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1.14 INVESTIGATION ON THE PERFORMANCE OF POLYMER ZIRCONIUM COMPOUND (PZC) FOR CHROMATOGRAPHIC Tc-99m GENERATOR PREPARATION

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ABSTRACT

The performance of PZC was investigated for chromatographic Tc-99m generator preparation. Mo-adsorption of PZC in different Mo-solutions and Tc-99m elution of ^{99}Mo-PZC column were studied. Mo- adsorption capacity of higher than 250mgMo/gPZC and Tc-99m elution yield of higher than 80% were achieved with PZC adsorbent. Mo-99 breakthrough of 0.02% and Molybdenum element breakthrough of around 5μg Mo/ml were found in Tc-99m eluate. A good relationship between the Mo-content of adsorption solution and the Mo-adsorption capacity, adsorption percentage, Mo-breakthrough and Tc-99m elution yield was found. The preparation of PZC based Tc-99m chromatographic generator with 4 gram weight of PZC was successfully conducted.

INTRODUCTION

Today Technetium-99m is the main radioisotope used in Nuclear Medicine for diagnosis. More than 80% of all diagnostic nuclear medicine procedures based on using ^{99m}Tc. ^{99m}Tc (6.0 h) is almost exclusively produced from the decay of its 66 h parent ^{99}Mo.

At present nearly the entire supply of Mo-99 is based on the research reactor produced Mo-99 sources by using the (n,γ) nuclear reaction with natural Mo (^{98}Mo, ~24%), resulting in inexpensive but low specific activity ^{99}Mo or by neutron-induced fission of ^{235}U, which results in expensive but high specific activity of ^{99}Mo. In the "fission method", the technological and infrastructure requirements are more complex and possibly can be sustained only by countries with advanced nuclear technology.

The technology requirements for processing of ^{99}Mo from (n,γ) "activation method" is rather simple, and is within the reach of most developing countries operating research reactors.

Alternative technologies for ^{99}Tc^{m} generators using (n,γ) nuclear reaction with natural Mo were developed or are being under development . Although some new technology has technically been accepted in many countries, but there will have to be a substantial economic incentive for a large producers of Mo-99 or Tc-99m generators to change to a new process by reason of the existing investment in production infrastructure and in the approval of ^{99}Mo and derived products.

Among these the technologies for ^{99}Tc^{m} generators using Zirconium- or Titanium-Molybdate gel, so called "gel technology" and polymer Zirconium- or Titanium compound (PZC, PTC) based technology are considered as new ones. Under the frame of Forum for Nuclear Cooperation in Asia (FNCA) cooperation program the PZC based technology for production of Tc-99m generator developed first in Japan is a topic for further evaluation and comparison between participant countries. Any new process having a potential influence on the product quality, compared to existing process will have to be demonstrated and licensed fully. The product should be qualified by the various regulatory authorities, which is a long and expensive process adding to the market inertia referred to previously. As a contribution ,our report is aimed to investigate and evaluate the performance of PZC adsorbent for the preparation of a clinically available Tc-99m generator.

EXPERIMENTAL

Polymer Zirconium Compound (PZC) supplied by Kaken Co. (Japan) was used in all experiments. The PZC samples of four different preparation batches were investigated and compared with each other.

Totally 23 PZC columns (6 columns of 0.75 g weight for each PZC batch) were tested. Seven different conditions for adsorption and post-adsorption treatment were applied. These conditions are as follows:

a- Normal adsorption in water solution of Molybdate;

b- Adsorption in Acetate buffer solution of Molybdate (Acetate buffer solution of 0.2M acetic acid, pH=5)

c- Adsorption in H_2O_2 added Acetate solution of Molybdate (Acetate buffer solution of 0.2M acetic acid, containing 5% H_2O_2, pH=5)

d- Adsorption in CrO_4^{2-} added Acetate solution of Molybdate (Acetate buffer solution of 0.2M acetic acid, containing 2.5% K_2CrO_4, pH=7)

e- Normal adsorption in water solution of Molybdate (with different conditioning solutions) followed by sterilization in autoclave.

f- Normal adsorption in water solution of Molybdate (with different conditioning solutions) followed by drying at 100°C for one hour.

g- Normal adsorption in water solution of Molybdate followed by conditioning PZC column with different solutions.

