ISOTOPIC GENERATOR FOR ^{212}Pb AND ^{212}Bi

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A large potential exists for the use of short lived alpha emitting isotopes for therapeutic purposes. Most prior research has been performed with isotopes such as ^{211}At which require a cyclotron for production, it obviously would be more convenient to use a long lived isotopic generator system. For this reason, we have undertaken a study of the properties of several such generators, one of which is described here.

^{228}Th has a half life of 1.91 years and is present in natural thorium. The most salient features of its decay series are that the daughters include a short lived emanation (^{220}Rn, $t_{1/2}$ = 56 sec), and a longer lived lead (^{212}Pb, $t_{1/2}$ = 10.64 hrs) and bismuth (^{212}Bi, $t_{1/2}$ = 60.6 min) isotope. All decays of the lead and bismuth isotopes lead to alpha emission, either directly, or through their daughter, ^{212}Po ($t_{1/2}$ = 0.3 microseconds). Therefore, each millicurie of ^{228}Th has in equilibrium with it a millicurie of ^{212}Pb and of ^{212}Bi, both of which yield a millicurie of alpha radiation. When the various radiations are considered, one millicurie of ^{212}Pb (in a one cm^3 volume) will provide an integrated radiation dosage of 232,000 rads of high LET radiation and 24,000 rads of low LET radiation over its lifetime. Therefore, it is an intense source of radiation, with a (high LET/low LET) ratio of $\approx$ 10/1.

Our generator consists of a small (3 mm diameter, 5 mm high) column of sodium titanate on which the ^{228}Th and ^{224}Ra are absorbed. The absorption is quantitatively performed by allowing a solution of 2 ml of dilute HCl, pH = 6.0, containing the ^{228}Th and ^{224}Ra to pass through the column and then washing the column with 10 ml of pure water. The column output is connected to a reservoir containing 2 ml of H_2O and this is connected to a second, lower column which has a dual bed (5 mm in diameter, 2 cm high) of Biorad D-50 cation exchange resin followed by Dowex AG-1 anion exchange resin.

When water is allowed to flow through the upper column the ^{220}Rn (formed in the decay of ^{224}Ra) is eluted into the reservoir where it decays to form ^{212}Pb. The lead is absorbed on the lower column. After sufficient ^{212}Pb has been absorbed, the lower column is removed and the ^{212}Pb and ^{212}Bi are eluted from it into a collection vial. The lower column is first eluted with 2 ml of 2N HCl, which transfers the Pb and Bi to the anion resin as $PbCl_3^-$ and $BiCl_4^-$. The column is then eluted with 1.5 ml of water which elutes both the lead and bismuth into the receiving vial. If the second elution is performed with 6N HCl the lead and bismuth are readily separated from each other with the lead eluting first. When

the composite column is used, no detectable ^{228}Th or ^{224}Ra has been observed in the ^{212}Pb fraction (limit $<10^{-3}\%$). The yield of ^{212}Pb and ^{212}Bi at flow rates greater than 1 ml/min is about 85% as shown in Table I.

We have used several generators of this type, containing up to 1 mCi of ^{228}Th for the past year and have found no change in performance. They make a safe, useful, and dependable source for large quantities of these isotopes.

TABLE I. Yield of ^{212}Pb

Elution Rate ml/min	Yield %
0.05	3 ± 1
0.10	7 ± 2
0.20	29 ± 2
0.30	35 ± 6
0.50	53 ± 4
0.70	68 ± 2
1.00	80 ± 3
1.50	82 ± 3

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