BM-3252 MEDICAL PHYSICS

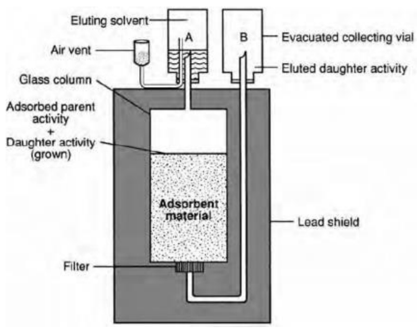
UNIT II

Radionuclide Generators

- Radionuclide generators provide the convenient sources of short-lived radionuclides that are very useful clinically.

The basic requirements for a generator are that a parent radionuclide has a longer half-life than that of the daughter, and the daughter can be easily separated from the parent. In a generator, a long-lived parent radionuclide is allowed to decay to its short-lived daughter radionuclide, and the latter is then chemically separated.

- The importance of radionuclide generators lies in the fact that they are easily transportable and serve as sources of short-lived radionuclides in institutions without cyclotron or reactor facilities.
- A radionuclide generator consists of a glass or plastic column fitted at the bottom with a fretted disk.
- The column is filled with adsorbent material such as ion exchange resin, alumina, and so forth, on which the parent nuclide is adsorbed.
- The parent decays to the daughter until transient or secular equilibrium is established in several half- lives of the daughter.
- After equilibrium, the daughter appears to decay with the same half-life as the parent.
- Because of the differences in chemical properties, the daughter activity is eluted with an appropriate solvent, leaving the parent on the column.
- After elution, the daughter activity builds up again and can be eluted repeatedly.
- The vial containing the elutant is first inverted onto needle A, and an evacuated vial is inverted on the other needle B.



- The vacuum in the vial on needle B draws the eluant from the vial A through the column and elutes the daughter nuclide, leaving the parent nuclide on the column.
- In some commercial generators, a bottle of eluant is placed inside the housing, andaliquots of eluant are used up in each elution by the evacuated vial.
  - An ideal radionuclide generator should be simple and sturdy for transportation. T
- he generator eluate should be free of the parent nuclide and the adsorbent material.
- Several radionuclide generators are available for ready supply of short-lived radionuclides: ^{99}Mo(66hr)–^{99m}Tc(6hr); ^{113}Sn(117 days)– ^{3m}In(100 min); ^{68}Ge(271 days)–^{68}Ga(68min); ^{82}Sr(25.6 days)–^{82}Rb(75sec); ^{81}Rb(4.6 hr)–^{81m}Kr(13sec).

Technetium Generator

- The technetium generator is constructed with alumina (Al_2O_3) loaded in a plastic or glass column.
- The ^{99}Mo activity is adsorbed on alumina in the chemical form MoO_4^{2-} (molybdate) and in various amounts.
- The amount of alumina used is about 5–10 g depending on the ^{99}Mo activity. Currently, all generators use fission-produced ^{99}Mo.
- The ^{99m}Tc activity is eluted with 0.9% NaCl solution (isotonic saline) and obtained in the chemical form of $Na^{99m}TcO_4$.
- Considering that only 87% of ^{99}Mo decays to ^{99m}Tc, the ^{99m}Tc activity A_{Tc} can be calculated from equation as follows:

$$A_{\mathrm{Tc}} = 0.957(A_{\mathrm{Mo}})_0(e^{-0.0105t} - e^{-0.1155t})$$

- where $(A_{Mo})_0$ is the ^{99}Mo activity at t = 0, λ_{Mo} = 0.0105 hr−1, and λ_{Tc} = 0.1155 hr−1. The time t has the unit of hour. At transient equilibrium,

$$A_{\mathrm{Tc}} = 0.957(A_{\mathrm{Mo}})_0 e^{-0.0105t}$$
$$= 0.957(A_{\mathrm{Mo}})_t$$

- Upon elution with saline, approximately 75% to 85% of the total activity is eluted from the column. After about 4 half-lives, the ^{99m}Tc activity reaches maximum.

- Moly generators are typically delivered with approximately 37 to 111 GBq (l to 3 Ci) of Mo-99, depending on the work load of the department.
- The activity of the daughter at the time of elution depends on the following:
    - The activity of the parent
    - The rate of formation of the daughter, which is equal to the rate of decay ofthe parent
    - The decay rate of the daughter
    - The time since the last elution
- The elution efficiency (typically 80% to 90%).