMM)

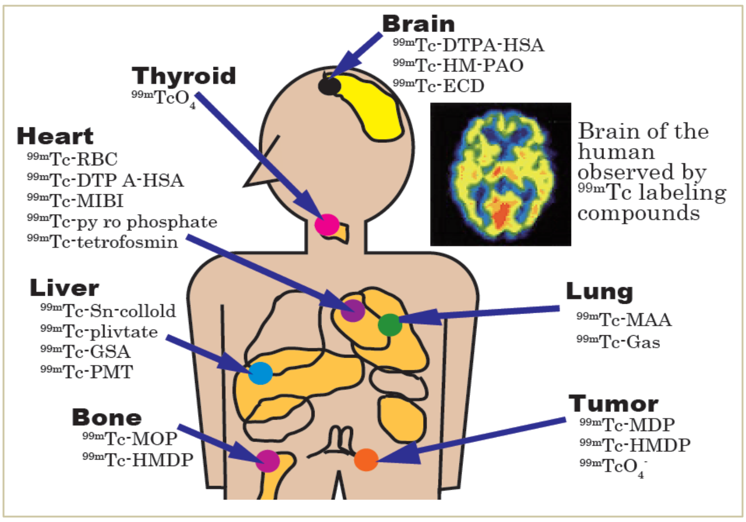
Generator of highly concentrated pure ^{99m}Tc from low specific activity ^{99}Mo produced by reactor and/or electron linear accelerator

Based on a newly discovered phenomenon!!

- *A general activated carbon has the peculiar characteristics to be able to collect ^{99m}Tc preferentially and completely from highly concentrated LSA-Mo(^{99}Mo) solution.*

Kaken ^{99}Mo-^{99m}Tc Process@

for Globally Local ^{99}Mo-^{99m}Tc production on demand by combination with TcMM and neighboring reactor or Linac



Kaken Inc., Japan

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^{99m}Tc Master Milker (TcMM)

Generator of highly concentrated pure ^{99m}Tc from low specific activity ^{99}Mo produced by reactor and/or electron linear accelerator

OUTLINE

Extraction technique of ^{99m}Tc extraction from ^{99}Mo was examined by the newly developed Technetium Master Milker (TcMM) method. For the production of ^{99}Mo here, the ^{98}Mo(n,g) reaction using neutrons generated by a nuclear reactor and/or the ^{100}Mo(g,n) reaction using bremsstrahlung photons generated by an electron linear accelerator were utilized respectively.

By this study, it has been proved that a highly concentrated pure pertechnetate ($^{99m}TcO_4^-$) in saline can be separated and collected through the TcMM method.

Procedurally, the TcMM method utilizes combined activated carbon (AC) and alumina (AL), with or without ion exchange resin (IER). The AC-AL process has used a highly concentrated Mo with low specific and large activity ^{99}Mo of 3.0×10^{12} Bq generated by the irradiation of neutrons in the nuclear reactor, JRR-3 in Japan Atomic Energy Agency.

It was found that a chemical yield and purity of the produced ^{99m}Tc are 90-95% and 6N (99.9999 %), respectively. Therefore, the TcMM method is able to generate a high quality $^{99m}TcO_4^-$ that is eligible to obtain the permission of pharmaceutical affairs law.

It is revealed that the TcMM method has the practical capability of the efficient ^{99m}Tc generator with a wide range from small amount level (kBq) to large level (TBq) per batch, furthermore, the main parts consisted of the AC-AL or AC-IER-AL columns system are simple and are able to collect pure ^{99m}Tc within 30 min automatically.

Conclusively, ^{99m}Tc can be produced domestically and further locally on demand by the combination of the TcMM method and ^{99}Mo with a low specific activity (produced from the ^{98}Mo(n,g) and/or ^{100}Mo(g,n) reaction, using a neighboring reactor and/or an electron linear accelerator without enriched uranium (HEU and LEU)), and furthermore, the advanced use for diagnosis can be available everywhere in the world.

[TcMM Process]

Step(1) Dissolution of irradiated $^{nat}MoO_3$ pellets

Irradiated $^{nat}MoO_3$ pellets are dissolved in a molar equivalent NaOH solution, and the resulting $Na_2Mo(^{99}Mo)O_4$ solution with the neutral pH can obtain.

Step(2) Adsorption of ^{99m}Tc in AC

Using the TcMM system, $Na_2Mo(^{99}Mo)O_4$ solution (max. 1000 mL) is poured into AC column at a flow velocity of 100 mL/min for 10 min. to adsorb ^{99m}Tc on the AC column. A trace amount ^{99m}Tc is preferentially and completely adsorbed in the AC column.

Step(3) Removal of Mo contaminants from AC

Mo(^{99}Mo) and other nuclides contaminants in AC is removed by flowing H_2O, next 6.0 M NaOH (30 mL) and finally H_2O.