15 ml radioactive Mo-99 solution of concentration of 13.316 mg Mo / ml, pH=7 were added to PZC samples of 0.75 g weight, then these samples were gently shaked in water bath of 50°C overnight. After shaking the samples were let to stand and a portion of clear supernatant solution was taken out to measure Mo-99 radioactivity for Mo–adsorption capacity calculation and then the remained solution was decanted to get the solid PZC part. This solid PZC sample was packed in 8ml glass column and washed with 30 ml water followed by passing column with 10 ml saline. After this step first Tc-99m elution was started after 24 hours equilibration time and daily an elution was conducted.

All experiments were carried out with PZC columns of Mo-99 radioactivity of 10 – 30 mCi.

Each column was eluted for five to seven days (one elution a day). Totally more than 120 elutions were carried out.

Elution yield, Mo-99 break-through (by Capintec Dose Calibrator), Mo element content (by photospectrometric method) were determined for each elution.

RESULTS AND DISCUSSION

A. The performance test of PZC under different column treatment

Real adsorption capacity of each PZC column and effective loading capacity (% of solid PZC loaded on the column after decanting fine PZC particles), elution profiles of each column and Mo break-through in function of standing-time were also determined. A large number of interesting results were collected and reported in the following tables and figures. (Table 1-4 and fig. 1).

Mo adsorption capacity is of about 248.1 mgMo/g PZC for the first PZC batch and 244.0 Mo mg/g PZC for the second,

254.8 mg Mo/g PZC for the third and around 265 mg Mo/g PZC for the fourth one. The capacity also varied depending on the applied adsorption conditions.

Elution yield of higher than 90% was achieved in the a, b, c, d cases and about 80% in the e, f cases.

The adsorption in Acetate buffer solution of Molybdate showed a better integrity of PZC particles (amount of fine particles is smaller) comparing with PZC particles adsorbing Mo in pure water solution of Molybdate.

Elution profile showed that the exhaustive elution would be achieved with 4 ml of saline (for a column bed of 0.75 g PZC). From these results we can estimate 25 ml saline for exhaustive elution of PZC column of 4 g.. So a real generator of 4 g PZC bed using 15 ml saline elution will be of elution yield of about 80 %.

Mo break-through remains as a problem to be discussed. This break-through is not so high (around 2-10 μg Mo/ml for a column of 0.75 g PZC and eluant volume of 8 ml). Mo-99 breakthrough is a little higher than the limit of 0.015% of Tc-99m radioactivity. An accumulation of Mo-breakthrough was observed for the elution after the equilibration time of longer than 24 hours .

If we consider a real generator of 4 g PZC column and Mo-breakthrough being dominated in the first stage of elution profile (see fig. 1), the above-mentioned value of Mo break-through is overtaking the limit required for pertechnetate solution applicable in Nuclear Medicine.

The sterilizing PZC column in the autoclave reduced to some extent the elution yield of Tc-99m, but did not affect the Mo-breakthrough of column.

It is found that the drying ^{99}Mo-PZC column brought about the shrinking of PZC. The shrinking reduced the volume of column packing .The shrinking may cause the deformation of PZC gel structure and its adsorption affinity for Molybdate ion. This effect brought about the tailing of the elution profile, the lower Tc-99m elution yield and the increase of Mo-breakthrough.

Of course, we can use Alumina clean-up column to reduce Mo-content in pertechnetate solution, but the Mo-capacity of Alumina is not so high. So the design of generator is considered as an important theme.

