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AN IODINE-123 GENERATOR/IODINATION KIT: A PRELIMINARY REPORT*

P. Richards, T. Prach, S. C. Srivastava and G. E. Meinken

Medical Department
Brookhaven National Laboratory
Upton, New York 11973

ABSTRACT

Preliminary results are described of a xenon-123 filled device to serve as a combination iodine-123 generator/iodination kit. Xenon-123 is produced in the Brookhaven Linac Isotope Producer (BLIP) by the reaction $^{127}I(p, 5n)^{123}Xe$. The device consists of a small glass ampoule containing an internal glass breakseal and a flanged neck on which is crimped a multi-injection type septum. The ampoule contains a hydrogen sulfide atmosphere to assure that the iodine generated from the decay of the xenon is in the form of iodide. Following an adequate period for xenon-123 to decay (this period can be used for shipment), a needle is forced through the septum breaking the seal and residual gases are pumped off. The iodine-123 in the form of iodide can then be rinsed from the ampoule with any desired solvent or reagent added directly to the device to carry out an iodination in an enclosed environment. Preliminary results of both iodine recovery and iodinations have been promising.

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The potential of iodine-123 was recognized as early as 1962 by Meyers and Anger[1] as a tracer in medical research and diagnostics. Excellent physical properties, including photon energy suitable for imaging and a half-life short enough for low radiation dosage while still adequate for iodination, make iodine-123 the most attractive of the radionuclides of iodine.[2] However, a number of factors has restricted the use of iodine-123, particularly in the U.S., but also elsewhere. These include the following:

1. The logistics of distribution due to the relatively short half-life.
2. Cost.
3. Radionuclidic purity, primarily contamination with other iodine isotopes.
4. Availability in a form and volumes suitable for iodination.

The cost, and to some extent the availability of iodine-123 is due to the fact that it is accelerator produced, generally in either cyclotrons or linear accelerators with their relatively high operating cost and maintenance problems. Cyclotron produced iodine-123 is usually obtained by the direct method - bombarding highly enriched tellurium targets to produce iodine. Major drawbacks in this method are contamination of the product with iodine-124 and the cost and recovery of enriched target materials. Iodine-123 is also produced by the decay of its precursor xenon-123. This normally involves the bombardment of iodine targets with protons to produce xenon-123 by the reaction (p,5n). Iodine-123 has been produced by this reaction in the BLIP

at Brookhaven,[3,4] Crocker Laboratory in California[5], and the TRIUMF at Vancouver[6] as well as several facilities in Europe. The purity of iodine-123 produced by this method is greater but the availability of accelerators with 65 MeV protons is limited.

This report describes preliminary work in the development of a combination iodine-123 generator/iodination kit. This device can improve but not eliminate the problems associated with distribution and the use of iodine-123, particularly for iodinations.

Xenon-123 is produced by bombarding sodium iodide targets with 65 MeV protons in the Brookhaven Linac Isotope Producer (BLIP). Several curies of xenon-123 are produced with a bombardment of two hours and at currents of 50 microamps. The target, 7.5 cm diameter by 0.75 cm thick, is made by pressing sodium iodide powder at 70 tons per square inch pressure. The pellet is contained in a welded inconel or stainless steel capsule containing a gas fitting for connecting to the processing equipment.

Following bombardment the target capsule is transported to the processing facility and attached to a gas train by means of the sealed gas fitting. A flow of helium is started through the system at a rate of approximately 25 cc per minute and 0.15 cc of xenon gas carrier is added. Carrier xenon greatly improves the collection efficiency of the radioxenon due to the relatively high vapor pressure of xenon at liquid nitrogen temperature. The seal in the gas fitting is then ruptured and the target capsule heated to approximately 750-800°C to melt the sodium iodide. Xenon diffusing out of the molten salt is

carried by the stream of helium through a cold trap at dry ice temperature to remove condensables and over a metallic silver mesh heated to 300°C to react any traces of directly produced iodine contamination. The xenon is then frozen on a stainless steel spiral at liquid nitrogen temperature.

