Targeted Copper Radioisotopes for Nuclear Medicine: Production of ^{64}Cu from ^{nat}Ni by Cyclotron and ^{67}Cu by Reactor

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Introduction

The Copper is one of the most important trace elements in the biosphere. Its importance in blood system and chelate bonds to the bioactive macro-peptides are well known. The nuclear medical applications of Copper radioisotopes such as ^{64}Cu also have wide literature. The ^{67}Cu became the target of the scientific interest due to the optimal nuclear properties for nuclear medicine. The optimal production of these isotopes in quality of high specific activity is different. For production of ^{64}Cu it is more preferable to apply the ^{64}Ni(p,n)^{64}Cu nuclear reaction by cyclotron, as can be seen in Fig. 1. The production of ^{67}Cu is possible using the ^{67}Zn(n,p)^{67}Cu nuclear reaction by nuclear reactor (see Fig. 2).

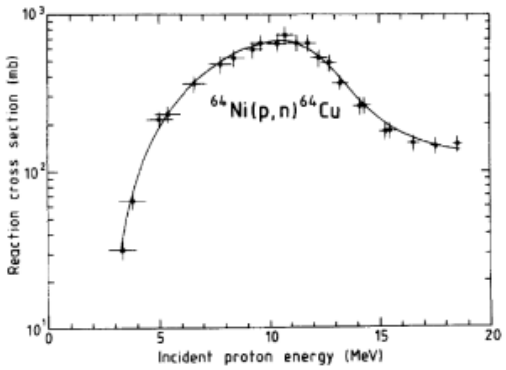

Figure 1. Cross section curve of ^{64}Ni(p,n)^{64}Cu [1]

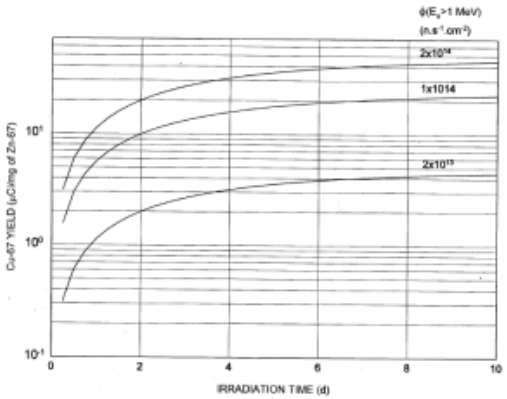

Figure 2. Target yield of ^{67}Zn(n,p)^{67}Cu [2]

Theoretically the ^{64}Ni(α,p)^{67}Cu and ^{64}Ni(^{7}Li,α)^{67}Cu are also useable to produce the ^{67}Cu, but the Atomki's cyclotron isn't dedicated for that reactions. However for that two radioisotopes have two different production routes, both radioisotopes can be separated by the same chemical method.

The strength of complexation of metal ions with chloride ions depends of the concentration of chloride ion. This is the theoretical background for separation of different transition metal ions by ion-chromatography [3].

Experiment

Due to the extremely expensive price of the enriched ^{64}Ni the natural Ni was used for the irradiation (15 MeV proton beam with 20 μAs intensity). In case of Ni target the separation was carried out in 4 moldm^{-3} HCl media, when the Ni^{2+} ions went through the anion-exchanger column as effluent and after that the ^{64}Cu was washed out by water. However the contaminating ^{56,57,58}Co radioisotopes originated from the side reaction were also separated when the Co^{2+} also eluted in the effluent together with the Ni^{2+} ions. The 10 times higher dose rate of the Co radioisotopes compared to the dose rate of ^{64}Cu is a real disadvantage of the procedure. The same anion-exchanger is also suitable for separation of the ^{67}Cu from the irradiated ^{67}Zn, only we have to use different HCl media: 8mol/dm^3. In this case the ^{67}Cu will be in the effluent.

Results

The separation by ion exchange method is a powerful tool to get the stock solution of ^{64}Cu and ^{67}Cu radioisotopes for labelling procedure in nuclear medicine. The separation ratio on ion exchange column for ^{64}Cu versus Co radioisotopes was enriched a value of 377. Therefore the ^{64}Cu ions in the product were 265 times more than Co ions. However the one magnitude higher dose-rate of the Co isotopes comparing to the ^{64}Cu in the irradiated target limits the further investigation with the ^{64}Cu source.

Conclusion

The Copper radioisotopes are intensively used in nuclear medicine for PET diagnostic as well as for the targeted radionuclide therapy. This paper suggest a cheap production way for the famous ^{64}Cu and ^{67}Cu and an easy and same radiochemical separation for both radioisotope in range of few MBq of radioactivity, which would be eligible for the small animal PET study.

References

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