Carbon-14 handling precautions

This document contains general information designed to provide a basic understanding of radiation safety. While we believe the information to be accurate, regulatory requirements may change and information contained herein is not tailored to individual needs. A radiation protection specialist should be consulted for specific applications.

Physical data

Maximum beta energy: 0.156 MeV (100%)[1]
Maximum range of beta in air: 22 cm (8.6 in)[2]

Occupational limits[3]

Annual limit on intake: 2 mCi (74 MBq)
Derived air concentration: 1 x 10^{-6} µCi/mL (37 kBq/m^3)

Dosimetry

Millicurie (37 MBq) quantities of ^{14}C do not present a significant external exposure hazard because the low-energy betas emitted barely penetrate the outer dead layer of skin. ^{14}C-labeled compound uptake may be assumed to be uniformly distributed throughout all organs and tissues in the body[4]. Most ^{14}C-labeled compounds are rapidly metabolized and the radionuclide is exhaled as $^{14}CO_2$. Some compounds and their metabolites are eliminated via the urine. Biological half lives vary from a few minutes to 40 days[4].

General handling precautions for Carbon-14

1. Designate area for handling ^{14}C and clearly label all containers.
2. Prohibit eating, drinking, smoking and mouth pipetting in room where ^{14}C is handled.

^{14}C
5730 y
ß– 0.156
No γ
E 0.156

3. Use transfer pipets, spill trays and absorbent coverings to confine contamination.
4. Handle potentially volatile compounds in ventilated enclosures.
5. If enhanced containment is necessary, handle volatile compounds in closed systems vented through suitable traps.
6. Sample exhausted effluent and room air by drawing a known volume through a membrane filter followed by an impinger containing dilute NaOH.
7. Wear disposable lab coats, wrist guards and gloves for secondary protection.
8. Select gloves appropriate for chemicals handled.
9. Maintain contamination and exposure control by regularly monitoring and promptly decontaminating gloves and surfaces.
10. Use pancake or end-window Geiger-Mueller detectors or liquid scintillation counter to detect ^{14}C.
11. Submit periodic urine and breath samples (as appropriate) for bioassay to determine uptake by personnel.

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Some ^{14}C-labeled compounds may penetrate gloves and skin. Handle these compounds remotely, wear two pairs of gloves and change the outer layer frequently. Special caution should be observed when handling ^{14}C-labeled halogenated acids. These compounds can be incorporated in the skin and deliver local dose commitments in the order of 10-100 rad per µCi (3-30 Gy per MBq) deposited.

References

1. Kocher, David C., Radioactive Decay Data Tables, Springfield: National Technical Information Service, 1981 DOE/TIC-11026.
2. Kaplan, Irving, Nuclear Physics, New York: Addison-Wesley, 1964.
3. U.S. Nuclear Regulatory Commission. 10 CFR 20 Appendix B – Standards for Protection Against Radiation, 1994.
4. ICRP Publication 30, Part 3, Limits for Intakes of Radionuclides by Workers. Pergamon Press, Oxford, 1981.

Revvity, Inc.
940 Winter Street
Waltham, MA 02451 USA
www.revvity.com

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