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
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 ($^{99m}$TeO$_4^-$) 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 3.0x10$^{12}$ 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 $^{99m}$TeO$_4^-$ 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$_2$MoO$_4$ solution with the neutral pH can obtain.

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

Using the TcMM system, Na$_2$MoO$_4$ 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$_2$O, next 6.0 M NaOH (30 mL) and finally H$_2$O.

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

In order to elute $^{99m}$Tc collected into AC column, H$_2$O 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.
Performance of TcMM process for generating $^{99m}$Tc from ($\gamma$,n) & (n,$\gamma$) LSA-$^{99}$Mo

**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 radiochemical purity.

**Waste for production**
- Liquid waste: 250mL/run
- Solid waste: AC 4.5g/run, AL 6–12g/run, IER 5cc/run, and column casing

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**Sufficient performance for $^{99m}$Tc generator!!**
- Complete removing impurities such as accumulated $^{99m}$Tc, generated radioactive Nb and other nuclides contaminates.
- 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 $^{99m}$Mo can automatically be collected in a short time (< 30min.).
- $^{99m}$Tc can also be utilized just a $^{99m}$Tc

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**High purity High recovery**

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Contact to: tatemuna@kakenlabo.co.jp
**Kaken 99Mo-99mTc Process**

**99Mo-99mTc Domestic & Local Production on demand**

- **99Mo production [Reactor or Accelerator]**
  - Natural or Enriched isotope MoO$_3$ or Mo
  - [by Reactor] $^{99m}$Mo(n,$\gamma$)$^{99m}$Mo
  - [by Linac] $^{100}$Mo(y,n)$^{99m}$Mo

- **Low Specific Activity 99Mo**
  - LSA-$^{99m}$Mo 0.1-1Ci/g(Mo)

- **99mTc Master Milker [TcMM]**
  - Concentration & purification of 99mTc by activated carbon (AC) & alumina (AL)
  - 99mTc milking performance:
    - kBq-10TBq within 30min.
    - Mo(99Mo) specific activity and concentration: without restriction.
    - 99mTc purity in saline: >6N
    - milked 99mTc concentration:
      - kBq-TBq/mL
    - 99mTc chemical form: TcO$_4^-$

**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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**Tritium(3H)/Li/Be Resource Recycle System for nuclear fusion**

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