Table 1 : The Mo adsorption test of PZC under different column treatment

Lot No. of PZC	Sample	pH		Colour of PZC (After adsorption)	Non-adsorbed Mo-99 radioactivity (%)	Discarded fine PZC powder Mo-99 radioactivity (%)	Generator column Mo-99 radioactivity (%)	Adsorption capacity (mg Mo/g PZC)	Weight of PZC	
		Before Adsorption	After adsorption						Discarded fine powder (%)	Generator Column (%)
020522	A	7	5	White	6.3	7.9	85.8	249.7	8.5	91.5
	B*	7	5	White	7.7	6.6	85.7	246.2	7.1	92.9
	C*	7	5	White	6.7	10.5	82.8	248.6	11.3	88.7
010905	A	7	4.5	Light Brown	10.2	3.8	86.0	239.5	6.2	93.8
	B	7	4.5	Light Brown	7.2	4.1	88.7	247.4	5.9	94.1
	C	7	4.5	Light Brown	8.6	5.8	85.6	245.3	6.3	93.7
020315	A	7	4.5	White	5.3	6.6	88.1	252.3	7.7	92.3
	B	7	4.5	White	4.2	7.0	88.8	255.4	7.3	92.7
	C	7	4.5	White	3.7	7.5	88.8	256.7	7.7	92.3

Table 2: The elution test of PZC under different column treatment

Lot No. of PZC	Sample	First elution			Second to fifth elution		
		Elution Yield of Tc-99m (%)	Mo breakthrough		Elution Yield of Tc-99m (%)	Mo-breakthrough	
			μg Mo (*)	(%) (**)		μg Mo (*)	(%) (**)
020522	A	77.8	27.4	0.023	92.5 ± 0.5	27.8	0.020
	B*	69.5	132.4	0.128	84.5 ± 0.3	126.6	0.114
	C*	66.5	94.9	0.098	86.5 ± 0.5	63.4	0.050
010905	A	92.5	50.4	0.036	94.5 ± 0.5	25.1	0.017
	B	82.6	85.6	0.071	83.3 ± 0.5	85.6	0.071
	C	77.2	35.2	0.030	79.3 ± 0.6	12.6	0.010
020315	A	92.4	43.2	0.035	92.8 ± 0.5	12.2	0.010
	B	80.4	72.0	0.057	85.0 ± 0.5	52.0	0.040
	C	78.5	36.8	0.030	84.5 ± 0.5	18.1	0.014

Sample symbol:

(A) With normal condition of Mo-adsorption in water solution of Molybdate and column washing with 50 ml distilled water, eluted with saline.

(B) With normal condition of Mo-adsorption in water solution of Molybdate and column washing with 15 ml distilled water, then drying PZC powder at 100°C for one hour followed by washing with 35 ml water, eluted with saline.

(C) With normal condition of Mo-adsorption in water solution of Molybdate and column washing with 15 ml distilled water, then sterilizing PZC column at 124°C for half an hour followed by washing with 35 ml water, eluted with saline.

(B*) With normal condition of Mo-adsorption in water solution of Molybdate and column washing with 50 ml distilled water followed by conditioning column with 5 ml saline, then drying PZC powder at 100°C for one hour, eluted with saline.

(C*) With normal condition of Mo-adsorption in water solution of Molybdate and column washing with 50 ml distilled water followed by conditioning column with 5 ml saline, then sterilizing PZC column at 124°C for half an hour, eluted with saline.

(*) Total Molybdenum content in 8 ml eluate.

(**) Percentage of Mo-99 radioactivity in the eluate of Tc-99m.

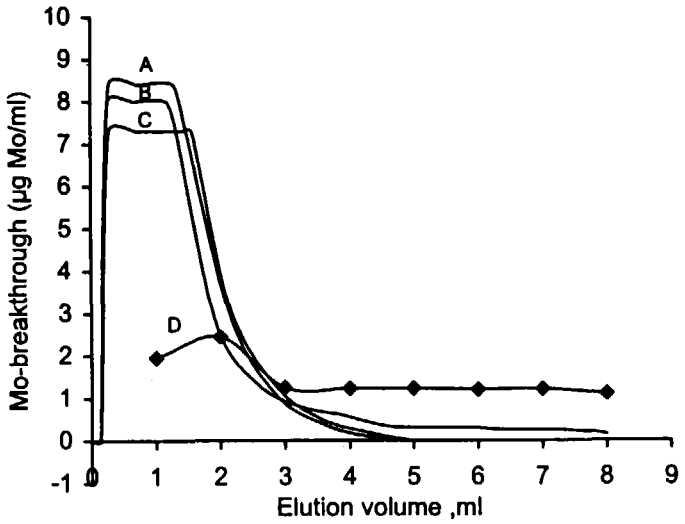

Fig. 1 : Elution profiles of ^{99}Mo-PZC column
A, B, C : The Tc-99m elution profiles of Sample A, B and C, respectively (Arbitrary Tc-99m Radioactivity Scale).
D : Mo content in the different eluate fractions of the elution profile A.

