CANS PRODUCTION OF TECHNETIUM-99M AND TECHNETIUM-101

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Technetium-99m (^{99m}Tc, $t_{1/2}$ = 6.007 h) has been widely used for radiodiagnostic purposes for decades, and it is still one of the most used radioisotopes worldwide with an estimated 40 million doses consumed annually. Tc-99m can be produced through various nuclear transmutation methods, but commercially speaking, it is generally derived from molybdenum-99 (^{99}Mo, $t_{1/2}$ = 65.925 h), where the origin of it is dependent upon chemistry and isotopic composition of the target material, e.g., natural or enriched Mo, or enriched ^{235}U targets. However, the production and distribution of ^{99m}Tc relies on a complex supply-chain that has proven itself prone to disruptions in years past and was most recently observed during the SARS-CoV-2 pandemic.[1] Ultimately, this leads to delays on diagnoses of patients due to postponed imaging procedures as well as the loss of material and capital.

As a solution to this problem, the deployment of a decentralised network of compact accelerator neutron sources (CANS) for producing ^{99m}Tc and ^{101}Tc ($t_{1/2}$ = 14.22 min) using the (n,γ) reaction on Mo-based targetry has been proposed.[2] For example, the use of fusion-driven deuterium-deuterium (D-D) neutron generators for producing both ^{99m}Tc and ^{101}Tc has been demonstrated along with their subsequent isolation using a separation tailored for low-specific activity ^{99}Mo targets.[2]

Another under-utilised source of neutrons already being generated in this fashion is during the production of many positron emission tomography (PET) radionuclides in cyclotrons, where parasitic neutrons are liberated from the cyclotron target, e.g., ^{18}O(p,n)^{18}F. The implementation of larger production batches, high yield targetry, and more production runs are all complementary to generating neutrons. From this, the hybridised production of ^{99m}Tc and ^{101}Tc concurrently during [^{18}F]FDG has been demonstrated and its feasibility explored (FIG. 1).[3]

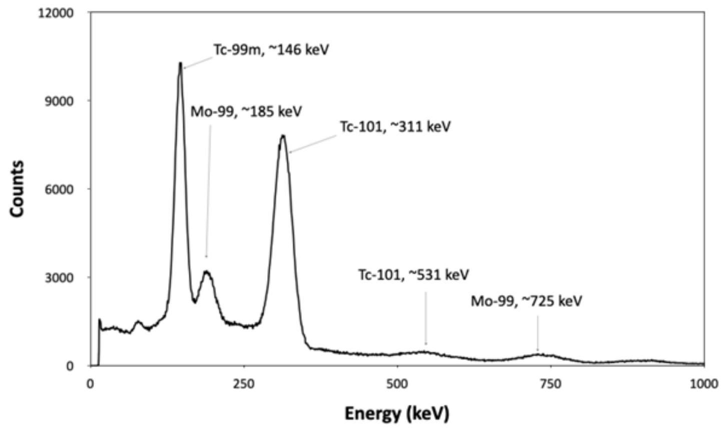

FIG. 1. NaI gamma spectrum of Mo / Tc isotopes generated from the irradiation of a natural Mo target during [^{18}F]FDG manufacturing

The aim of the work presented herein is to compare various CANS production modes for ^{99m}Tc and ^{101}Tc production in regard to their subsequent applications. Further, it provides potential alternatives for the future production of radiopharmaceuticals, meanwhile meeting the objectives of several Unesco and sustainable development goals.

REFERENCES

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