UTILIZATION OF 30MEV DAE MEDICAL CYCLOTRON FOR PRODUCTION OF MEDICALLY USEFUL RADIOISOTOPES AND CORRESPONDING RADIOPHARMACEUTICALS

Pradip MUKHERJEE
BRIT, Mumbai, India

Sankha CHATTOPADHYAY
BRIT, Kolkata, India

Cyclotrons are extensively used to produce radioisotopes for diagnostic and therapeutic use for cancer care. In India, the IBA Cyclone-30, 30MeV, 350µA proton cyclotron has been commissioned and made operational in September 2018 for the production of radioisotopes/radio pharmaceuticals for medical application. This cyclotron has the potential to produce SPECT (Single-Photon Emission Computed Tomography) Isotopes (^{67}Ga, ^{111}In, ^{123}I, ^{201}Tl etc.), PET (Positron Emission Tomography) isotopes (F-18, Ge-68/Ga-68 generator for in situ production of Ga-68, Ga-68, Cu-64, Zr-89, I-124 etc.) and therapeutic isotope like Pd-103. Here, we report the production of ^{18}F-FDG, ^{68}Ga-PSMA, ^{68}Ga-DOTATATE and ^{201}TlCl radiopharmaceuticals using Cyclone-30. The specification of the radiopharmaceuticals complies with norms of the regulatory bodies in India. Presently, India is importing long lived SPECT Isotopes. Indigenous production of RI is going to be a boon to make the treatment cost more affordable.

The production of ^{18}F was achieved by irradiating $H_2{}^{18}O$ using IBA niobium target assembly (1.8ml in 2.4ml Nb target cavity) with 18 MeV, 35-40µA average proton beam current for 1 to 2 hrs. and subsequent production of ^{18}F-FDG has been carried out in hotcells (Comecer, Italy) using IFP (integrated fluid processor) cartridge in IBA synthera module. The production yield of ^{18}F-FDG varies from 65-70 % (without decay correction). The radiochemical purity of the ^{18}F-FDG has been found to be 99.9% by using TLC method. The radionuclidic purity was greater than 99.99% (determined by HPGe). Regular production and supply to hospitals have been started after obtaining necessary regulatory clearances. Supply logistics for the short-lived isotopes are usually challenging and the same was resolved through meticulous transport planning and optimizing the procedures and resources.

The SPECT isotope ^{201}Tl ($t_{1/2}$= 73.06 hours) in the form of ^{201}TlCl is a diagnostic myocardial flow tracer to detect coronary artery disease and to assess myocardial viability, with an accuracy comparable to that of positron emission tomography. ^{201}Tl was produced in 30 MeV cyclotron using electroplated enriched ^{203}Tl target via ^{203}Tl(p,3n)^{201}Pb→^{201}Tl (^{201}Pb decayed for ~32h to ^{201}Tl) nuclear reaction utilizing 28MeV proton beam energy and 50µA beam current for up to 6-8h. The production of ^{201}TlCl has been carried out in hot cells and automated radiochemistry module.

At present, the supply of Ga-68 for medical imaging is primarily based on the imported [^{68}Ge]Ge/[^{68}Ga]Ga generator ($t_{1/2}$ of Ge-68 : 271 days; $t_{1/2}$ of Ga-68 : 68 min). Since these commercial generators can deliver only a limited amount of activity and the demand for Ga-68 is high, an effort has been made to produce Ga-68 directly from the cyclotron and supply to the nearby hospitals at a much affordable price. We have produced Ga-68 directly from electroplated enriched ^{68}Zn target via ^{68}Zn(p,n)^{68}Ga nuclear reaction. The enriched ^{68}Zn electroplated on the copper base material were irradiated with 15 MeV proton beam energy and current 40-60 µA in the Cyclone-30 cyclotron for 30-60 minutes. The irradiated target was transferred to the processing hotcell (100 mm lead shield) from the irradiation station by remote-controlled rabbit transport system to complete radiochemical

processing in 30-45 minutes. The Ga-68 chloride produced was labelled with PSMA-11& DOTA-TATE ligands. The R.N. Purity of ^{68}Ga-chloride was found to be 99.90-99.99%. The R.C. Purity of ^{68}Ga-PSMA &^{68}Ga-DOTA-TATE was >95%.

Potential of the 30 MeV cyclotron is immense. The complete utilization of this Cyclotron is going to bring a paradigm shift in the use nuclear medicines in the country to offer a more affordable cancer care.