B. The performance test of PZC in different solutions

In table 3-4 the results of studies on the adsorption and Tc-99m elution performance of ^{99}Mo- PZC in different solutions were presented. It is found that the oxidizing agent added Mo-solution did not affect the Mo-adsorption and Tc-99m elution performance of ^{99}Mo- PZC columns. The conditioning ^{99}Mo-PZC columns with solution containing agent of higher Zirconium-adsorption power such as PO_4^{3-} and with a solution of high Cl^- concentration will affect the performance of ^{99}Mo- PZC column. This effect brought about higher Mo-breakthrough in Tc-99m eluate and reduced to some extent the Tc-99m elution yield.

Table 3: The Mo adsorption test of PZC in different solutions

Lot No. of PZC	Sample	pH		Colour of PZC (After adsorption)	Non-adsorbed Mo-99 radioactivity (%)	Discarded fine PZC powder Mo-99 radioactivity (%)	Generator column Mo-99 radioactivity (%)	Adsorption capacity (mg Mo/g PZC)	Weight of PZC	
		Before Adsorption	After Adsorption						Discarded fine powder (%)	Generator Column (%)
020522	I	7	5	White	6.3	7.9	85.8	249.7	8.5	91.5
	II*	7	5	White	6.3	11.7	82.0	249.7	12.5	87.5
	III	7	5	White	6.3	10.5	83.2	252.1	15.8	84.2
	IV*	7	5	White	6.3	10.6	83.1	250.2	13.8	86.2
010905	I	7	4.5	Light Brown	10.2	3.8	86.0	239.5	6.2	93.8
	II	7	5.5	Light Brown	21.8	3.5	74.7	208.4	4.5	95.5
	III	7	5.5	Light Brown	26.6	4.1	69.3	196.0	4.6	95.4
	IV	7	5.5	Light Brown	19.4	4.7	75.9	214.9	5.0	95.0
020315	I	7	4.5	White	5.3	6.6	88.1	252.3	7.7	92.3
	II	7	5.5	White	22.3	5.7	72.0	207.1	5.4	94.6
	III	7	5.5	White	21.3	4.4	74.3	209.8	5.6	94.4
	IV	7	5.5	White	24.1	5.7	70.2	202.2	5.5	94.5

Table 4: The elution test of PZC in different solutions

Lot No of PZC	Sample	First elution			Second to fifth elution		
		Elution Yield of Tc-99m (%)	Mo breakthrough		Elution Yield of Tc-99m (%)	Mo-breakthrough	
			μg Mo (*)	(%) (**)		μg Mo (*)	(%) (**)
020522	I	77.8	27.4	0.023	92.5 ± 0.5	27.8	0.020
	II*	80.7	196.6	0.168	94.5 ± 0.7	184.8	0.134
	III*	90.1	60.1	0.024	90.2 ± 0.5	34.3	0.014
	IV*	92.5	55.5	0.022	93.1 ± 0.3	31.2	0.012
010905	I	92.5	50.4	0.036	94.5 ± 0.5	25.1	0.017
	II	94.2	49.6	0.040	98.4 ± 0.6	22.5	0.017
	III	99.2	50.4	0.042	97.1 ± 0.6	21.4	0.018
	IV	99.5	52.8	0.039	98.2 ± 0.3	24.0	0.018
020315	I	92.4	43.2	0.035	92.8 ± 0.5	12.2	0.010
	II	96.4	40.0	0.033	97.5 ± 0.3	13.4	0.011
	III	98.0	35.2	0.028	98.5 ± 0.3	11.7	0.010
	IV	97.0	40.0	0.034	98.2 ± 0.3	16.2	0.013

Sample symbol:

(I) With normal condition of Mo-adsorption in water solution of Molybdate and Column washing with 50 ml distilled water, eluted with saline.

