Development of [NH_3] Ammonia target for Cyclone-30 at KFSH&RC

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Introduction

Nitrogen [^{13}N] NH_3 is a liquid radioisotope, produced by medical cyclotrons for nuclear medicine application and widely applied for evaluation of myocardial perfusion in clinical assessments [1,2]. Owing to its short half-life (10 minutes), the unloading procedure of the radioactive solution of [^{13}N]NH_3 from the target is crucial in saving the activity produced for patient. Therefore, an efficient technique in unloading the radioactive solution from the target body was developed using COMSOL Multiphysics®. The new design of the target with improved unloading technique resulted in 30% increase of the available ^{13}N activity. In our experiments, ^{13}N was produced by the ^{16}O(p,α)^{13}N reaction. The energy of proton beam was 16.5 MeV.

Material and Methods

A 2D model was developed using COMSOL Multiphysics to simulate the inner geometry of [^{13}N] Ammonia target. In the 2D model, water and aluminum were used as materials for the inner body and outer boundary (walls), respectively. The physical equations used to solve the problem of allocating proper place for the loading/unloading opening is turbulent, k-ε Module being extracted from fluid flow module. FIGURE 1 shows the result of simulating water flow on the target water channels. The entrance of the pushing solution (for unloading) was designed to create a turbulent flow inside the target body and, hence, to collect most of the activity inside the target.

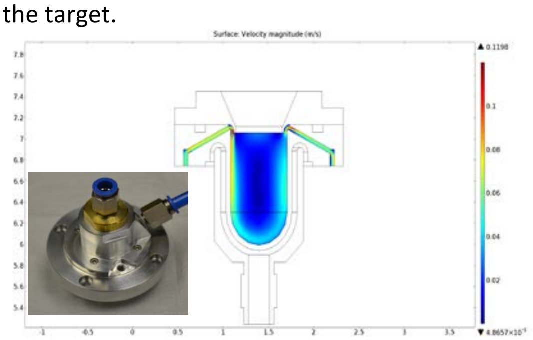

FIGURE 1. Simulation results suggested by COMSOL and photo of the target after fabrication

FIGURE 2 shows the setup for ^{13}N production. A peristaltic pump is used to push the solution after irradiation to the hotcell at 6 ml/min flow-rate. The distance from the target to the hotcell is approximately 30 meters.

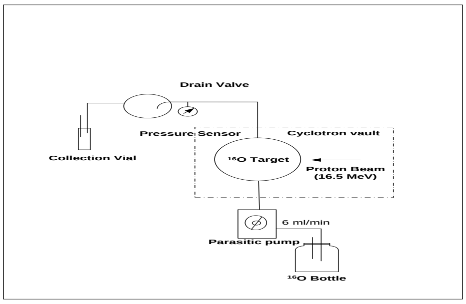

FIGURE 2. Schematic diagram for ^{13}N production

Results and Conclusion

FIGURE 3 presents activity produced in milicurie (mCi) for several patient runs. The activity obtained in some experiments reached up to 330 mCi when we irradiated the target with 25 µA for 15 min. This was satisfactory for delivery to the patient at the nuclear medicine department. Moreover, purity of [^{13}N] purity was above 95 % what meets the standard regulation for administration to a patient.

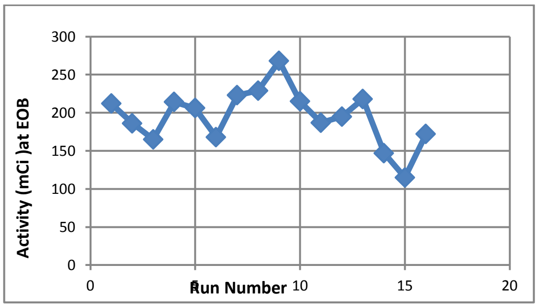

FIGURE 3. Activities produced at EOB

References

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