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Labeling of Compounds using the Szilard-Chalmers Reaction

V.C. Anselmo⁽¹⁾
Department of Chemistry
New Mexico Highlands University
Las Vegas, New Mexico 87701

Abstract

A procedure is described for preparing labeled compounds from a Szilard-Chalmers reaction on another but related compound using no chemical synthesis.

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The Szilard-Chalmers reaction is useful for labeling of molecules for tracer studies and other radiochemical work. Among the criteria for success are a radioisotope with an adequate half-life; a parent nuclide with a reasonable cross-section; and relative freedom from extensive radiation damage as a result of the capture reaction. Of course some means of physical separation is required to achieve proper purity. The alternative to S-C labeling is radiosynthesis, a procedure that is tedious and expensive.

A procedure is suggested for labeling of a non-parent chemical entity that follows from the amount of work that has been done analyzing chemical systems following radiative-neutron capture reactions. Perhaps an illustration will be appropriate. A phosphate salt irradiated with thermal neutrons yields about 20% ^{32}P as hypophosphite(2) which may be cleanly and conveniently separated from the other chemical species by anion-exchange chromatography. This activity can be collected and concentrated by solvent extraction, chromatographic methods, or precipitation, with or without carriers. By choosing the proper salt for irradiation, and the length of time of the irradiation, a practical ^{32}P activity may be achieved.

To continue with the example, a comparison is made of the saturation activity obtained in the irradiation of a hypophosphite salt with the specific activity possible with this method. Using a neutron flux of 2×10^{12} neutrons per centimeter squared per second and 0.20 barns for the capture cross-section, the saturation

activity (say 10 half-lives or 140 days) for a millimole of hypophosphite salt is approximately 10 mc/mMole. (This calculation excludes the activity lost during purification). See references (3,4) for an explanation of the calculation. In comparison, a 14 day irradiation of one mole of a phosphate salt (assuming 20% of the activity is found as hypophosphite and 30% recovery of this activity) can give 1 curie per millimole hypophosphite added as carrier to the extracted hypophosphite fraction. This gives an added concentration factor of 100 which may be increased by adding less carrier.

There are other aspects to this procedure which are intriguing, such as the possibility of double labeling by adding a carrier with another labeled position, e.g., $^{22}\text{NaH}_2$ $^{32}\text{PO}_2$ and $\text{Na } ^{32}\text{PO}_3$ ($^{15}\text{NH}_2$).

In summary, a procedure is outlined for preparing high specific activity compounds based on the S-C reaction that does not involve synthesis nor irradiation of the parent compound. It is applicable to compounds where labeling with ^{32}P , ^{35}S , ^{36}Cl , and others, is desired.

References

- (1) This work was performed under contract At(11-1) 1618 with the U.S. Atomic Energy Commission. I also wish to thank J. Christian Romero who performed some extraction experiments.
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