(II) With normal condition of Mo-adsorption in Acetate buffer solution of Molybdate and column washing with 50 ml distilled water, eluted with saline.

(III) With normal condition of Mo-adsorption in Acetate buffer solution of Molybdate added with H_2O_2 and column washing with 50 ml distilled water, eluted with saline.

(IV) With normal condition of Mo-adsorption in Acetate buffer solution of Molybdate added with CrO_4^{2-} and column washing with 50 ml distilled water, eluted with saline.

(II*) With normal condition of Mo-adsorption in water solution of Molybdate and Column washing with 20 ml solution of 0.2M KH_2PO_4, pH=6.2 followed by washing with 30 ml distilled water, eluted with saline

(III*) With normal condition of Mo-adsorption in water solution of Molybdate and Column washing with 20 ml solution of 9% NaCl followed by washing with 30 ml distilled water, eluted with saline

(IV*) With normal condition of Mo-adsorption in water solution of Molybdate and Column washing with 20 ml solution of Acetate buffer solution of 0.2M Acetic acid, pH=5, followed by washing with 30 ml distilled water, eluted with saline

(*) Total Molybdenum content in 8 ml eluate.
(**) Percentage of Mo-99 radioactivity in the eluate of Tc-99m.

C. Effect of the solution Mo-content on the Mo-adsorption capacity of PZC and on the Tc-99m elution yield and Mo-breakthrough of Tc-99m eluate.

The variable volumes (as specified in the Table 5 below) of the radioactive Mo-99 solution of concentration of 13.316 mg Mo / ml , pH=7 were added to PZC samples of 0.2 g weight, then these samples were gently shaked in water bath of 50 °C overnight. After shaking the samples were let to stand and a portion of clear supernatant solution were taken out to measure Mo-99 radioactivity for Mo-adsorption capacity calculation and then the remained solution was decanted to get the solid PZC part. This solid PZC was washed with 10 ml water followed by passing column with 10 ml saline. After this step first Tc-99m elution was started after 24 hours equilibration time and daily an elution was conducted.

Table 5 : Effect of the solution Mo-content on the Mo-adsorption capacity of PZC and on the Tc-99m elution yield and Mo-breakthrough of Tc-99m eluate.
(**) PZC sample, Batch Number: PZC020731
- Certified Mo- adsorption capacity: 265 mg Mo / g PZC
- Applied elution volume: 5 ml 0.9% NaCl

(*) Adsorption percentage (%) = 100 x $\frac{\text{Mo adsorption capacity}}{\text{Mo content of solution}}$

Sample **	PZC-IVA	PZC-IVB	PZC-IVC	PZC-IVD
Weight of PZC , (g)	0.20	0.20	0.20	0.20
Volume of Mo solution , (ml)	3.75	4.50	5.25	6.00
Mo-content of adsorption solution , (mgMo /g PZC)	249.67	299.61	349.54	399.48
Mo-adsorption capacity , (mg Mo / g PZC)	237.69	276.54	289.77	308.40
Adsorption percentage, (%) *	95.20	92.30	82.90	77.200
Tc-99m elution yield , (%)	74.10	92.70	84.00	81.00
Mo -Breakthrough in first elution ,(μg Mo/ml)	85.0	134.0	220.0	240.0
Mo -Breakthrough in second-to-fifth elution ,(μg Mo/ml)	2.0 ± 0.5	22.1 ± 0.8	43.5 ± 0.9	48.2 ± 0.8

The experimental results presented in Table 5 and on Figs: 2-3 revealed the fact that the Mo-adsorption capacity of PZC and Mo-breakthrough of Mo-PZC column decreased with the increasing Mo-content of adsorption solution. This is attributed to the excess of weakly bound Molybdate ion on the surface of PZC. This excess of Molybdate ion may block the pathway of Tc-99m pertechnetate ion out- diffusion and cause the lower Tc-99m elution yield observed on the right side of curve in fig. 3.

