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PRODUCTION OF ^{57}Co, ^{109}Cd, ^{111}In and ^{117m}Sn USING CV-28 CYCLOTRON AT IPEN-CNEN/SP

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Several radioisotopes produced in Cyclotrons have physical properties of decay suitable to be used as: radiopharmaceuticals, for *in vivo* Diagnosis images (with the techniques of *SPET* and *PET*, *Single Photon Emission Tomography* and *Positron Emission Tomography*, respectively) and for Therapy, in Nuclear Medicine; calibration sources of several instruments applied in the nuclear area and in Metrology; and as radioactive tracers of elements investigated in many fields, such as Chemistry, Physics and Biology.

This work describes the production of four of these radioisotopes that are very important in these areas: ^{57}Co, ^{109}Cd, ^{111}In and ^{117m}Sn. They can be obtained using the *CV-28* Cyclotron at *IPEN*, because it can accelerate proton beams with energies up to 24MeV and currents up to 20μA (external).

^{57}Co ($t_{1/2}$ = 271.3 d) decays by electron capture to ^{57}Fe with the emission of γ-rays and one characteristic X-ray. It is widely used as calibration source of detectors such as: Ge(Li), Ge(HP), NaI(Tl) and dose calibrators (well type detectors). Besides these applications, ^{57}Co *Flood Sources* are used to test the response uniformity of gamma cameras, in Nuclear Medicine.

^{109}Cd has a half-life of 462.6 d and decays by electron capture to ^{109}Ag with the emission of one γ-ray and one characteristic X-ray. This radioisotope can be employed as calibration source of X-ray and γ-rays detectors; as a radioactive tracer of Cd, an environment pollutant and used in the *EDXRF (Energy Dispersion X-Ray Fluorescence)* technique.

^{57}Co was produced through the irradiation of ^{nat}Ni. Thick target yields for ^{55}Co, ^{56}Co, ^{57}Co, ^{58}Co, ^{56}Ni and ^{57}Ni were measured and the mean values were 346.69kBq/μA.h (9.37μCi/μA.h), for the direct production of ^{57}Co and 150.59kBq/μA.h (4.07μCi/μA.h), through the decay of ^{57}Ni (11.31days after *EOB - End of Bombardment*). A solution of $^{57}CoCl_2$ was prepared, to fill a *flood source* for calibration of gamma camera, with activity of 222MBq (6mCi) of ^{57}Co and impurity levels of 1.13 and 1.29% for ^{56}Co and ^{58}Co, respectively, at delivery time. In order to achieve these results, a chemical separation method was developed with a separation yield of 93% for ^{57}Co and a negligible loss of Ni. A composite target of Ni and Ag was prepared and a chemical separation method proposed to allow the separation between the targets and the products of interest, ^{57}Co and ^{109}Cd. The yields obtained in the irradiation of the composite target were: 947.94kBq/μA.h (25.62μCi/μA.h) of ^{57}Co - direct reaction, 259.00kBq/μA.h (7μCi/μA.h) of ^{57}Co - indirect reaction (11.31days after *EOB*) and 71.41kBq/μA.h (1.93μCi/μA.h) of ^{109}Cd, which showed the efficiency of its use, as well as the chemical separation, with a yield of 80% for ^{57}Co and ^{109}Cd [1].

^{111}In ($t_{1/2}$ = 67.5 h) has appropriate characteristics for Diagnosis in Nuclear Medicine due to its decay mode (100% by electron capture) and its adequate half-life to slow biological studies, that makes it one of radioisotopes of interest of Brazilian Physicians. It can also be used in angular correlation studies in Nuclear Physics. ^{111}In was produced by the

$^{112}Cd(p,2n)^{111}In$ reaction, that has the highest yield. The Cd targets were prepared by electroplating of $CdSO_4$ solution in copper and copper/nickel backings. After being irradiated, a chemical separation was performed by an acetic acid extraction method, with an overall recovery yield for ^{111}In higher than 95%. The level of the chemical impurities of Cd, Ni and Cu were bellow than the permissible values [2].

^{117m}Sn ($t_{1/2}$ = 14 d) has suitable characteristics of decay to be used as a tracer of $SnCl_2$ in the labeling of organic molecules with ^{99m}Tc and also in radiotherapeutical applications. It was prepared by the irradiation of natural tin through the nuclear reactions $^{nat}Sn(p,xn)^{117}Sb \rightarrow {}^{117m}Sn$. The production thick target yield of ^{117m}Sn was 784.4kBq/μA.h (21.20μCi/μA.h) and with the proper decay time of its precursor, ^{117}Sb, no radionuclidic impurities appeared in the final product. A chemical separation method was developed to separate first ^{117}Sb from the irradiated Tin and then ^{117m}Sn from Sb with a good chemical yield. The quality control procedures showed the good quality of the final product, ^{117m}Sn [3].

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