The xenon-123 in the trap, contaminated with small quantities of xenon-125 and xenon-122, is cryogenically transferred to a special glass ampoule containing one atmosphere of H_2S, which is then isolated from the processing equipment by means of a valve. The xenon hydrogen sulfide gas mixture is allowed to warm up to room temperature and to expand and equilibrate into a series of similar gas ampoules. Following equilibration, the ampoules are valved off and removed from the cell for flame sealing prior to shipment or distribution. It has been reported by others that the hydrogen sulfide acts as an electron donor to form iodine-123 iodide and prevent the reaction of active iodine species with the glass.[7] It has been our experience that without the hydrogen sulfide it is impossible to rinse the iodine from the ampoule. With hydrogen sulfide present during the xenon-123 decay period, activity recoveries, with a single 0.3 ml wash with phosphate or bicarbonate buffer, of 60-70% and greater than 90% with a second rinse, have been obtained.

The iodination generator/iodination kit consists of a small glass ampoule containing an internal glass breakseal and a flanged neck on which is crimped a multi-injection type septum (see Figure 1). The device containing the xenon-123 is shipped to the user taking advantage

of decay time for delivery.[6,7] Following an adequate period for xenon-123 decay, a needle is forced through the septum breaking the breakseal and residual gases are pumped off by means of a vacuum pump. The longer the decay period, the higher is the iodine-125 contamination due to the decay of xenon-125 present in the mixture. A 2 hr decay yields a contamination of approximately 0.1 to 0.2% iodine-125, while an overnight decay results in about 1% iodine-125 contamination.

A series of iodination tests have been carried out using human serum albumin as a typical molecule both within the kit and with iodide rinsed from the ampoule. Iodination yields of 80-90% have consistently been achieved with either the chloramine-T method or with lacto-peroxidase beads with iodine-123 rinsed from the ampoule with a phosphate buffer. Labeling yields of 60% have been obtained by the addition of lacto-peroxidase beads to the ampoule, along with the proper reagents and mixing on a rotator; the lower yeilds are probably the result of inadequate mixing.

In summary, this work describes preliminary results obtained with a device which can serve as a source of iodine-123 in the users' institution. The decay period of xenon-123 can be used for shipment and the iodine-123 generated is predominantly in the form of iodide. Iodine may be rinsed from the ampoule with a small volume of any desired solvent or iodinations may be carried out directly in the enclosed atmosphere of the ampoule with iodine-123 iodide initially in an anhydrous form if desired.

REFERENCES

1. W. G. Myers, H. O. Anger, Radioiodine-123, J. Nucl. Med, 3 (1962) 183.

2. W. G. Myers; Radioisotopes of Iodine, in Radioactive Pharmaceuticals, USAEC Symp. Series 6 (1966) p. 217.

3. E. Lebowitz, M. W. Greene, P. Richards, On the Production of ^{123}I for Medical Use, Int. J. of App. Rad. and Isotopes, 22 (1971) 489.

4. P. Richards, E. Lebowitz, L. G. Stang, Jr., The Brookhaven Linac Isotope Producer (BLIP), New Development Radiopharmaceuticals and Labelled Compounds, Vol. I, IAEA, Vienna, 1973, 325.

5. M. A. Fusco, N. F. Peek, J. A. Jungerman, F. W. Zielinski, S. J. De Nardo, G. L. De Nardo, An Inexpensive New Method for the Cyclotron Production of ^{123}I, J. Nucl. Med., 13 (1972) 430.

6. R. T. Morrison, Tri University Meson Facility, Proceedings Conference Application ^{123}I in Nuclear Medicine, Rockville, Maryland, Report HEW (FDA) 76-8033 (1976) 80.

7. L. Lindner, J. A. Bul, F. M. Kaspersen, A. Schimmel, Carrier-free Iodide-^{123}I Generated from ^{123}Xe; Kit-Preparation and Quality Control, Int. J. of App. Rad. and Isotopes, 27 (1976) 653.