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COIMBATORE-641 035, TAMIL NADU

Department of Biomedical Engineering

Course Code & Name: 19BME301 & Medical Physics

III Year : V Semester

Unit III – PRODUCTION OF RADIONUCLIDES

Cyclotron-Produced Radionuclides

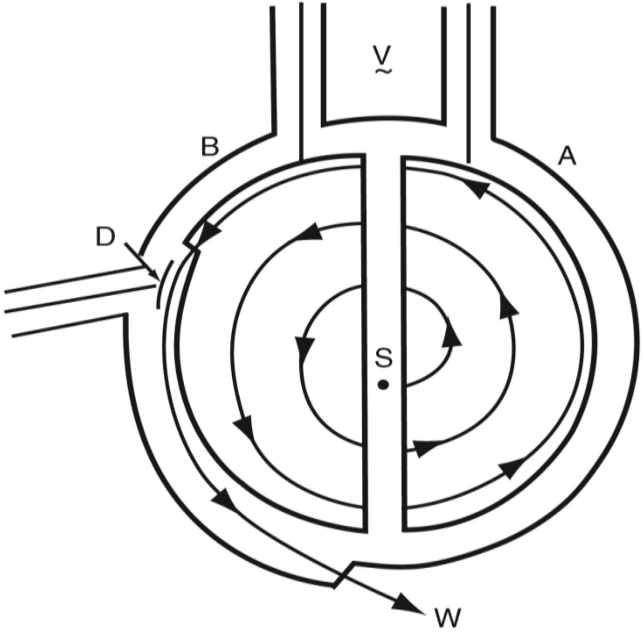
- For radionuclide production in nuclear medicine, cyclotrons are commonly used.

- Charged particles can be accelerated under an electromagnetic field in cyclotrons or linear accelerators to have high kinetic energy, which are then allowed to react with stable nuclides to cause nuclear reactions producing different radionuclides.

- Both positively charged (protons, *α-particles) or negatively charged (H−) particles* can be accelerated in cyclotrons,

construction

- consists of two hollow D-like copper structures called “dee” separated by a small gap.

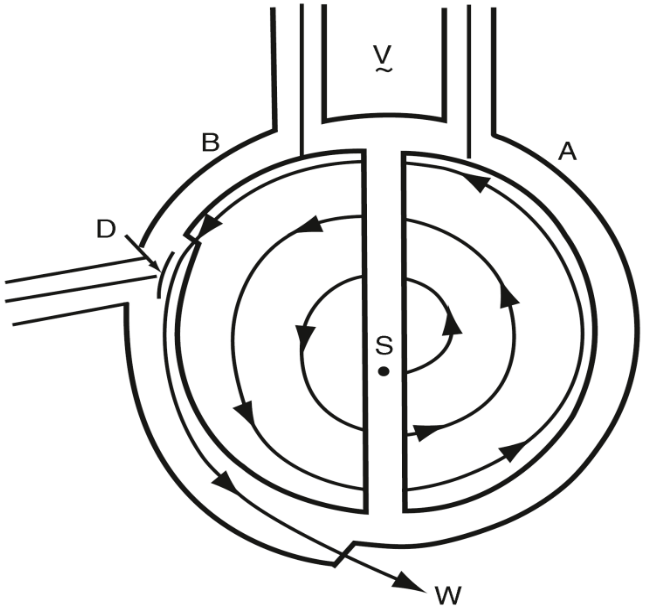


- The dees (A & B) are kept in a high vacuum tank, and an electromagnetic field is applied between them.
- Positive or negative ions are produced in an arc ion source at the gap, which are then attracted toward the oppositely charged dee.
- The magnetic field then bends them in a circular path instead of letting them in a straight path.

- When the charged particles arrive at the gap, the electrical polarity is changed, by which the particles are repelled by the like charges and attracted by the opposite charges, thereby gaining further acceleration.

- This scenario happens every time the particles cross the gap between the two dees and approach toward the periphery with increasing energy.

- Ultimately the particles are deflected outside in the form of a beam by a deflector D through a window W.



- The kinetic energy of the particles depends on the charge (e) and mass (m) of the particle, the magnetic field (H) in Gauss, and the radius (r) of the cyclotron, as given below:

$$K.E. = \frac{H^2 e^2 r^2}{2m}$$

- Medical cyclotrons are compact negative ion cyclotrons that are commonly used for production of short-lived radionuclides such as 18F, 11C, 13N, 15O, and so on used in positron emission tomography (PET) imaging

- The typical energy of the medical cyclotrons ranges between 3–18 MeV.