The lower Mo-content of adsorption solution has caused the unsaturated adsorption and left to some extent free active groups of high anion-affinity on PZC surface. The action of these groups may contribute a retention power to reduce Tc-99m elution yield and Mo-breakthrough in Tc-99m eluate.

In our experiment the adsorption percentage of around 90% was chosen as an optimal value for Mo-adsorption to give a ^{99}Mo- PZC column of highest performance.

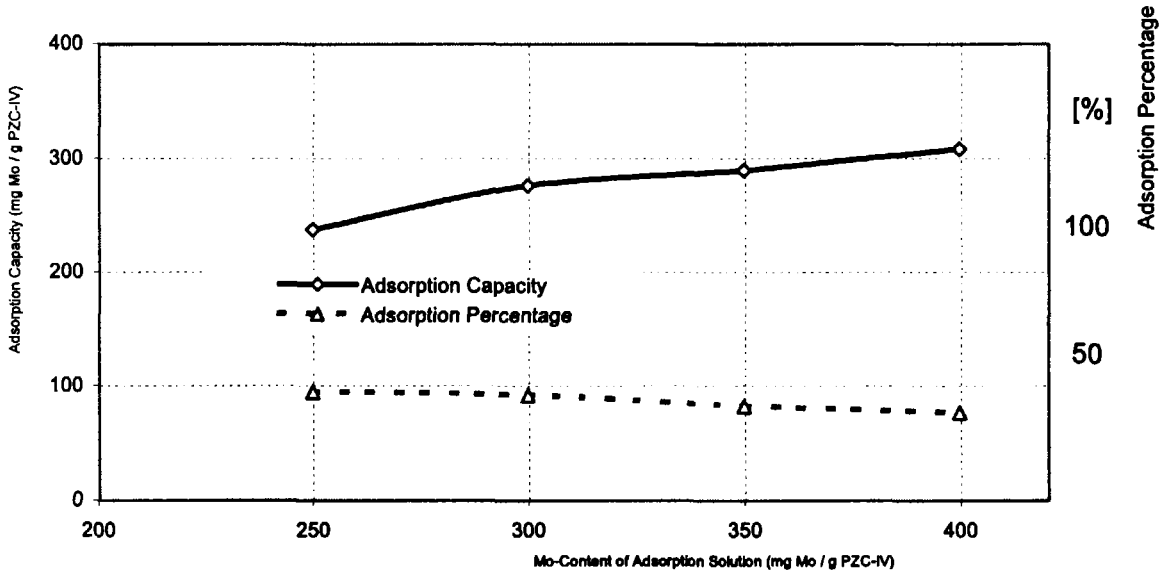

Fig.2 : Effect of Mo-content of adsorption solution on Mo-Adsorption and Adsorption percentage of PZC (Experimental Data Presented in Table:5)