Step(4) Elution of ^{99m}Tc from AC

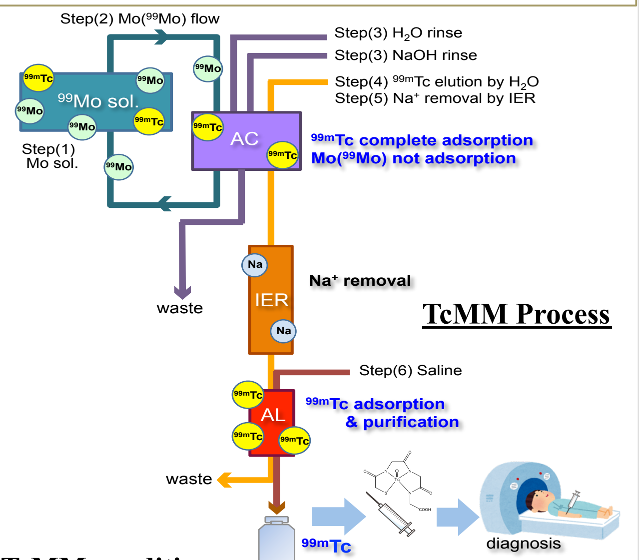
In order to elute ^{99m}Tc collected into AC column, H_2O is run through the AC column, then the whole quantity of ^{99m}Tc adsorbed on AC column can be eluted.

Step(5) Removal of Na-ion in alkaline ^{99m}Tc eluted

^{99m}Tc solution obtained in step(4) above is alkaline solution is flowed through to the strong acid type of ion exchange resin (IER) and the activated alumina (AL). By this procedure, Na-ion in eluted ^{99m}Tc solution can be taken hold in the IER column and ^{99m}Tc can be caught in the AL column.
If the IER column is not used, the TcMM process can also be operated by the combination of AC-AL columns system.

Step(6) Elution of ^{99m}Tc

Finally, a highly pure ^{99m}Tc can be recovered from the AL column by flowing 10-20 mL of saline (0.9% NaCl solution), and the resulting ^{99m}Tc can be concentrated 50-100 folds from the initial Mo (^{99}Mo) solution.



TcMM Process

TcMM conditions

TcMM type (TcMM process)	TcMM 10T (AC-AL)	TcMM<IER> 10T (AC-IER-AL)
amounts of ^{99}Mo	kBq-10TBq	kBq-10TBq
Mo solution	200g(Mo)/L	200g(Mo)/L
AC column	LH2c-AC 4.5g, Flow rate of Mo sol. 100mL/min 6M-NaOH 30mL ^{99m}Tc elute H_2O 85mL	LH2c-AC 4.5g, Flow rate of Mo sol. 100mL/min 6M-NaOH 30mL ^{99m}Tc elute H_2O 85mL
IER column	-----	DIAION(SK1B H) 5cc
AL column	MP-acid AL 12g Saline 20mL	MP-acid AL 6.0g Saline <10mL
^{99m}Tc milking time	≤30min	≤30min
^{99m}Tc collected volume concentration rate radiochemical purity	20mL 50 folds >99.99%	≤10mL 100 folds or more >99.99%
wastes per batch	Liquid: 250 mL Solid: 17g	Liquid: 250 mL Solid: 16g

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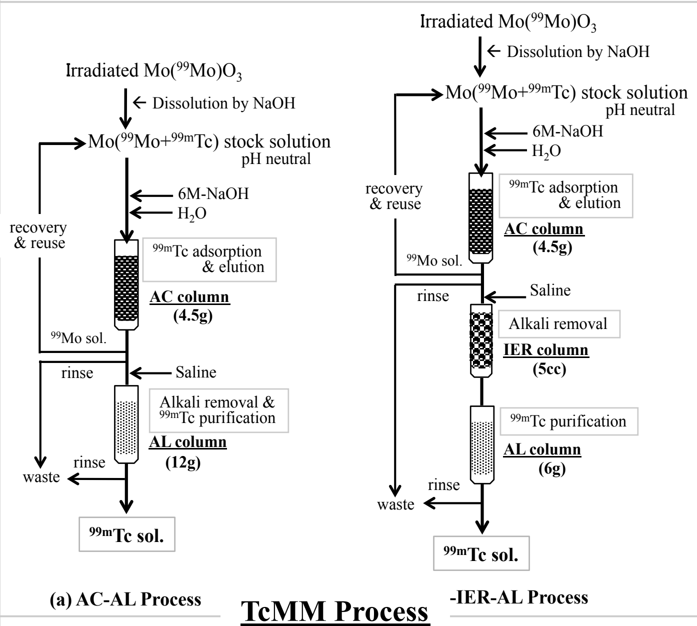
KAKEN

