Feasibility study for ^{99m}Tc production

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This report presents an initial survey of data for a feasibility study on the production of the ^{99m}Tc radioisotope on the Cyclotron model CV-28 installed at the IEN. Due to the global crisis in the supply of ^{99m}Tc due to an unscheduled shutdown of a reactor by one of the major suppliers of this radioisotope, new alternatives have been sought for emergency production of ^{99m}Tc. One proposal involves irradiating a molybdenum target with a proton beam. There are four main nuclear routes for the production of the ^{99m}Tc metastable isotope through bombardment with protons, only direct production, where ^{99m}Tc is the final product, which occurs through the ^{100}Mo(p,2n)^{99m}Tc reaction. The other three are indirect production routes: i) through the ^{100}Mo(p,pn)^{99}Mo reaction and the ^{99}Mo decay by ^{99m}Tc beta emission; ii) through the ^{100}Mo(p,2p)^{99}Nb reaction and the decay from ^{99}Nb to ^{99}Mo and by beta emission to ^{99m}Tc; iii) through the ^{98}Mo(p,γ)^{99m}Tc reaction. Natural molybdenum has an abundance of 9.63% for the ^{100}Mo isotope (see Table 1).

Table 1 – Isotopic composition of natural abundance molybdenum

Isotope	Natural abundance
^{92}Mo	14.84%
^{94}Mo	9.25%
^{95}Mo	15.92%
^{96}Mo	16.68%
^{97}Mo	9.55%
^{98}Mo	24.13%
^{100}Mo	9.63%

At first, data were investigated regarding the cross section of the ^{100}Mo(p,2n)^{99m}Tc excitation function with other functions. In Figure 1, the cross section values for various reaction energies ^{100}Mo(p,2n)^{99m}Tc are compared with other cross section values of other technetium isotopes produced through the reaction (p,2n).

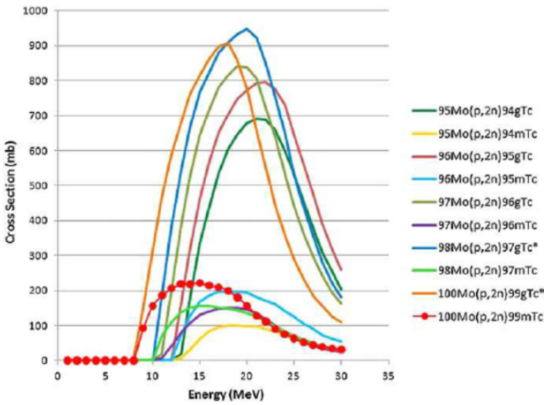

Figure 1. Comparison between the cross section reaction ^{100}Mo(p,2n)^{99m}Tc with other technetium isotopes produced through the reaction (p,2n)[1]

The production of ^{99m}Tc through the ^{100}Mo(p,2n)^{99m}Tc reaction begins to occur with an energy of around 9 MeV, reaching its peak between 15 and 16 MeV. The production yield of ^{99m}Tc also depends on the irradiation time. A major obstacle to the production of ^{99m}Tc through bombardment of protons on a natural molybdenum target is the large cross section of other technetium isotopes, which are undesirable at first when compared to direct production: ^{100}Mo(p,2n)^{99m}Tc. These isotopes, in addition to being undesirable, are chemically inseparable from ^{99m}Tc, which impairs the final quality of the radioisotope. A solution found to minimize the production of undesirable isotopes is the irradiation of a molybdenum target enriched with the ^{100}Mo isotope. For a next step, the project will now focus on assessing the availability and cost of molybdenum enriched with ^{100}Mo. Samples of natural molybdenum will also be irradiated on CV-28 so that the production level of ^{99m}Tc and other isotopes is measured. This measurement will enable an economic evaluation of the production of ^{99m}Tc through the irradiation of natural molybdenum.

References

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