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Isotopic effect observed by distillation of ¹²³I and ¹²⁴I from irradiated ¹²⁴TeO₂ target matrix

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Non-conventional longer-lived PET radionuclides with half-life higher than that of ¹⁸F (109 min) are very promising PET tracers for imaging of biochemical processes or body structures requiring slower kinetics. Among them, ¹²⁴I (4.18 d) plays an important role. Radiochemistry of iodine radioisotopes (¹²³I, ¹²⁴I, ¹²⁴I, ¹²⁵I and ¹³¹I) is well known. Widely used production process of ¹²⁴I is based on the (p,n) reaction on highly enriched ¹²⁴TeO₂ (99.4 %), and distillation of iodine from irradiated target matrix at temperatures slightly above the melting point of TeO₂ (733 °C). Depending on the entrance beam energy, some amount of ¹²³I can be produced by the (p,2n) reaction (E_{thr} ≈ 11.5 MeV).

For production we have developed our own target system. Target layer is water and helium cooled. The target was irradiated at the beam angle 10° in order to increase effective thickness of the target layer and to get more favourable distribution of the beam over the target area. The entrance proton beam energy varied between 11.5 and 13.2 MeV, beam currents were 10–22 μ A and irradiation times 0.5–2 h. The distillation was performed in pre-heated quartz tube (735–750 °C). The radioiodine was carried out with stream of air. The flow rate was set to 25 mL/min. Evaporated iodine was trapped in 0.01M NaOH. Time of separation was 15–20 min. Radionuclidic purity and activity of produced isotopes was measured with γ -ray spectrometry using HPGe detector, in all steps of production (irradiated target, target after distillation and solution of separated product). Since the protons'entrance energy was higher then treshold of the (p,2n) reaction, we also measured activity of the co-produced ¹²³I and ¹²⁴I in the target matrix after the separation of radioiodine was 2–3 times higher than in the target matrix after irradiation. In accordance to this effect, we also observed that ratio of decay-corrected activities of ¹²³I and ¹²³I and ¹²³I and ¹²⁴I in the solution of separated product was proportionally lower than the ratio in target.

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