Performance of TcMM process for generating ^{99m}Tc from (γ,n) & (n,γ) LSA-^{99}Mo



TcMM Process

Producing process of ^{99m}Tc	➢Equivalent ^{99m}Tc recovery rate in kBq-10TBq ➢Recovery of ^{99m}Tc : 90~95% ➢Concentration of ^{99m}Tc solution: >1Ci/mL ➢Producing time: ≤30 min/run
Quality of ^{99m}Tc	➢^{99m}Tc collected in sterile saline ➢Collected as $^{99m}TcO_4^-$ (pertechnetate) ➢Endotoxin-inspection: negative ➢Radiochemical purity: >4N~7N ➢By the labeling experiment using many kits, the target medicines are given with high radio-chemical purity.
Waste for production	➢Liquid waste: 250mL/run ➢Solid waste: AC 4.5g/run, AL 6~12g/run, IER 5cc/run, and column casing

TcMM can,

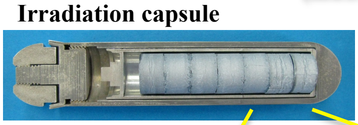
in the near future, where the ^{99}Mo-production system using a neighboring reactor, a LINAC and the ^{99m}Tc-separation system of the TcMM are available in an appropriate number of clinics and hospitals in each area.

TcMM-10T Front panel (max. 10TBq)

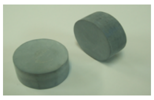
Sufficient performance for ^{99m}Tc generator!!

- **Complete removing impurities such as accumulated ^{99g}Tc, generated radioactive Nb and other nuclides contaminants.**
- **Highly pure ^{99m}Tc (radiochemical purity: >99.99%) is successfully separated with a chemical yield of 90% over.**
- **TcMM enables one to generate a high quality $^{99m}TcO_4^-$ (pertechnetate) available for obtaining permission of pharmaceutical affairs law.**
- **By using the TcMM system, a highly concentrated pure ^{99m}Tc of kBq-TBq from a low specific activity ^{99}Mo can automatically be collected in a short time (<30min.).**
- **TcMM can also be utilized just a ^{99m}Tc**

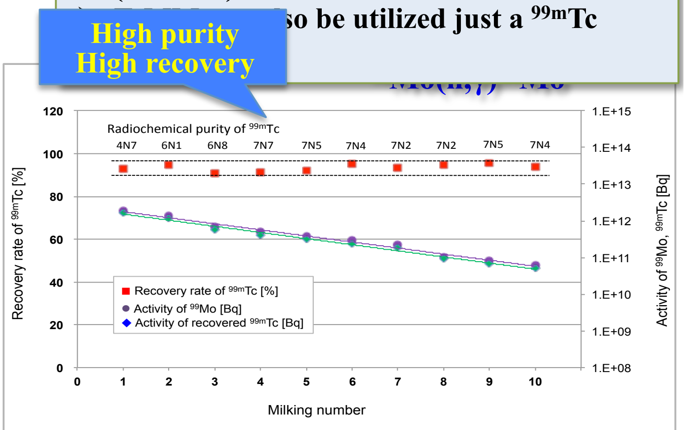
Irradiation capsule



MoO_3 pellet Φ20mmx10mmt

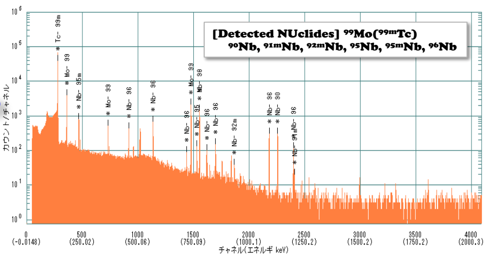


Irradiation by Linac or Reactor



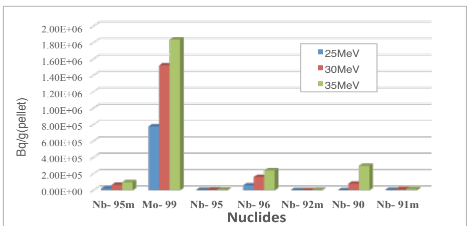
Linac $^{100}Mo(\gamma,n)^{99}Mo$

$^{nat}MoO_3$ pellet Irradiated by Linac

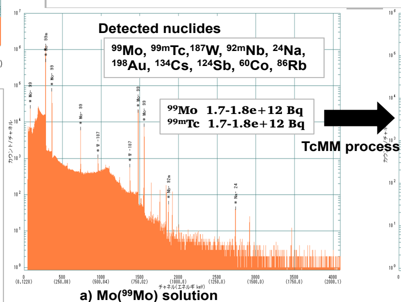


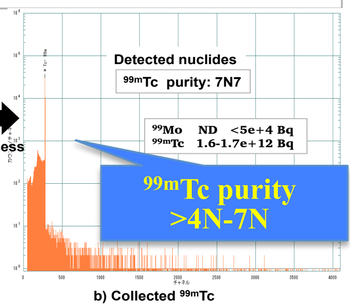
Nuclides generated in Linac-irradiation $^{nat}MoO_3$