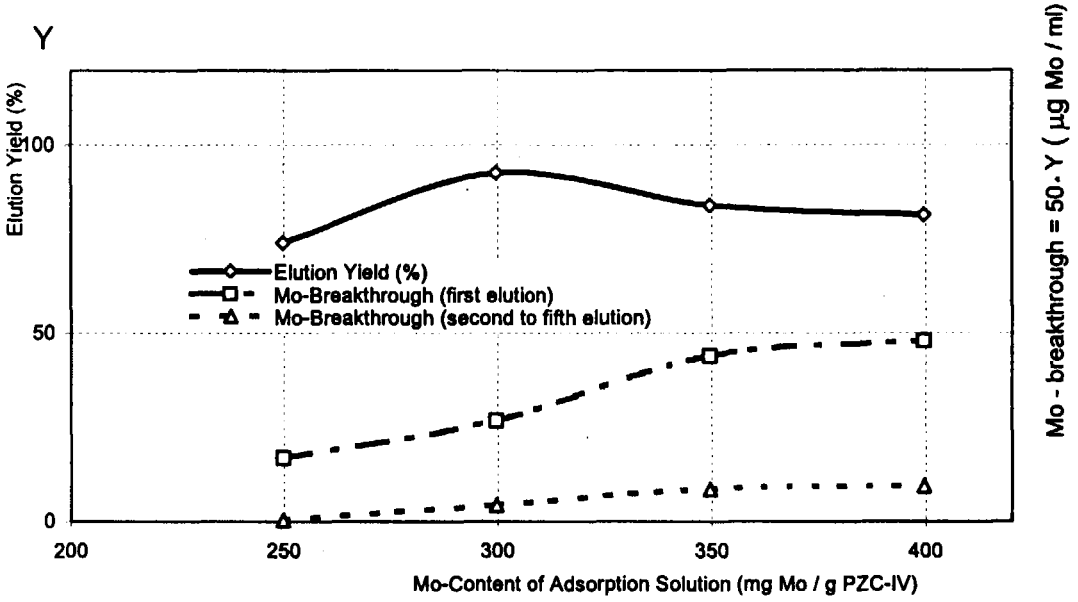

Fig. 3 : Effect of Mo-content of adsorption solution on Molybdenum element breakthrough and Tc-99m elution yield of Mo-99 PZC column (Experimental Data Presented in Table:5)

D. Practical application of PZC for Tc-99m generator preparation using Mo-99 solution of low specific radioactivity.

Based on the results obtained above and the available radioactivity of Mo-99 solution produced on the Nuclear research reactors of thermal neutron flux ranging from 10^{13} n.cm^{-2}.sec^{-1} to 10^{14} n.cm^{-2}.sec^{-1}, a column of 4 gram PZC packing was chosen to prepare the Tc-99m generators of radioactivity changing from 100 mCi to 1000 mCi Mo-99 (see Table 6 below and Fig.4).

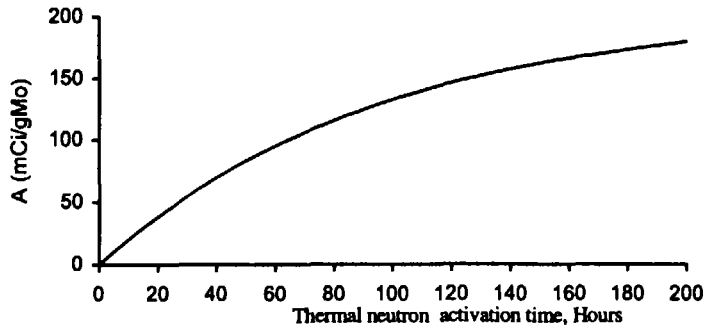

Fig.4 : Thermal neutron activation of natural Molybdenum in a nuclear reactor of thermal neutron flux of 10^{13} n.cm^{-2}.sec^{-1} .

Table 6 : Tc-99m generator production capability using a PZC column of 4 gram weight and of 250 mg Mo/g PZC Mo-adsorption capacity in the nuclear reactors of different neutron flux . Irradiation time : 186 hours continuously

Thermal neutron flux ($n.cm^{-2}.sec^{-1}$)	10^{13}	2.5×10^{13}	5×10^{13}	10^{14}
Mo-99 radioactivity at E.O.B	164.88 mCi	412.2 mCi	824.4 mCi	1648.0 mCi
Mo-99 radioactivity after one day cooling time and one day of generator preparation .	100.10 mCi	250.2 mCi	500.4 mCi	1000.8 mCi

(The values in the Table 6 were calculated for one gram weight of Molybdenum equivalent to Mo content of 4 gram PZC column.)

The following conditions for generator column preparation were established:

- PZC weight: 4g
- Mo absorption capacity of PZC: 265mgMo/g PZC
- Molybdenum adsorption percentage: 90%
- Total Mo content of PZC column: (4g PZC x 265mgMo/PZC) = 1060 mg Mo
- Total Mo content of adsorption solution: 1060: 90 % = 1178 mg Mo (Equivalent to 1768 mg MoO_3)
- Volume of 6M NaOH solution for dissolution of MoO_3 target: 4.42 ml (Concentration of Molybdenum in solution : 266.5 mg Mo/ml)
- Volume of H_2O_2 solution of 30% concentration for oxidizing Mo^{+5} to Mo^{+6} : 2,0ml
- Volume of H_2O for diluting Mo solution: 15.7ml (total volume: 22.1ml ; Mo concentration: 53.3 mg Mo/mg)
- Adequate amount of 1M HCl solution and H_2O were added to adjust pH to pH=7 and volume of final solution to V= 88.7ml, respectively (Mo- concentration: 13,325 mg Mo/ml) .
- This radioactive Mo-99 solution was added to PZC sample of 4-gram weight and gently shaked at 50^0C overnight, then let it to stand for 30 minutes. The supernatant solution was decanted and solid part of PZC was loaded in a 8 ml volume glass column of G-3 sintered glass filter, then PZC column was washed with 100ml H_2O, closed with septa and aluminum cap and autoclaved at 120°C for 30 minutes. Then PZC column was conditioned with 50ml sterile 0,9% NaCl solution. The Mo-99 radioactivity of column was measured using a Dose calibrator before being assembled in a generator body.
- The Tc-99m elution was conducted daily after equilibration of 24 hours.

As an example, a target of 1768 mg MoO_3 was irradiated in DaLat nuclear research reactor of thermal neutron flux of $2,1.10^{13}$ $ncm^{-2}.sec^{-1}$ for 100 hours continuously. After neutron activation the target was cooled for 11 hours and processed (Mo-99 dissolution and adsorption on a 4-gram PZC column) as mentioned above. This process has taken 24 hours. Following this the Tc-99m elution was conducted daily after equilibration of 24 hours. The results obtained from this generator were presented in table 7.

The good performance of this generator gave a Tc-99m pertechnetate solution reaching the requirement of European Pharmacopoeia. To fulfill the requirements of American and Japan Pharmacopoeia, this generator should couple with an Alumina clean-up column of about 2 gram weight to reduce the Mo-breakthrough lower than 0.015%.

Table 7: Testing results on the 99mTC generator preparation using PZC adsorbent (PZC , Lot No : PZC020731)

MoO_3 target weight (g)	Total Mo-99 radioactivity of Mo-solution (mCi)	Mo adsorption percentage (%)	Mo-adsorption capacity of PZC column of 4 gram weight (mg)	Mo-99 radioactivity adsorpted in solid PZC (mCi)	Mo-99 radioactivity of PZC column at delivering point of time (mCi)	Tc-99m elution yield (%)		Molybdenum element and Mo-99 breakthrough in 15 ml eluate	
						With 15 ml saline	With 25ml saline	Mo-99 radio activity percentage in Tc-99m solution (%)	(μg Mo/ml)
1.768 (1.178) gram Mo	111.20	90.00	1060.00	100.10	93.50	78.3 ± 0.6	91.2 ± 0.5	0.017 ± 0.002	4.5 ± 0.5

Production timetable:

- **21:00, Sunday:** EOB -----11 hour cooling ------**8:00, Monday:** Start MoO_3 target dissolution and PZC based generator preparation -------24 hour process -----**8:00, Tuesday:** Deliver Tc-99m generator.
- Total time elapsed after EOB until delivery: 35 hours.

CONCLUSION

The experimental results reveal the fact that PZC adsorbent has good performance for the preparation of chromatographic Tc-99m generator.
The Molybdenum adsorption capacity of PZC and its Tc-99m elution yield were not strongly affected by the column treatment conditions and composition of adsorption solution. The Molybdenum breakthrough of Tc-99m eluate eluted from PZC column was sensitive to Mo-adsorption and PZC column treatment conditions. A good relationship between the Mo-content of adsorption solution and the Mo-adsorption capacity , adsorption percentage , Mo-breakthrough and Tc-99m elution yield was found. So the optimal parameters for Mo-99 adsorption and Tc-99m generator column preparation were successfully found for the production of a Tc-99m generator giving a Tc-99m pertechnetate solution reaching the requirements of the International pharmacopoeia.
The main parameters of PZC based Tc-99m generator were stated as follows: Mo-adsorption capacity of higher than 250 mgMo/g PZC and Tc-99m elution yield of higher than 80% were found with PZC adsorbent. Mo-99 breakthrough of lower than
0.015% for a generator system of Mo-99 PZC column coupled with a clean-up Alumina column and Molybdenum element breakthrough of around 5 μg Mo/ml were found in Tc-99m eluate.

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