[main nuclear reactions]
$^{97}Mo(\gamma,p)^{96}Nb$
$^{96}Mo(\gamma,p)^{95m}Nb$&$^{95}Nb$
$^{94}Mo(\gamma,pn)^{92m}Nb$
$^{92}Mo(\gamma,p)^{91m}Nb$
$^{92}Mo(\gamma,pn)^{90m}Nb$



Linac-(γ,n)^{99}Mo and impurity nuclides generated





γ-spectra of (n,γ)^{99}Mo and ^{99m}Tc collected by TcMM process

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KAKEN

Kaken ^{99}Mo-^{99m}Tc Process@

^{99}Mo-^{99m}Tc Domestic & Local Production on demand

^{99}Mo

^{99}Mo production [Reactor or Accelerator]

Natural or Enriched isotope MoO_3 or Mo

[by Reactor] ^{98}Mo(n,γ)^{99}Mo

[by Linac] ^{100}Mo(γ,n)^{99}Mo

Low Specific Activity ^{99}Mo

LSA-^{99}Mo 0.1-1Ci/g(Mo)

LSA-^{99}Mo

^{99m}Tc

^{99m}Tc Master Milker [TcMM]

Patented

Concentration & purification of ^{99m}Tc by activated carbon(AC) & alumina(AL)

- ^{99m}Tc milking performance: **kBq-10TBq within 30min.**
- Mo(^{99}Mo) specific activity and concentration: **without restriction.**
- ^{99m}Tc purity in saline: **>6N**
- milked ^{99m}Tc concentration: **kBq-TBq/mL**
- ^{99m}Tc chemical form: **TcO_4^-**

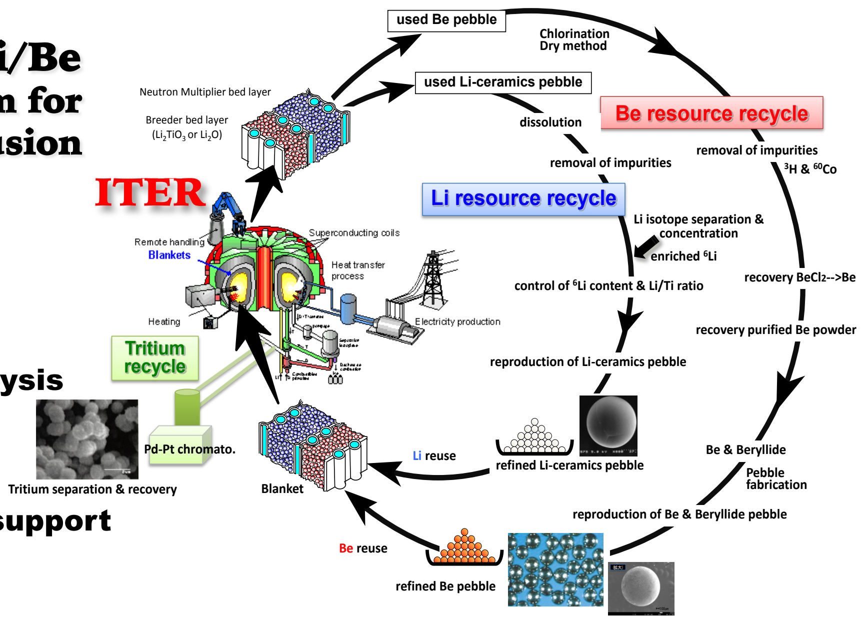
TcMM

kBq-10GBq → Small AC-(IER)-AL **^{99m}Tc generator**

GBq-10TBq → AC-(IER)-AL **^{99m}Tc pharmaceutical**

Kaken ^{99}Mo-^{99m}Tc Process@

Tritium(^{3}H)/Li/Be Resource Recycle System for nuclear fusion



Outline of Kaken tasks

Chemical and Instrumental Analysis
- Environmental analysis
- Physical analysis
- Ultra-trace analysis
- Inorganic and Organic analysis

Chemical Experiment and R&D support
- Chemical process development
- Material test and evaluation
- Functional material development

Radionuclides-related research and analysis
- Radioactivity analysis on environmental samples/Transitional surveys
- Test and technology based on radioisotopes
- Technology development with application of radioactive substances
- Radioactive waste reprocessing

Engineering Design and Manufacture
- Design & fabrication of original devices and equipment

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